Proceedings of the Seminar on Advances in Fish Processing Technology in Southeast Asia in Relation to Quality Management

Singapore, 29 October - 1 November 1996

PROCEEDINGS OF THE SEMINAR ON THE ADVANCES IN FISH PROCESSING TECHNOLOGY IN SOUTHEAST ASIA IN RELATION TO QUALITY MANAGEMENT

Singapore, 29 October - 1 November 1996

Editors : Hooi Kok Kuang
Low Lai Kim
Lim Pang Yong

Organised by
Marine Fisheries Research Department
Southeast Asian Fisheries Development Center
in collaboration with
The Government of Japan

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

The Southeast Asian Fisheries Development Center is a technical organisation devoted to the accelerated development of fisheries in the region. The member countries of SEAFDEC are Japan, Brunei Darussalam, Malaysia, Philippines, Singapore, Thailand and Vietnam. SEAFDEC has four Departments, namely, the Aquaculture Department in the Philippines; the Training Department in Thailand; the Marine Fishery Resources Development and Management Department in Malaysia; and the Marine Fisheries Research Department in Singapore.

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WELCOME ADDRESS

by
Dr Maitree Duangsawasdi, Secretary-General, SEAFDEC

Dr Ngiam Tong Tau, Director - Primary Production Department & SEAFDEC Council Director for Singapore; Prof. Keishi Amano - Keynote Speaker; Mr K Kazuo Inoue, Chairman - Workshop on Compilation of Fish Products in Southeast Asia, Mr Tan Sen Min - Chief, SEAFDEC/MFRD and Dr Shiro Konagaya, Deputy Chief, Distinguished Speakers, ASEAN Country Representatives, Ladies and Gentlemen.

It is my honour and pleasure to welcome you to the MFRD 3rd Technical Seminar on Advances in Fish Processing Technology and also to the Workshop on the Compilation of Fish Products in Southeast Asia. I would also like to extend a special welcome to the participants from Brunei Darussalam and Vietnam. As new members of SEAFDEC your participation and contribution to the Seminar and Workshop is a strong indication of your country's commitment and enthusiasm in contributing towards the development of fisheries post-harvest technology in the ASEAN region. I would also like to thank Indonesia for participating in both the Seminar and Workshop and look forward to Indonesia's membership to SEAFDEC in the near future.

As a technical organisation, SEAFDEC plays a unique role in the development of fisheries in the ASEAN region. Over the years, SEAFDEC has become a strong organisation and the four Departments established in Thailand, Singapore, Philippines and Malaysia have gained international recognition as centres of excellence in their area of expertise.

With the expertise and experience acquired over the past 28 years, SEAFDEC now plays a major role in fisheries human resources development not only in the Southeast Asian region but also in the Asia-Pacific area. SEAFDEC can now look forward to the challenges ahead and explore how we can cooperate further with other regional and international organisations such as ASEAN, APEC, FAO and the Colombo Plan Bureau to complement each other's efforts in promoting the development of fisheries in this part of the world. In line with the current emphasis on the Technical Cooperation among Developing Countries Programs (TCDC), SEAFDEC has extended its cooperation beyond its members to provide technical assistance to third countries. All the SEAFDEC Departments provided training programmes for participants from less developed countries in collaboration with JICA under the Third Country Training Programs with the Colombo Plan Bureau and the Singapore Government. Since the establishment of SEAFDEC, more than 13,000 participants have been trained by the TD in Thailand, the MFRD in Singapore and the AQD in the Philippines. Recently the MFRD have also specially organised 3 training courses for Vietnam as a new member of SEAFDEC.

As you can see, SEAFDEC's success has been its ability to effectively transfer technology relevant to the growth and development of the fisheries. In addition, development programme to identify and adapt apprioriate technology for direct transfer to research institutes and government agencies in member countries have provided valuable feedback on the requirements and priority areas for research. The Workshop on the Compilation of Fish Products in Southeast Asia is therefore a valuable source of information to assist us in identifying important fish products in the regions and the problems associated with production, marketing, etc. The Seminar on Advances in Fish Processing Technology in Southeast Asia is also an important source of information on the status of the fish processing industry in ASEAN and the priority areas for development.

I would like to thank MFRD and their staff for hosting and organising this Workshop and Seminar, which will provide valuable discussion and recommendations for further development in fish processing technology specifically to quality management. All SEAFDEC Departments will get together this coming November in Phuket to formulate plan of operation of SEAFDEC which will include the activity in fish processing technology as well.

Lastly, I would like once again to thank you for your participation and contribution to this Seminar and Workshop and wish you success in your deliberations. Thank you.

OPENING ADDRESS

by
Dr Ngiam Tong Tau, Director, Primary Production Department and
SEAFDEC Council Director for Singapore

Dr Maitree Duangsawasdi, Secretary-General, SEAFDEC; Prof. K. Amano, Keynote Speaker; Mr K. Inoue, Chairman, Workshop on the Compilation of Fish Products in Southeast Asia; Distinguished Speakers, ASEAN Country Representatives; Ladies and Gentlemen.

Good morning and welcome to this MFRD Seminar on Advances in Fish Processing Technology and the Workshop on the Compilation of Fish Products in Southeast Asia. I would like also to extend a special welcome to the participants from Brunei Darussalam and Vietnam which are new members of SEAFDEC.

As this is the 3rd Seminar that MFRD has organised since it initiated its activities in fisheries post-harvest technology in 1980, I would like to share with you the genesis of the post-harvest technology programme in MFRD.

With the rapid increase in fisheries production and development in Southeast Asia in the late 1970's, SEAFDEC recognised the need to look into post-harvest problems in fisheries. At the request of the Singapore Government in 1976, the Government of Japan despatched a team of experts to SEAFDEC Member Countries to study the situation and to recommend a programme covering this aspect of fisheries development.

This team was led by Prof. Keishi Amano who was at that time the President of the Tokyo University of Fisheries. The survey team recognised the urgent need for the establishment of a programme in fisheries post-harvest technology to look into the utilisation of low-market value fish resources, and the handling and preservation of the catch in the Southeast Asian region. Since then, Dr Amano has played an active role in not only initiating the programme, but has also taken a personal interest in providing valuable technical advice and in identifying highly qualified Japanese experts for assignment in MFRD. He also took personal interest in the training and development of MFRD Counterpart staff and has arranged for their attachment to research institutes and fish processing establishments in Japan.

In recognition of his contributions to the activities of MFRD, but more importantly to the development of fisheries post-harvest technology in Southeast Asia, MFRD has implemented the Amano Award to be presented to the best research paper presented at the MFRD Seminars. I would like to take this opportunity to express our gratitude and thanks to Dr Amano for his contribution and dedicated interest in the development of MFRD.

The MFRD has over the last 16 years, developed a strong and comprehensive programme in fisheries post-harvest technology which has direct relevance and application to the fish processing industry in SEAFDEC Member Countries. To address the problem of utilisation of low-market value fish species and the trawl by-catch in the region, MFRD embarked on an intensive programme to introduce surimi technology to the region. As a result, Thailand now has 14 surimi factories exporting about 50,000 tonnes of surimi a year. Malaysia now has 7 surimi factories with a total production capacity of about 40 tonnes per day. In Singapore, the fish processors were taught how to use surimi as a raw material for the fish-ball / fish cake processing industry and now imports about 4,500 tonnes per year mainly from Thailand. Singapore factories now produce 50 tonnes of fish jelly products per day.

With the success of the surimi programme, the MFRD then embarked on the next phase of development which focused on product development, improved packaging and shelf life and mechanisation. Presently, many of the surimi manufacturers have gone downstream to produce imitation crab-sticks and a whole range of surimi-based products. MFRD has also recently introduced the concept of fish sausage and fish ham as examples of the range of products that can be made using surimi technology.

The success of the MFRD's programme in fisheries post-harvest technology is closely associated with the rapid transfer of technology to industry. This is achieved through MFRD's training and lecture-demonstration courses. Participants from industry and from member countries come to MFRD to learn technology first-hand. Over the years, the MFRD has successfully trained 1062 participants of whom 562 were from the industry.

With rapid growth and development of the fish processing industry in the ASEAN region, it is now of utmost importance to place greater emphasis on quality management. In 1992, in collaboration with MFRD, the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II was implemented. One of the specific objectives was to strengthen and upgrade fisheries products quality control and fish inspection services within the ASEAN countries.

Over the last few years, major importing countries like the USA, EU and Canada have implemented fish inspection programmes incorporating good manufacturing practices (GMP) and hazard analysis critical control point (HACCP) programmes. The theme for this MFRD Seminar this year therefore looks at advances in fish processing technology in relation to quality management. I am sure the sharing of our experiences at this seminar will provide the necessary impetus to further establish the GMP and HACCP programmes for fishery post-harvest processing factories in our respective countries.

The Workshop to be held this afternoon is the result of the survey and compilation of fishery products found in the Southeast Asian region. With the new participation of Vietnam in this survey, the Inventory is now more comprehensive and will continue to be a valuable reference on the great variety of fishery products unique to this region.

Over the next few days we will be hearing from the speakers, the ASEAN country representatives and research scientists speaking on the latest developments in fisheries post-harvest technology, quality management and the status of the fish processing industry in ASEAN. As in previous years this Seminar and Workshop serves as a perfect forum for us to discuss these developments and to highlight areas of priority for further research and development.

I wish you success in your discussions and now it is my pleasure to declare the MFRD Seminar and Workshop open. Thank you.

INTRODUCTION

SEAFDEC celebrated its 25th Anniversary in 1992. This is a milestone marking the coming to maturity of the organisation and its acceptance as the leading centre for fisheries research and development in Southeast Asia.

The Marine Fisheries Research Department of SEAFDEC has been conducting research in the development and packaging of processed fish products and in quality preservation and quality changes of fish and fish products. The Department networks with the other SEAFDEC Departments, tertiary educational institutions and other research institutions within and outside Southeast Asia.

As the fish processing industry becomes more sophisticated, emphasis is now placed on improving the quality of fish and fish products in the region. In addition, exports of fish and fish products from Southeast Asia has increased tremendously, and there is pressure for compliance with quality management principles by the processing industry. Thus the focus of this Seminar is on Advances in Fish Processing Technology in Southeast Asia in Relation to Quality Management.

The objectives of the Seminar are to review the status and provide an update of the fish processing industry in the region, to review the advances in fisheries post-harvest technology especially in the area of quality management and to discuss how to apply research results and development to upgrade the fish processing industry.

Workshop on Compilation of Fish Products in Southeast Asia
29 October 1996

The inventory of fish products in Southeast Asia identifies the fish products available in the region, the quality level of the products and the constraints in their marketing and promotion. The first inventory was compiled in 1985 and published in 1987 at the request of the Council Directors of SEAFDEC. The inventory was subsequently updated in 1989, resulting in the second edition published in 1991.

The MFRD has completed the third survey on the inventory of fish products in Southeast Asia. The information and data collected in 1995 and the outcome of the survey will be discussed at this Workshop on Compilation of Fish Products in Southeast Asia.

The objective of the Workshop is to allow country coordinators of participating countries to meet and discuss the results of the third survey and problems encountered during the compilation.

ACKNOWLEDGEMENT

SEAFDEC gratefully acknowledges the invaluable assistance of the following representatives who served as chairmen for the proceedings :

Dr K Amano, Mr K Inoue, Prof. Y Shimizu, Dr M Okada, Mr Len G Limpus, Dr Maitree Duangsawasdi, Mr Hooi Kok Kuang, Dr S Konagaya and Mr Tan Sen Min.

SEAFDEC also gratefully acknowledges the excellent work of the co-ordinator of the Seminar, Mr Tan Sen Min; the technical editor, Mr Hooi Kok Kuang; the technical co-ordinators/editors, Mrs Tan-Low Lai Kim and Mr Lim Pang Yong; the rapporteurs for the meeting, Ms VT Sulit, Mr Sarifudin Bin Sapari and Mr Yeap Soon Eong; and also the co-operation and dedicated effort of the Secretariat staff headed by Mrs Lim Su Ji; typing services , Mrs Lim-Ng Ah Gek; and the contribution of the Government of Japan.

KEY-NOTE ADDRESS

A Simple Way to Maintain the Fish Processing Industry

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Abstract

This paper emphasizes that efforts in the upgrading of the fish processing industry in Southeast Asia should be directed at each country's traditional fish products.

In the coming era, the increase in food production may not match the world's population growth. In this respect, the major challenge for the fish processing industry is the utilization of all fish caught.

Emphasis on development of new products might be one area of responsibility. However, this paper stresses the importance of traditional fish products of each country because these products have survived many decades without any assistance from government or perhaps even society. In other words, there must be some reason for their existence.

When fish technologists are able to help the traditional fish products industry, the industry will play a more powerful role in the future. This paper focuses on a simple and fast way of boosting the fish processing industry in the region by emphasizing on the upgrading of existing traditional fish products.

In my Keynote Address at the last Seminar in 1991, also hosted by MFRD in Singapore, I emphasized that the primary action for fish processing technologists and scientists is to enter the fish processing plants concerned and find out at ground level the subjects which the industry really needs. Since I am still the Keynote Speaker for this Seminar, I will possibly dwell on similar topics.

However, what I want to speak about will not be exactly the same as before. What I really want to emphasize is that you, as fish processing technologists, should identify precisely the fish product which has survived through the centuries while other products have changed.

In 1961, the FAO convened an International Seminar targeted at the fish processing industries in the world, including various parts of Southeast Asia, at Quezon City, Philippines. Dr Kreuzer from FAO, Dr Cutting from the United Kingdom and myself were involved as lecturers. At that time, a new product, fish sausage, was introduced in Japan and its production was increasing. This was attractive because of its cheap price compared with that of meat sausages. The reason for this cheaper fish sausage was due to the lower price of the raw material. Tuna fish was the raw material and the price of the fish was falling because of the possible radioactive contamination by nuclear fallout from the 1954 nuclear detonation at Bikini Atoll.

I was quite enthusiastic to speak about new product development and used the fish sausage as an example. Nobody commented on my speech then. Nearly forty years have passed since the FAO Seminar at Quezon City. However, the production of fish sausage in Japan has dropped to less than 50,000 tonnes per year. This fact, I presume, tells you how difficult it is to achieve any new sustainable product development.

Our world is fast changing and faces many difficulties ahead. Not only are we challenged with a population explosion problem, but we are also faced with the massive task of feeding our people. At this very moment, the total world population is 5.7 billion, of which 3 billion people are living in Southeast Asia. The population experts tell us that the total figure will reach more than 10 billion in the early part of the 21st century. The relation between food supply and population increase presents itself as a dilemma, which is very difficult to resolve.

Recently, some people introduced a word 'trilemma' because human beings are now faced with another problem, that is the destruction of our environment, caused largely by ourselves. Examples include atmospheric contamination by carbon dioxide emitted by the excessive use of fossil fuels, increase of desertification, and destruction of natural forests.

I do not wish to dwell too much on trilemma, but I would like to stress that our world is undergoing tremendous changes. As for fish processing, we should pay more attention to the traditional fish products of our countries. We should study why these products remain popular. I assume that these products have survived the many years because of the food habits and preferences in each country of Southeast Asia. Therefore, the people did not change their preferences for such traditional products but supported them.

Fish sauce such as *nuoc-nam* in Vietnam, *nam-pla* in Thailand, and *patis* in the Philippines are typical examples. The production of similar fermented fish products like fish paste or shrimp paste is still widespread in this area. Because of the relatively high air temperatures in this region, the distribution of fresh raw fish, molluscs or crustaceans faces difficulties due to the ever increasing price of ice or refrigerated systems. This might be one of the reasons hindering fresh fish distribution! Though I would like to commend MFRD for its excellent activities in fish preservation, which has demonstrated that raw tropical fish keeps better compared to those from temperate waters, the practice of boiling fish prior to distribution is still a mainstay in countries in this region such as Thailand. The people there have become accustomed to boiled fish. In other words, boiled fish has established their position in the people's diet. In addition, fish dried by sun drying is also quite common in this region. Some years ago, I observed good quality dried shrimp along the seaside of Malaysia. Minced products of shark, ray and snapper may be another type of traditional product in this region.

As for comminuted fish products, Dr Shimizu has discovered an excellent technology to remove the fishy smell by soaking raw fish balls. I must emphasise that the comminuted fish products developed in this region is the result of this excellent technology. Smoked fish or fish crackers may be other types of traditional products. Fish crackers, in particular, are very unique in this part of the world. Such sophisticated fish products are seldom seen in other parts of the world.

I do not wish to ignore the problems faced by these traditional products, many of which may not be solved easily. It may be necessary and feasible to establish a standardization for fish sauce as some producers might make secondary extraction from the same raw material. However, modernized production methods may not always be practical. Many years ago, when Vietnam was still under the French regime, certain scientists tried a rapid way to prepare *nuoc-mam* by using papaya which releases a powerful proteolytic enzyme. But no one picked up this quick fermentation method. Before pointing fingers at the conservative industry, we should consider the duration required to mature this product. Thus, this must be one of the subjects fish processing technologists should consider very carefully. The example quoted above is a typical example demonstrating that modern methods of processing are not always practical in the field. The question as to why products of traditional methods of processing are supported by the consumers and public may be a difficult one to answer, but technologists concerned should probe deeply into the subject.

According to the fish resources experts, it is difficult for the total world catch to increase to more than 10 million tonnes. Of this, 28% or a little more than quarter of the total world fish landing is for non-human use. (See Figs. 1 & 2) Efforts must be made to utilize this 28% for human consumption; if not now, we must do so in the future. In this context, the technology behind traditional fish products will begin to command a more important position.

Discussion

After his Key-note Address, Dr Amano encouraged MFRD to find ways and means to make the compilation of fish products in the region as comprehensive as possible and minimize the numerous "NA's" in the inventory and compilation. He commended MFRD for its efforts in sustaining the conduct of the inventory as well as the publication on Fish Products in Southeast Asia which reflects the status of fish and fishery products in the region.

Disposition of World Fish Production

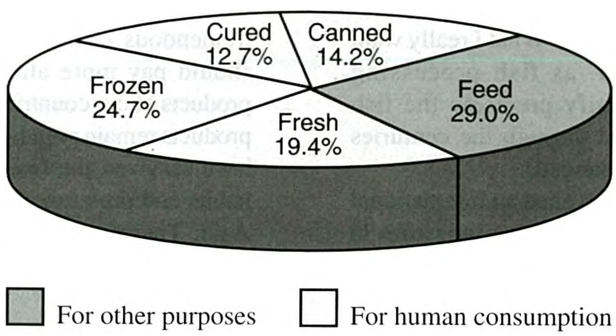

Fig 1. Percentage of world total fish production in live weight in 1983 (FAO/FIDI, 1995).

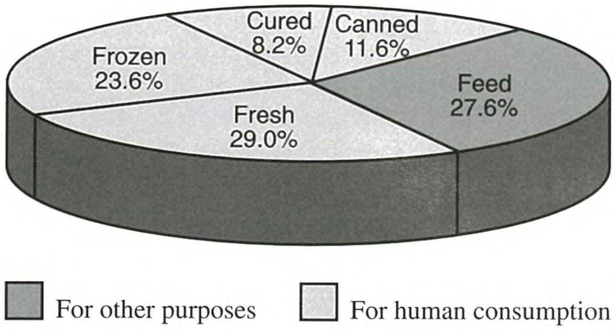

Fig 2. Percentage of world total fish production in live weight in 1993 (FAO/FIDI, 1995).

SPECIAL PAPERS

Four special papers were presented by invited specialists.
The text of these papers are reproduced.

Some Clever Techniques in the Processing of Traditional Fish Products

YUTAKA SHIMIZU
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Introduction

"New things, nice-looking things and convenient things are good". This seems to be the trend of the world today. However, I think food should be an exception to this trend, because food contains all the essential materials for building up our body and for keeping our health. There's no substitute for food. In this sense, I wish traditional food will be more highly commended for its merits. The essential characteristics of traditional food may be summarised by following three points:

1. Exhaustive utilization of materials

This means that each piece of raw material is processed as an undivided whole, and it results in not only nutritive and flavour-rich products but also with little waste.

2. Regional character

This results from the manner of processing, and the characteristics of the product are varied according to the climate and the native tastes in the region.

3. Clever processing

This is due to the ingenuity of our ancestors in selecting the most appropriate processing procedures.

Now, I would like to talk about the third point, that is the technical interest in traditional foods, by the following five examples of traditional fish products in Japan and Southeast Asia.

Clever Technique for Preserving *Umami* Taste (Good Flavour) of Dried Fish

In Japanese-style cooking, soup stock made from dried fish and dried *kombu* is usually used. The dried fish used for the stock is usually made from dark-meat fish, like anchovy, sardine, mackerel or bonito, and among these species anchovy and sardine are the most popular.

Now, for drying anchovy or sardine three kinds of drying methods have been carried out in Japan. One is "direct drying method" (drying without any previous treatment), the second is "drying after being boiled" and the third is "drying after being salted". But only one of those three methods has been applied to the fish for soup stock. The method of "drying after being salted" is of no use in this case, because the product is too salty.

Then, which of the other two methods is used? Anyone would think that the "direct drying" method must be used, because the method of "drying after being boiled" would result in a big loss of the water soluble components of *umami* taste of the meat during boiling. Actually, the "boiled and dried" anchovy and sardine have been used for soup stock since ancient times. There are two kinds of dried anchovy on your table. Please try to taste the difference between them.

The reason why the boiled and dried anchovy has a more intense *umami* taste than the directly dried one is explained as follows:

As is well known, the *umami* taste of fish meat is due to the *umami* multiplying effect of inosine mono-phosphate (IMP) and glutamic acid. When either disappears, the *umami* taste decreases to one-fifth or less of the original taste intensity. In the case of the directly dried anchovy, the IMP in the raw fish is gradually decomposed by phosphatase to inosine during and after drying and almost disappears by the time it is placed in the market. So, the directly dried anchovy has little *umami* taste, although the glutamic acid remains as it was.

On the other hand, in the case of the boiled-dried anchovy, some parts of IMP as well as glutamic acid are lost in water during boiling, but those remaining in the fish body do not decompose any more, because IMP-phophatase has been destroyed during boiling. So, the boiled-dried anchovy keeps an intense *umami* taste for ever. I think "drying after being boiled" is the technique "sacrificing a little to have a lot".

Triple Effects of Intermittent Dry-Roasting Method in *Katsuo-Bushi*

Let's suppose that there is a quarter split of a bonito 10 - 15 cm thick. Will it be possible to completely dry to 15% moisture? The answer should be "no". Even if the outer layer of the fillet could be successfully dried, the inner part must remain as it was by any modern drying machine.

However, a very clever technique for drying such a big fillet has been handed down from our ancestors in Japan. It is the "intermittent dry-roasting" treatment in the processing of dried bonito and it is shown in Fig. 1.

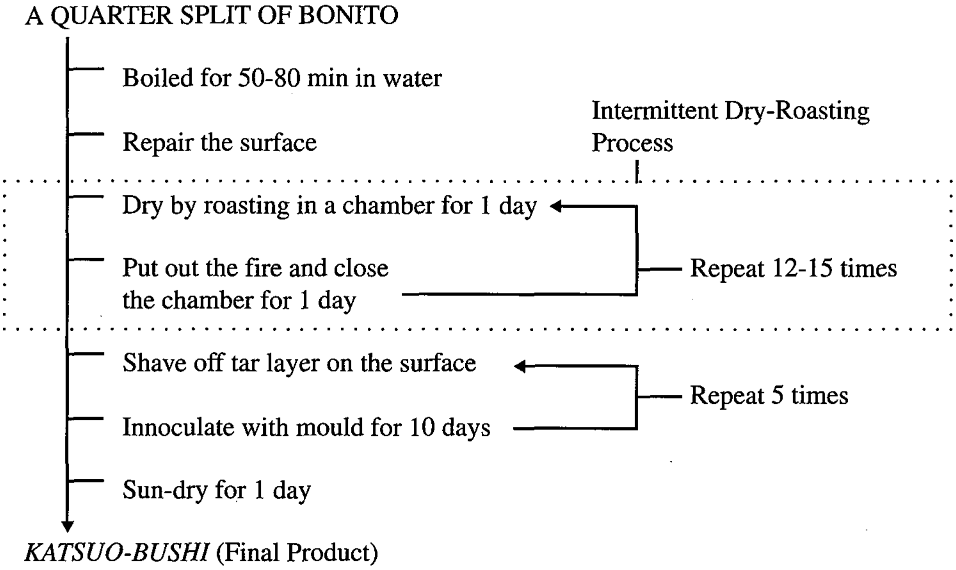

Fig 1. Procedure for Drying Bonito Fillet to make *Katsuo-bushi.*

The fillet is first boiled in water for about 60 min. After the surface cracked during boiling is repaired, the fillet is placed on a rack side by side and roasted over burning wood in a drying chamber.

During initial roasting, the surface of the fillet dries up to make a skin, and the evaporation is then completely interrupted. The fire is put out and the drying chamber is tightly closed up, leaving the fillet inside. During keeping for one day, the moisture is evenly distributed in the fillet by diffusion of the water from the inside to the surface. Then, the chamber is opened and the fire is started again. As the roasting process and the breaking-off process are repeated about fifteen times, the fillet is dehydrated little by little and finally dries up to a deep black bonito stick of 16-17% moisture. After the tar layer on the surface is scrapped off, the stick is further dried down to 15% moisture by repeating an alternating moulding process and a sun-drying process. The dried bonito thus produced is called *katsuo-bushi.*

This intermittent dry-roasting method, which made it possible to completely dry such a big bonito fillet, is known to give two more wonderful effects to the finished product. One is a smell improving effect. Fishy smell is replaced with a nice smell characteristic of dried bonito. The other one is an oxidation-preventing effect to the lipids in the fillet. Both effects are known to be due to the smoke components, especially phenol derivatives which permeated into the fillet.

From these wonderful merits, the intermittent dry-roasting method is considered to be the technique of "killing three birds with one stone".

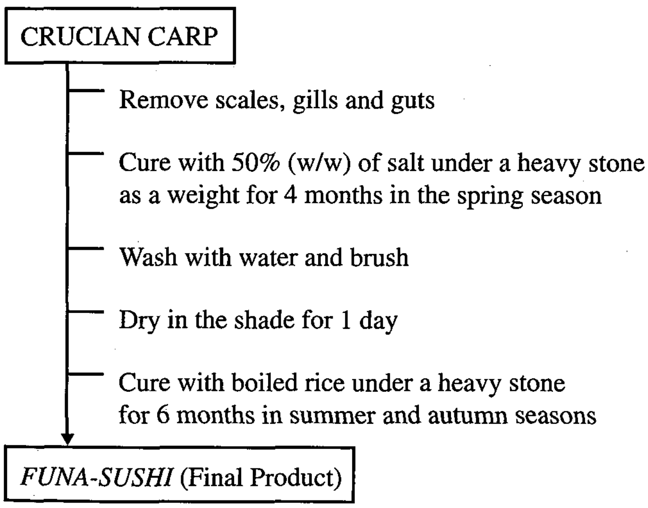

Fig 2. Procedure for Making *Funa-sushi*, fermented *sushi* with Crucian Carp.

Method for Desalting Fish by Using Boiled Rice

When fish are preserved by salting during the hot summer season in Japan, 30-50% (at least 30%) of salt should be added to prevent spoilage. Such a salted fish is then too salty to eat. So it is necessary to desalt the fish. But when soaked in water, the fish body absorbs water and simultaneously loses its good flavour.

The ancient people devised a clever method for desalting by using boiled rice. The method has been applied to crucian carp around Lake Biwa since the 8th century. The product is called *funa* (crucian carp)-*sushi*, or fermented *sushi* of crucian carp. The procedure is shown in Fig. 2.

Crucian carp are first removed of their scales, gills and viscera, leaving the ovary only and cured in a bucket with 50% salt by weight of fish, weighted down by a stone for 4 months from March to July. In the beginning of summer when the temperature suddenly raises to 30°C or more, the salted fish is taken out from the bucket, washed with running water, dried in the shadow for one day and then cooked rice is stuffed into its gill cleft and abdominal cavity. Then, the rice-filled fish are put back into the bucket, with cooked rice in layers between the fish. The fish are covered with a lid and a heavy stone is put on top as a weight.

While curing with cooked rice, salt in the fish body gradually diffuses in the rice and its concentration ultimately goes down to 2%. Simultaneously, the boiled rice ferments and produces organic acids, most of which is lactic acid. The acids permeate the fish body and lowers the pH to 4-5. Due to the simultaneous exchanges of salt and acids between the fish body and the boiled rice, the shelf-life of the fish can be maintained in spite of the lowered salt concentration. Changes in the chemical components of crucian carp meat before and during curing are shown in Table 1. After curing with boiled rice for more than five months, the fish becomes good

Table 1. Changes in the Composition of Crucian Carp Meat in the Curing Process of *Funa-Sushi* (%).

	Raw Fish (June 1)	After Cured with Salt for 50 days (July 20)	After Cured with Boiled Rice for 107 days (November 4)
Moisture	80.45	53.31	63.89
Total Nitrogen	2.04	4.56	4.01
Crude Protein	16.49	28.48	25.09
Crude Fat	1.70	3.78	4.50
Ash	1.27	14.31	4.53
NaCl	-	11.34	2.27
Total Acid	0.0123	0.0407	1.48
Latic Acid	0.008	0.025	1.10

According to Kuroda (1972)

to eat together with skin and bone.

This clever desalting technique was devised in the olden times when rice vinegar had not yet been produced.

Method of Drying Fish in Sauce

Drying and salting are two major techniques for preserving fish since ancient times. Both are based on the principle that the growth of micro-organisms is repressed by lowering water activity.

The third method based on the same principle was devised for preserving small-sized fish in a fishing village in Japan about 300 years ago. The method is very simple. Fish are only boiled down with a sauce. Table 2 shows an example of the composition of the sauce: soy sauce, Japanese rice wine, Japanese cooking rice wine, sugar and some spices are mixed together.

Table 2. An Example of the Sauce for *Tsukuda-ni* of Sand Eel.

(To 2 kg Sand Eel)

Shoyu, Soy Sauce	450 ml
Sake, Japanese Rice Wine	100 ml
Mirin, Japanese Cooking Rice Wine	100 ml
Sugar	450 g
Thick Malt Syrup	60 g
Race Ginger cut into fine stripes	150 g

While boiling down, germs are killed and water in the fish body is drawn out into the sauce by osmotic action, and salt, sugar and other hydrophilic substances in the sauce simultaneously permeate the fish body. As a result, the raw fish becomes dried and the water activity of the system drops to 0.6-0.7. The finished product can be at room temperature even in the summer season in Japan.

This simple and clever technique for drying fish in sauce has many advantages, including

(1) No need for space.
(2) The process is not influenced by the weather.
(3) Large-scale equipment is not necessary. Only a pot or pan is needed.
(4) Products are delicious and eatable as they are.

The finished product is called *tsukuda-ni* after the name of the fishing village, where this method was invented.

Special Leaching Technique in *Yu-Wan*, Chinese-Style Fish Balls

Two kinds of fish jelly products are being produced in Asia. One is *kamaboko* in Japan, and the other is *yu-wan*, so called fish balls in south China and Southeast Asian countries. Both are practically the same in respect of the processing principle and the texture of the products, but somewhat different from each other in their processing.

Fig. 3 shows the processes for making *kamaboko* and *yu-wan*. In the case of *kamaboko*, chopped fish meat, that is the raw material, is first leached with 3-5 times the volume of water several times, and then the leached meat is ground with about 2% salt to make meat sol. In the case of *yu-wan* the chopped meat is first of all ground with salt and the meat sol produced is immediately shaped into balls and then soaked in water.

The leaching process in *kamaboko* is done to remove fish smell as well as meat colour. For fish as food material, its fishy smell is the weakest point together with its rapid post-mortem deterioration. So, the idea that the smell should be removed from the raw meat before grinding with salt seems to be quite natural.

In contrast to that, the soaking treatment in *yu-wan* is primarily a device for keeping raw fish balls from sticking together. But I think this process undoubtedly functions as a means of leaching for raw fish balls. The idea that the fishy smell and the meat colour should be removed not from the raw meat but from the meat sol is really unique and wonderful, because this idea makes it possible to produce fish gel of good quality without using iced water even in the tropics.

If there was no ice, we cannot make *kamaboko* in such a hot climate, because myosin in the chopped meat would have been considerably denatured by heat during the leaching and dewatering processes. In the case of *yu-wan*, myosin has already been solubilized to a sticky sol prior to denaturation. After having been formed into balls and put in water, *yu-wan* of good quality are ours.

After all, *yu-wan* could be produced without ice even in the open air in the tropics. I think *yu-wan* is produced by such a clever leaching process similar to raw fish balls. It seems quite natural that it is considered to have been born in the hot Fuchou district, Fujian, south China.

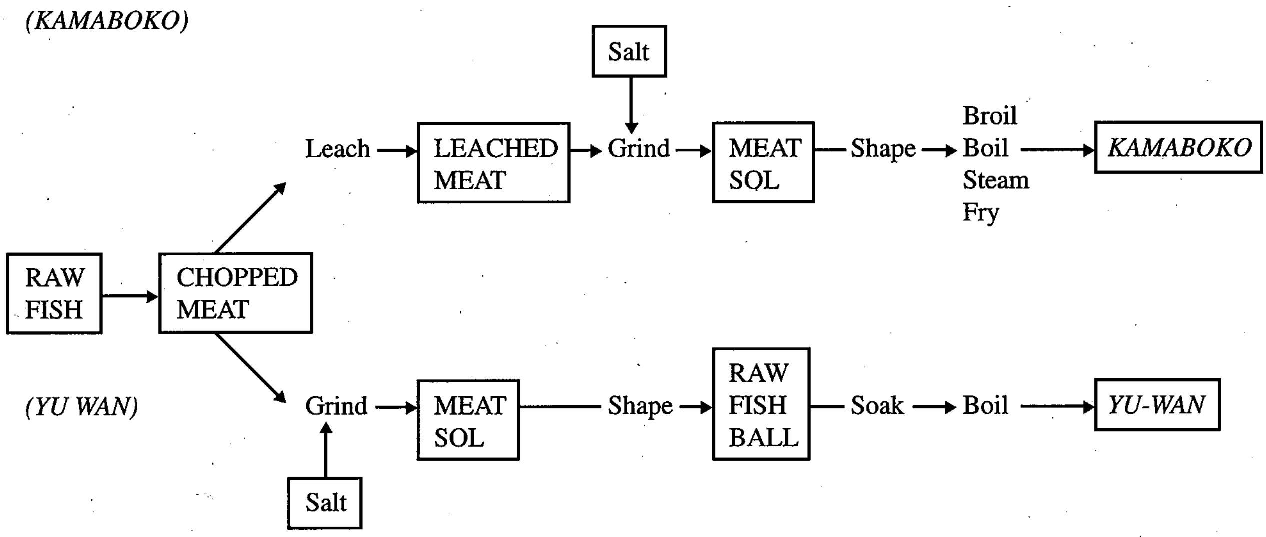

Fig. 3. Procedures for Making *Kamaboko* and *Yu-wan*.

Conclusion

Most traditional foods were made by the natives, in a specified district or a country, according to the available food sources and the climate conditions. Therefore, those foods prove their merits only in their native region and cannot be easily transferred to other regions with a different climate.

I hope that various kinds of traditional fish products from Southeast Asian countries will be taken up more often as the subject of your research work, and that the fruits of your work will be used not only for the quality improvement of the product concerned, but also for the development of new fish-utilizing technology in the region.

World Trend in Surimi Processing with Respect to New Technology and Quality Contol

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Abstract

1. Internationalization and Diversification of Surimi Industry

It is estimated that the world's surimi production in 1994 was 512,000 tonnes. Japan was the biggest surimi producer in the middle of 80's, but the surimi production of Japan decreased to 132,000 tonnes in 1994. The USA started the commercial production of frozen surimi in Alaska in 1985 and became the biggest surimi producer in the world with 209,000 tonnes in 1994.

Thailand started surimi production in 1978 and has increased its production to 65,000 tonnes in 1994. The success of the Thai surimi industry stimulated development of surimi production in other countries in the region.

With an increase in the number of countries producing surimi, the fish species used for frozen surimi has been diversified. Of about 500,000 tonnes of frozen surimi in the world, the share of Alaska pollock surimi was 60% in 1994. The share of surimi from other fish such as whiting, threadfin bream, etc., has been increasing over the years.

2. Intrinsic Quality of Frozen Surimi

Stability of the meat proteins (especially of myofibrillar proteins) against heat and frozen storage is species dependent. Protein stability of cold water species is much poorer than of temperate/tropical water species. The stability or the rate of denaturation of myofibrillar proteins is closely related to the temperature of the water in which the fish lives. Strict temperature control is required for surimi of Alaska pollock and other cold water species.

3. Internationalization of Surimi-Based Products

The world production of surimi-based products in 1993 was estimated at 1,090,000 tonnes. The biggest kamaboko producer is Japan, followed by Korea, USA, Taiwan and Thailand. The production of imitation crab and seafood analogs began in the middle of the 70's and are now manufactured throughout the world.

4. Recent Trend of Kamaboko Products in Japan

Japanese consumers now prefer softer textured foods than previously and pay more attention to healthy foods. Some of the successful soft textured products are made by incorporating isolated soy protein into surimi-based products.

5. New Surimi-Based Product Technology

Vacuum grinding mixers have been introduced more and more into kamaboko processing plants in Japan.

Imitation crab meat, scallop or squid with fine texture and juiciness as compared to conventional products are now produced by twin-screw extrusion cooking. Ohmic cooking, or Joule cooking, with heat generated by flowing electric current through the foods is becoming popular in the kamaboko industry.

Proteinase inhibitors such as blood plasma are used for Pacific whiting surimi infected by Myxosporidian parasites.

Internationalization and Diversification of the Surimi Industry

1. Internationalization of frozen surimi production

It is estimated that in 1995, 506,000 tonnes of frozen surimi was produced in 1995 worldwide. Commercial frozen surimi production was started by a few Hokkaido shore plants in Japan in 1960. Since the frozen surimi production on Japanese factory boats started in the USA waters in 1965, Alaska pollock surimi had made tremendous growth with more than 500,000 tonnes produced in the middle of the 1970's. In those years, Japan was the only surimi producer in the world and most frozen surimi was made from Alaska pollock. The Japanese surimi production, however, has been decreasing over the last 10 years and production in 1994 was 132,000 tonnes.

The USA started commercial production of frozen surimi in Alaska in 1985. Since the shutting out of foreign surimi factory fleets from USA waters in 1990, more than 20 surimi factory boats and about 10 shore plants were producing frozen surimi from Alaska pollock and Pacific whiting. USA became the biggest surimi manufacturer in the world, with production exceeding 200,000 tonnes of surimi in 1994.

Korea started Alaska pollock surimi production in the mid 1970's on factory trawlers. With the American policy of shutting out foreign fishery boats from their 200 miles EEZ, the Japanese and Korean surimi factory fleets had to stop their operations in US waters. They moved to the southern hemisphere waters, first to New Zealand and then to Argentine waters. Korea produced 36,000 tonnes of frozen surimi in 1994.

Both these southern hemisphere countries have produced frozen surimi from *hoki* and southern blue whiting in joint ventures. Argentina is now one of the big surimi producers with production of 26,000 tonnes of frozen surimi in 1994.

The success of the Thai surimi industry stimulated developments of surimi production in the other South East Asian countries such as Hongkong, China, Malaysia, Myanmar, Vietnam, India and Indonesia, etc.

Chile started horse mackerel surimi production in a few shore plants in the early 90's and produced 5,000 tonnes of surimi in 1994.

Besides the countries mentioned above, frozen surimi is produced commercially in Russia, Mexico, Venezuela, France, etc. and many other countries are interested in the frozen surimi industry to use efficiently use their unused or underutilized species as human foods. This is shown in Table 1.

Table 1. Surimi production by country in 1994 (tonnes).

Country	Output (tonnes)	Country	Output (tonnes)
Japan	132,000	Malaysia	3,000
USA	209,000	Indonesia	500
Korea	36,000	India	1,000
Thailand	65,000	Hongkong	5,000
Argentine	26,000	Vietnam	1,000
Russia	17,000	Myanmar	1,000
China	10,000	Chile	4,500
Sub-total	495,000	Sub-toal	16,000
Total	512,000		

2. Diversification of Raw Material Fish

The surimi manufactured from temperate and tropical water species such as threadfin bream and croaker are quite different from that manufactured from fish of high latitude waters such as Alaska pollock and Southern blue whiting. As the fish caught for surimi in the high latitude waters consists of one species of almost the same-sized fish and the manufacturing lot is as big as 100 tonnes, it is common to install large scale, highly mechanized processing lines in frozen surimi plants.

On the contrary, in temperate/tropical waters, the catch consists of fish of a variety of species as well as size. As the catch must be separated by hand according to species, size, and freshness of fish before processing, the manufacturing lots become very small, usually 1 to 5 tonnes. Further, fish of various shapes and sizes and in small quantities make it very difficult to introduce highly mechanized processing systems in the manufacture of surimi.

With an increase in the number of countries producing surimi, the fish species used for frozen surimi has diversified. Alaska pollock, however, is even now the staple raw material for frozen surimi. Of about 500,000 tonnes of frozen surimi in the world, the share of Alaska pollock surimi was 88% and 60% in 1983 and 1994 respectively. Meanwhile, the share of other fish surimi has been increasing during these years. This is shown in Table 2.

Table 2. Surimi production by species in 1994 (tonnes)

Country	Output (tonnes)
Tropical water species	107,000
Southern blue whiting	36,000
Pacific whiting	38,000
Cold water species	31,000
Alaska pollock	300,000
Total	512,000

3. International Trade in Frozen Surimi

Japan supplied the raw material for its own surimi-based products until 1975, but since then, it became an importer of frozen surimi and its imports of frozen surimi has increased dramatically. Thus, Japanese consumption of frozen surimi was 454,000 tonnes and 382,000 tonnes in 1988 and 1993, of which 37% and 67% were imported respectively.

The surimi imported into Japan is diversified in species. The share of Alaska pollock surimi was 60% in 1994 and that of other species has been increasing. As the number of countries manufacturing surimi-based products increases, the international trade of frozen surimi has been carried out among the other countries as well, eg., from the USA to Korea, Taiwan and Europe, from Thailand to Singapore and Korea, etc.

Intrinsic Quality of Frozen Surimi

1. Cold Water Species

Frozen surimi of Alaska pollock and other cold water species were recently introduced into Singapore and other Southeast Asian countries as a result of the growth of international trade. Manufacturers in these tropical countries are unfamiliar with the intrinsic qualities of Alaska pollock surimi and have encountered problems in dealing with this "new" surimi. They should first understand the intrinsic qualities of the surimi and learn how to use it properly.

Stability of the meat proteins, especially the myofibrillar proteins, against heat and frozen storage is species dependent. The protein stability of cold water fish species is much poorer than that of temperate/tropical water species. Myofibrillar proteins of land animals are more stable than that of fish. The stability or the rate of denaturation of myofibrillar proteins is closely related to the body temperature or the temperature of the water in which the fish lives.

For example, Alaska pollock loses the gel-forming ability very rapidly when it is stored in the frozen state; the meat proteins denature completely and cannot be used as raw material for frozen surimi after 3 months storage at -25°C. When the meat temperature of Alaska pollock rises above 15°C during the surimi manufacturing process, its jelly-forming capacity decreases significantly. If the temperature of the meat after grinding with salt rises above 15°C, the texture of the surimi-based products of Alaska pollock becomes fragile and poor, while that of threadfin bream is good even when the meat temperature rises above 15°C. The critical temperature for threadfin bream might be 23 - 25°C. (See Fig. 1)

Suwari, or pre-incubation of the ground surimi paste at low temperature, is widely practised in the commercial production of surimi-based products to enhance their texture. The Alaska pollock meat paste after grinding with salt sets very rapidly when the meat temperature raises above 20°C and then becomes very difficult to shape. Very poor texture might result when the meat paste of Alaska pollock is set at 40°C, the optimum *suwari* temperature for tropical water species surimi. The favourite conditions used in Japan for *suwari* to increase the jelly-strength of surimi-based products of Alaska pollock are 5°C overnight, or 30°C, for 20 - 30 minutes.

In summary, strict temperature control is required for Alaska pollock and other cold water species as follows :

1. Frozen surimi should be stored below -20°C.
2. The meat temperature during grinding with salt should be kept below 15°C.
3. The meat paste should be shaped as soon as possible after grinding with salt.
4. Setting treatment should be carried out at low temperature.

2. Jelly Meat

Some fish species such as Peruvian hake, Australian barracuda and Pacific yellowfin tuna are often infested with micro-parasites, *Myxospordian* spp., which secrete enzymes with very strong proteolytic activity.

Pacific whiting has recently become an important raw material for frozen surimi on the American Pacific coast. Pacific whiting, however, suffers from a serious problem of meat softening by the parasites' enzymes. The washing treatment of minced meat cannot remove all the proteolytic enzymes from the minced meat resulting in its poor gel-forming capability.

Blood plasma having very strong protease-inhibiting activity was found to improve the gel-forming capability of Pacific whiting surimi. By adding this ingredient, frozen surimi of good quality is manufactured successfully from Pacific whiting.

When a new species of fish is explored as raw material for frozen surimi, a careful preliminary study of *Myxosporidian* parasitic infestation is necessary.

3. Small Pelagic Fish

Small pelagic fish such as sardine and horse mackerel are very difficult to use as raw material of frozen surimi. The meat pH of these fish is as low as below 6 and myofibrillar proteins are likely to suffer from acid denaturation. Besides, the meat color is dark and the meat contains a large amount of fat and water soluble components which reduce the gel-forming capability; they also develop strong fish odor.

In the late 80's, technologies for manufacturing frozen surimi from small pelagic fish such as sardine were developed in Japan.

The points the technology studied were:

1. minimization of acid denaturation of myofibrillar proteins,
2. effective removal of fat and water-soluble meat components, and
3. development of hardware such as fish processing machines, meat bleaching facilities, continuous de-watering machines, etc.

After further pulverizing minced meat to the myofibril level, it is bleached with alkaline brine. Lactic acid formed by the post-mortem glycolysis reaction is removed and neutralized efficiently. Water soluble components such as sarcoplasmic protein, myoglobin and extractives are washed out rapidly. Fat is removed by continuous centrifuging. The surimi thus obtained is colored only lightly, has excellent gel-forming ability, contains low level of fat (approx. 1%), and has little fishy odor.

Small pelagic fish in tropical waters generally have higher pH value than fish in Japanese waters. Their meat proteins therefore present us with less problems of acid denaturation. Therefore, the tropical small pelagic fish might be more easily utilized as surimi raw material, though their dark color remains a problem.

Internationalization of Surimi-Based Products

1. World Production of Surimi-Based Products

World production of surimi-based products in 1993 was estimated at 1,090,000 tonnes. The biggest *kamaboko* producer is Japan, followed by Korea, USA, Taiwan and Thailand.

The Japanese production level of one million tonnes of surimi-based products had gradually continued to decline since 1974, and a further sharp depression was noted in 1991/92. *Kamaboko* production was down 4.5% and 7.5%, respectively, as compared to that of 1990. The big decrease was primarily due to the dramatic rise in the surimi price. The price of frozen surimi more than doubled that of the previous year. Though the *kamaboko* producers tried hard to stabilise the market, the decreasing tendency in 1994 continued to the present and the production was 823,000 tonnes.

Table 3. Production of surimi-based products in the world in 1993 (tonnes).

Country	Output (tonnes)
Japan	830,000
Korea	120,000
USA	60,000
Taiwan	60,000
Thailand	20,000
Singapore	6,000
Total	1,096,000

The same type of products as the Japanese traditional *kamaboko* are produced in Korea and Taiwan. Southeast Asian countries produce "fish ball" from minced fish and also recently from frozen surimi for the domestic market.

The production of imitation crab sticks and seafood analogs began in the middle of the 70s and are now manufactured throughout the world. The major producers are Japan, USA, Korea and Taiwan; Thailand and Malaysia are new producers. Besides these countries, imitation crab sticks and seafood analogs are manufactured in Canada, Argentina, Russia, Scotland, France, China, Singapore, Israel, Australia, and other countries.

The Minato News newspaper recently predicted a big growth in the production of surimi-based products in China. The estimated demand for frozen surimi for China in the year 2000 is 100,000 tonnes, while the demand in 1995 was only 1,000 tonnes.

2. International Trade in Surimi-Based Products

Japanese imports of prepared fish products containing more than 20% fish meat, most of which are imitation crab sticks from the USA, have increased recently although the quantities are small. Besides seafood analogs, import of deep fat-fried *kamaboko* from Thailand and China have also increased in these few years.

Export of imitation crab sticks and seafood analogs from Japan to the USA and Europe peaked in 1985 with a record of 39,000 tonnes, but has since declined because both the USA and Europe have their own manufacturers and also because of stiff competition with other new producing countries. Thailand and Malaysia are developing their imitation crab sticks industries and are exporting their products to Europe, USA, Korea and other countries.

Recent Trends Of *Kamaboko* Products

The Japanese *kamaboko* manufacturers have been trying to maintain or expand their market by developing new products to fit in with consumer trends. Generally speaking, consumers, especially the young ones, prefer softer textured foods than previously and pay more attention to healthy foods.

Some of the successful soft-textured products are made by incorporating isolated soy protein into surimi-based products. Incorporation of isolated soy protein gives many advantages: healthy and natural image, reduction in production cost, improvement in qualities such as soft texture, white color and light flavour, etc..

Addition of up to 50% shredded vegetables to the surimi-based products gives the consumers an impression that the products are healthy and natural. Mashed carrot and pumpkin paste, which contain plenty of b-carotene, are used as colorants to give a healthy and natural image to a variety of surimi-based products. To make products with a healthy image, many *kamaboko* manufacturers are interested in adding dietary fiber rich *konyaku mannan*, calcium-enriched ingredients, DHA and EPA, etc.

In Thailand, dried surimi products are

becoming popular recently. Surimi paste is shaped into a thin belt, cooked on a big drum, dried and puffed and then shredded. Many varieties of the product with various flavours are on the market. A very sophisticated surimi-based product, imitation baby eel, is on the market in Spain.

New Trends of Surimi-Based Product Technology

1. Vacuum/Non-Thawing Grinding

Vacuum grinding mixers have been introduced more and more into *kamaboko* processing plants in Japan. The final products made by the vacuum mixers are of excellent quality with more smooth, flexible and homogeneous texture as compared to those made by the conventional silent cutters. The improvement to the *kamaboko* texture by the vacuum mixer might be due to the "no thawing grinding"; salt and other ingredients are added to the surimi in its frozen state at the beginning of grinding and mixing. The improvement to the texture of *kamaboko* by the "no thawing grinding" method could be expected for any *kamaboko* manufacturer switching from the method using the conventional silent cutter. Some of the other benefits of using a vacuum mixer are savings in both time and labour for grinding and mixing. More water can also be added to the surimi without lowering the quality of the *kamaboko*.

2. Extrusion Cooking

Imitation crab meat, scallop or squid with much more fine texture and juiciness than the conventional products are produced by twin-screw extrusion cooking. High temperature and high pressure during extrusion cooking alters the protein components of the original surimi and results in a new type of texture for seafood analogs.

3. Ohmic Cooking

Ohmic cooking or Joule cooking with heat generated by flowing an electric current through the foods is becoming popular in the *kamaboko* industry. The fish paste can be heat-processed in a short time with excellent energy efficiency. In addition, the fish paste is cooked uniformly regardless of its size. As the *modori* phenomena, the enzymic degradation of the gel network structure at 60-70°C is minimized by quick Joule heating, *kamaboko* with higher gel strength can be obtained as compared to conventional cooking methods from lower grade surimi. Various Ohmic heating facilities are used for the production of traditional surimi-based products such as *kamaboko* and *chikuwa* and also new products such as imitation crab sticks.

4. Blood Plasma

Proteinase inhibitors such as blood plasma are recently used for the production of frozen surimi of Pacific whiting, which is often infected by *Myxosporidian* parasites.

These protease inhibitors are also effective in preventing "modori" due to gel structure degradation during cooking at 60-70°C and improve the texture of the surimi-based products.

5. Transglutaminase

Suwari, a pre-incubation of the ground surimi paste at low temperature, is widely applied in the commercial production of surimi-based products to enhance their texture. It is recently known that *suwari* is in part related to the transglutaminase activity of fish meat. Transglutaminase, TGase, crosslinks a glutamine residue in a polypeptide chain and a lysine residue in another polypeptide of protein. As the cross-linkage reaction strengthens the network structure of fish meat proteins, *suwari* phenomenon proceeds.

As the bacterial-origin TGase preparation is recently available in the market, many *kamaboko* manufacturers are adding the enzyme to their products. The TGase preparation increases both the breaking strength and the breaking strain of the *kamaboko*, though the enhancing effect varies among surimi made from different species. The combined treatment of TGase addition and *suwari* is very effective for improving the quality of *kamaboko*.

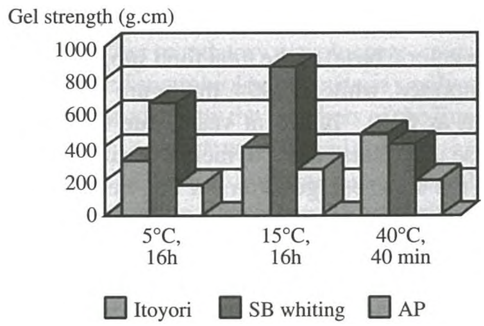

Fig. 1. Effect of *suwari* temperature on gel strength of meat from threadfin bream (*itoyori*), southern blue whiting (SB whiting), and Alaska pollock (AP).

Present Status and Perspective on the Implementation of HACCP in Japanese Fish Processing Industries

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Paper read by Mr Yeap Soon Eong

Abstract

The HACCP philosophy is gaining momentum with industry and regulators alike as the best approach to assuring the highest degree of food safety. This is exemplified by the numerous publications and courses on this subject in recent years as well as examples of successful application by industry and the efforts of committees such as the NACMCF. The HACCP philosophy is also gaining worldwide acceptance, as shown by the recent activities of the Codex Alimentarius Commission's Food Hygiene Committee.

HACCP is a common-sense philosophy that can be applied to food systems ranging from the simple to the complex. Applying the principles as described in this paper demonstrates that the process, while requiring careful thought, is not unattainable. Joining HACCP with another related management philosophy which is growing in popularity - Total Quality Management (TQM) - can provide a formidable combination for competitive advantage.

Recently, owing to the shortage of labor, a high Yen exchange rate and the diversification of consumer's needs, the industrial structure of Japan has markedly changed, resulting in a rapid expansion of import of foods and raw materials. In 1990, 54% (on the calorie base) of the total food supply of Japan was imported, while in 1994, the figure has reached as high as 63%. In recent years, due to the rapid increase in the surplus of payment from international trade, the Japanese government has been strongly requested by its trade partners to harmonize with international regulations, together with the easing of internal legal restrictions and regulations. On April 1, 1995, the Ministry of Health and Welfare and the Ministry of Agriculture, Forestry and Fisheries decided to change the date-indication system for food products from the "date of manufacture" to "use by date" or shelf life.

In order to harmonize with international food regulations, the Ministry of Health and Welfare presented a revised plan in the Food Sanitation Law and Nutritional Improvement Law to the Diet for discussion, and the proposed bills were carried through the Diet on May 24, 1995; the new acts came into force on May 24, 1996. Among the revisions to the Food Sanitation Law, articles relating to the improvement and enforcement of a self-imposed sanitary control system to secure food safety are involved, in which the approval system for manufacturing foods through "Comprehensive Sanitation Controlled Manufacturing" is included. This new system has been derived from the HACCP concept. However, its implementation is different from other countries, as it is applied voluntarily in Japan.

In July 1, 1994, the Product Liability Law, so-called PL-Law was enacted in Japan and came into force on July 1, 1995. As to the safety problem of a product, the food industry would be one of the most seriously involved groups among various industries in Japan by the enforcement of the PL-Law. In general, for industry to cope with the PL-Law, there would be two measures, viz., PL-prevention and PL-defense against legal proceedings.

Recently, food industries in Japan are much interested in the HACCP system as a counter- measure against the PL-Law.

The Hazard Analysis and Critical Control Point (HACCP) concept has been gaining momentum in recent years as the best approach to assuring food safety at every stage of the food chain. The HACCP approach has already been adopted in the regulations to control quality and safety of seafoods and other food items in EU countries and the U.S.A.; their influence is felt in the international food trade, especially fishery products. In 1994, the Bureau of Food Distribution, Ministry of Agriculture, Forestry and Fisheries started a new project called "Comprehensive Control System for Improving Food Safety" aiming to establish a model HACCP plan applicable to medium-sized and regional producers and even to small family-operated plants in Japan.

An expert committee was organized under the Japan Food Industry Center to establish a generic model HACCP plan for pre-cooked frozen foods. In 1994, 6 items of pre-cooked frozen foods were selected, viz hamburger, macaroni au gratin, potato-croquette, creamy-croquette, "*shaw mai*"(Chinese dish) and "*gyo-za*"(Chinese dish). In September 1995, a guidebook for developing HACCP plans for the aforementioned frozen pre-cooked foods was published by the Japan Food Industry Center.

In 1995, the Ministry of Health and Welfare organised a team to investigate the application of "Comprehensive Sanitation Controlled Manufacturing System" targeting at meat and dairy products. The generic model HACCP plans for the aforementioned foods will be published in the near future.

In the middle of March 1995, a team came to Japan from the EU to investigate the actual status of fish processing plants. When they visited a scallop shucking plant in the Aomori Prefecture where frozen scallop ligaments (adductor muscles) were produced, they found several defects in the hygiene conditions of the plant. Consequently, due to defects prescribed in the "Council Directive of EC, 1991", the export of all fishery products from Japan to European countries was suspended. After repeated negotiations by the Ministry of Health and Welfare and the Fisheries Agency of Japan with the authorities of the EU, the export of seafoods except frozen scallop ligaments resumed at the end of 1995. In 1991, the EC (currently EU) enforced HACCP-based regulations for fish and fishery products including imported fish and fishery products. Moreover, on December 18, 1995 the US-FDA announced the new regulation of "Procedures for the Safe and Sanitary Processing and Importing of Fish and Fishery Products", commonly called "Seafood HACCP Regulation" which will be enforced on December 18, 1997.

In accordance with the international trend of HACCP implementation, the Fisheries Agency has decided to adopt the HACCP concept in fish processing plants in order to promote the correct hygienic handling of fresh and processed fishery products at all stages of production. A new project has begun for developing generic models for HACCP to secure safe products of high quality. In the current project, some 15 items of fresh and processed fishery products are included. In 1995, three items of fishery products, frozen scallop ligaments (adductor muscles, to be eaten raw), frozen mechanically minced fish meat (surimi), and frozen fish fillets (mackerel, eaten after cooking) have been selected. After intensive investigation, the expert committee published a guidebook for each product to develop its HACCP plan. The purpose is to present a detailed approach to developing HACCP plans for individual food items, and these guides should not only be useful to fish processors, but be also particularly helpful to the smaller processor attempting to develop a HACCP plan for his facility.

In 1994, the Japan Society for Research of Food Protection organized the following two divisions, the technology for control of food micro-organisms, and the HACCP divisions. The latter division has already conducted three workshops on the implementation of HACCP, in 1994, 1995 and 1996, to enlighten researchers and technologists working at food laboratories and various food factories in Japan. In addition, the HACCP division is now preparing guidebooks for developing HACCP plans to address the safety concerns of various food products, in which several types of fish paste products, *kamaboko* in Japanese, and 5 kinds of cooked, ready-to-eat chilled foods are included. These will appear in the series of "Advances in Food Protection Research" published by our Society in the near future.

Appendix

(REFERENCE MATERIAL FOR HACCP IMPLEMENTATION)

Basic Knowledge to Establish HACCP Plan with Special Reference to the Hazard Analysis of Fish and Shellfish

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Introduction

Traditionally, the means of preventing foodborne illness have been by inspection and surveillance of final products. The distribution of dangerous contaminants in foods is sporadic and the accuracy and precision of analytical procedures, particularly the microbiological monitoring of foods, are relatively low. Consequently, sample examinations will only exceptionally reveal deficiencies, thus making negative results almost worthless.

Microbiological examination of final products has been and is still carried out in large numbers as a means to provide safety. The results are evaluated against microbiological criteria, which may have either mandatory or voluntary status. The currently used microbiological criteria apply to fish and fishery products by the members of the European Union (EU) together with Canada, Japan and the U.S.A. The tests required are listed in Table 1. Therefore, it can be stated that current practices for providing safety, or assurance of safety, and normal shelf life of fish products by microbiological end-product testing, are costly but of very limited value. Point-of-entry testing of fish products must generally be considered as an inefficient means of retrospective assessment of processing, transport and storage conditions.

Hazard Analysis Critical Control Point System Adopted by the Codex Alimentarius Commission, and its Application

The Hazard Analysis Critical Control Point (HACCP) system, which is science-based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing.

The HACCP system, which was first outlined in 1971 in the U.S.A. (APHA, 1984) has now been widely accepted internationally, and in 1993 FAO/ WHO, the Codex Alimentarius Commission (CAC) published the "Guidelines for the Application of Hazard Analysis Critical Control Point (HACCP) System".

1. *HACCP Principles*

The HACCP system consists of the following seven principles:

a. Conduct a hazard analysis.
b. Determine Critical Control Points (CCPs).
c. Establish critical limits for CCPs.
d. Establish a system to monitor and control CCPs.
e. Establish corrective action to be taken when monitoring indicates that a particular CCP is not under control.
f. Establish methods for verification to confirm that the HACCP system is working effectively.
g. Establish documentation concerning all procedures and records appropriate to these principles and their application.

2. *Logical Sequence for Application of HACCP*

It is possible to implement the 7 principles of HACCP in 12 separate steps according to the Codex document:

a. Assemble a HACCP team.
b. Describe the product.
c. Identify its intended use.
d. Construct a flow diagram.
e. On-site verification of flow diagram.
f. List all potential hazards associated with each step, conduct hazard analysis, and consider any measures to control identified hazards (Principle 1).
g. Determine CCPs (apply the decision tree) (Principle 2).
h. Establish critical limit for each CCP (Principle 3).
i. Establish a monitoring system for each CCP (Principle 4).
j. Establish corrective action for deviation that may occur (Principle 5).
k. Establish verification procedures (Principle 6).
l. Establish record keeping and documentation (Principle 7).

Factors Contributing to Foodborne Disease Outbreaks

1. *Improper Storage/Holding Temperatures*

Foodborne disease organisms will grow in foods held at temperatures between 5°C and 55°C; most pathogenic bacteria grow very rapidly at temperatures between 25°C and 40°C.

2. *Inadequate Cooking*

Inadequate cooking represents a hazard since cooking is relied upon to destroy many foodborne disease organisms and toxins.

- Undercooked food — poultry, hamburger, fish products, etc.
- Improperly processed food — botulism from canned food.

3. *Poor Personal Hygiene*

Many foodborne disease organisms are transferred by the faecal-oral route — viruses (hepatitis A, Norwalk), *Shigella.*

Infected food handlers with poor personal hygiene transfer organisms to food — *S. aureus*, viruses, *Shigella.*

4. *Cross-contamination*

Foodborne pathogens can be transferred from raw product to utensils and equipment, which, if then used for cooked or other ready-to-eat foods, can in turn transfer pathogens which may lead to illness.

Cutting boards, slicers, mixers and grinders with hard-to-clean surfaces are particularly problems.

Utensils and equipment used in the preparation of raw products should never be used for cooked products.

5. *Improper Reheating*

6. *Poor Storage Practices*

Cross contamination may occur when cooked products are stored with raw products or materials in the same refrigerator and when chemicals and foods are stored together.

Microbiological Hazards Relating to Fish and Fishery Products

1. *Identification of Microbiological Hazard Relating to Seafoods*

Seafood hazard categories in order of decreasing safety risk are as follows :

a. Eating of raw fish and shellfish: Japan has a tradition for eating raw fish and shellfish (sashimi and sushi).
b. Molluscs, including fresh and frozen mussels, clams, oysters in shell or shucked. Often eaten with no additional cooking.
c. Lightly-preserved fish and shellfish products (ie. NaCl < 6%(w/w) in waterphase, pH > 5.0). This group includes salted, marinated, cold smoked and gravid fish and shellfish eaten without cooking.
d. Heat-processed (pasteurized, cooked, hot smoked) fish products, molluscs (including squid, octopus and scallop) and crustaceans (crabs, lobsters and shrimps).Some products are eaten with no additional cooking.
e. Heat-processed, fish and shellfish (sterilized, packed in sealed containers). Often eaten with no additional cooking.
f. Semi-processed fish and shellfish (ie. NaCl > 6%(w/w) in water phase, pH < 5.0), preservatives (sorbate, benzoate and NO_2) may be added, although the use of sorbate and benzoate in these products is prohibited in Japan. This group includes salted and/or marinated fish and fish egg products (eg. salted Alaska pollock roe, salmon eggs and caviar) and molluscs including squid, octopus and bivalves eaten after or without cooking.
g. Dried, salt-dried and smoked-dried fish and shellfish. Usually eaten after cooking.
h. Fresh and frozen fish and crustaceans. Usually eaten after cooking.

2. *Biological Risk Factors Affecting the Safety of Fresh and Frozen Fish and Shellfish*

Foodborne disease organisms which represent health hazards have been arbitrarily divided into four groups (ICMSF, 1986; NAS/NRC, 1985) as follows:

Severe; direct health hazards.

- Moderate; direct hazards with potentially extensive spread.
- Moderate; indirect hazards with limited spread.
- Low; indirect hazards, or microbes that serve as indicators of a potential for a more severe hazard or condition.

Table 2 provides the classification of the most common foodborne disease agents.

Table 3 provides the classification for some of the most common foodborne disease agents relating to fresh and frozen fish and shellfish.

Prevention of Food-borne Microbial Diseases

General principles :

1. *Prevent Contamination of Foods*

a. The use of good personal hygiene practice.
b. Avoid cross-contamination between raw foods and cooked and read-to-eat foods.
c. Thoroughly clean and sanitize utensils and work surfaces used for raw foods.
d. Equipment and utensils should be clean and made from appropriate materials to avoid contamination from toxic materials.

2. *Destruction of Foodborne Disease Agents*

a. Many foodborne disease organisms will be destroyed by proper cooking.
b. Freezing can be used to destroy parasites in fish and meat, but it has little effect on bacterial pathogens in foods.
c. Use of acids and preservatives.
d. Irradiation of foods to kill pathogenic micro-organisms - radicidation (to kill non-spore forming pathogenic micro-organisms such as *Salmonellae* and *Staphylococcus*) and radappertization (to destroy spore-formers such as *Clostridium botulinum*).

3. *Prevention of Multiplication of Foodborne Disease Organisms*

a. Food poisoning organisms must multiply to large numbers before they can cause disease: eg. *S. aureus* — $10^5 \sim 10^6$ to produce enough toxins to cause disease, and *C. perfringens*, *V. parahaemolyticus* — 10^6/g.
b. Infectious disease — cause infection with minute quantities of an organism: e.g. *S. typhi* and *V. cholerae* cause infection with the order as low as $10^1 \sim 10^3$/g.
c. Freezing generally prevents growth of all foodborne disease organisms.
d. Proper refrigeration temperature (< 4°C) will prevent multiplication of most foodborne disease organisms, although *Y. enterocolitica* can grow at temperatures as low as -2°C.
e. To lower the temperature of foods rapidly: 60°C to 4°C ("dangerous zone" for microbial growth) in 4 hours.
f. Decreasing the pH and/or the water activity (Aw) of a food can prevent or slow down the growth of foodborne pathogens.
g. Holding foods at elevated temperatures (> 60°C; 140°F).

Destruction of Pathogens and Spoilage Bacteria by Pasteurization of Seafoods

Clostridium botulinum is the organism of concern in many canned products, and their number in most foods is usually very low; an average of less than one per container is assumed (Stumbo, 1973). On the other hand, if high numbers are expected, or if a more heat-resistant organism is targeted, then a suitable process is recommended. No target organism has been identified for the pasteurization of crabmeat and the process is based on historical data that gave the desired shelf life; a *z*-value of 8.9°C was picked arbitrarily in the absence of a specific target organism. Within the range of normal crabmeat pasteurization temperatures, F-value calculations based on $z = 8.9$°C produce a reasonable and safe conservative process (Ward *et al.*, 1984).

Fortunately, pasteurization provides a very large safety factor for the destruction of type E, the type most commonly associated with marine environments. Innoculated crabmeat, given a typical commercial process, achieved at least an 8 - D reduction of *Clostridium botulinum* type E spores (Cockey & Tatro, 1974). Other researchers have determined D_{85} values of 0.2 - 0.32 min in a variety of heating media. Based on these findings, a process of F = 31 min (reference temperature: 85°C, $z = 8.9$°C) should provide at least a 96 - D process for *C. botulinum*, type E.

However, other types of psychrotrophic, non-proteolytic *C. botulinum* are more heat resistant. Non-proteolytic type B is reported to have D-value of 0.45 - 14.33 min. A 31 min F-value provides a 2.4 - D process for the most heat-resistant strain of this organism. Type F is reported to have similar heat resistance. Numerous researchers have explored this area (Cockey & Chai, 1991; Simunovic *et al.*, 1985; Lynt *et al.*, 1982, 1977; Eklund, 1992; Stumbo, 1973).

Most spoilage micro-organisms and pathogens are heat sensitive and can be destroyed by low to moderate heat. The heat resistance of various bacteria and bacterial spores are summarized in Table 4.

The D-values and F-values of non-spore forming pathogens and spoilage organisms were calculated from heat resistance data in the literature (Rippen & Hackney, 1992) with milk being the most common heating medium are shown in Table 5.

As can be seen in Table 5, crabmeat's ready-to-eat status has made the control of *Listeria monocytogenes* in these products a high priority to the US-FDA (Hooker *et al.*, 1991). Although *L. monocytogenes* exhibits greater heat resistance in crabmeat than in fluid milk products, D-values reported by Harrison and Huang (1990), showed it is eliminated by pasteurization as prescribed for fresh-cooked seafoods and of milder thermal processes targeting vegetative pathogens in products destined for frozen distribution. These applications are likely to become more important in the 1990s as safety concerns predominate.

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Table 1. Microbiological tests included in the Microbiological Standards and Regulations of some European countries, Japan and USA (FAO, 1989)[b]. (Note: Belgium, Canada, Denmark, Germany, Ireland and Portugal have no microbiological standards for fish and fish products.)

	Italy	France	Luxembourg	Netherlands	United Kingdom	Spain	USA	Japan
Raw fish, fillets, fresh/frozen		1,2,7,10,11[a]	1,3,7,10,11			1,2,5,6,7,10		1,2 or 6
Semi-preserved fish products								
Pasteurized		1,2,7,10,11						
non-pasteurized		1,2,7,10,11						
Smoked salmon		1,2,7,11						
Crustacean								
raw		1,2,7,11	1,3,7,11				1,6,10	
cooked		1,2,7,11	1,3,7,11		1,6,7,10			
cooked and peeled		1,3,7,10,11	1,3,7,10,11	7,10				
Molluscs								
live	6,7	3,4,7	3,4,7					
raw	6,7			6;7		1,6,7		1,6
pre-cooked	6,7	1,3,7,10,11	1,3,7,10,11			1,7,8,9,10		

[a] The figures refer to tests for:
1. Aerobic plate count (APC); 2. Coliforms; 3. Faecal coliforms; 4. Faecal streptococci; 5. Enterococci; 6. *E. coli*; 7. *Salmonella*; 8. *Shigella* spp.; 9. Total enterobacteriaceae; 10. *Staphylococcus aureus*; 11. Anaerobic sulfite reducing bacteria.

[b] Referred and adopted from H.H. Huss, International J. of Food Microbiol, 15: 33-44 (1992)

Table 2. Classification of foodborne disease agents[a].

♦ Severe; Direct Health Hazards:

- *Clostridium botulinum*
- *Shigella dysenteriae*
- *Listeria monocytogenes*
- *Escherichia coli 0157:H7* (enterohemorrhagic)
- *Salmonella typhi*
- *Salmonella paratyphi A & B*
- *Brucella abortus; Brucella suis*
- *Mycobacterium bovis*
- *Vibrio vulnificus*
- Hepatitis A virus
- Fish and Shellfish toxins
- Certain Mycotoxins (aflatoxin)

♦ Moderate; Direct Hazards with Potentially Extensive Spread:

- *Salmonella* spp.
- pathogenic *Escherichia coli* (e.g. enterotoxigenic)
- *Streptococcus pyogenes*
- *Shigella* spp.

♦ Moderate; Indirect Hazards with Limited Spread:

- *Staphylococcus aureus*
- *Clostridium perfringens*
- *Bacillus cereus*
- *Vibrio parahaemolyticus*
- *Coxiella burnetii*
- *Yersinia enterocolitica*
- *Campylobacter fetus*
- *Trichinella spiralis*
- histamine (from microbial decomposition of scombroid fish)

[a] Adapted from ICMSF, 1986

Table 3. Biological risk factors relating to fresh and frozen fish and shellfish.

Organisms/component of concern	Hazard		Severity	Risk
	Contamination	Growth		
Pathogenic bacteria:				
a) Normally found in aquatic environment				
Clostridium botulinim	—	+	high	low
Vibrio cholerae	—	+	high	low/N.R.[a]
V. parahaemolyticus	+	+	moderate	high/N.R.[a]
NAG *Vibrio*	—	+	moderate	low/N.R.[a]
Listeria monocytogenes	—	+	moderate	low/N.R.[a]
Aeromonas hydrophila	—	+	moderate	low/N.R.[a]
b) From animal/human, reservior				
Salmonella	(+)[b]	+	high	high
E. coli(e.g. enteropathogenic)	(+)[b]	+	moderate	high
Shigella	(+)[b]	+	high	low
S. aureus	(+)[b]	+	moderate	high
Producer of biogenic amines (histamine)				
Morganella morganii	—	+	moderate	high
Photobacterium histaminum	+	+	moderate	high
P. phosphoreum (psychrophilic)	+	+	moderate	high
Spoilage bacteria				
Pseudomonas spp.	+	+	low	high
Flavobacterium spp.	+	+	low	high
Achromobacter spp.	+	+	low	high
Moraxella spp.	+	+	low	high
Serratia spp.	+	+	low	high
Parasites				
Anisakis larva	+	—	low	low/N.R.[a]
Tapeworm (*Diphyllobothrium latum*)	+	—	low	low/N.R.[a]
Distoma hepaticum (*Clonorchis cinensis*)	+	—	low	low/N.R.[a]
Paragonimus (*P. westermanii*)	+	—	low	low/N.R.[a]
Biotoxins				
Ciguatoxin	+	—	high	high/N.R.[c]
Saxitoxins	+	—	high	high/N.R.[c]
Dinophysis toxins	+	—	high	high/N.R.[c]
Viruses				
Hepatitis virus A	+	—	high	high/N.R.[c]
Norwalk virus	+	—	high	high/N.R.[c]
Rotavirus	+	—	high	high/N.R.[c]

[a] N.R., no risk, provided the fish is cooked before consumption.
[b] Depending on fishing area and local conditions.
[c] Depending on fishing area and season.

Table 4. Heat resistance of bacteria and bacterial spores.

Bacteria species	D-value (min)	
Brucella spp.	at 65.5°C	0.1 - 0.2[1]
Salmonella Senftenberg 775W	at 65.5°C	0.8 - 1.0[1]
Salmonella spp.	at 65.5°C	0.02 - 0.25[1]
Staphylococcus aureus	at 65.5°C	0.2 - 2.0[1]
Yeasts and molds and spoilage bacteria	at 65.5°C	0.5 - 3.0[1]
Spores of mesophilic aerobes		
Bacillus cereus	100°C	5.0[2]
Bacillus subtilis	100°C	11.0[2]
Bacillus polymyxa	100°C	0.1 - 0.5[2]
Spores of mesophilic anaerobes		
Clostridium butyricum	100°C	0.1 - 0.5[2]
Clostridium perfringens	100°C	0.3 - 20.0[2]
Clostridium botulinum		
Type A and type B proteolytic strains	100°C	50.0[2]
Type E and non-proteolytic types B and F	80°C	ca. 1.0[2]
Spores of thermophilic aerobes		
Bacillus coagulans	120°C	0.1[2]
Bacillus stearothermophilus	120°C	4.0 - 5.0[2]
Spores of thermophilic anaerobes		
Clostridium thermosaccharolyticum	120°C	3 - 4[2]
Desulfotomaculum (Clostridium) nigrificans	120°C	2 - 3[2]

Note: (1) ICMSF, 1980a, Table 1.9, p.26
(2) ICMSF, 1980a, Table 1.8, p.25

Table 5. D-values and F-values of non-spore forming micro-organisms at two temperature [a].

Organism	D-value[b] (85°C,sec)	D-value (65°C,sec)	z-value (°C)	F-value[c] (calculated for 7D) (85°C,sec)	(65°C,min)	Heating medium
Vibrio cholerae	0.16	11.7	10.5	1.12	1.4	buffer
	0.29	93.0	7.7	2.03	10.8	crabmeat
V. parahaemolyticus	0.14	2.8	14.8	0.98	0.33	clam
Listeria monocytogenes	0.16	39.8	8.4	1.12	4.6	crabmeat
	0.02	11.2	7.2	0.14	1.3	milk
	0.09	28.2	8.0	0.63	3.3	milk
	0.007	19.8	5.8	0.05	2.3	skim milk
	0.02	17.2	6.8	0.14	2.0	cream
Staphylococcus aureus	0.002	15.0	5.1	0.01	1.7	various foods
	0.04	132.0	5.5	0.28	15.4	various foods
Salmonella typhimurium	0.002	2.3	6.2	0.01	0.3	milk
	0.001	4.2	5.5	<0.01	0.5	—[d]
Salmonella Senftenberg	0.017	53.6	5.5	0.18	6.3	—
Yersinia enterocolitica	0.0007	21.4	5.5	<0.01	2.5	milk
Shigella dysenteriae	0.0002	3.0	4.7	<0.01	0.3	milk
Campylobacter jejuni	0.0007	1.03	5.8-6.7	<0.01	0.1	skim milk
Non-spore-forming bacteria[e]	0.008-0.01	60-180	4-6	<0.01~0.07	7.0~21.0	various foods

[a] Referred and adopted from T.E. Rippen & C.R. Hackney, Food Technol., Dec. 1992, pp. 88 (Table 1).
[b] D-value (decimal reduction times, in minutes or seconds) are mostly calculated from values determined at lower temperatures and should be considered as estimated values.
[c] F-value: Accumulated heat exposure to destroy a given number of organism in seconds or minutes at a specified temperature.
[d] Not reported.
[e] *Pseudomonas, Achromobacter, Enterobacter, Micrococcus, Lactobacillus.*

Regional HACCP and Training Requirements to the Year 2000

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Abstract

Basic HACCP requirements for the region, and the role of the Project and the ASEAN Network are outlined. Training materials developed by the Project in prerequisite requirements and curriculums developed for HACCP training packages intended for Managers, non-QC Supervisors, QC-Supervisors/ Managers and Line Workers are detailed.

In today's world of global markets and the WTO, where the agreement on the application of the Sanitary and Phytosanitary Measures and the Technical Barriers to Trade are being acted upon, worldwide initiatives have been taken to remove internal and external trade barriers, producing a more open "food marketplace" marked by :

1. gradual elimination of non-tariff barriers;
2. equal regulatory treatment of domestic and imported products;
3. actions such as legislative/regulatory reviews to ensure domestic regulations are consistent with tenets of trading agreements, based upon sound science and risk analysis;
4. greater transparency in all aspects of food legislation and regulation;
5. harmonization of domestic standards with international standards such as Codex, unless higher levels of protection can be justified.

How in fact is this being achieved? Well, governments are looking at their own legislation and the legislation of their major markets, and attending international meetings, such as those of the Codex Alimentarious Commission, where international codes of practice and standards are being elaborated.

One such program which has more or less been universally accepted is the Codex Committee on Food Hygiene's "Code of Practice General Principles of Food Hygiene" and its accompanying annex, "Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application."

The above mentioned Code of Practice provides Good Manufacturing Practices (GMP) for food hygiene and the annex, a system of controls to ensure food safety (HACCP).

You need a HACCP program. Everyone is saying this, but what is it? The HACCP system, which is science-based and systematic, identifies specific hazards and the measures for their control to ensure the safety of food. HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. HACCP when implemented is a management system for ensuring safety of products prepared in an establishment.

All companies have management systems, such as financial management, personnel management, production management and quality management systems. Quality management systems may be simple, such as the processor's unwritten understanding of the process (no organized system), or complex such as the ISO 9000 series. The application of HACCP is compatible with the implementation of quality management systems and is the system of choice in the management of food safety within such systems. HACCP systems must be considered as essential for any enterprise that deals with fishery products whether or not other organized management systems are in place; therefore, HACCP systems must be capable of operating independently of other quality management systems.

The reason why HACCP has developed is that regulatory authorities for food products have a duty to ensure that foods offered to the consumer are safe to eat. In the past they have required a positive approach of using GMP, producing food in a hygienic manner and by inspection of finished product. It is now realized that inspection of finished product gives a poor control over the safety of foods. Regulatory agencies are increasingly requiring establishments to take a preventative approach to safety based on the principles of HACCP. This requirement might be incorporated in primary legislation on food control, or be applied by executive action of the regulatory authority. The management of the establishment must then be able to produce for the regulatory authority a documented HACCP plan, and be able to demonstrate that the plan is being effectively implemented.

When implemented, this system will help bring about equivalency, harmonization and transparency so as to minimize any barriers to international trade with respect to food safety. There is, however, a trend for countries to customize their HACCP programs to meet local realities. While there is nothing wrong with that, a danger exists that the customization of HACCP programs due to valid social, economic and cultural reasons could be challenged in negotiating Mutual Recognition Agreements (MRA's) or equivalent agreements. MRA and similar negotiations dictate that measurement criteria against which other countries' HACCP programs are to be assessed be developed. These measurement criteria may become increasingly unique and have only limited applicability to other countries' HACCP programs; therefore, we must return to the basics of HACCP when assessing other countries' HACCP programs to establish a common baseline and common-policy approach. This will become increasingly important as the Codex Committee on Food Import and Export Inspection and Certification Systems (CCFICS) provides a framework to determine equivalency of inspection systems between countries.

HACCP is not a stand-alone control system; it is one part of a larger system of control procedures. HACCP plans apply to specific products and to specific processes and are in addition to appropriate food safety legislation by the responsible authority and codes of practice for hygiene or any codes of good manufacturing practice that might be in force for the establishment as a whole. You need certain prerequisite programs in place to operate a HACCP system. Prerequisite programs may be defined as universal steps or procedures that control the operational conditions within a food establishment allowing for environmental conditions that are favourable to the production of safe food.

Various prerequisite program areas may include:

Premises
Outside property, building, hygienic facilities, water quality program

Receiving/Storage
Receiving of raw materials, ingredients and packaging materials, storage

Equipment Performance and Maintenance
General equipment design, equipment installation, equipment maintenance

Personnel Training Program
Manufacturing controls, hygienic practices, controlled access

Hygiene
Sanitation program, pest control program

Health and Safety Recalls
Product identification program and coding, recall system, recall initiation

Labelling
Meeting requirements for the market intended

Prerequisite programs are the foundation of the HACCP plans and these must be adequate and effective. For example, when Sanitation Standard Operating Procedures (SSOP) are in place, HACCP can be more effective because it can concentrate on the hazards associated with the food or processing and not on the processing plant environment. However, when aspects of hygiene directly impact food safety, it may be more appropriate for those hygiene controls to be handled with the HACCP plan. If any portion of a prerequisite program is not adequately controlled, then additional critical control points would have to be identified, monitored and maintained under the HACCP plans. Effective prerequisite programs will simplify HACCP plans and will ensure that the integrity of HACCP plans are maintained and that the manufactured product is safe.

Further, consumers and clients want not only safe food; they want food of acceptable quality, properly labelled and which has an actual weight that matches the weight designation which appears on the label. Such considerations must be met by the quality management system of both industry and government.

While HACCP is an excellent, though narrowly defined, food safety system that does not deal with quality or economic fraud, its principles can be applied to non-safety hazards such as the prevention of economic fraud in relation to labelling, grading, weights, etc., or other aspects of food quality. One should consider incorporating the HACCP system into the present quality control/quality assurance program leading to a system of Total Quality Control.

For example, the Canadian Fish Inspection Service developed a Quality Management Plan (QMP) which was implemented in 1992, largely based on HACCP principles. It is currently in place at 1200 processing plants and independent national and international reviews found that :

- QMP provides appropriate levels of consumer protection;
- The framework ensures production of safe food;
- Reduced inspection effort has not increased food safety risks.

The reviews resulted in a number of recommendations to improve the QMP, including incorporating all HACCP principles in the QMP, eliminating paper burdens, and better and more training. The inspection service of DFO is now restructuring QMP to provide for a three- pronged approach :

- Pre-requisite Programs: universal requirements, ie: construction & equipment, sanitation, grounds, recall, etc.;

- QMP Critical Control Points: Established through HACCP Hazard Analysis;
- QMP Defect Action Points: Established through Regulatory Hazard Analysis. Identifies regulatory quality and fair marketing practices (eg: labelling and weight) requirements that products must meet.

Other countries are taking similar approaches, such as mandatory adoption of HACCP by EU and the US seafood industry in 1997 and requiring that fish exported to their countries were processed in a plant with an approved HACCP plan in operation. The plant must also meet international requirements for construction and hygiene.

While all this is going on at an international level, how does the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II fit into the picture?

The ASEAN-Canada Fisheries Post-Harvest Technology Project-Phase II started in 1992. When the Project was designed, it had very specific outputs relating to :

- improving the quality of fish and fish products, and strengthening fish inspection services within the ASEAN countries;
- assist in the development and promotion of improved technology in fish processing, preservation and packaging; and
- enhance the transfer of appropriate technology to the fish processing industry in the region.

Through the use of country activities and training workshops on fish inspection, the Project facilitated regional development. Three Regional Centres (RC) in the fields of Fish Inspection and Quality Control (FIQC), Fish Processing Technology (FPT) and Information Preparation and Dissemination (IPD) have been created. Eleven activities were conducted in Pilot Project (PP) countries and RC's, and nine-product specific information packages/ manuals have or are being developed. In the process of developing the materials, competency in FPHT of staff of participating institutes and industry was built up. For example, as a result of consultant-related training from the Project, by the end of 31 March 1996, more than 2255 persons received training from the Project, of which 64% came from the private sector, and 56% were female.

As the Project evolved, new work plans were developed such as the development of core information materials that were required of every activity. These could be considered as prerequisite information/training packages. The four which are being developed relate to :

1. Hygienic Design of Fish Processing Plants.
2. Hygienic Design of Equipment, Utensils and Working Surfaces in Fish Processing Plants.
3. Sanitation and Hygiene Control.
4. Personnel Hygiene.

The first is now available as a video/ workbook for a one-day course and the others are in various stages of preparation.

Additionally, realizing a need for sustaining the Project's activities, ASEAN took steps to develop a sustainability program. The ASEAN Ministers of Agriculture and Forestry (AMAF) established an ASEAN Network of Fisheries Post-Harvest Technology Centres (ASEAN Network) upon which a program for Project sustainability could be built.

One of the work items identified for the ASEAN Network was to harmonize quality assurance of fisheries products through HACCP programs in the ASEAN region. This is, of course, taking the recommendations from Codex on the world scale and applying them to ASEAN. How can it be done? The idea, developed by the ASEAN Network/Project, was to develop an ASEAN HACCP curriculum for standard training of industry. A HACCP Curriculum Development Working Group was set up. Its first meeting was held on 10 - 15 June 1996. At that time it was noted that a number of HACCP curriculums were in development by various developed countries, but they were all aimed at training a HACCP team. It was decided to develop sets of job competencies for four (4) types of users of HACCP :

1. Managers.
2. Non-QC Supervisors.
3. QC Supervisors/QC Managers.
4. Line Workers.

Competencies developed at the meeting were validated by experts and industry in the various ASEAN countries and a second WG Meeting was held in Penang from 26 - 30 August 1996. At that meeting, the summary of competencies for HACCP training was refined (Annex I) and curriculums developed (Annexes II - V). Training packages are now being developed and should be available by March 1997 for trial runs.

As can be seen, the Project is one means to lower technical barriers to trade. It is one of a large set of wheels moving towards the goal. With the materials developed by the Project, a significant training program aimed at the industry has been proposed to the year 2000.

In addition to what has been mentioned above, the Project is also trying to harmonize Good Laboratory Practices in fisheries laboratories within the region, and to provide information and exchange of information with an electronic information network located in Singapore on the Internet at http:// www.asean.fishnet.gov.sg

The Project will terminate on 31 March 1997. While the initiatives taken by the ASEAN Ministers lay the foundation for Project sustainability, it is estimated that a transitional phase of two (2) years to the end of March 1999 would be necessary to hand over the direction from the Project to the ASEAN

Network. Further, an extension would significantly assist the implementation of training with the materials that have been developed by the Project. A proposal has been put to Canadian International Development Agency (CIDA), and a decision is expected by the end of the year. If the Project is not extended, the ASEAN Network and its program will still exist and continue.

Annex I

SUMMARY OF COMPETENCIES FOR HACCP TRAINING

Contents:

1. HACCP COMPETENCIES FOR ALL MANAGERS
2. HACCP COMPETENCIES FOR NON-QC SUPERVISORS
3. HACCP COMPETENCIES FOR QC SUPERVISORS/QC MANAGERS
4. HACCP COMPETENCIES FOR LINE WORKERS CONDUCTING HACCP-RELATED ACTIVITIES

HACCP CURRICULUM DEVELOPMENT WORKING GROUP
26 - 30 August, 1996 Penang, Malaysia

1. HACCP COMPETENCIES FOR ALL MANAGERS

STC-A : EXPLAIN THE HACCP CONCEPT

1. Differentiate "food safety", "quality" and "economic fraud".
2. Describe quality management systems in use.
3. Describe the HACCP concept.
4. Explain how HACCP relates to the company's quality assurance program.
5. Outline the prerequisites for implementing HACCP.
6. Describe the components of a HACCP Plan.
7. Outline the process flow for relevant products.
8. Identify potential hazards associated with relevant products.
9. Explain national regulatory requirements.
10. Outline briefly the costs and benefits of using HACCP.

STC-B : ENSURE HACCP PLANS ARE WORKING PROPERLY

1. State company policy for HACCP and the standards for products produced.
2. State the responsibilities of the management team related to HACCP.
3. Describe where knowledge levels and responsibilities of employees begin and end.
4. List sources of current information on HACCP.

2. HACCP COMPETENCIES FOR NON-QC SUPERVISORS

STC-A : EXPLAIN THE HACCP CONCEPT

1. Differentiate "food safety", "quality" and "economic fraud".
2. State product standards and market requirements for products produced.
3. Describe the HACCP concept.
4. State the rationale for HACCP.
5. Describe how HACCP fits into the Q.A. Program.
6. Outline the prerequisite requirements for implementing HACCP.
7. Outline company's process flow and sanitation program.
8. Describe potential hazards for products produced.
9. Define CCPs for your products.

STC-B : ASSIST HACCP TEAM

1. Describe the role of the non-QC supervisor in the development of HACCP plans and manuals.
2. Describe the role of the non-QC supervisor in the verification of the HACCP plans.

STC-C : IMPLEMENT COMPANY POLICY RE: HACCP

1. State company policy regarding HACCP.
2. State how the prerequisite requirements for HACCP can be met.
3. Outline non-QC supervisor's role in HACCP and role(s) of his workers.
4. Perform duties as defined in the HACCP plan.
5. Co-operate with the QC supervisor in implementing HACCP.
6. Support HACCP program in the company.

3. HACCP COMPETENCIES FOR Q.C. SUPERVISORS/Q.C. MANAGERS

STC-A : EXPLAIN THE HACCP CONCEPT

1. Differentiate "food safety", "quality" and "economic fraud".
2. State product standards and market requirements for products produced.
3. Describe Q.A. Programs in use.
4. Describe the HACCP concept.
5. State the rationale for HACCP.
6. Describe how HACCP fits into the Q.A. Program.
7. Explain basic food safety, the sanitation program and prerequisite requirements for HACCP.

8. Describe the components of a HACCP plan.
9. Describe the food processing operations for products produced.
10. Identify potential hazards.
11. Define CCPs for your products.

STC-B : EXPLAIN THE RESPONSIBILITIES OF THE HACCP TEAM

1. Describe the steps in developing a HACCP plan.
2. Describe the roles of members of the HACCP team in developing HACCP plans and manuals.

STC-C : IMPLEMENT COMPANY POLICY REGARDING HACCP

1. State company policy regarding HACCP.
2. State how the prerequisite requirements for HACCP can be met.
3. Describe the duties of personnel performing HACCP-related activities.
4. Perform his/her duties as defined in the HACCP plan.
5. Support HACCP program in the company.

STC-D : ASSESS TRAINING NEEDS FOR HACCP

1. Determine employees' competencies in conducting HACCP-related duties.
2. Specify training requirements for employees to perform HACCP-related duties.

4. HACCP COMPETENCIES FOR LINE WORKERS CONDUCTING HACCP-RELATED ACTIVITIES

STC-A: EXPLAIN HOW THE HACCP PROGRAM FITS INTO THE PROCESSING OPERATION

1. Explain basic process of spoilage/contamination.
2. Outline basic HACCP concept and rationale.
3. State prerequisites for HACCP required of the employee.
4. Briefly describe product process flow.
5. Describe characteristics of the product at his/her area of responsibility.
6. State hazards at his/her area of responsibility.
7. Describe CCPs at his/her area of responsibility.
8. State tolerances/deviation limits for his/her area of responsibility.
9. State the control(s) required at his/her area of responsibility.

STC-B : PERFORM HACCP DUTIES

1. Identify his/her duties in the HACCP plans.
2. Explain the reason(s) why duties are necessary.
3. Demonstrate the proper use of equipment related to HACCP at his/her area of responsibility.
4. Identify defects/problems at his/her area of responsibility.
5. State actions to be taken when deviations occur.

Annex II

COURSE AIMS AND MAJOR TOPICS

COURSE TITLE : DRAFT TRAINING COURSE ON HACCP OMPETENCIES: MANAGERS

COURSE DURATION : 1 Day

COURSE AIMS : After completing the course, the participant will be able to:

1. Describe the HACCP concept and its application in food processing plants.
2. Explain the importance of HACCP in ensuring food safety in food production.
3. Perform an effective role in HACCP implementation.

MAJOR TOPICS :
1. INTRODUCTION
2. HACCP
3. ROLES IN HACCP IMPLEMENTATION
4. MODEL HACCP PLAN
5. COURSE EVALUATION

COURSE OUTLINE

1. INTRODUCTION
- 1.1 Quality Management Systems
- 1.2 Prerequisite Programs
- 1.3 National & International Regulatory Requirements

2. HACCP (Hazard Analysis Critical Control Point)
- 2.1 Principles
- 2.2 HACCP Plan
- 2.3 CCPs Determination

3. ROLES IN HACCP IMPLEMENTATION
- 3.1 Company Policy for HACCP
- 3.2 Standard for Product Produced
- 3.3 Responsibilities of the Management Team Related to HACCP

4. MODEL HACCP PLAN
- 4.1 Model Plan
- 4.2 How It Suits the Current Operation
- 4.3 Costs & Benefits

5. COURSE EVALUATION

Annex III

COURSE AIMS AND MAJOR TOPICS

COURSE TITLE: DRAFT TRAINING COURSE ON HACCP COMPETENCIES: NON-Q.C. SUPERVISORS

DURATION : 1 Day

AIMS: At the end of the workshop, the participants will be able to :
1. Define the HACCP concept.
2. Recognize the importance of HACCP in ensuring food safety.
3. Apply the HACCP concept.

MAJOR TOPICS :
1. INTRODUCTION
2. PREPARING FOR HACCP
3. PRINCIPLES OF HACCP
4. APPLYING AND MAINTAINING HACCP

COURSE OUTLINE

1. INTRODUCTION
- 1.1 Food Safety And Quality Assurance
- 1.2 What is HACCP?
- 1.3 Why We Need To Use HACCP

2. PREPARING FOR HACCP
- 2.1 Review Operation
- 2.2 Prerequisite Requirements for HACCP
- 2.3 Who Would Be Involved?
- 2.4 Resource Requirements

3. PRINCIPLES OF HACCP
- 3.1 The Seven Principles of HACCP

4. APPLYING AND MAINTAINING HACCP
- 4.1 How to Fit HACCP into Your Q.A. Program
- 4.2 Developing a HACCP Plan
- 4.3 Your Role in Developing and Implementing HACCP
- 4.4 Information on HACCP

Annex IV

COURSE AIMS AND MAJOR TOPICS

COURSE TITLE: DRAFT TRAINING COURSE ON HACCP COMPETENCIES: QC MANAGERS /QC SUPERVISORS

COURSE DURATION : 4 Days

COURSE AIMS: After completing the course, participants will be able to:
1. Describe the HACCP concept and its application in food processing plants.
2. Explain the importance of HACCP in terms of safety in food production.
3. Play an effective role in the implementation of HACCP in their own food processing plants.

MAJOR TOPICS :
1. AN INTRODUCTION TO FOOD SAFETY
2. MARKET REQUIREMENTS
3. QUALITY ASSURANCE PROGRAM AND HACCP CONCEPT
4. PREREQUISITE REQUIREMENTS FOR HACCP
5. HACCP PRINCIPLES AND THEIR APPLICATION
6. GROUP PRESENTATION ON CASE STUDIES

COURSE OUTLINE

1. AN INTRODUCTION TO FOOD SAFETY
- 1.1 Important Factors Affecting Food Safety.
- 1.2 Regulatory Hazards involving Food Safety.

2. MARKET REQUIREMENTS
- 2.1 National and International Regulatory Requirement
- 2.2 Product Standards

3. QUALITY ASSURANCE PROGRAM AND HACCP CONCEPT
- 3.1 What is a Q.A. Program and HACCP
- 3.2 The Benefits of Implementing HACCP

4. PREREQUISITE REQUIREMENTS FOR HACCP
- 4.1 General Food Hygiene, Sanitation Centres and GMP's
- 4.2 Implementation of Prerequisite Program

5. HACCP PRINCIPLES AND THEIR APPLICATION
- 5.1 Sequence of Steps in Developing a HACCP Plan.
- 5.2 Hazard Analysis and Preventive Measures
- 5.3 CCPs Identification
- 5.4 Critical Limits
- 5.5 Monitoring System
- 5.6 Corrective Actions
- 5.7 Verification Procedures
- 5.8 Record Keeping
- 5.9 Implementation of HACCP
- 5.10 Assess Training Needed for HACCP

6. GROUP PRESENTATION ON CASE STUDIES
- 6.1 Groups 1, 2, 3 and 4

Annex V

COURSE AIMS AND MAJOR TOPICS

COURSE TITLE: DRAFT TRAINING COURSE ON HACCP COMPETENCIES: LINE WORKERS

COURSE DURATION : 1 Day

COURSE AIMS: At the end of the training, the participants will be able to :

1. Acquire the basic knowledge in HACCP needed to perform their HACCP-related duties.
2. Play an effective role in the implementation of HACCP in the plant at his/her area of responsibility.

MAJOR TOPICS :

1. BASIC PRINCIPLES OF FOOD SAFETY
2. INTRODUCTION TO HACCP
3. PREREQUISITE PROGRAMS FOR HACCP
4. HACCP - RELATED DUTIES

COURSE OUTLINE

1. BASIC PRINCIPLES OF FOOD SAFETY

2. INTRODUCTION TO HACCP
- 2.1 Concept and Rationale.
- 2.2 Food Hazards.
- 2.3 Critical Control Points (CCPs).

3. PREREQUISITE PROGRAMS FOR HACCP
- 3.1 Personnel Hygiene.
- 3.2 Plant Sanitation.
- 3.3 Good Manufacturing Practices (GMP).

4. HACCP - RELATED DUTIES
- 4.1 Monitoring.
- 4.2 Corrective Action.
- 4.3 Record Keeping.

COUNTRY PAPERS

Seven country papers were presented on the status and problems of the fish processing industry in Southeast Asia in relation to quality management.
The text of these papers are reproduced, each followed by a summary of the discussion which took place.

Seafood Processing Industry in Brunei Darussalam

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Ministry of Industry & Primary Resources
BRUNEI DARUSSALAM

Presented by Ms Hajah Hamidah bte Haji Ladis

Status

Mechanical seafood processing is a relatively new industry in Brunei Darussalam. However, processed seafood trades had been carried out in this country for more than a hundred years, the production being undertaken by housewives. To date, the majority of commercial operations are within the category of small backyard operations with about 50 processors actively involved throughout the country.

The products are as follows: fish balls, fish cakes, shrimp paste (*belacan*), marinated products (*budu*, *cincaluk*), cured products (*liking*), crackers, dried smoked fish (*tahai*) and dried-salted fish. In addition there are a few supermarkets which freeze their own products for sale in their own outlets. Total annual production for the last three years appears as Table 1.

Table 1. Fish products (tonnes) for 1993 - 1995.

Products	1993	1994	1995
1. Frozen fish	9.2	5.7	0.2
2. Prepared, chilled	4.4	20.0	41.0
3. Comminuted product	64.0	72.0	88.0
4. Crackers	12.6	7.0	7.1
5. Dried, salted	1.7	2.4	1.8
6. Marinated products	2.2	3.2	2.5
7. Cured products	1.5	2.9	9.0
8. Others	38.0	19.2	15.6
TOTAL	133.6	132.4	165.2

Source : Post Harvest Section, Department of Fisheries, Ministry of Industry and Primary Resources, Brunei Darussalam.

Plants which operate 'commercially' usually employ between 2 and 6 semi-skilled workers. Plant machinery is usually low capacity equipment. The equipment includes meat/bone separator, mixer, mincer, fish ball former, slicer, steamer, oven drier and packaging machines such as heat sealer. These equipment is usually bought from Malaysia, Singapore and Taiwan.

Production and Local Consumption

The total local production of processed seafood products caters to less than 10% of the total domestic requirement. Therefore more than 90% are still imported. Table 2 provides a list of products and the volume of imports for 1989 to 1991, whilst Table 3 provides a list and volume of imported products which are channelled through the major supermarkets between 1993 - 1995.

Table 2. Imports of processed seafood products (tonnes) for 1989-1991.

Products	1989	1990	1991
Frozen fish	662	1989	940
Fillet	16	9	20
Dried, salted	2922	1282	963
Canned	113	454	332
Others	314	247	218
Total Volume	4027	3981	2473
Value $ (CIF)	4.4 Million	5.5 Million	5.2 Million

Source : External Trade Statistics, Economic Planning Unit, Ministry of Finance, Brunei Darussalam.

Table 3. Selected imported fish products (tonnes) channelled through major supermarkets for 1993 - 1995.

Products	1993	1994	1995
Frozen	9.98	18.35	32.36
Fillet, slice	4.77	6.24	0.97
Comminuted	3.84	8.46	11.12
Dried, salted	4.42	11.6	12.31
Total	23.01	44.83	56.76

Problems Faced

The problems faced by the industry may be divided into 5 areas, namely :

1. Production Economics

Cost of raw materials and rentals are relatively high especially for plants operating in private commercial buildings. Analysis has shown that whilst raw materials made up 50 - 55% of the cost, the rental costs comprise 18% of overall cost of production.

Labour cost was found to be between 10-13% of production; however, the main problem in this area was the rapid turnover of labour and thus losses were incurred during recruitment and re-training of new workers.

2. Supply of Raw Materials

Fish, the main raw material, is the most expensive and may sometimes make up more than 50% of the production cost. For plants which depended on fresh fish as raw materials, they are further faced by problems of uncertainty of quality and volume available, which vary according to season. This will therefore affect the price. The majority of the plants are capable of storing only up to one week's requirement of raw materials.

3. Product Quality, Hygiene and Sanitation

Handling practices of raw materials by processors are poor as little or no ice is used prior to processing. They usually do not adhere to set formulation of their products, resulting in inconsistent quality of the final product with regards to the taste (e.g. saltiness, hotness, etc.) and appearance. Products are usually packed simply in polyethylene bags and styrofoam trays with plastic wraps to cater for the domestic market. They are stored at room temperature or chilled. They have short shelf life. The handling practices of personnel (often with no proper attire) during processing may cause contamination and render the products unwholesome/unsafe.

The plants are usually renovated shophouses and workshops and are not conducive for food processing, in terms of environment and layout. Although the walls are adequately tiled to facilitate cleaning, the drainage within and outside the plants are inadequate.

Due to the small size of the plants, it is also difficult to separate the wet from the dry area. There are instances where the toilet/washroom are not separated from the processing area, resulting in likely cross-contamination of the products.

Equipment and machinery are adequate in terms of size and capacity for the volume of production. Some machinery had been found to be made of unsuitable metals such as brass. Fortunately, these parts are usually parts which do not come into direct contact with food. The machinery is usually found to be in clean condition. However there are those which are in need of proper repair.

4. Supporting Industry

The country itself lacks the service infrastructure required to provide proper support to a seafood processing industry. To date, all the processing equipment are procured from overseas with no local agents to provide after-sales services and maintenance.

There are 5 local companies with the potential to become equipment fabricators. However, they need incentives in terms of volume of sales, in order to succeed and expand.

Packaging and printing services are available locally. However, these too are limited in their capabilities and can only provide simple printing jobs on materials which are not suitable for proper food packaging.

5. Marketing

There is always a market for seafood products in Brunei Darussalam. However, local products have to compete with imported products, which are usually better packaged and represented.

This problem is further complicated by the seasonal changes and other factors affecting the supply of products in the market.

Government Assistance

In order to alleviate the problems identified above, the Government of Brunei Darussalam has undertaken a number of projects. This include projects/programmes to :

1. Promote transfer of appropriate technology related to handling, processing, packaging and distribution, to local processors.
2. Establish storage and distribution facilities to ensure continuous supply of raw materials.
3. Promote improved food safety and quality assurance in seafood processing plants.

These programmes and projects are undertaken through National Projects as well as regional activities such as the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II.

Discussion

In response of the query from the representative from FAO, the representative from Brunei Darussalam explained that the decrease in the import volume figures may have been substituted by local production. However, the corresponding import value increased due to inflation. She also added that the fish processing industry is still being developed in her country and its long-term plan is only available at the country's management level.

Development of Fish Processing Technology in Relation to Quality Management in Indonesia

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Abstract

1. *The fishery industry in Indonesia comprise domestic-based traditional fish products factories and export-oriented companies. The traditional processing units are usually operated by small to medium-scale processors while the export-oriented products are mostly operated by means of advanced technology.*
2. *The traditional processing units are predominantly engaged in fish curing such as salting and drying, smoking, steaming/boiling and fermentation, whereas modernised industries usually produce products for export purposes, including handling of live and fresh or chilled shrimp and other fish products and frozen, canning factories, etc.*
3. *The fish inspection and quality control programme includes the development of a standardization system, inspection of production facilities in terms of Good Handling, and/or Manufacturing and Hygienic Practices and inspection of product quality.*
4. *The inspection and quality control policy consists of compulsory and supervisory approaches. The compulsory programme was manifested with certifications of a) GMP, which includes sanitary and hygienic status of plant; b) competence provided to in-plant processing technologist and quality control supervisors; c) quality or health for exported product and d) letter of origin/ quality for products transported and distributed inter-provincially.*
5. *The application of quality management in the fishery industry, whether they are traditional or more modern and whether their products are for domestic or export markets, are all at different states of development. The processing plants are classified according to the degree of compliance for meeting prerequisite conditions. The plant must achieve at least "C+" rating to pass the inspection; those which fall under plant-rating of "C-" and D are considered to be in non-compliance and will go through the supervisory programme to correct deficiencies within a specified period.*
6. *For the past five years, an Integrated Quality Management Programme (IQMP) based on HACCP concept adopted from the Canadian QMP, has been exercised by those fishery industries which meet the acceptable prerequisite conditions.*

Introduction

Fisheries play an important role in contributing to socio-economic development in Indonesia. Fishery is considered as one of the important commodities and it also provides employment opportunities and generates foreign exchange. Fish has also traditionally been one of the sources of animal protein in the Indonesian diet.

The processing industry comprise mainly domestic-based traditional fish products factories and export-oriented fish processing plants. The traditional fish products, which are commonly operated by small to medium-scale processors, mostly cater to the needs of the domestic market, whereas some larger-scale factories process for export purposes. The traditional processing units, are predominantly engaged in fish curing, such as salting/drying, smoking, steaming/ boiling and fermentation, the operation of which varies from home to medium-scale factories.

The export-oriented industries include handling of live, fresh and chilled shrimp and other products such as finfish, seaweed, jellyfish and value-added products. The products are usually destined for a large number of countries, mainly Japan, our neighbouring countries, Australia, European Union, United States of America, and Canada

1. Fisheries Resources

Indonesia is an archipelago, 70% of which comprise marine waters with a potential yield of 6.6 million tonnes. The level of exploitation of such marine fisheries resources was indicated in 1994 to be still at a low level, probably at about 30%. This means that a great deal of potential resources remain unexploited.

The areas of potential freshwater culture cover 180,000 hectares and the yield could be expected to reach some 675,000 tonnes. From areas of brackish water ranging from 420,000 to 840,000 hectares, production of 761,000 to 1,155,200 tonnes could be expected, if semi- to fully intensive culture is applied.

2. Fisheries production

During 1989 - 1993 total fish production increased from 3,036,268 tonnes in 1989, 76% of which being marine products, to 4,013,831 tonnes in 1994, an increase of approximately 6% each year.

Indonesia is now in the third year of its Sixth Five-Year Development Plan (1994-1999). The current plan is still geared towards promoting income for fishermen and fish farmers: providing employment opportunities, optimising utilization of production and increasing consumption of fish.

Fish production is projected to reach 4,587,000 tonnes in 1996, an average increase of about 5% per year.

3. Export of fishery products

Export of fishery products increased from 228,590 tonnes in 1989 to 545,371 tonnes in 1994, an increase of 9.7% per year, while value is projected to US$2,134 million in 1998. This represents an average increase of 9.7% per year.

During this period, the main species exported were shrimp, tuna and skipjack. In 1993, the export of shrimp contributed 58.3%, tuna-like species 14.2% and others included froglegs, seaweed, crabs, etc. accounted for 27.5%.

4. Fish consumption

Fish was estimated to provide about 60% of the domestic animal protein supply. The average annual per capita consumption of fish has been demonstrating a general increase in recent years although the level is still below the national recommendation of 26.55 kg per capita per year. The average consumption of fish currently reaches 19.14 kg per capita per year.

Status of Fishery Post-harvest Technology

1. Development of fish and fishery products

Of the total fish production 54% was distributed fresh in 1994 and the rest were processed products as seen in Table 1.

The traditional processing factories, comprising over 4721 units, engage in salting, drying, steaming, boiling, smoking and fermentation. They are mostly operated by small-scale processors to cater for the domestic market, while a number of medium and larger-scale factories are found which are also oriented for export market.

The export-oriented processing plants comprise over 220 freezing and 20 canning factories.

Those industrial processing plants target their products mainly for export markets. The main export commodities include shrimp, tuna, froglegs, sardine, seaweed, anchovies and jelly fish. High market value species such as red snapper, tilapia, pomfret, crab, sand goby, snail, etc. are also exported.

The main species marketed include tiger shrimp (*Penaeus monodon*), white shrimp (*Penaeus marguiensis*), pink shrimp (*Metapenaeopsis* spp.), flower shrimp (*Metapenaeopsis* spp.), *kuruma ebi* (*Penaeus japonicus*), freshwater shrimp (*Macrobrachium rosenbergii*) and lobster (*Panulirus* spp.).

Shrimp are presented to the market, either alive, fresh (chilled), frozen or dried. Product forms include headless shell-on (HL), head-on (HO) peeled and deveined (PD), peeled undeveined (PUD), peeled tail-on (PTO), individually quick frozen (IQF) and block frozen according to the requirements of the intended market.

Tuna include big-eye (*Thunnus obsus*), albacore (*Thunnus alelunga*), yellowfin (*Thunnus albacore*), bluefin (*Thunnus thynnus*), and Skipjack (*Katsuwonus pelamis*). They are marketed either fresh, frozen, canned or smoked and dried for domestic and export markets.

Bullfrog (*Rana catesbiana*) and Stone frog (*Rana macrodon*) and green frog (*Rana rana*) are usually marketed alive. These species are also marketed as individually quick frozen (IQF) froglegs.

Other fishery commodities of potential economic importance include :

- Sardine (*Sardinella longiceps*) is normally canned or prepared for fish meal.
- Seaweed: species like *Sargossum* spp., *Euchema spinosum*, *Gelidium* spp., *Gracilaria* spp. and *Hypnea* spp. are processed into dried agar (sheet, powder) and jelly.
- Anchovies from the *Stolephorus* species are processed into a variety of products such as chilled, dried, dried salted or unsalted.
- Dried jelly fish and sea-cucumber are prepared for domestic and export market.
- Other species of potential market value such as grouper, red snapper, pomfret, crab, sand goby, tilapia, eels (*Anguila anguila, A. bicolor*) can be marketed fresh, frozen, lives, canned, dried or smoked.
- Other value-added products include fish nugget, shark fin (dried, frozen), fish steak, *sushi ebi*, tuna steak, tuna ham are also developed.

2. Development of Quality Management Measures

The concept of quality assurance in terms of providing safety of fish and fishery products was developed by means of preventing food borne hazards through inspection and quality control.

Historically, the Indonesian fish inspection and quality control policy was launched in 1975; the Fish Inspection and Quality Control Programme was based on the Health and Hygiene Acts of 1960 and 1962. Since then, the Directorate-General of Fisheries has administered the inspection and quality control programme. The programme includes development of a Standardization system and of inspection of production facilities in terms of Good Manufacturing Practices (GMP) and the testing of product quality.

3. Current Legislation and Jurisdiction

a. Government Regulation no. 15/1991 issued on March 1, 1991 laying down the Indonesian National Standardization (INS).
b. Presidential Decree No. 19/1991 issued on March 1, 1991 setting forth the formulation, application and control of the Indonesian National Standard.
c. Presidential Decree No. 2/1990 issued on May 28, 1990 setting forth the Quality Control and Inspection of fresh and frozen seafood products.
d. A Memorandum of Understanding between Ministers of Agriculture, of Health, and of Trade, issued on May 28, 1990 setting forth the implementation of Inspection and Quality Control of fresh and frozen fish and fishery products.
e. An implementation decree issued by the Minister of Health no. 397/Men.Kes/SK/VIII/1990 dated August 24, 1990 setting forth regulation on additives permissible for use in handling and processing of fish and fishery products.
f. Presidential Decree No. 47/1986 issued on September 17, 1986 setting forth the Improvement of Post-Harvest Technology of Agricultural Product.
g. Ministry of Agriculture decree no. 303/Kpts./OT.210/4/1994 setting forth the development of quality management system of agricultural products.
h. Ministry of Agriculture decree No. 304/Kpts./OT.210/4/1994 setting forth the development of Standardization and Accreditation System for Agricultural Products.

4. Fish Inspection and Quality Control Programme.

The fish inspection and quality control policy was strategically taken through compulsory and supervisory approaches. The compulsory regulation was manifested with providing certifications, namely:

a. certification of Good Manufacturing Practices (GMP) which include sanitary and hygienic means.
b. certification of competence provided to the in-plant processing technologist and quality control supervisors.
c. certification of quality for exported products.
d. Letter of Origin/Quality for products transported inter-provincially.

Good Manufacturing Practices, including sanitary and hygienic compliances, need to be met by producers or processors as a prerequisite requirement for qualifying the plant to be registered as an approved establishment.

The inspector will verify whether or not the processing facilities meet the requirements of sanitation and hygiene assessment of the plant, and the operational aspects of their handling and processing. The inspection and certification guidelines were adopted from the "Codes of Practices" prepared by FAO/WHO Codex Alimentarius Committee for Fish and Fishery Products and other GMPs used by other countries (US, Canada, etc).

The certificate of GMP/sanitation will only be issued by the Director-General of Fisheries if the processing facilities pass the prescribed assessment of sanitation, hygiene and operational aspects of handling and processing. Otherwise, the plant will be categorised as non-compliant and will have to go through the supervisory programme for improvement before being re-assessed for registration as an approved establishment.

The application of quality management at fishery plants, whether they are traditionally or modernistically operated and whether their products are for domestic consumption or export purposes, are at different stages of development.

The processing plants are classified according to the degree of compliance of the prerequisite requirement. The processing plant must achieve at least "C+" grade to pass the inspection. Those which fall under grade "C-" and D are considered to be in non-compliance and will be supervised to correct the deficiencies within a specified period.

Most processing plants have employed a technologist-supervisor and a quality controller, each holding a certificate of competence issued by the Directorate-General of Fisheries through participation at formal and informal training on the subject of Fish Processing Technology and Quality Management System based on HACCP concept.

The final product will be sampled and tested by the inspectors engaged at the Laboratory of Fish Inspection and Quality Control (LFIQC) prior to exportation. Certificates will be issued if the products comply with the standard requirements of importing countries.

In addition, fish and fishery products transported and marketed inter-provincially or regionally should obtained a Letter of Origin from the local authority/LFIQC.

Development of HACCP-Based Integrated Quality Management Program (IQMP) in Fish Industries

1. Implementation of HACCP-based Quality Management system in developed countries

The international market for fish and fishery products is becoming more competitive in this globalization era. This is partly due to :

- growing concern over consumer protection which is based on food quality and safety with the developed countries leading the way to a tightening of requirements of importing countries;
- environmental issues which have forced producing countries into a difficult position and which have been used by some developing countries to protect their own interests.

The challenges above have been addressed by both government and private sector. As far as quality and safety is concerned, the fish and fishery industries inevitably have to keep pace with the current requirements imposed by the importing countries.

While the formal procedures for seafood quality assurance is now widely recognised under the GATT/WTO and Codex Alimentarius, the potential importing countries, namely EU (European Union), USA, Canada, Japan etc. have the expectation that producing countries will implement their fish inspection and quality control programmes, in terms of quality management, equivalent to the system applied in their own countries.

The Fish Inspection and Quality Control Systems of such major importing countries regulate the implementation of HACCP-based quality assurance programmes.

a. EU's HACCP-based own-check system

EU Council Directives nos. 91/492/EEC, 91/493/EEC, 92/48/EEC and 96/340/EC or so-called "EU's own-check system" rules, lay down the health conditions for the production and placing in the market of fish and fishery products for distribution and consumption to the EU.

The Directives require that all levels of operation must be regulated from the environment where products are harvested, fishing vessels, factory vessels, fish landing and auction halls, storages and transportation facilities. EU-version Health Certificate is required for all exported products certifying that those have been handled, prepared or processed, identified, stored and transported under conditions at least equivalent to those laid down in the Directives.

The EU Commission Decision no. 95/34/EC of 16 February 1995 amending no. 94/324/EC of May 1994, endorsed 152 processing plants to export fish and fishery products from Indonesia to EU countries. The approved establishments are recognised to be in compliance with the Council Directives no. 94/492/EEC; 91/493/EEC and 92/48/EEC.

b. US FDA-HACCP Mandatory Inspection

The HACCP programme became a law on 17 December 1995 and was stipulated in the 21 CFR part 123. The regulation will effectively be implemented by 18 December 1997. There are about 30 processors at the moment who have exported regularly to the USA.

c. Canadian HACCP-based Quality Management Programme

QMP follows HACCP fairly closely. It also includes all those 7 principles in different forms.

Canadian Federal Regulation stipulates that to facilitate entry of products into Canada, or in any case, producers wish to comply with "prefered status", the QMP shall be consequently implemented.

Based on the MOU established between the government of Canada and the exporting countries, fish processors of the producing countries who wish to possess "prefered status" should meet standardised prerequisite requirement before adhering to the Canadian QMP and have in place a QMP-equivalent quality control programme approved by the Department of Fishery and Oceanography (DFO) as the Canadian Competent Authority.

The plant facilities are inspected and rated by the DFO according to the compliance requirement for an in-plant QMP as described in the Canadian Fish Inspection Regulation.

Different programmes are used to describe such quality management systems, namely HACCP programme applied in the USA, own-check in UE and QMP in Canada. Regardless of which system is applied, the objectives are the same and the method are equivalent to the 7 principles.

2. Development of HACCP-based IQMP in Indonesian Fish Industries

In the development of the fishery industry a strategic policy is taken through an agribusiness development approach. The development of each sub-system of the agribusiness system from pre-harvest through post-harvest up to marketing is made with good management in all aspects of the production chain in mind. The objective is aimed to maximize the utilization of resources by minimizing losses and to maintain the safety of seafood produced.

In terms of export market development, both government and private sector have positioned themselves to harmonise the quality assurance system by developing for the past five years a HACCP-based quality management system. This is the so-called "Integrated Quality Management Programme (IQMP)" in the fishery industry. It is an approach to encompass the complete system of production system, the development of which is adopted from the Canadian QMP. The development of this IQMP is aimed not only to improve quality and safety, but also to improve the Indonesian product reputation in the international market, as well as to establish a self-regulatory quality control system in the fishery industry.

To enhance the implementation of a self-regulatory quality control system in the fishery industry, prerequisite requirements on Good Handling/ Manufacturing Practices (GHP/GMP) and hygienic practices have also been developed as an integral part of the quality management function, the activity of which is manifested in the HACCP-based IQMP.

To achieve the above objectives, development programmes have been carried out to strengthen the government and private sector institutions by providing transfer of technology on the application of HACCP-based IQMP.

Training have been provided to :

a. Senior fish inspectors who were trained as trainers (TOT). The training was conducted overseas as well as in-country.
b. Management personnel were also briefed on the concept of HACCP-based IQMP.
c. Fish inspectors engaged at the provincial and district levels and industry personnel (QA/QC) were trained in the IQMP-concept and an IQMP-Manual preparation.
d. Further training to both government and private personnel on the inspection system of IQMP implementation.

In exercising the implementation of IQMP procedure in the selected factories :

a. The inspectors were trained to conduct preliminary assessment on sanitation and hygiene and GMP as a prerequisite requirement of the plants for further training of application of IQMP.

The plant should meet the requirement of GMP including the sanitation and hygienic practices.

The inspection training provides the trainees with a detailed sanitation and hygienic assessment of the establishment and the operational aspects of the handling and processing techniques.

- Assessment of processing facilities
    - Environment / infrastructure
    - Building / construction
    - Production appliances and equipment
    - Transportation of product
    - Sanitary and hygienic procedures
- Assessment of material, handling and processing
    - Raw material
    - Water and ice quality
    - Additives
    - Packaging
    - Storage of raw materials, water, ice, end products, hazardous material and containers
    - Transportation and distribution
- Assessment of other components involved in the quality management program
    - Facilities
    - Material and final product
    - Employees
    - Waste products

b. Training on preparation of IQMP-manual based on the 7 principles of HACCP

To harmonize the program, all plants were trained in the development of in plant IQMP, adopted from Canadian QMP, which apply the rules on an approach to the identification of the hazards at their 12 generic CCPs, namely :

- Incoming shrimp/fish
- Packaging material
- Other ingredients
- Chemicals
- Labelling
- Construction / equipment
- Operation / sanitation
- Process control
- Cold storage
- Final product
- Recall

At each CCP the plant must :

- identify the standard that is being applied to ensure compliance with requirement
- identify the monitoring procedures and inspection frequencies that the standard is being met during production.
- identify the reporting mechanism that will be used at each CCP to document the results of the inspections (record keeping).
- to develop corrective action plans that will be followed, if and when the standard is not being met.

c. Exercising for validation, audit and verification of IQMP plan.

The training for both inspectors as well as plant-auditors to conduct the external and internal control measures, respectively, of the quality management function include :

- Validation of the written IQMP to ensure that the documented standards meet the minimum requirement
- Audit of the IQMP application in order to confirm that the written IQMP is being followed in the plant
- Verification that the processor's records are accurate.

d. Supervising the trial/implementation of IQMP.

The implementation of HACCP-based inspection programme requires :

- utilisation of skilled and experienced fields inspectors and in-plant QA/QC personnel
- upgrading of fishermen's knowledge
- enhanced awareness and understanding of processors with regard to the task of inspectors.
- development of sufficient facilities and equipment for fish landing, fishing vessels, fish auctions, and laboratories.

A significant output of the development of HACCP-based IQMP, an MOU on inspection of raw frozen shrimp between Department of Fisheries and Oceans (DFO) Canada and Directorate-General of Fisheries (DGF) Indonesia was materialized to facilitate the flow of trade shrimp products between Indonesia and Canada.

Moreover, according to the EU's Commission Decision number 95/34/EC of 16 February 1995 amending number 94/324/EC of May 1994, 152 processing plants have been endorsed to export fish and fishery product to EU member countries. The approved establishments are recognised to be in compliance with the Council Directives numbers 94/492/EEC; 91/493/EEC and 92/48/EEC.

Table 1. Distribution of fish and fisheries products in 1994.

Distribution	Weight (tonnes)	%
Freshly Consumed	1,675,372	54.39
Traditionally processed		
- dried / salted	778,093	25.26
- boiled / steamed	173,948	5.66
- cured / fermented		
* shrimp paste	21,122	0.68
* cured	10,374	0.34
* fish sauce	2,345	0.08
- smoked	62,891	2.04
- other preserved product	34,360	1.11
Frozen	262,168	8.52
Canned	26,626	0.86
Fish Meal	32,869	1.06

Source : Central Bureau of Statistics, Indonesia

Table 2. Fish and fishery products of market importance.

No.	Resources	Species	Processing	Form of product	Country of destination
1.	**Shrimp :**				
	Tiger	*Penaeus monodon*	Fresh / chilled Block frozen IQF	Raw/cooked, chilled shrimp Head on, shell on (HO) Headless, shell on (HL) Peeled, deveined (PD) Peeled, undeveined (PUD) Peeled, tail on (PTO) *Sushi ebi* Butterfly Shrimp ring Live	Japan, Singapore, Hong Kong, USA, Europe, Canada, Australia
	White	*Penaeus merguiensis*	Block Frozen IQF	Peeled, undeveined (PUD) Canned, peeled	- ditto -
	Pink	*Metapenaeus* spp.	Block frozen Canned IQF	Peeled, undeveined (PUD) Cocktail *Ebi*	- ditto -
	Flower	*Metapenaeopsis* spp.	Block frozen IQF Canned Dried		- ditto -

No.	Resource	Species	Processing	Form of product	Country of destination
1.	*Kuruma*	*Penaeus japonicus*	Live	Dry packed	- ditto -
	Lobster	*Panulirus* spp.	Live Chilled Frozen IQF	Dry / wet packed Head on Headless	- ditto -
2.	**Tuna :** Big eye Albacore Yellowfin Bluefin Skipjack	 *Thunnus obesus* *Thunnus alalunga* *Thunnus albacares* *Thunnus thynnus* *Katsuwomus pelamis*	 Fresh Frozen Canned Smoked	 Whole Whole, loin, chunk Chunk in brine oil Solid in brine oil Tuna in dressing sauce *Kastuobushi*	 Japan, Thailand, USA, Singapore
3.	**Frogleg :** Bullfrog Stonefrog Greenfrog	 *Rana catesbiana* *Rana makrodon* *Rana rana*	 Live Block frozen IQF	 Froglegs	 Singapore, Europe, Korea
4.	**Sardine :** Balinese sardine	 *Sardinella longiceps*	 Canned	 Solid in tomato sauce Solid in oil	 Domestic
5.	**Seaweed :** Brown Red	 *Sargassum* spp. *Eucheuma spinosum* *Gelidium* spp. *Gracilaria* spp. *Hypnea* spp.	 Dried Agar Jelly		 Japan, Denmark, Germany
6.	**Anchovies**	*Stolephorus commersonii*	Chilled, dried Dried unsalted/ Dried salted	Whole	Japan, Singapore
7.	**Others :** Grouper Red snapper Pomfret	 *Epinephelus merra* *Lutjanus sanguineus* *Pampus argenteus* *Formio niger*	 Fresh, frozen Salted, dried Fresh, frozen Salted, dried	 Whole, gutted, fillet Whole, gutted, fillet Whole, gutted, fillet Whole, gutted, fillet	 Singapore, Hong Kong
	Crab		Fresh frozen Live Canned	Whole Whole Meat only	Singapore, USA, Hong Kong
	Sand goby				
	Snail Tilapia Marine catfish	*Achatina* *Tilapia* *Arius thalassinus*	Live, canned Frozen Dried, salted	 Fillet, gutted Fillet, gutted	Europe, USA, Malaysia, Saudi-Arabia

Status and Development of the Fish Processing Industry in Malaysia

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Abstract

The main emphasis of the National Agriculture Policy is to increase food production. At the same time, the importance of managing the fishery resources on a sustainable basis is fully recognized. In the fisheries sector, the new Seventh Malaysian Plan stresses even further on achieving this objective via increasing efforts in off-shore fishing, aquaculture (essentially seawater cage culture) and downstream value-added activities, while at the same time reducing aquatic environmental degradation. This paper looks at the fishery resources, market outlook and consumption trends.

This paper also outlines trends and developments in the fish processing industry in Malaysia and includes research conducted by government organizations, research institutions and institutions of higher learning in the country. Emphasis will be given to the development and improvement of traditional products for wider acceptance, surimi and surimi-based products and product development from aquaculture produce. This involves the introduction of technological know-how by understanding the basic processes in an effort to upgrade the quality of the fishery products processed in the country.

The increasing consumer's demand for safe and high quality food products requires a concerted effort on the part of the food producers and R & D authorities to incorporate good quality management in food production. The fish processing industry is no exception. Priority settings in R & D with sound quality management are discussed.

Introduction

Food is vital to the survival of mankind. With the ever increasing population of the world, the demand for more food becomes critical. The industry itself is growing at a rapid rate. In Malaysia, it contributes significantly to the gross national product of the country, while providing the much needed employment opportunity for the population.

New technologies for better food production and processing are continually being introduced. To be competitive in the international markets, the food industry must keep abreast of any new developments in the fields. In the fishery sector, the post-harvest technology or rather the fish processing technology, provides a means and opportunity to maximize utilization and minimize losses of available resources.

With an increasingly complex scenario on managing the fisheries resources on a sustainable basis, R & D in fish processing emphasized on upgrading the production and development of new products. In this regard, MARDI has embarked on extensive research in the areas of development and improvement of traditional products, surimi and surimi-based products, and utilization of aquaculture produce (Wan Rahimah, 1995). However, commercialization of such products by the private sector has been rather slow as compared to other economic generating industries.

The demand for fresh and safe seafood has been high at all times, both locally and internationally. The present consumers are more conscious about food quality and safety. In response, regulations are made more stringent to ensure food safety and to facilitate fair trading. International trade has become more competitive. All these have put pressure on the producer to increase product quality and safety in a cost-effective manner. The government has an obligation to assist the industry in facing such challenges. Given a limited labour force and having to compete with other more attractive economic generating industries, the fish processing sector is now facing labour constraints. Again, this would call for concerted efforts by both the government and private sectors to address the situation, especially in formulating R & D priorities in areas of immediate needs.

Industry Analysis

Fish and fishery products will continue to form an important component of the Malaysian diet. At present, fish constitutes about 60-70% of the national animal protein intake with *per capita* consumption of about 37 kg per annum (Ibrahim, 1994). The rate of demand is expected to increase in the future not only because of the increasing population, but also because the population (lately quoted at close to 20 million people) is becoming increasingly conscious of fish and fishery products as health food items.

In 1994, fish production in Malaysia accounted for about 1.2 million tonnes valued at RM 2.99 billion and this has contributed about 1.61% to the national GDP. More than 90.2% of the total fish production were from the capture fisheries, whereas aquaculture contributed close to 9.6%, and the inland fisheries registered at 0.2% (Department of Fisheries, 1994). Export figures in the same year, amounted to RM 865.9 million whereas import was at RM 808.1 million; thus giving a trade surplus of merely RM 58 million. This was far below the figures registered in previous years, as indicated in Table 1.

The fishery sector also supports direct employment to 79,802 fishermen and 18,143 aquaculturists, giving a total of 97,945 persons employed directly in the fisheries industry. This constituted about 1.29 % of the labour force in the country. Indirect employment through fishery-related activities is too numerous to consider, but on the whole contributed a significant role in the development of the fishery's industry.

Table 1. Fisheries trade of Malaysia (1987-1994).

Year	Export (RM million)	Import (RM million)	Surplus (RM million)
1987	445	353	92
1988	508	384	124
1989	577	456	121
1990	630	405	225
1991	740	480	260
1992	765	633	132
1993	801	691	110
1994	866	808	58

Source: Department of Fisheries, Malaysia

Fishery Trade and Consumption

In terms of value, Malaysia is a net exporter of fish and fishery products. However, in terms of quantity, the country is a net importer. The strong economic performance and improved health conditions has somewhat influenced the increase in population, with bigger old-age and young infant groups in addition to the increasing size of the youth group. This had also resulted in an increase in fish consumption as the main animal protein source. Taking into account the increasing fish landings annually, both from capture fishery as well as aquaculture, Table 1 shows that, while there were substantial increase in exports, there was also a big leap in the import figure from 1993 to 1994. Possible reasons include the following:

a. An overall increase in household income has influenced the eating preference of an individual family unit. Seafood restaurants are more frequently visited either as a family function or as an organized group function. The demand for good quality fish has in fact increased together with an increase in the demand for special delicacies that are of foreign origins. In effect, more Grade I and II fish are being sought after. At the same time, the demand for Grade III fishes maintained a slower momentum of growth, especially for the lower income-group.
b. With the rapid development in industrialization, the influx of foreign workers, to meet the urgent requirement in labour force, has also increased. To date, it has probably been estimated to be more than two million. Fish consumption trend, especially in the urban areas, was mostly affected by this increase in foreign workers, with more demand for Grade III fishes, aquaculture and freshwater species.
c. The tourism industry has spurred the seafood consumption substantially. Organized group functions for foreign tourists are more visible in big cities. This has prompted the increase in the number of seafood restaurant chain, and at the same time developed 'foreign taste' in the menus provided. More Grade I and II, and imported items were being sought after.

d. An increased emphasis on aquaculture has resulted in an increase in the demand for aquaculture feed supply. More fishery resources were being diverted into fishmeal production and more import of fishmeal that is unfit for human consumption was observed. Consequently, the fishery trade observed more import and less export.
e. Market trend and consumption have also triggered fish processors to increase production and introduce product varieties in the market. Nevertheless, it seemed that effort is still short of meeting the increasing demand. Therefore, there is a need to double up the present effort.

Traditionally, we have been exporting Grade I and some Grade II, while importing Grade III fish for the mass majority. This was done in accordance with the preferential taste and demand. However, from the above scenario, this trend has lately changed somewhat. The following tables provide some indication of the fishery trade in Malaysia.

Table 2. Fish exports to various countries, 1993 and 1994.

Country	1993		1994		Change (%)
	Quantity (Tonnes)	Percent (%)	Quantity (Tonnes)	Percent (%)	
Thailand	63,751	30.9	77,526	31.4	+ 21.6
Japan	26,341	12.8	55,317	22.4	+110.0
Singapore	71,088	34.5	54,108	21.9	- 23.9
Italy	2,177	1.1	17,812	7.2	+ 718.2
Australia	7,204	3.5	7,652	3.1	+ 6.2
U.S.A	5,944	2.9	5,285	2.2	- 11.1
Hong Kong	3,883	1.9	4,751	1.9	+ 22.4
United Kingdom	2,351	1.1	3,608	1.5	+ 53.5
Others	23,450	11.3	20,664	8.4	- 11.9
Total	206,189	100.0	246,723	100.0	+ 19.7

Source : Department of Fisheries, Malaysia

In 1994, the bulk of the fishery commodities was exported to Thailand (31.4%), Japan (22.4%) and Singapore (21.9%); as indicated in Table 2. In terms of export value, however, Japan still remained the top importer (31%), followed by Singapore (14.4%), Australia (8.5%) and U.S.A at 7.6%; as indicated in Table 3.

Table 3. Value of fish exports to various countries, 1993 and 1994.

1993 Country	1993		1994		Change (%)
	Value (RM million)	Percent (%)	Value (RM million)	Percent (%)	
Japan	264.9	33.1	269.3	31.1	+ 1.7
Singapore	132.3	16.5	124.8	14.4	- 5.7
Australia	59.0	7.4	73.9	8.5	+ 25.3
U.S.A	61.6	7.7	65.8	7.6	+ 6.8
Hong Kong	50.7	6.3	54.5	6.3	+ 7.5
Italy	27.7	3.4	40.5	4.7	+ 46.2
Spain	27.0	3.4	35.5	4.1	+ 31.5
Thailand	27.8	3.5	35.1	4.1	+ 26.3
Others	149.7	18.7	166.5	19.2	+ 11.2
Total	800.7	100.0	865.9	100.0	+ 8.1

Source : Department of Fisheries, Malaysia

The difference in export quantity and value to the various countries suggested that export to countries like Japan, U.S.A and other European countries mainly of fishery commodity of higher value, whereas the export to countries like Thailand consisted mainly of cheaper fishery commodities. As evident from Table 4, Malaysia exported high value fishery commodities like fresh and frozen prawns, while importing lower value fishery commodities like fresh, chilled and frozen fish in order to obtain foreign exchange and country to meet the domestic demand.

Tables 5 and 6 indicate that there was a significant amount of trade in fishmeal which is unfit for human consumption, between 1993 and 1994. All in, about more than 70% increase was observed. Obviously, this increase could be due to the increase in aquaculture activities throughout the period.

Table 4. Composition of export and import of fish and fish products, 1994.

Composition	Export		Import	
	Quantity (Tonnes)	Value (RM)	Quantity (Tonnes)	Value (RM)
Live fish	6,115.4	57,684,339	1,122.8	56,832,420
Fish, fresh or chilled	21,815.9	51,430,606	132,234.9	277,216,113
Frozen fish	26,590.7	36,423,170	43,962.0	137,982,070
Shrimps, prawns, lobsters fresh, frozen	14,148.3	269,685,889	24,146.2	119,605,944
Squid, cuttlefish, octopus & other mollusc, fresh, chilled or frozen	127,008.4	76,487,488	2,141.5	6,489,956
Fish prepared or preserved, n.e.s: caviar and other caviar substitutes prepared from fish eggs	24,414.1	190,121,205	12,916.0	61,473,620
Crustaceans, mollusc and other aquatic invertebrates, prepared or preserved, n.e.s	11,955.9	130,067,635	6,437.1	27,087,440
Fishmeal unfit for human consumption	4,273.8	4,514,571	25,935.2	34,990,746
Miscellaneous	10,400.4	49,511,946	26,983.8	86,456,769
Total	246,722.9	865,926,849	275,879.5	808,135,078

Source : Department of Fisheries, Malaysia

Table 5. Composition of export of fishery commodities from Malaysia, 1993 and 1994.

Composition	Export Quantity (Tonnes)		Change (%)
	1993	1994	
Live Fish	6,325.92	6,115.36	- 3.3
Fish, Fresh or Chilled	22,309.86	21,815.89	- 2.2
Frozen Fish	19,216.15	26,590.71	+ 38.4
Shrimps, Prawns, lobsters fresh, frozen	12,918.96	14,148.35	+ 9.5
Squid, cuttlefish, octopus & other mollusc, fresh, chilled or frozen	81,569.04	127,008.04	+ 55.7
Fish prepared or preserved, n.e.s: caviar and other caviar substitutes prepared from fish eggs	32,544.50	24,414.12	- 25.0
Crustaceans, Mollusc and other aquatic invertebrates, prepared or preserved, n.e.s	11,542.89	11,955.93	+ 3.6
Fishmeal unfit for human consumption	6,895.76	4,273.76	- 38.0
Miscellaneous	12,866.15	10,400.39	- 19.2
Total	206,189.23	246,722.55	+ 19.7

Source : Department of Fisheries, Malaysia

Table 5. Composition of import of fishery commodities from Malaysia, 1993 and 1994.

Composition	Import Quantity (Tonnes)		Change (%)
	1993	1994	
Live Fish	1,042.9	1,122.8	+ 7.7
Fish, Fresh or Chilled	132,5.1.4	132,234.9	- 0.2
Frozen Fish	43,887.6	43,962.0	+ 0.2
Shrimps, Prawns, lobsters fresh, frozen	23,365.3	24,146.2	+ 3.3
Squid, cuttlefish, octopus & other mollusc, fresh, chilled or frozen	1,334.2	2,141.5	+ 60.5
Fish prepared or preserved, n.e.s: caviar and other caviar substitutes prepared from fish eggs	10,681.2	12,916.0	+ 20.9
Crustaceans, Mollusc and other aquatic invertebrates, prepared or preserved, n.e.s	4,878.3	6,437.1	+ 32.0
Fishmeal unfit for human consumption	19,476.7	25,935.2	+ 33.2
Miscellaneous	24,463.0	26,983.8	+ 10.3
Total	261,630.6	275,879.5	+ 5.4

Source : Department of Fisheries, Malaysia

On the whole, consumption of fish has increased substantially both for direct human needs as well as for aquaculture. Increase efforts in aquaculture for an increase in fish production, to some extent, affect the availability of raw materials for value-added fish processing and also for fresh consumption. With the present trend in fish consumption and fish production, Malaysia would still be a net importer as well as exporter of other fish and fishery commodities at the turn of the century.

R & D in Product Development

In recent years research in selected areas of the fishery processing sector was conducted by research organizations, government agencies and institutions of higher learning in the country. Research is essential in upgrading the quality level of products processed by small and medium scale processors located throughout the country.

1. Improvement of Traditional Products

A lot of effort has been made with a view to upgrade the status and acceptability of fish-based traditional products in Malaysia. With the presence of traditional products such as snacks, fermented and dried and/or salted products, efforts are directed towards the use of appropriate technology to control the processes involved.

In the processing of fish crackers various critical control points have been identified and selected technologies have been adapted for use at the processor's level (Wan Rahimah, 1996). This includes the introduction of the mechanical stuffer for uniformity of shape and the use of mechanical dryers for better control of the drying process. Recently, there is the emergence of ready-to-eat fish crackers that are processed in a slightly different manner from the norm. Many small-scale processors have closed down their activities in recent years due to shortage of traditional raw materials and a simultaneous increase in cost of production.

In the case of dried salted fish, efforts are being undertaken by various government agencies towards more organized activities at the processor's level so that some control during salting and drying is achieved. This would contribute towards overall quality improvement of the products.

An effort has also been made by MARDI to improve the production of *sesar unjur* a traditional dried product of Sarawak made from prawns by the use of a mechanical drier for better control of the drying process (Wan Johari, 1994).

2. Surimi and Surimi-Based Products

Even though surimi-based products have been introduced into the country decades ago, it was only a few years back that the processing was established in the country in spite of the availability of technology. This is attributed mainly to the rapid growth of small-scale processors of surimi-based products who previously were highly dependent on fresh raw material or surimi imported from neighbouring countries. Presently, there are three big processors of surimi in the country located in Peninsular Malaysia and two in East Malaysia. These processors are located throughout the country, mainly in the vicinity of urban dwellings.

Surimi and surimi-based production makes up 6.4 percent of total processed products for 1994 (Department of Fisheries, 1994). Some studies have been conducted on the suitability of local raw materials for surimi production, their gel strength and shelf life (Wan Rahimah *et. al.,* 1994). Che Rohani and Indon (1994) have developed high protein and low fat products which range from steamed, boiled, fried and breaded products thus paving the way for more varied products on the market.

3. Products From Aquaculture Produce

With the expected increase in aquaculture production to 200,000 tonnes in the year 2020 under the National Agricultural Policy, efforts have been concentrated on better utilization of aquaculture species. Presently, the uses of freshwater and brackish water species are not fully exploited and these are mainly in the form of dried, salted and fermented products.

Research on the utilization of aquaculture produce included the development of surimi, breaded and smoked products. Red tilapia and grass carp have been found to yield high grade surimi comparable to threadfin bream and bigeye snapper (Che Rohani *et. al.,* 1994). Breaded tilapia has also been developed (Jamilah, 1994). Catfish, tilapia, grasscarp and *sultan* fish have been found to yield quality smoked products using *meranti* sawdust or wood shavings as the smoke source.

The above research activities show that the scope for developing quality products using appropriate technology to complement the rapid growth of the aquaculture industry in the country is tremendous.

Constraints Faced by the Fish Processing Industry

There are at present, more than sixty fish processing industries in Malaysia (Mohd. Khairuddin, *pers. comm.*) and mostly associated with the Federation of Food Manufacturers of Malaysia. However very few are in fact associated with the ASEAN Fishery Federation - Malaysian Chapter. There are probably more than double this figure as there are fish processors operating at the cottage industry level. Besides the fishmeal processing industries, the big players are mainly canneries, frozen fish processors and surimi-based industries. Others include the fish cracker industry, salted-dried fish, fermented products and boiled products.

1. Raw Materials

There is just not enough suitable raw materials with regular supply to meet the need of the industries. As such, competition for limited raw materials always result in a higher sales price for raw materials. This situation is not conducive to the small operators and even some big players have also expressed their grievances. As such, supplies from aquaculture are very much in demand.

2. Manpower

Due to the shortage of manpower, the use of foreign workers is seen as just a short term measure. Upgrading the technology from labour-intensive to mechanization would seem to be the logical move. But such move would entail high initial capital cost. This is where the management would have to decide the priorities for sustainable operation, taking into consideration the possible scale of operation.

3. Processing Technology and Quality/Safety Compliance

There are still a lot of venues for improvement since the rate of processing technology development is very much faster than the adoption of such technology by the industry. Obviously the fish processing industry has improved, so as to keep up with the keen competition in this arena, but generally, at a slower pace as compared to other food processing industries. Faced with stricter rules and regulations pertaining to food safety and quality, the fish processing industry has no choice but to keep pace with the latest technology available and adapt wherever appropriate. GMP, HACCP and possibly ISO 9000 series or even ISO 14000 will have to be considered as part of the quality management program, to ensure product integrity. Perhaps, for big operators, implementing such a quality management program would not be that difficult. But for small operators, government intervention is really a necessity. Towards this end, government agencies are actively involved in promoting quality management practices through training courses, preparation of audio-visual aids, through extension services and also through collaborative R & D efforts.

Future Developments

The National Agricultural Policy placed a high priority in an effort to increase food production. The 7th Malaysian Plan (1996-2000) further emphasized this aspect by defining the priority areas. In view of the increase in fish utilization, the thrust areas in fisheries post-harvest sector, amongst others, include :

a. Marine Biotechnology work encompassing Biodiversity, Biomining/Marine Natural Products, Bioremediation and Biomonitoring, and Mariculture Biotechnology.
b. Development of standards and quality assurance programs in the production of wholesome, *HALAL,* safe and healthy aquatic produce.
c. Product development targeting at improving traditional products, utilization of by-catch and reducing post-harvest losses through maximizing fish utilization.

Efforts to increase fish production through aquaculture essentially in off-shore cage culture, joint-venture in deep-sea operation and greater impetus in R & D in down-stream activities are very much encouraged. The industry is also encouraged to move from labour intensive production systems to capital intensive and to use of non-traditional labour force. The private sectors' participation in Science and Technology development together with research organizations and universities is very much needed to accelerate further the phase of development.

Yu (1995) had rightly outlined the direction of research for fish processing industry. In surimi and surimi-based products, these include studies on the use of new species, salt substitution for low salt surimi and the substitution for MSG (Monosodium glutamate). The use of lactic acid bacteria (LAB) and the application of enzymes in biopreservation of seafood, has attracted much interest of late. Concern on aquatic environmental pollution has generated interest on effort in evaluating treatments for waste generated from processing, refrigeration and packaging. Perhaps, academia and related research institutions would undertake further research in this regard.

In terms of ensuring food safety and quality, the Department of Fisheries has embarked on setting up an FIQC (Fish Inspection and Quality Control) mechanism to assist the Health Ministry to enforce Food Regulation 1985 essentially for fish and fishery products. New Food Import and Export Regulations are also being drafted to assist the food industry in fair trading and complying with quality and safety standards. Sanitation and hygiene as prerequisites for HACCP and the importance of implementing HACCP is greatly emphasized in the new draft. The draft which is still in the evaluation stage, is being perused by the relevant agencies and government authorities, before being tabled in the Cabinet. In product development, MARDI would still be the leading agency, with more active participation from the private sector and academia anticipated.

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Discussion

With regards to the procedure used in Malaysia for grading fish as reported in the paper, the representative from Malaysia clarified that grading was made according to species, so that low-priced fish were graded lower than high priced fish.

HACCP-Based Philippine Fish Inspection Program

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ABSTRACT

This paper presents the current fish processing activities in the Philippines with particular emphasis on fish product quality management. It highlights some significant laboratory, technological and industrial advances that affect fish product quality management. The current activities to implement the program which includes training, technical and advisory assistance are presented. Future developments, government policies and priorities to support the program are also presented.

The implementation of Hazard Analysis Critical Control Points (HACCP) as a quality management system is currently the most important agenda among the food manufacturers. Compliance with USFDA Regulations on HACCP by 1997 and with EC Directives have become major concerns of the industry. Such quality systems have urged the government to initiate moves by which the industry can comply in order to maintain the country's position in the highly competitive seafood trade.

Fish Processing Industry Status

The agreements on the Exclusive Economic Zone (EEZ) and the United Nations Convention on the Law of the Sea (UNCLOS) highlighted the Philippines as an archipelago having the second largest expanse of territorial waters next to the United States (Gatchalian 1996).

As an archipelago, this country is a favourable habitat for abundant marine resources where fish remains an important staple food for the people. The fish consumption of 40 kg per capita per year (Giron, 1994) which represents 60% of the protein requirement of Filipinos (Shahani, 1991) is twice the per capita consumption for fresh/processed meat, poultry and other meat products combined (16.5 kg per capita per year). This data underscores the significance of fish as a staple food (Gatchalian, 1996).

The Philippines is a major supplier of fish and fishery products to key seafood trading partners namely, Japan, USA and EC among others. It has active fish/prawn farming and processing industries with products that are mostly sought for the export market. Latest records show that the Philippines is the 12th largest fish producer in the world. Its fishing industry accounts for 3.9% and 4.9 % of the country's Gross Domestic Product (GDP) at current and constant prices, respectively (BFAR, 1995).

However, with a rapidly increasing population at an estimated rate of 2.4 % per year and the continuous abuse of the seas, studies and observations made of marine life have shown possible reduction in available fish supplies by the year 2000.

1. Processing Activities

The total fish production of the Philippines in 1994 was 2.6 million tonnes (BFAR, 1995). Approximately 70% of the total catch is consumed fresh/chilled while 30% are processed, viz cured, canned, frozen fillets, dressed fish or disposed live.

Fish processing activities involve the use of fish processing and preservation methods of smoking, drying, salting, fermenting, canning, icing, chilling and freezing.

The production of certain value-added products such as fish balls, squid and cuttlefish balls, fish and squid patties and nuggets proved to be successful. Exports of some of these products have been attempted by a few exporters on a limited scale.

The bulk of products from traditional fish processing industries is absorbed by the local market, with small quantities exported as ethnic products. Canned, fresh, chilled/frozen products are usually exported. Total fish products exported in 1994 was 172,080 tonnes valued at P 15,027 million (NSO, 1995) as shown in Table 1.

Trawl by-catch, rejects from dried and smoked fish and from by-products of imported raw materials are reduced into meals and used as animal feed ingredients and fertilizers.

Chitin and chitosan processing has been attempted to convert crustacean shell wastes into high-value by-products of relatively significant economic importance. A pilot plant for chitin and chitosan processing has been established in Roxas City. The products produced are now on market trial in Germany.

The major fish processing industries by region are shown in Table 2.

Significant Laboratory, Technological and Industrial Advances that Affect Fish Product Quality Management

1. BFAR as the Regulatory Agency for Fish and Fishery Products

The Bureau of Fisheries and Aquatic Resources (BAR) is mandated under Fisheries Administrative Order (FAO) no. L17 to regulate the operation of fish processing plants , and prescribe/ require standard quality control and inspection of processed fish and aquatic products. This is pursuant to the provisions of Sections 7, 16 and 18 Of Presidential Decree (PD) 704 known as the Fisheries Decree of 1975.

For the past years, the BFAR performed its regulatory functions as stipulated in this law. The fish inspectors inspect and monitor fish processing plants during which they prescribe minimum requirements to ensure that fish products are properly processed and that they are safe for human consumption. Among the other objects of inspection and monitoring of fish processing plants, this law enables the BFAR to check the quality standards for shrimps and prawns and the grades for tuna, the processing procedures and the hygiene and sanitation aspects of seafood processing operations.

2.New Developments in Fish Quality Management

New developments in fish quality management have taken place recently. With the trading of fishery products becoming highly active in the Asia Pacific region, there is also the trend in this region and world-wide toward more stringent consumer expectations regarding food quality and safety. Consequently, governments have to tighten up regulations and implement new control systems covering fish and fishery products. Adjustments are to be made in the Philippines and new techniques are necessary as countries and processing facilities move from end-product verification as a quality control system to evaluation of the system in the country where the product is produced.

This is also in response to the need to provide safe food supplies to the peoples of the world in addition to the continuously changing consumer demands and expectations. USA and Canada imposed the Hazard Analysis Critical Control Point (HACCP) quality system. Canada had earlier developed its Quality Management Program (QMP) which is HACCP-based in concept. USA made HACCP regulation mandatory by 1997. The European Economic Communities (EEC) prescribed their requirements for fish products entering the EC market in its Council Directives.

Under the Quebec Declaration for sustainable fisheries development, we should promote international trade, efficient marketing and distribution, reduce post harvest losses and realize the potential of traditional foods. This declaration is best addressed in the HACCP-based quality system. With a HACCP-based quality management program in place, smooth international trade in fish products can be easily achieved and safer supplies could be made available to all consumers.

Similarly, the Kyoto Declaration of 1995 states that for sustainable contribution of fisheries to food security, it is our responsibility to increase fish supplies for human consumption through optimum use of fish harvested and by reducing losses and developing and improving appropriate technology and effective systems while ensuring safety of foods.

Under the Code of Responsible Fisheries, the harvesting, processing and distribution of fishery products should be carried out in a manner which will maintain nutritional value, quality and safety of the products, reduce waste and minimize negative impact on the environment. There are similar provisions for responsible international trade in fishery products which could serve as guides for both government and the industry sectors.

a. The Second National Fisheries Development and Policy Planning Workshop

The Quebec and Kyoto Declarations and the Code of Responsible Fisheries became the guiding principles for the Philippine policy makers in developing strategic plans for fish post- harvest technology in its Second National Workshop on Fisheries Development and Policy Planning held in February 1996. This strategic plan highlighted the directions for priority actions to be undertaken to improve the management of fish post-harvest technology of the industry over the next 5 years.

b. The Medium Term Fisheries Management and Development Program

At present the BFAR is implementing the Medium Term Fisheries Management and Development Program (MTFDMP) in which Post-Harvest Marketing and Infrastructure is one of the major components which included aquaculture and marine fisheries. The objective of this program is to increase fish and aquatic resources production within ecological limits and to alleviate the living conditions of the fisher folk.

Under this component, the institutionalization of fish inspection procedures, research and extension on value-added products and on the reduction of post-harvest losses are top priorities. Presently, infrastructure improvement activities include establishment, improvement and rehabilitation of fishing ports and landing areas, ice plants and cold storages and other facilities related to post- harvest. Market matching and marketing support are also provided.

c. The Philippine Legislation as an Exporter of Fish Products to EC

This legislation known as 95/190/EEC issued by the European Commission (EC) on 17 May 1995 took effect on 01 August 1995. This legislation brought about a number of significant changes to the fish inspection and quality control program of the BFAR. Under this law, the BFAR is the government authority on fish and fishery products recognized by the EC. Thus focused a HACCP-based fish inspection and quality control program was developed for the BFAR.

3. HACCP-based Inspection, Monitoring and Verification of Fish Processing Plants

a. Designation of BFAR Fish Inspectors and Department of Agriculture (DA) Regional Office Fish Inspectors

The Post Harvest Technology Division (PHTD) of the BFAR is the core of fish inspection activities. It has seven (7) trained fish inspectors in Metro Manila who perform fish inspection and plant monitoring activities; they also co-ordinate with the DA regional fish inspectors.

The number of fish inspectors and their corresponding areas of inspection are shown in Table 3.

The regional fish inspectors inspect and monitor the fish processing plants located within their areas of inspection and submit reports of inspection to the PHTD-BFAR regularly. At present there are 58 fish processing plants accredited to export fish products to the EC. However, only 38 of them are actively exporting to EC.

With the approval of the Philippine legislation as an exporter of fish products to the EC, it became compulsory for the government to implement a HACCP-based inspection scheme to monitor and verify fish processing establishments, especially the EC-accredited plants. This scheme of inspection is described below.

b. Inspection of EC-accredited Fish Plants

The EC-accredited fish processing plants have been graded as grades A, B and C. The descriptions for each grade are as follows :

Grade A - fish plants which fully comply with EC requirements and are given unlimited approval to export to the EC. These plants are inspected once or twice a year.

Grade B - fish plants with a minimum of 5 minor to major deficiencies, but without critical or serious deficiencies. These plants are recommended for accreditation and are monitored by the regional fish inspectors every month.

Grade C - fish plants with 6 to 10 major and critical deficiencies. These plants are not recommended for accreditation if they cannot rectify their critical deficiencies.

Fish inspection is carried out by the fish inspectors using a set of prepared questionnaire. The fish inspectors study the records of the plant from the time raw materials are received until it becomes a final product. This includes, among others, the reports of the production manager as to the incoming raw materials and ingredients, processing methods performed on the product, records of plant, personnel hygiene and sanitation program. They also inspect the plant and equipment layout, and their maintenance during the operation. Some plants embody all these information in their plants' quality management program or the HACCP program.

After the review of plant records, the inspectors check and verify whether those information in the plant's quality management program are implemented in the production line.

All observations made are noted in the inspection report and are discussed with the plant manager at the end of the inspection. A copy of this report is given to the plant while another copy is kept with the DA/BFAR for filing and reference purposes. These inspection reports serve as guides for BFAR and DA signatories who subsequently issue the health certificates for the fish exportered.

c. Inspection of Fish Plants for Accreditation to EC

After the accreditation of the Philippines as an exporter of fish products to the EC, more and more fish plants have sought the help of the BFAR with the intention to join the scheme. The following are the requirements for accreditation of fish processing plants.

i. A License to Operate (LTO) Number

This is to be secured from the Bureau of Food and Drugs (BFAD), the government agency mandated to conduct inspection of all food processing plants to ensure that they are observing the Good Manufacturing Practices (GMP) and proper hygiene and sanitation. The LTO number issued by the BFAD eventually becomes the EC approval number of the plant which is required of an exporter to the EC.

ii. Plant Inspection by the BFAR/DA Fish Inspectors

As soon as the plant has secured its LTO, it can request the BFAR/DA to inspect their plant. If the plant fully complies with the EC requirements and has a quality management program in place, then it is recommended for unlimited approval to export products to EC.

If the plant is graded B, then it is recommended for an initial one year's accreditation. If they can fully comply with the EC requirements and a quality management program is in place, then they can be subsequently upgraded to unlimited approval. Grade C plants which are not complying with the EC requirements are advised accordingly and are recommended for accreditation only after all requirements are satisfactorily complied with.

iii. Compliance with EC Requirements

Each plant is given a copy of the Council Directives 91/493/EC and 95/190/EC for their compliance. These Directives are discussed by the fish inspectors with the plant manager during the initial inspection. Compliance with these requirements should be done not only when there is an inspection team visiting to the plant, but it should become the plant's quality management program guide in order that it can be recommended for accreditation.

d. Issuance of Product Health Certificate

The BFAR Director is the authorized signatory to the health certificate for fish products for export to EC. However, this function is delegated to its Post-Harvest Technology Division. In addition, due to the strategic locations of the accredited plants, the issuance of the health certificates in the regions was delegated to the DA Regional Directors for Fisheries.

d. Verification of Fish Product Quality

Verification of fish product quality is performed by government and accredited private laboratories. Representative samples of fish products for export are examined using chemical, sensory and microbiological methods. The results are used as reference as to the fitness of the products for human consumption. Records of fish product analysed are filed with the DA and BFAR as the signatories to the health certificates while the plants keep their own files for verification and reference purposes.

Current Activities to Implement the HACCP-Based Quality Management Program

1. Training and Seminars

a. Training on EC Directives

The BFAR conducted a training course on the implementation of EC Directives and the mechanics of plant inspection for the regional fish inspectors and signatories to the health certificate based on the requirements of the EC. This enabled the participants to understand the basic principles and application of HACCP which are the essence of the EC Directives. They were also taught the requirements for accreditation of fish processing plants and the provisions of the EC Council Directives 91/493/EC and 95/190/EC on the export of fish products to EC.

b. Training on HACCP for Fish Inspectors

The First National Training on HACCP was conducted for regional fish inspectors. This training includes exercises on the application of the seven principles of HACCP and provided the participants with practical hands-on experience on the development of a HACCP program for each given fishery product.

c. Training on HACCP for Fish Processors

Shortly after the training on HACCP for fish inspectors, the fish processors requested the BFAR to conduct a similar training course for them. It was in Mindanao where most of the tuna canning plants are located that this training was conducted. The participants were 25 QC-managers and supervisors, representing the seafood industry from this area. Other processing industries such as fresh/frozen fish, smoked fish and value-added fish product industries were also represented. The participants were taught how to develop their own HACCP plans.

d. APEC Seminar on Evaluation of HACCP and Quality Systems

The BFAR hosted the above seminar which was designed for seafood industry representatives from APEC member economies. This was conducted by quality systems specialists from US Food and Drug Administration (USFDA), Australian Quarantine Inspection Service (AQIS), the Canadian Department of Fisheries and Oceans (DFO) and the US National Marine Fisheries Service (NMFS). Taiwan and Singapore representatives were in attendance and the rest of the participants came from the Philippine seafood industries. This seminar was sponsored by USA and Canada.

This seminar was able to improve the working relationship between the plant QC managers and the BFAR fish inspectors during plant assessment activities. Both parties now understand how to deal with each other better during plant assessment activities.

e. HACCP Curriculum Steering Committee Meeting

The BFAR participated in an overview workshop of the HRD Process for HACCP curriculum development intended for skills training in each occupational level: managers, supervisors and line workers.

The ASEAN-Canada Post Harvest Technology Project-Phase II will be submitting a project intended solely to train plant personnel on HACCP to be funded by Canadian International Development Agency from 1997 to 1999 for the ASEAN region. The steering committee will formulate the training curriculum for 4 occupational levels.

This project will enable each processing plant to develop their own HACCP plans to best effect. Since more plant personnel will be trained on HACCP, they will become more quality-conscious and be able to upgrade their skills and competence in implementing their quality assurance programs.

2. Technical and Advisory Assistance

The BFAR and other government agencies performing regulatory functions related to fish product quality management work hand-in-hand to provide technical and advisory services to the industry.

The government and private laboratories accredited to conduct analysis of fish products provide similar support to the industry. The major technical and advisory services rendered to the seafood industry on quality management are as follows :

a. laboratory analysis of products (chemical, microbiological and sensory evaluation),
b. issuance of product quality certificate for export to both EC and non-EC countries,
c. development and quality improvement of products,
d. inspection of imported fish products,
e. inspection of fishing ports and landing areas,
f. inspection, monitoring and verification of fish processing plants, and
g. information dissemination through training, seminar and workshops.

3. Implementation of the Consumer Act of the Philippines

Republic Act No. 7394 is known as the Consumer Act of the Philippines which took effect on 15 July 1992.

Under this Act, the State protects the interests of the consumer, promotes his general welfare and establishes standards of conduct for business and industry.

The implementation of this act is delegated to the Department of Health (DOH) for food and drugs; the Department of Agriculture (DA) for agricultural products; and the Department of Trade and Industry (DTI) for other industrial products and services not covered by the DOH and the DA.

As implementors of this Act, these agencies are mandated to establish quality and safety standards of consumer products, tests and codes of practice to check the quality and safety of the products; assist consumers in evaluating product quality; protect the public against health risks; undertake research to improve product quality and assure the public of consistently standardized products and services.

They are also mandated to inspect processing plants before the issuance of a License to Operate (LTO), monitor operations, issue certificates of product quality and to recall any product in the market deemed not conforming to established standards and unfit for human consumption.

The sale and distribution of unprocessed fish for public consumption is regulated by the provincial, municipal, and city government pursuant to the provisions of the Local Government Code.

With the implementation of the Consumer Act of the Philippines, issues and problems pertaining to fish products for local consumption are now properly addressed. This also gives the local consumers the assurance that they can fully exercise their rights as consumers.

Issues and Problems

1. The need to strengthen the country's competitive position in the world market for fish and fishery products.
   Fisheries exports have made great strides in recent years and contributed significantly to the country's foreign currency earnings. However, the following developments have undermined the country's competitive position in the world market.
   - The Philippines has lost its position as the largest exporter of canned tuna, in spite of the country's advantage of being first in the export market, of having skilled labor, and being strategically located in the richest tuna area in the world.
   - The mid-1989 drop in the world price of shrimp caused a tremendous crisis in the local shrimp industry and the whole aquaculture industry. The industry found it almost impossible to compete with other suppliers in the world due to high input prices and limited markets.
   - The EC Council Directives on health requirements are very stringent and difficult to comply with by a third world country like the Philippines. In fact, with only 58 plants accredited to export to EC , it indicates that the volume of exports is limited.
   - The USFDA mandatory regulations on HACCP which will take effect on 18 December 1997 is another drawback to small-scale seafood entrepreneurs.
2. The need to strengthen government institutional support.
   The existing set up of government support to the fisheries industry is characterized by fragmented responsibilities and conflicting priorities among many agencies.
3. The need to speed up the rehabilitation and upgrading of the maintenance of infrastructure facilities such as fishing ports and complexes, landing areas, fish markets and ice plants and cold storages in major fish landing areas.
4. The need to institute an effective and extensive technology transfer program. An effective and extensive technology transfer mechanism is needed to address the industry's problem of poor handling practices, hygiene and sanitation, product quality and product development.

Future Plans

1. Strengthening the Fish Inspection and Quality Control Programme

The strategy for attaining the plans to strengthen the Fish Inspection and Quality Control Program can be achieved through :

a. Expansion of post harvest services to improve fish handling and distribution through additional infrastructure facilities such as fishing ports and fish processing complexes in strategic places.
b. Establishment of quality control standards for fish and fishery products to ensure product acceptability.
c. Formulation of Fisheries Administrative Orders (FAO) to regulate practices from the time of catch/harvest to landing areas and markets.
d. To review FAO 147 (Rules and Regulations Governing the Issuance of Permits/Commodity Clearance for the Exportation of Fish and Fishery/Aquatic Products) and E.O. No. 1016 (Withdrawing the Inspection, Commodity and Export Clearance Requirements on Philippine Export).
e. To provide additional equipment/apparatus for the Quality Control Laboratory in order to make the services more responsive to the needs of the industry. There is also a need to establish fish inspection and quality control laboratories in the regions.
f. The need for field training in fish inspection system, fish quality control and assurance program intended for fish inspectors, plant managers, supervisors and processors.
g. To implement a massive extension service program on good fish handling practices, quality consciousness and good manufacturing practices in the fish processing industry for effective and immediate transfer of technology at the regional level.
h. The need to increase the number of trained fish inspectors.

Despite the enormous problems that beset the fishery industry, both the government and the private sector are working hand-in-hand to create important steps for Philippine products to be fully accepted in foreign markets. The industry had shown considerable improvement and development over the past years as shown by the share of foreign exchange earnings. Full co-operation of these two sectors is needed to make the fishing industry survive and realize the benefits that can be derived from it.

The government will continue to provide support for traditional fisheries exports like tuna, shrimp/prawns and seaweeds as well as for non-traditional commodities like cephalopods, live fish and invertebrates. To expand exports of these products, BFAR will continue to enforce regulatory powers to strengthen the fish inspection and quality control programs.

2. The Fisheries Code is a proposed legislation which will institutionalize the fisheries management principles

This legislation is now pending in the Philippine Congress and has been certified as an urgent bill by our Honourable President. This Bill, when passed will provide further means whereby the Philippines can depend on its fisheries industry to contribute towards the country's food security.

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Table 1. Major Fishery Exports in Terms of Value (1994).

Commodity/Kind	Quantity (tonnes)	FOB Value (000P)	% Share (Value P)
1) Shrimps and Prawns	22,418	6,411,535	42.67
Frozen/Chilled	21,676	6,271,377	
Shrimp & Prawn other than Frozen	742	140,131	
Prepared/Preserved	-	27	
2) Tuna	78,365	4,397,932	29.27
Frozen/Chilled	20,332	709,079	
Prepared or preserved in airtight container	58,033	3,607,853	
3) Seaweeds	24,826	581,945	3.87
Seaweeds & other Algae	23,557	572,171	
Seaweeds & Algae, used for food	56	3,099	
Kelp Powder	1,213	6,675	
4) Cuttlefish/Squid	3,191	548,261	3.65
Fresh/Chilled	33	3,832	
Frozen, dried, salted in brine	3,123	539,897	
Prepared/preserved whether or not in air tight container	35	4,532	
5) Octopus	7,633	511,233	3.40
Frozen, dried, salted in brine	7,633	511,233	
6) Crabs/crab/fats	1,938	244,702	1.63
Frozen/other than frozen	1,652	160,797	
Prepared/preserved (includes crab fats)	286	83,905	
7) Ornamental Fish	6,211	213,328	1.42
8) Worked capiz shells and articles (including art, obtained by molding)	900	187,361	1.25
9) Lobster	912	157,402	1.05
Frozen	910	156,402	
Prepared/Preserved	2	857	
10) Live *Lapu-Lapu*	5,329	118,068	0.79
Total Major Commodities	151,723	13,371,767	88.98
Total of Other Commodities	20,357	1,655,567	11.02
GRAND TOTAL	172,080	15,027,334	100.00

1 US$ = P 26.02

Table 2. Major Fish Processing Industries by Region

Regions	Location	Major Processing Industries	Fish Used
I	Ilocos	fermenting/salting drying	fish & shrimp
II	Cagayan Valley	drying freezing smoking	*Acetes* sp. cephalopods roundscads, sardines, mackerel
III	Central Luzon	drying fermenting/salting smoking	fish/shrimp slipmouth roundscad
IV	Southern Tagalog	drying smoking canning freezing	sardines fish/shrimp tuna sardines
NCR	Metro Manila	canning drying smoking salting freezing chilling value-added products	milkfish, mackerel, tuna, sardines pelagics pelagics tuna, cephalopods grouper shrimps/prawns shrimps/cephalopods
Region V	Bicol Region	value-added products smoking drying salting canning	shrimps/cephalopods, sardines roundscads anchovies croaker, lizard fish, squid mackerel, sardines roundscad, *Acetes* sp., octopus, abalone, akigae/clams
VI	Western Visayas	drying chitin-chitosan salting freezing canning	pelagic fish, shrimp, squid, mussel, cephalopods, crabs, jelly fish shrimps heads (shell waste) *Acetes* sp., anchovies shrimp/prawns tuna, bangus, squid, abalone, tuna, crab meat
VII	Central Visayas	drying salting freezing	squid, fish, mackerel, croaker, shrimp, *Acetes* sp. anchovies, roundscad, bangus, shrimp, scallop, jelly fish
VIII	Eastern Visayas	curing drying freezing salting canning	abalone shrimp, pelagic fish shrimp, octopus, cuttlefish squid pelagic fish, fresh water fishes
X	Northern Mindanao	drying freezing fermentation	pelagics shrimps/prawns, cephalopods anchovies, pelagics
XI	Southern Mindanao	drying, fermentation,canning, icing, smoking	cephalopods, shrimp pelagic fishes, stone fishes, shell products, sea cucumber

XII	Central Mindanao	drying fermentation canning smoking	tuna fish & tuna like, cephalopods, nylon shell, abalone, pelagic fishes, aquaculture fishes, sea cucumber, tuna & like fishes
XIII	Caraga Region	drying smoking freezing fermentation	pelagic, fresh water fishes, shrimp, aquaculture product, fresh/seawater fishes, cephalopods, croaker, crabs, pelagic fishes

Table 3. Number of Fish Inspectors and their Corresponding Areas of Inspection.

BFAR / DA Regional Office	Areas of Inspection	No. of Fish Inspectors	No. of Plants
BFAR	Metro Manila area	7	28
Region 6	Iloilo City and vicinities	3	7
Region 7	Cebu City and vicinities	3	5
Region 8	Tacloban City and vicinities	3	2
Region 9	Zamboanga City and vicinities	2	7
Region 10	Cagayan de Oro and vicinities	2	2
Region 11	Davao City and vicinities	2	6
Region 13	Caraga Region	1	1
Total		23	58

Control of Fish Processing Establishments in Singapore

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Presented by Ms Chew Su-Pei

ABSTRACT

The Veterinary Public Health and Food Supply (VPHFS) Division of the Primary Production Department (PPD) is the government agency responsible for the inspection and licensing control of all fish processing establishments in Singapore. This paper reviews the current status of the fish processing industry in Singapore and the inspection and auditing approaches adopted by PPD to ensure the wholesomeness and public health safety of fish and fishery products for human consumption as well as to meet the health and sanitary requirements of the importing countries in respect of the plants' export and premises. The application of the Hazard Analysis Critical Control Point (HACCP) concept to the fish processing establishments is also discussed.

Introduction

The Veterinary Public Health and Food Supply (VPHFS) Division of the Primary Production Department (PPD) is the government agency responsible for the inspection and licensing control of all fish processing establishments in Singapore. The Department's primary concern for the local fish processing industry is to ensure the wholesomeness and public health safety of the fish and fishery products for human consumption as well as to meet with the health and sanitary requirements of the importing countries in respect of the plants' export and premises.

At present, there are altogether 100 fish processing establishments licensed by PPD. The establishments process a wide range of fish and fishery products, ranging from the traditional fish jelly products such as fish balls and fish cakes, Chinese delicacies such as shark's fins and sea cucumber to frozen seafood such as tuna, swordfish etc. and canned seafood products. Figure 1 shows the various fish processing establishments in Singapore. To ensure the establishments' strict compliance with PPD's mandatory requirements and in order to monitor their performance and standard of hygiene, inspection of the premises and on-line monitoring of the establishments' production processes are regularly conducted. The inspection and audit approach which PPD adopts for the fish processing establishments will be elaborated subsequently in the paper.

Export-oriented Fish Processing Establishments

There are a total of 16 export-oriented fish processing establishments in Singapore. Some of the importing countries of our fish and fishery products include those in the European Union, Australia, China, Cyprus, Hong Kong, Indonesia, Israel, Korea, Maldives, South Africa, Switzerland, and the United States of America. Some of the fish and fishery products exported overseas are frozen raw fish, crustaceans and shellfish, such as tuna, shark, swordfish, dory, prawn, shrimp, mussel, scallop, squid, and processed fishery products such as individually quick frozen cooked shrimps, retorted abalone, and canned seafood products. To facilitate the industry's export abroad, PPD which is the competent authority in Singapore, provides health certification services for them. Production processes of the products destined for export are monitored closely to ensure that they not only comply with the requirements imposed by the importing countries but also that the sanitary and hygiene standards of the establishments are maintained at the highest level at all times. Samples of the products are collected for the relevant laboratory tests, i.e. microbiological tests, chemical tests, heavy metals, freshness test, etc. Health certificates are then issued pending satisfactory laboratory results. The total quanitity of fish and fishery products exported from Singapore under PPD's export health certification over the past 5 years is shown in Figure 2. Some of the export-oriented establishments process their products for the local market as well.

Local Fish Processing Establishments

There are 84 fish processing establishments producing mainly for the domestic markets. They consist of small to medium-sized enterprises, many of which are family-owned businesses. Most of their operations are still performed manually and rely on labour intensive methods. Some of the products processed by the industry include fish jelly products such as fish balls, fish cakes, chilled /frozen seafood, shark's fins, sea cucumber and dried seafood products.

On-line monitoring of the production processes are carried out regularly at both the export-oriented and local fish processing establishments. Samples of products are collected at the various stages of production for the relevant laboratory tests to verify that the operations are carried out under strict control. Documents pertaining to the production such as temperature records, sanitation standard operating procedure records, corrective action records etc. are also audited periodically.

Inspection and Licensing Control

In September 1995, PPD officially took over the responsibility of approving and licensing 335 local meat and fish processing establishments in Singapore from the Ministry of the Environment, out of which 100 are fish processing establishments. Formerly, the Department only licensed a handful of export-oriented fish processing establishments. For the past year, PPD has been vigorously inspecting and auditing these establishments to assess the conditions of their premises and the sanitary standards of the processing activities and facilities. A comprehensive check list is used to audit these establishments. Faults and deficiencies observed during inspection are brought to the licensee's attention for rectification during each visit. Photographs of the establishments' premises and facilities are also taken for record and monitoring purposes. Periodic follow-up inspections are also conducted at these establishments regularly to ensure continued compliance with PPD's mandatory requirements. Samples of ingredients, raw materials or cooked products are also taken routinely for testing in the Department's laboratory.

Many of the family-owned fish processing establishments are small businesses and their processing areas are relatively small, typically of 90 - 120 square metres. The physical space constraints can give rise to poor housekeeping and maintenance of the premises and increase chances of cross contamination between the cooked and raw food. In addition, many of the workers have inadequate knowledge of food hygiene and sanitation. Hence, personal hygiene, quality control and assurance programmes are often not given sufficient attention in these establishments.

In the case of export-oriented fish processing establishments, workers are usually better trained and do observe food hygiene and sanitary practices at all times during processing. Many of these establishments have already adopted Good Manufacturing Practices (GMP) and have some form of quality control and assurance system in place.

In order to assist the industry in gradually overcoming the problems that they currently face, PPD has already adopted several approaches as follows:

- Conducting periodic inspections of the premises to ensure their compliance.
- Providing scientific guidance and advice on public health safety, hygiene and sanitation to the plant personnel.
- Assisting establishments in upgrading their premises in terms of technical expertise/skills and/or structural changes.
- Helping applicants of fish processing establishments in the set up of their new premises by assessing and confirming the layout of their establishments and the production flow of their process and ensuring that all conditions mandated by the Department are complied with.
- Carrying out surprise audit checks and in recalcitrant cases, enforcement action in the form of meting out compound fines and/or court actions to the licensee or company in question.

Implementation of the Hazard Analysis Critical Control Point (HACCP) Concept

The application of the HACCP concept to the fish processing industry has gained increasing popularity in many developed countries in recent years as the system of choice for enhancing food safety and quality. It has been widely recognized and accepted that the basic principle underlying the HACCP concept is that it is possible to identify and control potential hazards and problems at an early stage in food production, and thereby, preventing them from becoming risks to consumers or an economic burden to the industry. This is the key advantage of HACCP over the other conventional approaches such as inspection and end-item testings, where a negative result can only be remedied when detected, but does not prevent the occurrence of the hazard in the first place. As a result, many of the developed countries are now integrating this system into their food inspection services programme and national legislation. Some of these countries are now requiring their domestic industry as well as those that export fish and fishery products into their markets to adopt the same concept in their operations.

The concept of HACCP was brought into the food legislation in the European Union (EU), after the adoption of the EU Food Hygiene Directives in June 1993. Under the directive, food business operators are required to identify steps in their processes and activities that are critical to achieving food safety and to ensure that adequate safety procedures are identified, implemented, maintained and reviewed based on the principles of the HACCP concept. To comply with this directive, the EU-approved fish processing establishments in Singapore have gradually begun to adopt the principles and applications of this concept and are in the process of implementing it in their production operations. Although the implementation of a complete and fully-documented HACCP system is not a mandatory requirement under the regulation at this stage, PPD is strongly encouraging the industry to move in this direction. PPD has been actively communicating the basic principles and necessary information required for its effective implementation to the various establishments. As the regulatory authority, PPD assesses the appropriate means of implementation of the HACCP system by the establishments. Follow-up inspections to the establishments to ensure the consistent application of the concept and to verify and audit their relevant documents are also performed.

Some of these EU-approved fish processing establishments have taken the leap as they move from quality control to company-wide quality assurance by achieving accreditation to ISO 9002. With the introduction of the HACCP concept, a few of them are now trying to integrate this concept into the quality management systems i.e. ISO 9002 so as to produce both quality and safe products for the consumers. This will definitely enhance their sales and exports to overseas markets. In fact, meeting the export requirements of importing countries has generally been a strong motivation to the application of the HACCP concept by the establishments. Thus, the concept is better accepted and increasingly integrated by the fish processing industries who are targeting their products towards the export market.

Moreover, these export-oriented establishments are generally those which are better supported by resources in terms of financial capabilities, qualified personnel and facilities. With these, they are able to advance themselves to compete in the world market.

On the other hand, the local-oriented establishments have not embraced this concept into their operations so readily. Small business is bound to have greater difficulties in adapting to this system as they have little or no incentive to do so. Moreover, the smaller and traditional family-owned establishments are usually more resistant to any changes in their production technique or the way in which their production is being managed. Unlike the export-oriented establishments, the implementation of this concept in the smaller enterprises is also hampered by insufficient technical-resource base and training and the high turnover of plant personnel.

Future Developments

Since PPD has been entrusted with the task of controlling all fish processing establishments in Singapore, we recognize the important role we play as government regulators in helping the industry to improve and upgrade their standards of hygiene and sanitation as well as the advancement of processing technology, etc. In this connection, PPD will vigorously pursue the following:

1. Application of HACCP and other Quality Systems

To assist the fish processing industry in the application of the HACCP concept and other quality systems so as to assure food safety in their food production operations, improve their efficiency and cut down costs in the long run. Moreover, adoption of the HACCP concept, especially in the export-oriented establishments can boost and enhance international trade as more and more developed importing countries are now making this concept mandatory. As for the local-oriented fish processing establishments, PPD intends to help them in acquiring a better understanding and acceptance of quality control and gradually introduce the concept of HACCP to their production operations.

2. Training on Good Manufacturing Practices (GMP)

To provide relevant technical training courses, seminars and talks on GMP, public health and food safety concerns and specialized subjects such as HACCP to the various levels of personnel from the industry especially those from the smaller family-owned establishments. This aims to create a constant awareness of food safety amongst the industry and help train their personnel so as to improve the standard of hygiene and sanitation at their establishments.

3. Development of Fish Processing Technology and Value-Added Products

To assist the fish industry to go into areas of research and development which improve their processing technology and produce value-added fish products with the assistance of research agencies like the Marine Fisheries Research Department (MFRD) or other relevant authorities. As Singapore has limited natural marine resources, it is crucial that her local fish industry constantly upgrades and improves itself so as to stay competitive and to continue to create a niche for itself in the overseas markets.

Discussion

It was emphasized that most of the raw materials used by processing establishments in Singapore are imported. With regards to the implementation of Hazard Analysis and Critical Control Point (HACCP) and ISO 9002, the Seminar was informed that although the Primary Production Department of Singapore implements these criteria, consultants have been hired to prepare the plan and layout of such systems.

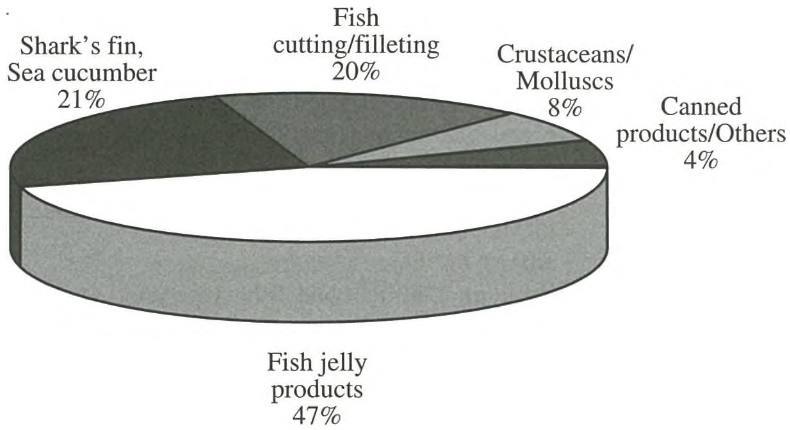

Fig. 1. Fish Processing Establishments in Singapore (as at August 1996).
Source : PPD, Singapore.

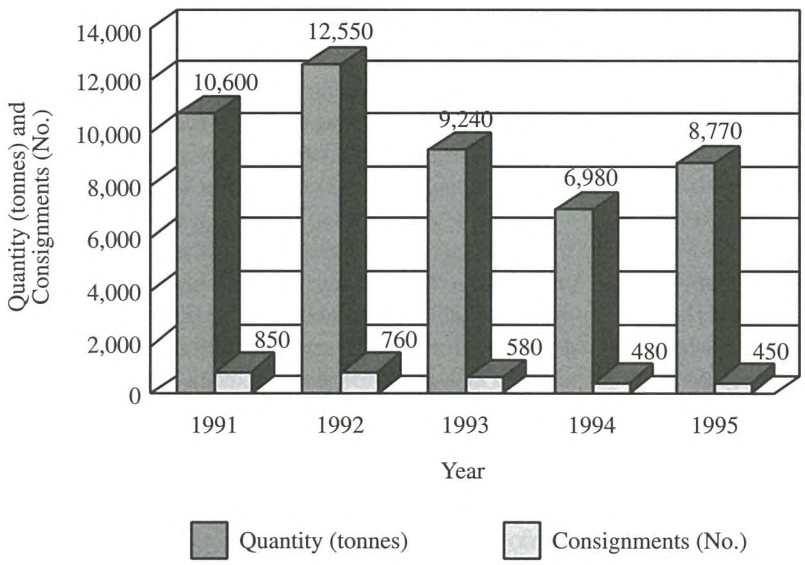

Fig. 2. Certification for Export of Fish and Fishery Products from Singapore (1991 - 1995).
Source : PPD, Singapore.

Advances in Fish Processing Technology in Thailand in Relation to Quality Management

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Abstract

Fish and fishery products are important sources of food and are economically important to Thailand. Though marine fisheries production has become stagnant in the past decade, output is supplemented by both fresh water and coastal aquaculture production. Total fisheries production in 1993 was reported to be 3.4 million tonnes, of which aquaculture fisheries accounted for 9.7 %. The consumption of fishery products especially seafood is probably a result of the country's high economic performance. The upturn in fish processing industries and the Department of Fisheries' HACCP-based inspection program were recognized in the region and internationally in the past five years. Consequently, Thailand has become, by value, the largest fish exporting country in 1993 and 1994.

Processing technology is being developed to meet market demands for quality, safety and wholesomeness. Preservation technology for dried and fermented products is upgraded utilizing modern equipment and technology to extend shelf life and to improve standard for wholesomeness. While technology involving value-added products are developed locally for industrial scale production, processing technology is also being developed for dried, chilled, frozen, canned, retort-pouched and comminuted products. Quality management becomes the most concern of the fish processing industry. The Hazard Analysis and Critical Control Point (HACCP) based inspection system was enforced as mandatory for fish exporting companies in January 1996. Inspection techniques, monitoring and verification procedures are developed to strengthen the implementation of HACCP quality assurance program by the industries. Fish inspection for quality assurance has been focussed on meeting with international standards. New inspection laboratories and scheme for raw material control were established to employ the latest techniques to assure quality and safety of products and raw materials to be used for processing.

The Government has put strong emphasis on quality management program for the industry. In the 8th National Economic and Development plan (1997 - 2001), the Department of Fisheries will continue projects to accelerate the development of quality products and quality system, to maintain the supply of safe and quality fishery products to local and international market and to resolve problems faced by the industry.

Introduction

The fish and fishery products industry of Thailand has grown into one of the country's major economic key areas. The fishing fleet of Thailand produces resources for both local and international markets; although marine fisheries resources have been declining it is still important to the development of the industry. Freshwater fisheries production continues to impact on local consumption and small scale processors, producing traditional products. The efforts of various government agencies to encourage better utilization of fishery resources for local consumption has resulted in the growth of a number of villages producing freshwater fish and fishery products.

Export of fish and fishery products affect both the economy and the development of technology. The fish export industry generate foreign income and create jobs for fishermen, fish handlers, traders, workers, technicians and administration at various levels. The export industry is relatively big in scale and production, with each exporter employing about 550 workers on the average. Their production capacity range from 5 to 150 tonnes per day. Their export has been valued at approximately $ US 4 billion since 1993. The export demand has urged the industry to develop new technology with the government and through joint ventures. Though the industry faced problems in relation to raw materials, standards and regulations on product quality and quality systems, they are able to adjust to the changes and adapted successfully rather rapidly in cooperation with the government. The industry should be credited for the technology innovation, their implementation of HACCP program and their initiatives in market penetration.

The government has been playing a supporting role in the development of the industry.

Research and development on product quality, safety and new product development have been conducted. In the area of quality management, Thailand has fish inspection system recognized internationally. The HACCP-based inspection program of the Department of Fisheries is a key factor to the success in market development as much as the cooperative efforts of various Government agencies to support the industry through research findings, inspection services, information services on marketing, standards and other trade issues.

This paper reviews the growth of the Thai fisheries industry emphasizing the technological development and quality management aspects in Government and industry, based on information obtain through statistical information and reports of Government and private industries association. Information from inspections carried out by the Department 's inspection services and preliminary reports on quality assurance projects conducted by technologists of inspection and research institutes are also presented.

Fishery Production

Total fisheries production from 1983 to 1993 showed an increase from 2.3 to 3.4 million tonnes (Table 1). Aquaculture is still contributing to this increase. In 1993, the most recent year for which official statistics are available (Department of Fisheries, 1996), capture fisheries both inland and marine totalled approximately 2.9 million tonnes, while coastal and freshwater aquaculture fisheries was as high as 457,000 tonnes. While captured fisheries is thought to be exploited at close to its upper limit, aquaculture has increased dramatically from 45,000 tonnes in 1983 to 300,000 tonnes in 1993. The estimated production of cultured black tiger shrimp alone in 1994 and 1995 were 263,000 tonnes and 280,000 tonnes respectively while marine shrimp production were 100,00 and 105,000 tonnes. The estimates for 1994/5 showed that cultured production of shrimp accounted for about 73 % rising from about 52% in 1989 (Table 2).

Table 3 showed the value of total production from 1983 to 1993. The value has increased substantially from 1983 to 1993, from US$769 million to US$3,136 million (Table 3); in 1993 aquaculture held a record of US$1,508 million.

Major Species Composition

Table 4 showed the composition of marine and freshwater fisheries production. As for marine fisheries in 1993, fish accounted for 79 %, while shrimp, cephalopods and mollusk were 11%, 5 % and 4% respectively. For freshwater fisheries in 1993, fish accounted for 97% of production, while *Macrobrachium* shrimp accounted for 3%.

The increase in the production of each major species group from 1989 was rather low; production of cephalopods fluctuated, while freshwater fish and marine shrimp increased at the rate of 69.7% and 68.6% respectively (Table 4).

The growth of freshwater fish production was substantial due to the Department of Fisheries's program on village, school and community ponds; this production is a source of protein supply for people in the northeastern and north of Thailand.

Utilization of Fishery Resources

Table 5 showed the utilization of marine catch by types of fish processing. The total volume of fish processed in 1993 was approximately 3.3 million tonnes. In 1993, fish meal processors utilized 42% of the resources, canneries ranked second utilizing 27%, freezing plants ranked third utilizing 25%, followed by traditional products, such as salted fish, fish sauce and dried squid, which utilized only 5 % of overall resources (Fig. 1).

It was noted that utilization of resource for freezing increased gradually, except in 1991, while the use of fish resources for canning, smoking, fish salting, shrimp, shellfish and squid drying, fish ball, fish cracker and fish meal processing have started to drop in 1993. The utilization of catch for traditional products in 1993 was salted fish (31%), fish sauce (23%), dried squid (20%), dried shrimp (19%), fish ball (3%) and equal amounts for dried shellfish, smoking and fish/shrimp cracker (1% each, Fig. 2).

Table 6 showed the number of fish processing plants for types of processors. Records of 1983 to 1993 of the Department of Fisheries revealed that the number of freezing plants and canneries were increasing, while fish meal establishments was decreasing. The freezing plants and canneries in Thailand are of industrial scale, each employing from 150 to 2,700 workers.

There is a large number of traditional fish processors. It should be noted that most processors are of small scale and produce products mainly for local consumption, and only some of those, eg., fish sauce establishments, are of industrial scale producing products both for domestic and overseas markets. Each processor employs fewer than 40 people.

Foreign Trade

In 1993 Thailand emerged as the number one exporter of edible fishery products in the world fisheries market with export amounting to US $ 3.64 billion as against US $ 2.2 billion in 1989 (Table 7). The Department of Fisheries further reported the export earnings for 1994 and 1995 to be at $ US 4.4 and 4.6 billion, respectively. Though the value of export continues to increase, the growth rate of export by volume was declining from 21% in 1989 to 5.7% in 1995. Total import in 1995 was $ US 876,988 million, the rate of import has been decreasing since 1992. This was particularly affected by the amount of frozen tuna imported for canning.

Table 8 showed the value of trade with major trading partners, as reported by the Department of Fisheries (DOF, 1996). The export to USA, EU and Canada increased significantly. The major markets for Thai fisheries products in 1994 remain to be Japan (39%), USA (32%), European Union (14%), Canada (4%), Australia (2%) and others (5%) which include ASEAN members, and new markets such as China, Eastern Europe, Middle East, South America and African countries (Fig. 3). Among ASEAN countries, Singapore is a major outlet, importing US$120 million worth from Thailand. In volume, Thailand still supplied up to 65% of Malaysia's imported fish (Ferdouse, F. 1994).

The Ministry of Agriculture and Cooperatives recorded the volume and value of various exported commodities, as shown in Table 9. The percentage by value of fish products exported in 1994 was frozen shrimp and shrimp products (48%), canned tuna and other seafood (36%), frozen fish fillet and minced fish products (8%), and frozen and processed cephalopods (7%). As for traditional products, a significant volume and value of dried shrimp, dried squid and fish sauce were exported.

Thailand imported a variety of fishery products, as shown in Table 10. Most of it was meant for further processing and for re-export. Import in 1994 of chilled and frozen fish valued at US$553 million, consisted mainly of tuna. Frozen cephalopods were imported for further into frozen products for re-export. An interesting import item of frozen shrimp and small processed shrimp was valued at US$34,120 consisting of shrimp for further processing into canned products and frozen value-added products. The value of imports of major fish and fishery products in 1984 was frozen fish (76%), frozen cephalopods (8%), frozen shrimps (5%) and others (11%). Import of fish and fishery products for domestic consumption was increasing, but not yet significant probably because of high import duties. Tuna was also imported from fleets of many countries but mainly of Japan, Chinese Taipei, France, New Zealand, Canada, USA and the EU.

The Ministry of Commerce estimated the export of several seafoods from 1992 - 1995 by volume and value (Table 11). The 1996 figure is the target figure set for export of fishery products. The volume of production of processed seafood increased substantially in volume from 31,949 tonnes valued at US$91 million in 1992 to 60,000 tonnes valued at US$172 million in 1995. The volume of processed cephalopods was also increasing during the period. These figures confirmed that the output of value-added products have increased. The percentage of Thailand's top ten fishery products exported by value in 1995 was frozen shrimp (53%), canned tuna (17%), frozen cephalopods (8%), fillet/minced fish (6%), canned pet food (5%), various processed seafood products (5%), frozen whole fish (3%), fish sauce (2%), and dried fish products (1%, Fig. 4). The export of these commodities significantly improved the standard of processing technology development and product quality of Thailand.

Post-Harvest Technology

Thailand has been active in the area of post-harvest technology research and development for many years; government institutes, research institutes and academia have been actively involved in technological development. The Department of Fisheries through the Fishery Technological Development Institute (FIQD, 1995) has been conducting development research for :

- better utilization of fisheries resources, for example by-catch and fresh water species
- product development from local freshwater and marine species
- preservation of fishery products and extension of shelf life of fresh and preserved products
- process development for dried and fermented products
- packaging development for various types of fishery products including the use of plastic and laminated film
- improvement of handling techniques for fresh and chilled fish and shellfish
- biotechnology research involving chitin and chitosan production and utilization of wastes for flavours

The technology and information gained were used in the department's extension program to small-scale village and women's cooperative groups resulting in the increase in home processing and small scale production for domestic sales. The capabilities developed were also used in providing technical consultation to the traditional fish product export industry to develop and improve products to meet requirements of importing countries and the demand for safe and wholesome products for the domestic market.

In the late 1980s, quality management became the most important focus of the fish processing industry. The Hazard Analysis and Critical Control Point (HACCP)-based inspection system was encouraged in international fish trade. Thailand enforced the HACCP - inspection system as mandatory for fish exporting companies in January 1996. Inspection techniques, monitoring and verification procedures are developed to strengthen the implementation of HACCP quality assurance program by the industries. Quality assurance in fish inspection laboratory to meet ISO/IEC Guide 25 or EN 45000 has been a focus. New inspection laboratories and raw material control units were established to employ advanced determination techniques to assure quality and safety of products and raw material to be used in processing. The government has put strong emphasis on quality management program for the industry (Suwanrangsi, 1996).

Quality control research emphasised on :

- development of techniques for quality evaluation, which includes development of sensory techniques, sensory profiles for various fishery products and establishment of critical limits for sensory quality determination
- suitable quality index for determining quality and safety of fish and fishery products, which also include development and validation of methodology
- contaminants level monitoring which include natural toxin, heavy metal content and bacterial contamination in fish and fishery products
- establishment of Good Manufacturing Practices for handling and processing of fish and fishery products
- establishment of HACCP system for the quality management of fish and fishery products
- establishment of Good Laboratory Techniques for fish inspection laboratories

The technical capabilities developed was used in the improvement of inspection procedures (Fish Inspection and Quality Control Division, 1995). Information gained were also used for risk assessment, establishment of critical limits, monitoring procedures, corrective action and verification procedures to support the industry in implementing the HACCP program.

Review of technology development by industry

Processing technology is continually developed to meet market demand for quality, safety and wholesomeness. Since 1991, the industry has gradually switched to semi-automation process with the aim to produce better yield, better quality and faster production cycle. In the early 1990s, technology involving value-added products were developed both through joint venture and innovation by the Thai processors for industrial-scale production. Processing technology was developed and improved for frozen, canned, retort pouch and comminuted products. Preservation technology for dried and fermented products were upgraded utilizing modern equipment and technology to extend shelf life and to improve standard for wholesomeness.

Frozen Products

Thailand is well equipped technologically for frozen fishery products. A large variety of products is being produced from basic labour-intensive technology to advanced automation technology. The factories are of industrial scale employing from 100 up to 2,000 workers. Frozen fishery product processors engage the following number of workers :

No. employees	< 100	101 - 300	301 - 500	501 - 900	901 - 1,300	1,301-2,000	>2,001	Total
No. factories	16	31	20	21	16	11	7	122

Table 12 showed the number of processors of traditional frozen product and value added products. Production of value-added products is growing rapidly; an assessment of the company profiles of frozen product processors revealed that they also have the capacity to produce value added products.

1. Shrimp

Processing technology was upgraded to semi-automation methods in order to speed up production and to reduce human-sourced contamination. Equipment is being installed to replace workers and these include washing tanks, shrimp graders and shrimp peelers. The uses of shrimp peelers was introduced in 1992 by processors but was discontinued because they did not prove economical. Improved grading tables and conveyor belts are now widely used. Since the Department of Fisheries is stringent in its requirement for plant sanitation and good manufacturing practices (such as the use of chlorine in washing or in dips for raw material), the industry has also introduced new technologies such as ozonized water. Modern freezing technology was introduced in 1992; there are several methods employed, such as nitrogen and carbon dioxide freezer, spiral freezer for individual quick frozen products.

Processing technology for the production of cooked, prepared and ready-to-cook as well as ready to eat products was introduced extensively in early 1990s; various new products were then developed to reach out to both local and international markets. Among the various products, fishery products became popular and these were combination shrimp, squid with vegetables, or bakery products, including the development of Thai recipe TV-dinner products. Automated production was used to lessen human contamination and cookers were introduced to speed up processes as well as to improve yield. The in-plant research on suitable cooking time and temperature to prevent *Listeria monocytogenes* contamination was required by the Department of Fisheries, as part of the HACCP plan. For cooked and ready to eat product, the establishment of a sanitary zone separating raw and cooked process is required. Good Manufacturing Practices for the control of *Listeria monocytogenes* developed by Canada was recommended to processors of cooked and prepared shrimp by the Fish Inspection and Quality Control Division.

New packaging system are being used. The most popular is vacuum packing for supermarket products. TV-dinner and microwavable packs are also used.

To date, 60% of freezing plants is capable of producing cooked, prepared, ready-to-cook and ready to eat frozen products (Thai Frozen Foods Association, 1995).

The industry has, since 1992 faced problems relating to veterinary drugs and chemical residues. Research has been conducted in the area of detection and screening methods for various types of drugs. The Department of Fisheries has introduced a HACCP-based quality control program, extending from farm to processing plant, as a preventive measure for drug and chemical residue in aquaculture shrimp (Tookvinas and Suwanrangsi, 1996).

2. Cephalopods

There has been no technological changes in cephalopods processing. The supply of cephalopods has fluctuated. There are four main markets for the products, viz Japan, Italy, Spain and USA. The need for technology is in improvement to cleaning and de-skinning. If technology could be developed, it would minimize the risk of contamination from humans and water used in cleaning as well as speed up the process. Cephalopods are used in seafood mixes, where demand is growing. There are currently 45 processors manufacturing frozen cephalopods and among them are 10 processors actively producing seafood mix products.

3. Fish fillet

The production of fish fillet utilized both local and imported fish such as cod, pollock, yellow fin sole and flounder. A process normally begins from thawing using bubble thawing process, de-skinning, filleting, inspection of fillet, packing and freezing. Filleting is still a labour intensive process, since it requires human skill for yield and inspection against parasites. Products are packed in individually quick frozen fillets or block frozen. Currently, there are 33 factories producing fish fillet for export. Breaded products produced; machinery is commonly used for battered and breaded products.

4. Surimi and surimi-based products

Surimi production in Thailand utilizes mainly local species. Surimi is exported as well as utilized in crab meat analogue products. Since 1992, the world market for surimi has faced a down turn and production by Thailand decreased significantly. There is no new technology utilized in surimi production, except the use of various types of cryoprotectants. The surimi industry faces stringent demands for processing hygiene and product wholesomeness imposed by the Department of Fisheries. To date, there are 12 active processors.

Imitation crab meat processing grew significantly in Thailand since 1991. Presently, there are 7 imitation crab meat processors. Japanese technology was employed with improvement of processing line to speed up process. Microwave thawing technique has been introduced. Likewise, in the cooked shrimp process, the establishment of a sanitary zone is required as well as the improvement of handling after cooking to prevent recontamination. Several types of analogue products were developed, including a dried surimi-based product.

5. Other frozen fishery products

Among existing freezing plants, there are at least 14 factories which have diversified their production to produce a variety of products from crab, freshwater fish, freshwater shrimp and cold water shrimp. Some are also capable of manufacturing value-added products from those species.

6. Fish Sausage and Ham

A major tuna cannery has successfully innovated the technology for producing sausage and ham from tuna in 1995. Yellow fin was utilized for fish sausage, ham and various flavoured sausages. The process was developed from meat sausage techniques, with the aim of producing products resembling chicken sausage. The product gradually gained market acceptance, even though competition from pork sausage remained strong. Further production and handling techniques are being developed for improvement of shelf life during transportation and marketing.

Canned Fishery Products

Canned fishery products are classified as low acid canned food items. Technology development mostly concerned quality assurance and product safety, packaging development and new product development. In 1996, there were 22 active tuna packers and 30 other canned seafood packers and traders. The President of the Thai Food Processors Association has divided the various stages of the development of the canning industry into :

- Initial stage (1970-1973): Development of canning technology and improvement of process to meet international standard.
- Development and export stage (1974 - 1979): Development of export of canned tuna, shrimp and baby clam.
- Development, production expansion and marketing stage (1980-1985): Dramatic increase in processing facilities, increasing at approximately 10 plants/year. Export rose steadily. Attention was paid to producing quality products.
- Quality improvement stage (1986-1990): Many changes in product quality, training, research and production facilities because of market demands.
- Production and market competition stage (from 1991 onward): Since 1991, competition in both areas has become strong. Raw material supply has fluctuated and decreased. Production facilities have to adapt and improve to meet international trade standards (Thai Food Processors Association, 1995).

1. Canned tuna

Canned tuna is a standard item in the international market. Products are packed in various sizes and in various packing medium, viz oil, brine, water, vegetable broth. Different types of tuna species are used, including skipjack, yellow fin and albacore which were imported from Japan, Taiwan, USA and EU purse seiners. Local tuna species are also used.

To date, technology improvement in the Thai tuna industry emphasises heavily on quality, safety, yield improvement and new product development.

From a quality point of view, the main concerns of industry are to control the decomposition of tuna and its product in order to produce a product that meets the demands on quality by the US and Canadian markets. The Department of Fisheries, since 1992 has introduced Good Manufacturing Practices for canned tuna specifically to resolve problems relating to product decomposition which mainly involve controls of :

- Grading standard for raw tuna
- Thawing temperature control
- Control of delay time after thawing, and
- Control of lag time for loin cleaning

In terms of product safety, stringent control of thermal processing and post-process control are necessary. As in the case of all other low acid canned food requirements, the processors are required to establish thermal process schedules for each product. The packers have improved their capability to conduct their own studies.

Technology development also emphasised yield improvement through the use of spray water cooling techniques to quickly reduce temperatures after pre-cooking, the introduction of different systems of filling machines or mechanical butchering and the use of hydrolyzed vegetable protein.

As for canning, more and more of the two-piece metal cans of various sizes and the easy to open end cans are being used. Retort pouch products, which became popular in the Japanese market, are produced by 6 of the 22 tuna canneries. Specific technology and control of packaging materials are employed.

Product development in tuna industry has progressed significantly since 1994 with the aim to introduce canned tuna to the local market and to improve marketing through competitive pricing in the world markets. To date, over 20 types of tuna based canned products are available, such as tuna spread, tuna salad, tuna in mayonnaise, tuna curry, tuna in chili sauce, etc. and these are sold in new packaging shapes and sizes.

2. Canned shrimp

Production technology for canned shrimp has emphasised quality improvement. The use of food additives e.g. sodium metabisulphite and EDTA have been of concern to importing countries such as USA and the European Union. The processing techniques have been changed and now use low temperature control and better handling of raw materials to solve problems relating to sensory quality of the products and to discontinue the use of prohibited food additives. Since the supply of sand shrimp has been decreasing, a large volume was imported, mainly from Vietnam.

3. Other Canned Seafood

The canning of sardine and mackerel progressed much slower than the above two commodities. This is due both to the lower market value of these products and the demands on quality from the destination of their markets are rather different. However, the industry faced the same stringent enforcement by the Department of Fisheries to maintain standard of production to meet hygiene and safety requirements.

Canned baby clam production was decreasing due to the shortage of raw materials. No technology development was observed.

Traditional products

There are cottage to village industries distributed country wide. Training courses are conducted by various government agencies, e.g. Department of Fisheries, Department of Agriculture Extension, Ministry of Industry, Ministry of Interior and Ministry of Defense to promote better utilization of resources available locally, and to uplift the livelihood of people in the provinces. Simple traditional product processing techniques are being introduced to promote utilization, consumption and sales to tourists and visitors. This has made the number of processors in the official statistics rather high, even though the volume of raw material utilized, and products are rather low.

Technology improvement benefitted processors of industrial or medium sizes, resulting in their successful export thrusts since 1993. Quality control is the key area being developed, and a HACCP generic model was jointly developed with processors. The Department of Fisheries supports the implementation of the program by offering training and technical guidance.

Fish Sauce

Significant changes over the past five years in the fish sauce industry are the result of market demand for quality and wholesomeness. The industry has employed modern equipment for raw material handling, mixing and packaging. The salting process, though, is still done in concrete tanks but hygiene improvements are significant to meet and satisfy market demand. Packaging is the area of dramatic growth. The industry began implementing a HACCP program, as required by the Department of Fisheries; technical assistance were given to develop and implement the program.

Dried Products

Dried fish, squid and shrimp are major items in this category. Since market demand did not increase significantly, the industry developed only product forms and packaging. Dried seasoning product appears to be the new direction of development. One such innovation of dried product is dried imitation crab meat.

Fish Snack

Fish (shrimp, fish and squid) cracker and extruded fish snack products are in this category. Fish cracker production combining traditional process techniques, quality control and modern packing technology are keys to success in export market. The products are available in raw and ready to eat forms. Improvement of shelf life of ready to eat cracker is the key to successful marketing of the products.

Other Products

Chilli-based products consisting mainly dried or fermented shrimp and fish, products are popular locally and among travelers. The US and Europe are major markets.

Fish inspection

1. Traditional Fish Inspection System (1964-1990)

The Fish Inspection and Quality Control Division of the Department of Fisheries (DOF) is the main organization providing service to the export industry on fish inspection and quality assurance. The fish inspection and quality control services of the Division have been engaged mostly in preshipment inspection and facilities inspection, which are the principle means used by most governmental agencies in the world to control safety of food. The Fish Inspection and Quality Control Division of the DOF inspects fishery products for compliance with international standards for export and where applicable, the importers' requirements related to health, safety, quality, identity, process and handling. Product and processing plants intending to export to North American and European markets are subjected to inspection by DOF. The department has established a list of approved fish processing plants for export to those markets since 1989. There are approximately 250 packers and traders registered to export fish and fishery products, among these DOF approved a total of 193 processors in 1996. Table 13 showed the number of approved establishments of the DOF from 1992 - 1996. The department was recognized by many countries for her inspection system and the list has been provided to those countries. Since 1994, the department has been recognized as the competent authority to conduct fish inspection for the European Union; it was also then that the department included in the program approval of traditional products processors. To date, the inspection services covering fishery products are intended for export only. The Ministry of Public Health has jurisdiction over products for domestic markets.

The department recognized that traditional inspection schemes have certain limitations. Inspection of facilities and operation are carried out with reference to various guidelines, standards and Codes of Practices. In many cases these documents fail to indicate the relative importance of various requirements and the requirements are stated in very imprecise terms such as "satisfactory, adequate, suitable, if necessary," etc.. This leaves interpretation to the inspector who may place to much emphasis on relatively unimportant factors and thus increase cost without reducing hazard. Microbiological testing also has some limitations as a control option. There are constraints of time, difficulties relating to sampling, analytical methods and use of indicator organisms.

2. HACCP-based Fish Inspection Program (1991-present)

The Department of Fisheries recognized the need to direct the inspection system to a preventive system based on HACCP. Therefore, in 1991 the DOF implemented voluntary HACCP fish inspection programs. The program involves with reviewing inspection procedures and establishing HACCP procedures in the inspection agency, pilot HACCP implementation by the industry and training for inspectors and industry. Inspection procedures of facilities and operation were revised with reference to CODEX guidelines, standards and Codes of Practices on HACCP and GMP. The inspection rating scale indicates very precise terms such as critical, serious, major and minor, which relate to health and safety, quality and good manufacturing practices. Instruction and training are given to inspectors to emphasize critical control points and problems relating to health and safety. Generic HACCP plans have been developed for major commodities, through studies, research, workshops and working groups with the industry. Guidelines for development of documented programs or quality manuals have been provided and updated to meet with international guidelines and importing countries' requirements on HACCP. Close monitoring of the processing industry's performance in HACCP programs have been carried out by inspection of facilities, control at critical control points, record review and quality program verification.

In 1996, the program is mandatory for approved fish processors under jurisdiction of the department. Approved processors must have HACCP-program implemented, documented and verified by the department. HACCP inspection procedures are developed and updated. Inspection manuals are prepared.

3. HACCP Inspection Approaches

The DOF set a prerequisite program, which concern sanitation, hygiene control and GMPs as minimum requirements of HACCP-based quality management program, with monitoring, verification and enforcement done by the department. The program will ensure that processors have the capability to monitor their own performance against Thai Department of Fisheries and foreign country requirements and have the ability to take appropriate corrective actions if and when required.

A generic HACCP program has been developed jointly by the DOF and representatives from industry. In many cases what the program demands is already being done; it can be best described as a confirmation of good manufacturing practices. Each processing establishment must develop a HACCP plan appropriate to its processing practice, hygiene and sanitation status.

The processors must identify hazards associated with the products and processing environment. Hazard analysis and risk assessment analysis should be conducted extensively. The industry is recommended to have basic sanitation, hygiene control and GMPs as a pre-requisite program; once the hazards can be controlled by these programs, critical control points can be easily identified using the Decision Tree and kept to a minimum to control product safety. By this approach, confusion between critical control points (CCP) and control points (CP) have been greatly reduced.

Guidelines for program development and documentation are also given. A handbook is available to industry in the local language.

4. Implementation of HACCP by industry

The interest of the industry in implementation of the program is very significant.

The department requires the program to be documented, verified and implemented. Therefore, the DOF has classified the various stages of implementation by the industry into 3 levels, recognizing that all fish processing establishments under the approved list already has sanitation, hygiene condition and processing practices meeting the requirement of DOF and that the principles of HACCP have already been applied by the Thai industry.

Stage 1. Initial development: these processors have already instituted control programs to ensure product safety and quality, the company has already identified hazards, established and implemented preventive measures, monitoring procedures, critical limits, corrective action and verification and a system of record-keeping and the program is in place. Documented HACCP plan is being formulated.

Stage 2. Development stage: the processors have already instituted a control program, identified hazards, established and implemented preventive measures, monitoring procedures, critical limits, corrective action and verification and a system of record keeping. Documented program is submitted to DOF for verification.

Stage 3. Fully implemented stage: the processors have HACCP plan fully functional and their documented program is already verified by DOF.

Processors have implemented HACCP programs and have submitted a quality control manual for verification by the DOF. Standard operational procedures for verification of HACCP program and industry have also been established by the Department.

As of 1 July 1996, 50% of the establishments have fully implemented HACCP, while 35 % are in development stage and 15 % are at initial stage.

Generally, traditional products processors, who are rather small scale producers, are at preliminary stage, requiring training and technical assistance from the department. Fish sauce processors however, have advanced in HACCP much quicker than the rest.

The department developed a three-day training course module on HACCP Application for the industry and fish inspector. Four training courses/year have been conducted for the local industry on the Principles and Application of HACCP (Suwanrangsi, 1996). This includes development of a HACCP generic model for products as follows:

- Canned tuna
- Canned seafood (shrimp/crab meat)
- Frozen raw shrimp
- Frozen cooked shrimp
- Frozen battered and breaded shrimp
- Frozen fish fillet
- Frozen surimi/imitation crab meat
- Fish sauce
- Fermented fish products
- Dried fish products

The industry would use the model as a basis for the development of HACCP plan to suit each individual processor.

Supplementary courses on monitoring and verification procedures are also conducted.

A regional HACCP training course was conducted for government officers from 16 countries in the Asia Pacific region in November 1991.

5. Inspection laboratories

The Department of Fisheries currently operates 4 regional inspection centers. Each center consists of field facilities and inspection services and laboratory services. Laboratories are equipped with facilities for determining physical, chemical and microbiological parameters. The laboratories operate under ISO/IEC Guide 25 and are now under the accreditation process with national and international laboratory accreditation bodies. Under this scheme, the laboratories maintain quality systems and documented manuals and operate according to established standard procedures from sample handling to certification. Laboratories participate in split sample testing program of Public Health Laboratory Services (PHLS) and Food Analysis Performance Assessment Scheme (FAPAS) of the United Kingdom and conduct regular collaborative study using standard reference materials with national and regional laboratories in ASEAN. The laboratories have experienced and trained personnel at different levels to conduct analyses for safety, quality and product conformity to market requirements. They also provide guidance to laboratories of the processing plants in order to perform testing and monitoring to meet international standards. Guidelines for establishment of fish quality control laboratory are published and freely available to the industry.

Problems Faced by the Industry

Although Thailand has been successful in technology innovation and export development, there are problems encountered by the industry and they are as follows :

1. Raw materials shortage and supply fluctuation

Since resources in Thai waters are overexploited, the industry has suffered raw materials shortage in cephalopods, dermersal fish, crab, mollusk and marine shrimp. Raw materials have therefore been imported, but fluctuations in world catches have also affected the industry. Moreover, an increase in the number and the production capacity of these processors have made the situation worse. Aquaculture could supplement the need to a certain extent but the low production period in the dry season and sporadic runs of disease have affected the stability of supply to the industry. Growth in local conusmers' demand, the result of better purchasing power, has also created competition for supply which has, in turn, driven up prices.

2. Barriers to trade

In the early 1990s, there were problems related to quality, health and hygiene regulation and importing countries requirements. However, in the past 5 years, the industry and the government have diligently worked on the problem through introduction of HACCP and negotiation with importing countries. It is therefore believed that the above problems, which are technical barriers to trade, can be resolved with importing authorities; yet problems related to non-technical barriers grew much stronger, especially those concerned with the environment and tariff barriers.

3. Cost of production

Thailand continues to enjoy the blessing of cheap and skillful labour but the minimum wage has increased by 40% in the past 5 years. Moreover, utilities cost are escalating which make the industry less competitive in price. In addition, since Thailand is considered to have a developed fish processing status, import priviledges now enjoyed may likely be terminated, thus making production cost much higher.

4. Information on standard and regulation of trading partners

As importing countries becoming more concerned with safety, quality and wholesomeness of the fishery products, new regulations have been imposed as well as new standards and action levels. However, access to information is limited in many countries'; there is no clear contact point for such information. The department has already implemented the program on Who is Who in Fish Inspection to identify contact points, but an improved system is needed to keep the industry and government up to date on information regarding changes to standards and regulations.

Government Policy

The Thai Government emphasized human resource development, rural development, poverty eradication and export promotion in its National Economic and Social Development Plan; this proved to be successful as the economic growth rate has been higher than 10 % since 1992.

In the 8th National Economic and Social Development Plan, the Department of Fisheries, in recognizing the problems faced by the industry in the area of post-harvest technology and inspection, has set priorities in the following areas :

- conduct a research and development program relating to safety and quality of fish products, product development and to develop technology to secure supply and reduce handling waste

- implement HACCP-based inspection program to strengthen capabilities in research and inspection services
- expansion of inspection and laboratory capabilities to the provinces to assure quality and safety of fishery products intended for export
- participation in international forums and programs relating to fish and fishery products
- establish Memorandum of Understanding or Mutual Recognition Agreement with trading partners
- conduct cooperative programs on FPHT and inspection with regional and international bodies
- establishment of national training and calibration centers on fishery technology
- establishment of integrated information system with trading partners

DOF Projects on Fishery Post Harvest Technology and Quality Management

1. Fishery Product Export Promotion Project (1996-2001)

The department has received US$20 million from the government to implement this five-year project aimed at :

- maintaining Thai fish processing industry's capabilities in the production of quality and safe fish products which conform to international and importing countries standards
- improving technology involving production and quality control and product development
- securing supply of raw materials
- promoting the export of new commodities

Major activities of the project involves the establishment of a training and calibration center, specific research development projects on product development and quality improvement and negotiation on equivalency of fish inspection system with trading partners and promoting the export of new commodities e.g. aquarium fish.

2. Raw Material Quality Improvement and Inspection Project (1994 -1999)

The department has received $US10 million from the Government to implement this five-year project aimed at establishing overall inspection control from raw material to end products. Major activities involve the establishment of raw material quality control centers in major aquaculture areas; strengthening of monitoring program and inspection of raw materials from marine capture fisheries, environmental monitoring and establishment of three new regional fish inspection centers.

The Ministry of Commerce also supported the program of the Department of Fisheries on trade development and export promotion as follows :

a. Development of inspection linkages with major trading partners

Currently, the Department has a two-year collaborative program with the European Union. The program involves training and visits of inspectors in the EU member states, recruiting of specialists from EU member states and collaborative studies with EU member states on research and inspection activities.

b. Development of laboratory capabilities for accreditation

The program involves the development of standard procedures and documents the system for laboratories to meet with criteria of ISO/IEC Guide 25 and national and international laboratory accreditation bodies.

c. Quality improvement for specific fishery products

The program aims at resolving immediate quality and safety problems faced by exporters. It involves technical studies and joint workshops or training with trading partners.

In addition to these the department is actively involved in joint programs with foreign governments e.g. Canada and Japan, regional economic group e.g. ASEAN and APEC and international bodies e.g. FAO and UNDP.

The programs include :

- The ASEAN Canada Fisheries Post-harvest Technology Project - Phase II (1992 - 1997)
- APEC Project on Health and Quality Rules for Fish and Fishery Products (1995 - 1997)
- The Research Project on Quality Development for Fishery Products funded by Japanese International Cooperation Agency (1994-1998)

The department also participate in international programs to assist in the development of post-harvest technology and inspection system in developing countries.

Future Development

The Government has planned for Thailand to be a regional center for food processing. Therefore, the Department foresees the role of the agency in supporting the industry in maintaining the production, development of technology and human resource development as well as market development.

Its role in research would be directed towards product and technology development for local consumption as source of protein and to improve handling to reduce waste and spoilage, as well as new product development from freshwater species. Since the industry has shown its own capabilities in product technology development, the department will continue to work towards product development to strengthen the industry. The department will also conduct joint programs with other government institutes and universities to conduct research on fish handling, processing and quality control and provide information, budget and equipment to support those agencies to conduct research relevant to the interests of the Department.

Research on quality assessment and risk assessment will continue. Meanwhile, laboratories and research institutes of the department will be strengthened to meet international standards for accreditation.

Training of inspectors and quality controllers are planned; training centers covering processing, handling and quality control are being established, while training on key aspects are being conducted regularly for the industry.

The department will play an active role in the area of inspection and quality control. This is to satisfy the requirement of many countries which recognises only the government institution's role in inspection and quality control.

The department supports the harmonization of standards for fish and fishery products and the recognition of equivalency of systems. Therefore, it will work with countries, economic groups and international agencies in these areas.

The department will continue to work for mutual recognition agreements with trading partners to facilitate trade in fishery products. There is an urgent need to establish information linkages within the department and with trading partners.

In recognizing the expansion of international trade, health and safety aspects of fish and fishery products, the department will continue to cooperate with international organizations. Assistance to countries needing to establish and improve their post-harvest technology and inspection system is also included in the plan, as well as to play an active role in the international forum in the development of technology on fish handling, processing and quality control.

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The Seminar was informed that in relation to quality inspection of aquaculture shrimps in Thailand, 22 stations all over Thailand have been equipped with High Performance Liquid Chromatographs (HPLCs).

Table 1. Fisheries production in quantity by sub-sector (1983-1993).

Unit : 1,000 tonnes

Year	Total	Capture		Aquaculture	
		Marine	Inland	Coastal	Freshwater
1983	2,255.40	2055.20	108.40	44.80	47.00
1984	2,134.80	1911.50	111.40	61.50	50.40
1985	2,225.20	1997.20	92.20	60.60	75.20
1986	2,536.30	2309.50	98.40	39.10	89.30
1987	2,779.10	2540.00	87.40	61.90	89.80
1988	2,629.70	2337.20	81.50	108.90	102.10
1989	2,740.00	2370.50	109.10	168.70	91.70
1990	2,786.40	2362.20	127.20	193.20	103.80
1991	2,967.70	2478.60	136.00	230.40	122.70
1992	3,239.80	2736.40	132.00	229.30	142.10
1993	3,385.10	2752.50	175.40	295.60	161.60

Source : Department of Fisheries, 1996.

Table 2. Production of shrimp by sub-sectors (1989-1995)

Quantity : Tonnes

Year	Total	Capture		Culture	
		Sub-total	%	Sub-total	%
1989	178,699	85,204	47.68	93,495	52.32
1990	201,239	83,012	41.25	118,227	58.75
1991	268,565	106,495	39.65	162,070	60.35
1992	276,500	91,616	33.13	184,884	66.87
1993	321,085	95,571	29.77	225,514	70.23
1994	363,446	100,000	27.51	263,446	72.49
1995	385,000	105,000	27.27	280,000	72.73

Source : Department of Fisheries,1996.

Table 3. Fisheries production in value by sub-sectors (1983-1993).

Value : Million US$

Year	Total	Capture		Aquaculture	
		Marine	Inland	Coastal	Freshwater
1983	769.53	561.96	119.86	47.48	40.22
1984	733.48	531.09	102.78	50.56	49.06
1985	791.42	563.09	102.79	62.93	62.61
1986	915.29	679.49	82.80	75.60	77.40
1987	1,105.66	774.28	84.52	149.04	97.81
1988	1,296.90	792.92	71.39	328.68	103.92
1989	1,434.80	797.41	89.13	459.74	88.52
1990	1,655.83	829.54	132.07	618.94	104.08
1991	2,121.03	1,056.15	83.63	814.48	118.77
1992	2,621.78	1,313.32	119.95	1,049.38	139.13
1993	3,136.27	1,448.96	179.58	1,344.14	163.58

Source : Department of Fisheries, 1996

Table 4. Total catch by species group (1983 - 1993).

Unit : 1,000 Tonnes

Year	Total	Marine Fisheries							Freshwater Fisheries			
		Sub- total	Fish	Shrimp	Crabs	Squid & Cuttlefish	Molluscs	Others	Sub-total	Fish	Shrimps	Others
1983	2,255.40	2,100.00	1,481.80	161.00	28.60	132.00	115.60	181.00	155.40	144.00	5.90	5.50
1984	2,134.80	1,973.00	1,514.10	137.30	27.00	129.30	153.60	11.70	161.80	150.20	7.40	4.20
1985	2,225.20	2,057.70	1,570.40	127.70	26.80	116.00	183.50	33.30	167.50	152.40	10.30	4.80
1986	2,540.00	2,352.20	1,798.90	141.20	35.60	134.90	164.30	77.30	187.80	175.30	8.50	4.00
1987	2,779.00	2,601.90	2,017.40	151.60	40.40	132.50	217.80	42.20	177.10	158.60	15.00	3.50
1988	2,629.70	2,446.10	1,867.70	165.90	41.90	124.20	227.20	19.20	183.60	167.10	14.40	2.10
1989	2,740.00	2,539.20	1,932.50	204.30	42.30	142.90	200.60	16.60	200.80	192.80	8.00	0.00
1990	2,786.40	2,555.40	1,948.10	225.70	41.60	135.10	190.90	14.00	231.00	224.40	6.60	0.00
1991	2,967.70	2,709.00	2,020.20	291.20	45.20	154.40	142.60	55.40	258.70	250.80	7.90	0.00
1992	3,239.80	2,965.70	2,230.70	301.60	44.50	150.30	135.40	103.20	274.10	263.50	10.40	0.20
1993	3,385.10	3,048.10	2,353.60	344.40	47.10	153.30	134.10	15.60	337.00	327.20	9.30	0.50
%Growth from 1989	23.50	20.00	21.80	68.60	11.30	7.30	-33.20	-6.00	67.83	69.71	16.25	23.81*

Source: Department of Fisheries ,1996.

* % Growth from 1988

Table 5. Disposition of marine catch by types of fish processing (1989-1993).

Quantity: tonnes

Type of plant	1989	1990	1991	1992	1993
Freezing	460,277	548,614	527,925	800,118	833,853
Canning	684,614	761,391	775,808	923,362	899,952
Fish sauce	31,467	35,989	37,550	34,762	38,671
Budu sauce	347	356	369	352	346
Steaming	4,219	3,808	4,297	4,707	4,721
Smoking	3,674	3,150	3,194	1,904	1,745
Salted fish	63,175	65,216	60,541	53,163	52,283
Dried fish	31,083	27,765	26,716	37,723	32,491
Dried squid	34,728	33,955	34,505	35,184	34,688
Dried shellfish	2,669	2,947	2,938	3,024	2,429
Fish ball	6,192	5,962	5,998	6,009	5,888
Fish cracker	832	606	948	1,919	1,414
Fish meal	1,071,025	1,087,026	1,115,298	1,389,521	1,374,683
Total	2,394,302	2,576,785	2,596,087	3,291,748	3,283,164

Source : Department of Fisheries, 1996.

Table 6. Number of fish processing establishments ,1983-1993.

Type of plant	1989	1990	1991	1992	1993
Freezing	94	108	100	120	129
Canning	43	42	42	49	52
Fish meal	118	116	110	110	104
Fish sauce	29	29	27	27	81
Budu	65	55	62	71	107
Steaming	38	36	30	28	28
Smoking	830	750	632	621	702
Salted fish	213	205	168	188	192
Dried shrimp	772	712	642	605	604
Dried squid	646	646	523	456	484
Dried shellfish	95	94	86	86	86
Fish ball	95	90	89	92	112
Fish-Shrimp cracker	85	104	102	106	115

Source : Department of Fisheries, 1996

Table 7. Value of Fisheries Trade (1983-1995).

Quantity : tonnes; Value : US$million

Year	Export			Import		
	Quantity	Value		Quantity	Value	
		US$	% Change		US$	% Change
1983	344,899	507,086.92	13.0	58,942	43,723.24	51.0
1984	411,722	603,235.72	19.0	119,064	84,773.52	94.0
1985	466,219	741,106.40	23.0	152,707	154,298.28	82.0
1986	602,486	1,076,174.48	45.0	268,089	303,601.12	97.0
1987	663,650	1,306,173.28	22.0	227,327	280,675.32	(8.0)
1988	799,357	1,778,673.28	36.0	347,676	588,579.76	110.0
1989	876,497	2,150,044.48	21.0	455,762	762,703.84	30.0
1990	912,181	2,453,926.92	14.0	506,540	829,088.40	9.0
1991	1,088,253	3,139,943.60	28.0	724,769	1,094,343.80	32.0
1992	1,106,141	3,298,771.92	5.0	714,012	982,747.52	(10.0)
1993	1,115,079	3,640,733.32	10.0	760,920	865,174.80	(12.0)
1994	1,254,656	4,411,409.08	21.0	893,656	853,156.36	(2.0)
1995	1,192,558	4,663,112.04	5.7	872,830	876,988.40	2.7

Source: Department of Fisheries, 1996.

Table 8. Fisheries Export to Major Desination

Value : US$ Millon

Country	1989	1990	1991	1992	1993	1994
Japan	790.51	873.99	1,117.41	1,172.11	1,313.03	1,474.10
USA	514.96	646.86	857.58	917.69	1,013.99	1,237.32
EU	378.63	455.65	524.33	505.06	452.33	526.60
Canada	60.91	2.22	82.93	109.69	143.60	161.15
ASEAN	141.34	110.70	113.68	137.15	142.91	79.02
ANZEC	95.32	88.66	114.52	114.01	126.61	66.70
EFTA	43.91	51.08	56.97	75.19	75.56	37.53
C. Taipei	3.49	7.91	9.21	22.85	74.75	44.45
Other	120.96	164.41	253.31	245.01	297.96	184.82
Total	2,150.04	2,401.48	3,139.94	3,298.77	3,640.73	3,811.68

Source : Department of Fisheires, 1996.

Table 9. Thailand export of fish and fisheries products (1990-1994).

Quantity : metric tonnes; Value : US$ million

Items	1990		1991		1992		1993		1994	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
EXPORT OF FISHERY PRODUCTS	750,170	2,312.08	903,515	2,958.32	940,327	3,127.60	969,147	3,447.68	1,072,353	4,215.04
1. Fish; fresh, chilled, frozen	191,977	181.56	236,896	324.24	291,838	322.40	281,572	327.84	286,383	338.16
Fish; fresh, chilled, frozen (excl. fillets)	140,690	75.68	150,876	74.52	205,603	99.96	195,875	98.88	199,180	120.52
Fish; fillet, fresh, frozen	51,287	105.92	86,020	249.72	86,235	222.44	85,697	228.96	87,203	217.64
Fish; live	1,877	6.28	1,897	6.32	3,190	10.20	3,960	11.36	14,368	12.24
Fish; live for aquarium	52	0.24	51	0.24	83	0.32	112	0.36	172	0.56
2. Cephalopod; fresh, chilled, frozen	62,206	182.52	62,460	220.32	63,405	226.08	58,256	234.48	60,228	282.24
3. Seaweed	135	1.36	99	1.28	98	1.28	95	1.24	102	1.60
4. Ark - shells; fresh, chilled, frozen	5	-	12	-	5	-	19	-	13	-
5. Shirmps; fresh, chilled, frozen	84,724	818.16	121,240	1,067.24	130,516	1,267.84	148,866	1,513.68	199,476	1,966.24
6. Agar - agar	1	-	2	0.04	5	0.08	8	0.16	9	0.16
7. Crabs, crab meat; fresh, chilled, frozen	290	0.84	380	1.52	1,036	4.60	1,113	4.44	2,005	7.08
8. Fish; dried salted or in brine, smoked	20,497	19.24	22,515	25.92	19,349	26.00	18,916	35.96	15,842	21.96
9. Cephalopod; brine, dried	3,938	41.48	2,765	32.64	3,402	42.40	2,430	35.16	1,442	19.92
10. Shrimps; salted in brine or dried	1,610	9.44	1,816	12.76	1,703	11.88	1,649	12.40	1,430	11.56
11. Shrimps; simply boiled in water	993	7.04	931	9.40	546	5.92	1,673	18.72	1,515	16.04
12. Sharks fins ; brine dried	25	1.24	28	0.84	18	6.40	22	0.84	35	1.68
13. Jelly fish; salted, brine of dried	6,412	4.28	11,938	10.80	6,543	6.76	2,559	3.48	7,439	7.28
14. Crustaceans and molluscs; salted or dried	3,673	14.16	4,578	19.08	4,258	15.60	4,651	17.56	4,910	20.48
15. Other crustaceans; fresh chilled or frozen	813	6.36	846	8.28	1,302	13.36	1,343	7.80	1,481	8.28
16. Shell	*	-	3	-	*	-	9	-	1	-
17. Other products of crustaceans	951	2.20	884	3.04	371	2.60	580	2.88	647	3.08
18. Fish roes and other fish parts, frozen	23	0.04	110	1.40	81	0.52	12	-	4	-
19. Prepared or preserved fish	28,779	57.40	36,454	73.60	40,893	81.76	104,274	102.84	60,681	126.32
20. Cephalopod; prepared	4,817	11.44	4,471	12.40	2,469	6.72	1,135	3.12	396	1.56
21. Cephalopod; prepared	4,328	25.20	4,025	23.44	2,693	16.48	3,019	18.48	2,306	14.60
22. *Blanchan* not in airtight containers	3,207	7.72	2,669	6.28	3,035	8.84	2,968	11.28	2,211	8.16
23. Other crustaceans and molluses prepared or preserved	85	0.40	2,105	11.44	3,566	18.84	2,420	13.40	5,428	28.08
24. Sardines; prepared or preserved	19,696	23.92	28,333	35.64	25,996	32.64	33,734	42.12	48,735	41.48
25. Tuna; prepared or preserved	258,401	625.56	305,277	736.64	279,070	622.04	258,484	597.12	291,854	689.80
26. *Asari* prepared in airtight containers	9,674	15.60	4,386	8.20	5,013	12.60	3,426	8.28	5,214	12.80
27. *Asari* prepared not in airtight containers	1,875	4.24	913	2.60	799	2.64	391	1.48	452	1.88
28. Crab; prepared or preserved	10,001	52.52	9,827	47.04	9,713	53.48	8,778	46.04	6,903	39.68
29. Shirmp; prepared or preserved	29,110	191.64	35,604	225.72	39,331	313.16	42,653	375.16	50,671	532.08

Source : Center for agriculture statistics, 1996.

Table 10. Thailand Import of Fish and Fisheries Products (1990-1994).

Quantity : metric tonnes; Value : US$million

Items	1990		1991		1992		1993		1994	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
IMPORT OF FISHERY PRODUCTS	752,358	807.16	670,545	1,054.20	645,289	930.80	616,844	769.92	683,681	727.44
1. Fish; fresh, chilled, frozen	698,621	753.68	596,539	973.28	563,403	820.92	539,040	645.72	568,692	555.16
Fish; fresh, chilled, frozen (excl. fillets)	696,379	751.20	593,800	970.68	561,267	819.00	535,091	642.88	567,401	553.48
Fish; fillets, fresh, frozen	2,243	2.48	2,739	2.64	2,136	1.96	3,949	2.84	1,295	1.68
2. Fish; live	11	0.16	12	0.32	13	0.24	12	0.20	41	0.08
3. Fish; live for aquarium	7	0.32	7	0.24	8	0.36	7	0.32	12	0.48
4. Cephalopod; fresh, chilled, frozen	2,462	1.80	5,639	8.72	10,281	13.76	14,018	22.84	36,901	59.48
5. Shrimps; fresh, chilled, frozen	1,363	7.00	6,010	13.96	3,495	17.48	4,824	28.68	7,367	34.12
6. Fish; salted, in brine, dried	297	0.20	19	0.20	506	0.64	1,261	0.60	2,520	1.40
7. Cephalopod; brine, dried	1,374	4.96	2,924	6.48	3,364	6.5 2	5,706	13.08	1,538	5.16
8. Sharks fins; brine, dried	67	0.80	19	0.28	60	0.68	100	1.44	127	1.60
9. Beche-demer; brine, dried	6	-	3	0.02	10	0.04	11	0.40	15	0.04
10. Ark-shells; fresh, chilled, frozen	32,285	4.92	36,721	5.48	41.846	6.72	35,185	5.64	39,744	6.12
11. Seaweed	90	1.04	106	1.48	151	2.84	213	4.16	305	7.96
12. Agar-agar	347	7.96	326	7.60	435	9.32	472	9.04	594	10.56
13. Other crustaceans; fresh, chilled, frozen	854	2.80	1,138	6.96	3.567	19.32	2,181	9.92	2,471	9.32
14. Fish and crustaceans preparation	8,986	9.24	12,720	6.92	9,489	9.48	6.902	9.04	12,374	13.44
15. Fish roes and other fish parts frozen	2	-	1,884	8.20	483	7.84	325	6.04	249	3.52
16. Other products of crustaceans	954	8.88	1,042	11.00	4,107	12.04	2.031	9.80	4,143	14.12
17. Fish liver oils	793	0.84	127	0.16	216	0.20	419	0.36	981	0.76
18. Fats and oils of marine mammals	3,839	0.84	5,309	2.88	3.853	2.36	4.130	3.00	5.801	4.00
19. Spermaceti	-	-	-	-	2	0.01	7	0.02	2	0.01

Source : Center for agriculture statistics, 1996.

Table 11. Export of major fishery products commodities (1992 -1996).

Quantity : metric tonnes; Value : US$ million

Target items	1992		1993		1994		1995		1996*	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1. Shrimp	132,761.0	1,286.1	152,220.0	1,544.9	176,735.0	1,993.9	183,200.0	2,034.0	203,900.0	2,242.0
1.1 Frozen shrimp	130,631.0	1,268.3	148,901.0	1,513.7	173,881.0	1,966.2	180,000.0	2,000.0	200,000.0	2,200.0
1.2 Dried shrimp	1,072.0	11.9	1,646.0	12.4	1,429.0	11.6	2,000.0	16.0	2,400.0	20.0
1.3 Frozen cooked shrimp	58.0	5.9	1,673.0	18.7	1,425.0	16.1	1,200.0	18.0	1,500.0	22.0
2. Cephalopods	69,495.0	284.9	63,708.0	288.1	64,117.0	317.1	66,600.0	362.0	68,100.0	376.4
2.1 Frozen cephalopods	63,404.0	226.1	58,258.0	234.5	60,229.0	282.3	62,000.0	320.0	62,000.0	328.0
2.2 Dried cephalopods	3,401.0	42.4	2,430.0	35.2	1,584.0	20.2	1,400.0	18.4	1,600.0	21.2
2.3 Processed cephalopods	2,609.0	16.5	3,020.0	18.5	2,304.0	14.6	3,200.0	24.0	4,000.0	27.2
3. Fish	314,721.0	353.5	304,264.0	360.4	306,931.0	372.3	320,000.0	391.2	311,000.0	398.0
3.1 Fillet/minced fish	86,251.0	222.5	85,697.0	229.0	82,203.0	217.6	90,000.0	232.0	90,000.0	240.0
3.2 Frozen whole fish	206,238.0	101.0	196,014.0	99.0	199,448.0	120.8	210,000.0	124.0	200,000.0	120.0
3.3 Dried fish	18,958.0	19.5	18,481.0	20.6	15,763.0	21.1	15,000.0	20.0	15,000.0	20.0
3.4 Live fish and fish fries	3,274.0	10.5	4,072.0	11.8	4,517.0	12.8	5,000.0	15.2	6,000.0	18.0
4. Seafood : canned / processed	409,524.0	1,152.4	408,859.0	1,201.4	442,720.0	1,483.3	461,650.0	1,586.0	482,000.0	1,728.0
4.1 Canned seafood	342,094.0	977.0	341,839.0	1,026.4	371,931.0	1,279.8	380,650.0	1,354.0	402,000.0	1,488.0
4.1.1 Canned tuna	243,591.0	537.5	229,901.0	522.5	253,985.0	624.8	250,000.0	624.0	255,000.0	640.0
4.1.2 Canned sardine	25,857.0	32.0	33,392.0	40.9	33,197.0	41.3	35,000.0	44.0	40,000.0	50.0
4.1.3 Canned fish (others)	16,135.0	21.7	22,561.0	30.4	21,572.0	27.6	24,000.0	32.0	25,000.0	34.0
4.1.4 Other canned seafood*	56,511.0	385.8	55,985.0	432.6	5,612.0	14.4	4,150.0	10.0	4,000.0	10.0
4.2 Processed seafood	67,430.0	175.4	67,020.0	175.0	70,789.0	203.5	81,000.0	232.0	80,000.0	240.0
4.2.1 Seafood products	31,949.0	90.9	33,440.0	100.4	47,909.0	138.5	60,000.0	172.0	60,000.0	180.0
4.2.2 Tuna products	35,481.0	84.5	28,580.0	74.6	22,880.0	65.0	21,000.0	60.0	20,000.0	60.0
5. Pet food from fish	153,543.0	123.9	155,158.0	189.2	158,275.0	182.1	168,000.0	203.2	135,000.0	211.2
5.1 Canned pet food	141,847.0	158.4	149,681.0	172.3	135,731.0	172.7	144,000.0	183.2	149,000.0	189.6
5.2 Others	11,696.0	15.5	15,477.0	16.8	22,544.0	19.4	24,000.0	20.0	26,000.0	21.6
6. Fish sauce	30,962.0	37.6	33,492.0	42.5	41,307.0	50.3	50,000.0	60.0	55,000.0	68.0

Souce : Department of Business Economic,1996.

* 1996 : Target Figure

Table 12. Number of frozen products processor by type of products.

Type of processor	Number
Raw shrimp	87
Value added shrimp	11
Cooked shrimp	40
Fish fillet	33
Immitation crab meat	7
Surimi	12
Cephalopod	45
Value added seafood	12

Source : The Frozen Product Associates, 1995.

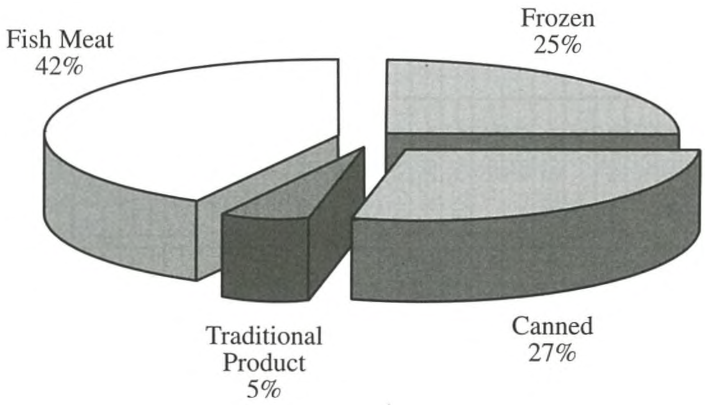

Fig. 1. Utilization of catch for major products for 1993.

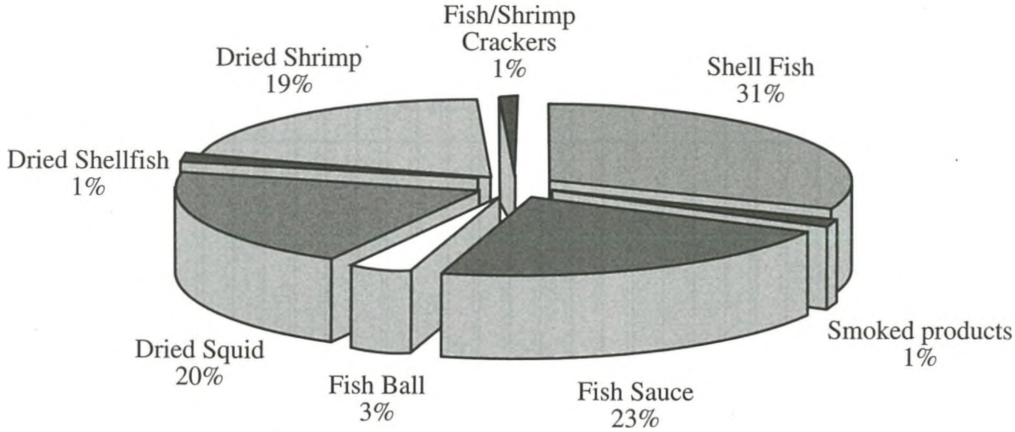

Fig. 2. Utilization of catch for traditional products for 1993.

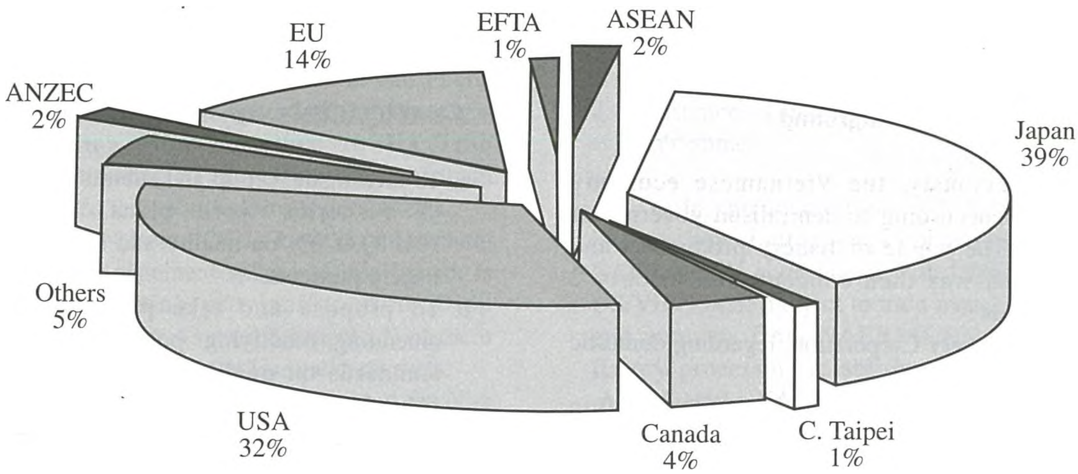

Fig. 3. Fish exports to major destinations in 1994.

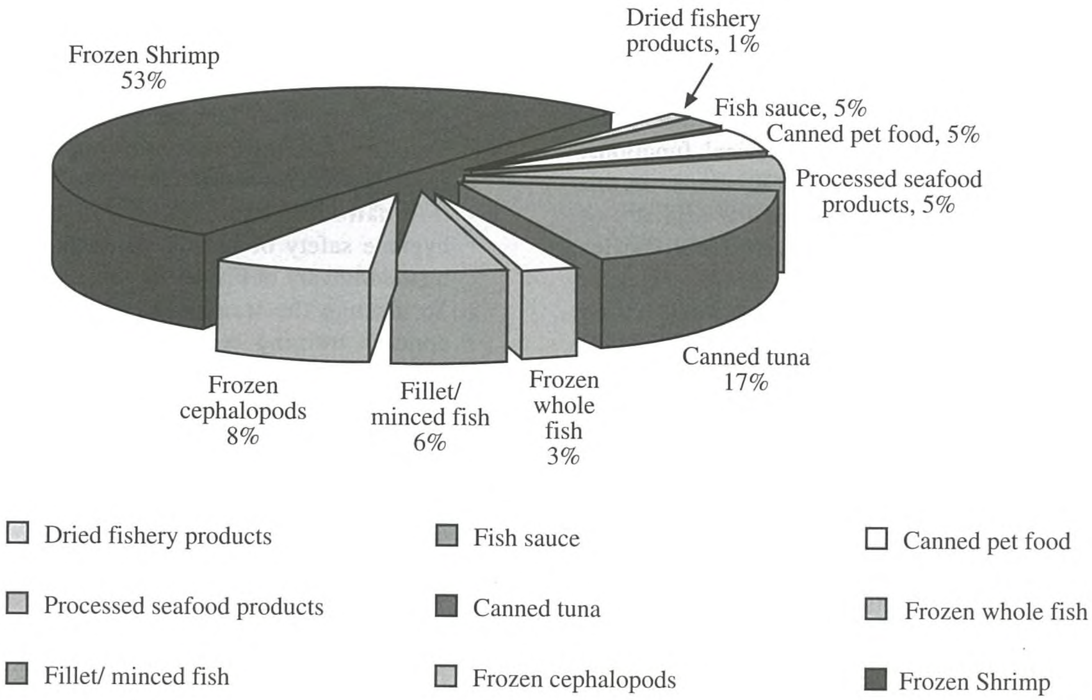

Fig. 4. Thailand's export of major fishery product commodities for 1995.

NAFIQACEN - The Vietnamese Governmental Competent Authority On Inspection And Certification For Fishery Production Conditions And Product Quality

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Background

Previously, the Vietnamese economy developed according to centralised government planning. The whole of fishery production and distribution was then concentrated in only 2 organizations :

- Central Fishery Corporation, regarding domestic fishery products
- Seaproducts Export-Import Corporation (SEAPRODEX), regarding export of fishery products.

There were two Quality Control Centers under them for fishery quality control in the country.

Nowadays, in a market economy, such quality management activities and organization structures are not suitable any more.

The Vietnamese fishery sector planned to succeed in developing its fisheries resources, expand export markets and meet the demands of consumption in the country, and keep up with development trends of the region and the world. The Vietnamese Government therefore promulgated Decree № 50/CP dated 21/6/1994 stipulating the Ministry of Fisheries' functions, responsibilities and organization structure. In this decree, the Government allowed the Ministry of Fisheries to establish the National Fisheries Inspection and Quality Assurance Center (NAFIQACEN). In this connection, the Minister of Fisheries promulgated Decision № 648 TS/QD dated 26/8/1994 stipulating the NAFIQACEN's functions, responsibilities and organization structure.

NAFIQACEN's Functions, Responsibilities and Organization Structure

1. NAFIQACEN's functions

The NAFIQACEN is the sole Vietnamese governmental authority on quality and hygiene safety inspection and governmental certificate issuance for fishery production conditions and fishery products.

2. NAFIQACEN's major responsibilities

a. To investigate, set up and submit to the Ministry of Fisheries work plans, programs of NAFIQACEN on quality and hygiene safety of fishery products.
b. To propose and take part in setting up, amending, modifying policies, regulations and standards on quality and hygiene safety of fishery products.
c. To control, set up a system of documentation, issue and revoke certificate of fishery production conditions for business units in the country.
d. To control, issue quality and health certificate of fishery products for export and domestic consumption according to the list stipulated by the Ministry of Fisheries.
e. To investigate, test, develop and apply progressive quality control methods, measures for quality assurance and hygiene safety of fishery products during processing, as well as modern and new analysis-metrology methods and equipment to ensure hygiene safety, and constantly improve the quality of fishery products.
f. To carry out international cooperation and foreign investment projects of other international organizations on quality and hygiene safety of fishery products as directed by the Ministry of Fisheries.
g. To arrange the transfer of information and conduct training courses for quality control staff of the Vietnamese fishery sector. To conduct and assist in developing acceptable methods for quality control organizations and establishments.
h. To provide services on quality and hygiene safety for fishery products according to current laws.
i. To carry out professional inspection for compliance with the Commodities Quality Ordinance and legal documents concerning assurance for hygiene safety of products and production conditions according to guidance of the Ministry of Fisheries.

3. NAFIQACEN organization structure

The NAFIQACEN's Headquarters is located in Hanoi and has 3 divisions:
- Administration
- Planning and General Division
- Professional Affairs Division

NAFIQACEN has 5 branches located in 5 key fishery areas:

- NAFIQACEN Branch I is located in Hai Phong City. The management sphere of this branch is from Quang Ninh province to Ha Tinh province, covering 25 establishments; 5 of them are approved to export to European markets.
- NAFIQACEN Branch II is located in Da Nang City. The management sphere of this branch is from Quang Binh province to Binh Dinh province, covering 43 establishments; 9 of them have approval to export to European markets.
- NAFIQACEN Branch III is located in Nha Trang City. The management sphere of this branch is from Phu Yen province to Ninh Thuan province, covering 22 establishments; 5 of them have approval to export to European markets.
- NAFIQACEN Branch IV is located in Ho Chi Minh City. The management sphere of this branch is from Binh Thuan province to the north of the Hau River (one branch of Mekong river), covering 74 establishments; 27 of them have approval to export to European markets.
- NAFIQACEN Branch V is located in Minh Hai province. The management sphere of this branch is South of the Hau River, covering 31 establishments; 13 of them have approval to export to European markets.

Initial Results of Vietnamese Fishery Quality Improvement Through NAFIQACEN Activities

1. Legal documents on quality control and management

In order to control and manage quality effectively, legal documents concerning quality policies, quality and hygiene safety regulations, guidelines, and standards were gazetted. Besides serving as references on fishery quality control and management activities, these documents also guide establishments to improve product quality. At the same time when application forms are sent out to establishments, these documents are also revised and amended to meet new quality requirements of specific markets. In response to recent changes in fishery quality control, inspection and management, the NAFIQACEN is preparing to submit the following documents to the Ministry of Fisheries for approval:

- Vietnamese standard on ensuring hygienic safety for fishery production conditions; this standard corresponds to Directive 91/493/EEC.
- Regulation on inspection and certification of fishery production conditions.
- Regulation on control and certification of fishery product quality.
- Regulation on fishery technical inspection.
- Regulation on approval for GMP application.

2. Assistance of quality control improvements in establishments

In appreciation of the fact that personnel is the key factor to improve quality, the NAFIQACEN coordinated with UNIDO/DANIDA US/VIE/93/058 Project to train over 120 inspectors and analysts from NAFIQACEN branches and fishery processing establishments in April 1995. After that, the NAFIQACEN also coordinated with DANIDA 95/300/2 Project to train over 270 managers from fishery establishments on GMP application in April 1995. As at August 1996, 65 establishments which have approval to export fishery products into the EU market applied for GMP accreditation. Twenty-seven (27) of them (approx. 40%) completed documentation in preparation for applying GMP on a trial basis. After the trial period, they will be duly considered for approval by the Ministry of Fisheries at the end of this year. We anticipate from this that there will be more and more new clients from overseas markets with strict requirements on hygiene safety and the quality of fishery products.

3. Inspection of production conditions

To protect consumers' health, many international quality organizations as well as large markets in the world requested a change from quality control of finished products to complete control of all procedures from culture, catching, handling to processing and distribution of fishery products. Actually, large fishery import markets such as the EU, USA and Taiwan stipulate that fishery export countries must have their own competent authorities to inspect production conditions of fishery processing plants. Prerequisite to exporting fishery products to those markets is that export establishments must comply with health conditions for fishery processing.

At the end of 1994, based on EU Directive 91/493/EEC, NAFIQACEN inspected 112 establishments and approved 62 of these to export fishery products to the EU in 1995. At the end of 1995 those establishments and 30 others had been inspected by NAFIQACEN. Based on NAFIQACEN's results, the Ministry of Fisheries forwarded to the EU Commission its recommendation for recognition of 65 establishments to export their fishery products to EU market in 1996.

It is significant that the NAFIQACEN not only inspects defects influencing product quality, but it also indicates measures to overcome the defects. One of the results of this activity is the better understanding of managers and QA/QC staff about production conditions influencing the quality of their products. The establishments' managers also understand that product quality depends not only on technology but also much more on production conditions. The NAFIQACEN has set up a 4-level scale, viz

A - Excellent
B - Good
C - Medium
D - Not Acceptable

There are as yet no establishments with grade A. In 1995 there were 9 establishments in grade B. With NAFIQACEN's assistance in the last two years, the establishments spent much capital to upgrade their production conditions. As a consequence of such upgrading, the number of plants at production conditions level B increased from 9 (15%) in 1995 to 15 (25%) in 1996. One of the approved establishments commented that due to improvements to production conditions it has increased the number of customers from all markets, and the turnover has increased. It can be said that if any businessman from whatever market wanted to buy fishery products from establishments whose production conditions were recognized by NAFIQACEN for export to EU, he can be sure about the hygiene safety and quality of the products.

4. Quality control and certification for fishery products

Vietnam has gradually been taking on responsibilities which are accepted as assuring maximal quality and hygiene safety of products for consumers. Simultaneously, Vietnamese manufacturers have also been assisted to better understand product quality so that they can make timely changes to improve it.

Although recently established, NAFIQACEN has quickly organized a network of branches and laboratories with the assistance of the Ministry of Fisheries to execute quality control and certification for fishery products all over the country. Figures for the first 6 months of 1996 indicate that the role of NAFIQACEN has been accepted by manufacturers and by domestic and foreign markets. In conformity with the requirements of various markets such as EU, Taiwan (for all fish products) and USA (for shrimp products), NAFIQACEN has proved its capability as the sole competent governmental authority for quality control and certification for fish products accepted by those markets.

Quality Control Activities in the Future and Necessity for Regional Cooperation

The development strategy of the fishery sector called for processors to improve quality management and control in order to enhance the prestige of fishery products which are labelled "Made in Vietnam". To achieve this target, NAFIQACEN has first to carry out the following :

- Provide legislation and technical regulations to perfect conditions to establish conditions for quality management and control of the fishery sector.
- Strengthen professional ability for quality control staff at all levels from state to local, and assist establishments to implement GMP and HACCP practices.
- Upgrade infrastructures (laboratory facilities, analytical equipment etc for inspection on hygiene safety criteria at ports).
- Intensify inspection of production conditions at the fishery establishments, and promote the upgrading of production conditions.
- Intensify quality management controls for raw-materials.

In order to implement the above successfully and advance toward equal participation in quality management activities in the region, the NAFIQACEN gives top priority to cooperation with other countries in the region, including the following :

- To participate in activities of fishery organizations in the region
- To participate in activities of the ASEAN - CANADA Fisheries Post-Harvest Technology Project - Phase II
- To participate in cooperative activities of the ASEAN Network of Fisheries Post-Harvest Technology Centres

We wish to propose the establishment of the ASEAN Fishery Quality Management Association in order to create opportunities for exchanging experiences and assisting one another.

Conclusion

The current Vietnamese economic development program is opening many new opportunities for the fishery sector. However, in order to optimise this development, it is necessary to strengthen the role of quality management and to improve the quality of Vietnamese fishery products. Therefore, the Vietnamese fishery sector has been renewing and improving its quality management system and facilities, training personnel for quality control programs and strengthening cooperation activities, particularly in cooperation with fishery quality management organizations of ASEAN countries, in order to advance towards synchronising the quality management activities of Vietnam with the region and the world.

Discussion

In response to the query of the representative from the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II, the representative from Vietnam clarified that the proposed establishment of the ASEAN Fishery Quality Management Association shall involve coordination of the various laboratories in ASEAN to ensure that these laboratories have the same results as far as harmonisation of products are concerned.

The representative from the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II apprised the Seminar that the ASEAN Canada Project is implementing an ongoing activity which includes checking of sample programmes.

RESEARCH PAPERS

Sixteen research papers were presented at the Seminar.
The text of these papers are reproduced, each followed by
a summary of the discussion which took place.

Evaluation on Nutritional Value of Javanese Salted-Boiled Fish During Processing with Special Reference to EPA and DHA Content

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Abstract

In order to implement a quality management concept for traditional processors, an evaluation of the nutritional value of raw materials and end products of salted-boiled fish obtained from a Javanese processor has been conducted. Chemical composition analyses which include moisture, protein, lipid and ash content was carried out to understand the changes in nutritional composition. EPA and DHA were analyzed using gas liquid chromatography to study the effect of processing on its stability.

The results showed that the moisture content of the end product decreased in the range of 0.9 to 16.7 % compared to the raw material. There were no significant changes to protein, lipid and ash content after the fish was processed. Data on fatty acid analysis revealed that EPA and DHA content were reduced by an average of 0.48 to 5.02 % and 0.16 to 9.97 % respectively. The loss of EPA and DHA was higher in the product which was processed using dry-salt boiling technique compared to those boiled with brine.

Introduction

Salted-boiled fish, which is locally called *pindang,* plays an important role in the staple diet of Indonesians because of its nutritional value particularly as a low cost food. This traditional fish product is generally prepared through two different ways of processing, which are dry-salt boiling and brine boiling (Saleh *et al.*, 1982). The major types of fish which are processed into salted-boiled fish by Indonesian traditional fish processors particularly in Java island are scad, *Rastrelliger* sp. and little tuna. However some processors also use sardine and milkfish as the raw material, although in a relatively small quantity compared to the former (Fitriati *et al.*, 1994).

Many research studies investigated the effect of processing methods on the quality of salted-boiled fish as well as the efforts to increase the shelf life of the product. Chemical composition of salted-boiled *Rastrelliger* sp. and *Euthynus* sp. which have been processed by several different methods has been determined by Ibrahim (1986). It was found that the content of protein, lipid, moisture and salt ranged between 17.9 - 31.4 %, 1.1 - 8.4 %, 45.0 - 71.4 % and 0.6 - 9.1 % respectively. Mulyani (1993) studied the effect of processing and storage on the quality of protein in salted-boiled mackerel by focusing mainly on the changes in the available lysine. The work revealed that the brine-boiling technique caused a higher loss of available lysine than that of dry-salt boiling and, in contrast, dry-salt boiling yielded higher loss of available lysine during storage at room temperature. A study on the changes in lipid quality which focused on omega-3 fatty acids (EPA and DHA) stability of several fishery products, including salted-boiled fish, during processing found that the decrease of EPA and DHA was not only influenced by the method of processing but also by the types of fish, which relates to its chemical composition, particularly fat content (Sunarya *et al.*, 1994).

Due to the limited information on the effect of processing on the omega-3 fatty acids, particularly EPA and DHA of salted-boiled fish produced by Javanese traditional processors, a study to understand the level of omega-3 fatty acids losses during processing of salted-boiled scad and little tuna was carried out. This paper describes the results of the work. A suggestion to support the efforts on the introduction of quality management concept to traditional processors in Indonesia is also made.

Materials and Methods

The raw materials and end products of salted-boiled fish processed using two different methods (dry-salt and brine boiling) were taken from traditional processors of major production centres in Java including Jakarta, Cirebon (West Java), Pekalongan (Central Java) and Muncar (East Java). The fish were scad (*Decapterus russelli*) and little tuna (*Auxis thazord*) of regular sizes. The samples were frozen and packed in insulated boxes filled with ice to keep the temperature low. They were then sent to The National Centre for Fishery Quality Control and Processing Technology Development (NCQC), Jakarta and kept frozen prior to chemical analysis.

The chemicals used for analysis were analytical grade (AR) from E. Merck whenever possible. Otherwise, general purpose reagent (GPR) grade was used, whereas standard fatty acid for individual identification were obtained from Sigma Chemical Co.

The moisture, ash, protein and lipid contents of the fish were determined; the methods of analyses used were oven drying for moisture, furnace for ash, total nitrogen of Kjeldahl for protein and soxhlet method for lipid determination (Anon., 1994). The fatty acid analysis was done according to Sunarya (1987) which is a modification of IUPAC method in which the extraction of fat was done using the Bligh and Dyer method (solvent combination with water, methanol and chloroform), formation of methyl ester (methylation) was done using potassium hydroxide in methanol with boron trifluoride (BF_3) as the catalyst and the final analysis of fatty acid was carried out using Gas Chromatography Model Packard 437A equipped with flame ionization detector and a packed SP 2330 column. Temperature of analysis was programmed starting from 180°C for 4 minutes and raised to 230°C with the increase of temperature at 5°C per minute. The individual fatty acid was expressed as its relative percentage by calculating the ratio between percentage of a fatty acid with total percentage of all identified fatty acids.

Results and Discussion

The composition of the raw materials and end products of salted-boiled fish are presented in Tables 1 and 2. It can be seen that there was a decrease in moisture content due to processing (heating) which varied between 0.9 % and 6.7 % for brine boiling and between 6.0 % to 17.2 % for dry-salt boiling. The decrease in moisture content coincided with the increase in protein content as well as ash and fat content calculated on wet weight basis. It is obvious that the increase of protein, ash and fat contents were more significant in the product processed using dry-salt boiling as the decrease of moisture content was relatively higher.

Analysis of fatty acid profile using gas chromatography on the raw material and end product of salted-boiled fish (Figs. 1 and 2) reflected that types of individual fatty acid and its relative percentage varied depending upon types of fish as shown in Tables 3 and 4. In general, types of individual saturated fatty acid which were detected in relatively large quantity were myristic acid (C14:0), palmitic acid (C16:0) and stearic acid (C18:0). Also present were palmitoleic acid (C16:1), oleic acid (C18:1), eicosaenoic acid (C20:1) and docosaenoic acid (C22:1) among the monounsaturated fatty acids (one double bond), whereas polyunsaturated fatty acid (more than one double bond) present were mainly linoleic acid (C18:2), octadecatetraenoic acid (C18:4), eicosapentaenoic acid (C20:5; EPA) and docosahexaenoic acid (C22:6; DHA). From Tables 3 and 4, it can be seen that saturated fatty acids were relatively more stable during processing compared to monounsaturated and polyunsaturated fatty acids, particularly EPA and DHA.

The loss of EPA in the product from brine boiling varied between 0.58 % to 2.78 %, whereas in dry-salt boiling was 0.48 % to 5.02 %. Furthermore, the loss of DHA was between 0.16 % to 5.24 % and between 0.67 % to 9.79 % for brine boiling and dry-salt boiling respectively. The highest loss of EPA and DHA were found in salted-boiled scad processed by boiling scad which has been known to contain quite high amount of fat.

From Tables 3 and 4, it can also be seen that the loss of EPA and DHA in dry-salt boiling process was generally higher compared to brine boiling. This is probably due to the higher temperature and longer duration of heating used in the dry-salt process. The loss of DHA seemed also to be higher in all samples compared those of EPA and the reason for this is because DHA contain double bonds (six double bonds) compared to EPA (five double bonds).

Conclusion

From this study, it can be concluded that during processing of salted-boiled fish the loss of EPA and DHA was relatively higher from the product which was processed using dry-salt boiling technique compared to those boiled with brine. It has been found also that the duration of processing (heating) influenced the level of EPA and DHA losses; longer time of processing (heating) resulting in higher loss of EPA and DHA. Furthermore, raw materials with high fat content such as scad seemed to be more susceptible to the destruction of EPA and DHA during processing.

Accordingly, it is suggested not to use the dry-salt boiling technique in the processing of salted-boiled fish for those fish that contain relatively high fat and also the cooking process must be done carefully to avoid overheating.

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Discussion

Regarding the query on decreased EPA and DHA of the end products as compared to the raw materials, Mr Achmad explained that the losses were only in the fatty acid and not in the lipid contents. He also stressed that the analysis was done only for EPA and DHA and not on the individual lipids and added that the result was derived from the mean of triplicate analysis.

During the discussion, it was suggested that the procedure used in the analysis should have been included in the paper. In response, Mr Achmad explained the process briefly which included brining for 2-3 days and dry-salt boiling for 6-7 days.

Table 1. Chemical composition (g/100g) of salted-boiled fish processed by brine boiling.

No.	Area	Type of sample	Moisture	Ash	Protein	Lipid
1.	Jakarta	Little tuna a	75.17	2.04	17.02	0.39
		Little tuna b	68.50	2.42	21.88	0.82
2.	Cirebon	Scad a	70.30	1.01	21.01	2.55
		Scad b	66.10	2.65	23.83	3.45
3.	Pekalongan	Scad a	74.55	1.58	20.12	1.18
		Scad b	70.12	2.61	23.12	0.96
4.	Muncar	Little tuna a	67.83	1.51	22.81	0.90
		Little tuna b	67.83	1.89	25.27	3.20

Note : a : Raw material b : End product

Table 2. Chemical composition (g/100g)of salted-boiled fish processed by dry-salt boiling.

No.	Area	Type of sample	Moisture	Ash	Protein	Lipid
1.	Cirebon	Little tuna a	71.48	1.24	23.42	0.37
		Little tuna b	63.51	1.60	28.17	4.38
2.	Pekalongan	Scad a	73.32	1.32	20.71	0.62
		Scad b	61.77	3.46	25.44	3.78
3.	Muncar	Little tuna a	56.82	2.13	18.44	1.93
		Little tuna b	52.26	5.63	24.15	2.50

Note : a : Raw material b : End product

Table 3. Relative percentage of fatty acid in salted-boiled fish processed with brine boiling.

Area	Sample	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:4	C20:1	C20:5	C22:1	C22:6
Jakarta	Little tuna a	6.48	25.53	5.58	10.41	12.09	5.40	1.28	3.20	4.20	2.11	23.46
	Little tuna b	6.00	29.44	6.33	13.51	10.45	1.23	1.27	2.76	3.62	2.13	23.30
Cirebon	Scad a	5.26	33.00	8.88	8.58	15.72	-	1.37	2.00	7.18	2.09	15.87
	Scad b	4.32	32.30	8.02	14.45	13.63	-	1.39	2.37	4.40	1.18	17.81
Pekalongan	Scad a	4.50	24.86	6.93	12.12	11.25	3.85	1.29	3.16	6.33	1.38	24.18
	Scad b	5.20	29.97	9.14	12.60	12.50	2.35	3.63	-	5.63	-	18.94
Muncar	Little tuna a	11.42	23.06	11.45	5.86	9.34	1.61	3.97	7.68	8.08	1.36	16.12
	Little tuna b	11.29	27.00	11.42	7.12	9.57	1.22	4.02	7.37	5.93	-	15.00

Note : a : Raw material
b : End product

Table 4. Relative percentage of fatty acid in salted-boiled fish processed with dry-salt boiling.

Area	Sample	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:4	C20:1	C20:5	C22:1	C22:6
Cirebon	Scad a	3.38	25.53	6.91	8.09	15.27	1.84	1.41	3.81	10.11	1.25	22.30
	Scad b	4.50	29.11	8.79	8.11	25.60	0.91	1.36	2.89	5.09	1.26	12.33
Pekalongan	Scad a	9.94	35.21	11.26	12.24	15.69	-	1.14	1.68	3.84	-	8.76
	Scad b	9.60	40.60	10.95	13.40	16.91	-	1.27	-	2.63	-	4.60
Muncar	Little tuna a	15.56	27.98	11.17	4.19	10.99	1.27	3.18	5.61	10.46	-	9.09
	Little tuna b	14.37	27.34	11.62	5.59	12.41	1.73	4.07	6.97	7.44	-	8.42

Note : a : Raw material
b : End product

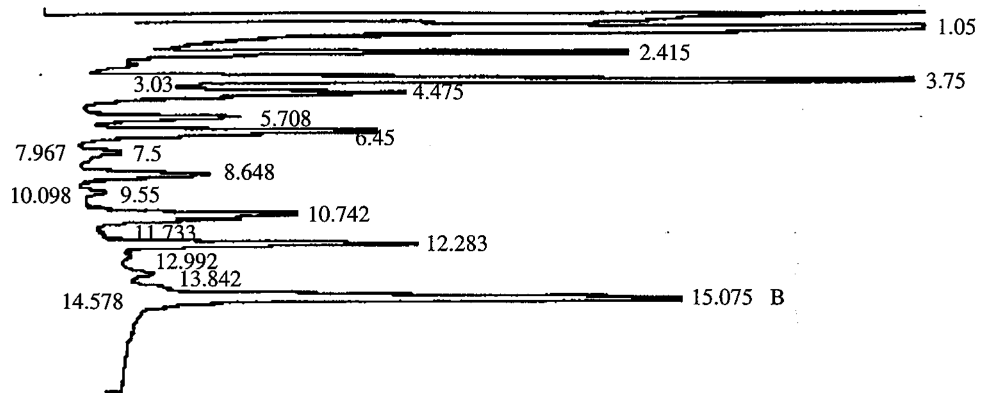

Fig. 1. Chromatogram of fresh scad taken from Pekalongan. (A=EPA; B=DHA)

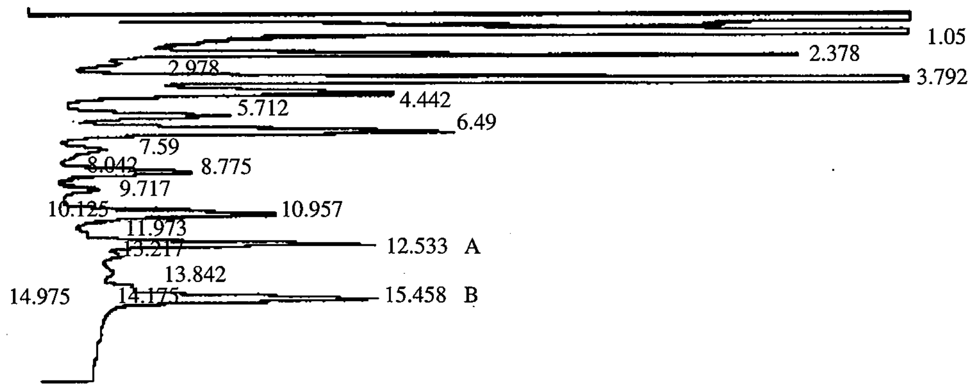

Fig. 2. Chromatogram of salted-boiled scad taken from Pekalongan (brine boiling). (A=EPA; B=DHA)

Food Additives and Effect of Thickness on Fish Crackers Quality

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Abstract

Investigation on the effects of the use of 0.2% food additives (sodium bicarbonate, sodium polyphosphate and ammonium bicarbonate) on the cracker quality has been conducted. Crackers were made from sago and fortified with 25% of fish meat (Congresox talabon). Cracker thickness studied were 2, 3 and 4 mm. The cracker quality was evaluated in terms of expansion volume and crispiness. The results showed that crackers with sodium bicarbonate addition and 2 mm thickness had the highest volumetric expansion and crispiness followed by sodium polyphosphate and ammonium bicarbonate.

Introduction

Cracker is a snack food commonly made from starch, such as sago starch which is high in carbohydrate content. The sago starch is produced from the sago plant which grows abundantly in Eastern Indonesia, especially Irian Jaya (600,000 ha) and Maluku (77,700 ha) (Soekarto & Wiyandi, 1983). Besides, Eastern Indonesia is also well known as a potential fishery region. The use of sago starch for fish cracker is therefore an effort to use starch for food products.

The fish generally used for cracker are featherback (*Natopterus chilata*), yellow pike conger (*Ophiocephalus micropeltis*), little tuna (*Euthynus affinis*), snapper (*Lutjanus* spp.), Spanish mackerel (*Scomberomorous comersoni*), and catfish (*Arius thalassinus*). So far, export of fish cracker is much lower than that of shrimp cracker. The main reason is due to the lower degree of expansion of fish cracker compared to shrimp cracker since cracker expansion and crispiness are the most important factors affecting consumer acceptability.

Amylopectin is one of the starch components which has an important role in influencing cracker expansion (Yu *et al.*, 1981). A higher amylopectin content in the starch gives a better expansion than a higher amylose content (Cecil *et al.*, 1982). In addition, these two components also influence the texture and density of the cracker (Bredger, 1990 and Smith, 1987 *in* Yu, 1993). Other factors affecting cracker expansion are thickness, moisture and protein content of the raw cracker. Chinnaswamy and Hanna 1990 (*in* Yu, 1993) and Yu (1991a) found that an increase of protein content tends to decrease the expansion. The ratio of fish to sago higher than 2:1 decreased the expansion which was related with the cracker crispiness (Yu, 1991a).

The aim of this research is to increase the expansion and crispiness of fish cracker and to find more information on factors affecting cracker expansion. The special purpose of this research is to determine the kind of fish, fish proportion, thickness of cracker and the kind of leavening agent which results in the maximum expansion, and better crispiness.

Materials and Methods

1. Raw Materials

Materials used in this research were sago starch (*Metroxylon* spp.), snapper (*Lutjanus* spp.), yellow pike conger (*Congresox talabon*), featherback (*Notopterus chilata*), salt and vegetable oil. Sodium bicarbonate, ammonium bicarbonate and sodium polyphosphate were also used as the leavening agents.

2. Methods

The research was carried out to evaluate the fish species and their proportion, to determine the leavening agent concentration and the cracker thickness.

a. Effect of Fish Species and Fish Flesh Percentage Studies

There were 2 treatments studied: treatment A (fish species : yellow pike conger, featherback and snapper) and B (percentage of fish flesh to starch : 0, 25, 40 and 50%). Complete Randomized Design in Factorial (4x3) was used for statistical analysis of the experiment.

b. Influence of Food Additive as Leavening Agents and Thickness Studies

Based on the first study, the fish used was yellow pike conger with the percentage to starch at 25%. Three leavening agents, i.e. sodium bicarbonate, ammonium bicarbonate and sodium polyphosphate each at 0 and 0.2 % were used. Besides, level of cracker thickness, i.e. 2, 3 and 4 mm was also evaluated on the quality of fried fish cracker. Experiment was done in 2 replicates and Complete Randomized Design was used for statistical analysis.

3. Processing of Fish Cracker

Fish cracker processing involves mixing into dough, shaping into sheet, steaming, shaping and drying. Firstly sago starch and water at ratio of 1 : 3 ware mixed in a mixer (Welbilt brand, USA) then cooked until the starch was gelatinized. The gelatinized starch was then mixed with minced fish until a homogenous dough was achieved. The dough was then shaped into sheet using sheeter (Dell Oro brand, Italy) and then steamed for 10 minutes at 90°C. Next, it was allowed to dry at ambient temperature for 5 minutes, then shaped into rectangular form. Sun drying was conducted on bamboo racks for about 12 h. until the moisture contents was approx. 9-10%. Finally the cracker was kept in dessicator which was filled with magnesium chloride saturated solution (RH 32.8%) until constant weight was achieved. Frying of cracker was done using 0.5 l of vegetable oil for about 12g raw cracker at 170-180°C.

4. Observations and Measurements

Observations were made on fresh fish (proximate composition), cracker before frying (moisture, protein, fat and specific volume) and fried cracker (expansion volume, organoleptic properties and crispiness). Protein was determined using Kjeldahl method, fat using Soxhlet method, and moisture content was also determined using air oven drying at 105°C (AOAC, 1984). Specific volume of cracker was measured according to Zulviani (1992) using beads and glass container. Six pieces of each sample (approx. 12g) was put vertically into the glass container which is filled to about a quarter of its volume with beads. The beads are then added to the glass until it is filled and a flat surface was achieved. The volume of beads was then measured using a volumetric glass. The volume of cracker was determined as V_1 - V_2, and specific volume was defined as volume of cracker divided by cracker weight:

$$\text{Specific volume} = \frac{V_1 - V_2}{\text{sample weight (g)}}$$

V_1 = beads volume without sample
V_2 = beads volume filled with sample

The difference between specific volume of fried cracker and specific volume of raw cracker was taken as expansion volume of cracker, which can be calculated as follows:

$$\text{Expansion Volume (\%)} = \frac{Vf - Vr}{Vr} \times 100\%$$

Vr = specific volume of raw cracker
Vf = specific volume of fried cracker

Crispiness of fried cracker was evaluated by using ranking and rating method, while evaluation of fish taste was done by using single stimulus method (Soekarto, 1985). Score 5 indicated the highest and 1 as the lowest intensity taste preference, while rating method was based on check sign entered by panelists on the rating test sheet.

Results and Discussion

1. Effect of Fish Species and Fish Flesh Percentage

a. Effect of fish species on volume expansion of fish cracker

<u>Proximate comparation of fresh fish</u>

Moisture, protein and fat contents of fresh fish used are presented in Table 1. It shows that the highest fat content was indicated by featherback followed by snapper and yellow pike conger while the highest protein content was produced by snapper followed by featherback and yellow pike conger. Featherback had the softest texture compared to the other two fish, resulting in a smooth minced meat. Conversely, the minced meat produced by snapper was coarser as the fish texture was the hardest. Fish texture is affected by the amount of connective tissue of each fish which commonly increases as the fish meat got darker (Suzuki, 1981) - the more connective tissues the harder the fish texture. Fish meat colour of snapper was the darkest among the fish used. Besides, fish meat texture also depends on the fat content. Higher fat content tends to decrease the softness of fish meat (Yeates *et al.*, 1975) and it is relatively higher in darker fish meat rather than lighter ones (Eskin, 1971).

Table 1. Proximate composition of yellow pike conger, snapper and featherback.

Fish species	Color and texture	Moisture (%)	Fat (%)	Protein (%)
Yellow pike conger	White, rather soft	77.98	0.86	17.83
Snapper	White reddish, hard	77.45	1.01	20.71
Feather-back	White reddish, soft	78.06	1.88	19.04

Dough characteristics

The differences in dough are measured by the ease of its forming and its adhesiveness. Good dough is characterised by shorter time and ease in dough forming, and the dough is not sticky. The dough forming of snapper was more difficult than yellow pike conger, which was probably due to the harder texture. On the other hand, featherback was too soft, resulting in a smooth and sticky dough which was difficult to shape into a sheet. It was also noted that as more fish was added into the dough, the more difficult it was to shape.

Fish cracker properties

The effect of type of fish and its proportion did not show any differences in the colour and characteristics of fish cracker. Fish cracker has a rectangular shape, 3.5 cm x 2.5 cm x 2 mm, yellow brownish in colour, hard and brittle texture.

The chemical composition of fish cracker as shown in Table 2 indicates that it's properties also depended on the chemical composition of fish used. Thus fish cracker with high fat and protein content was obtained from fish with high contents of these components.

Table 2. Proximate analysis of fish crackers.

Fish species	Fish flesh percentage	Protein (%)	Fat (%)
Control	0	0.78	0.04
Yellow pike conger	25	5.08	0.24
	40	8.13	0.38
	50	9.38	0.47
Snapper	25	5.87	0.27
	40	9.38	0.46
	50	11.44	059
Feather-back	25	5.48	0.48
	40	844	0.76
	50	10.49	0.94

Table 3. Physical characteristics of fried fish crackers.

Fish species	Color	Bubbles
Yellow pike conger	White	Small, evenly distributed
Featherback	White	Smaller, evenly distributed
Snapper	Yellow	Slightly bigger, unevenly distributed

Table 3 describes the physical characteristics of fried fish cracker. Fried fish cracker made from featherback was lighter in colour and had better expansion than that from snapper. It was due to the color and texture of raw material, where the featherback and yellow pike conger had better colour and texture than snapper.

<u>Expansion volume of crackers</u>

Cracker prepared by adding 25% fish flesh from yellow pike conger has higher expansion volume than snapper and featherback. Increasing the percentage of fish flesh resulted in a decrease in expansion volume (Table 4).

Table 4. Mean values of volume expansion of fried fish crackers.

Fish species	Fish Flesh percentage			
	0	25	40	50
Control	374	-	-	-
Yellow pike conger	-	308	281	252
Snapper	-	236	216	203
Featherblack	-	184	150	145

b. Effect of Fish Species on Fish Cracker Crispiness

Result of the rating test (Table 5) shows that increase of the expansion volume is not followed by increase of crispiness especially on the snapper (236) and featherback fish (184). Score of crispiness for the snapper cracker (4.0) is lower than featherback cracker (5.4). Statistical analysis shows that the score of crispiness for control and the addition of yellow pike conger is not different. Crispiness of the cracker with the ranking test shows the control is ranked 1 followed by yellow pike conger (2), snapper (3) and featherback (4). This showed that ranking test is more precise than the rating test. Crackers made from the addition of 25% fish flesh of yellow pike conger were more accepted by panelists than that with snapper and featherback fish flesh.

Table 5. Mean values of the expansion volume and crispiness of fish cracker added with 25% different fish flesh with rating and ranking tests.

Fish species	Volumetric expansion (%)	Crispiness	
		Rating test	Ranking test
Control	374^a	7.0^a	1
Yellow pike conger	308^b	6.9^a	2
Snapper	236^c	4.0^b	3
Featherback	184^d	5.4^c	4

Note: The same notation indicates statistically not different (P>0.05).

c. Effect of Fish Flesh Percentage on Fish Cracker Crispiness

Table 6. Mean values of the expansion volume and crispiness of fish cracker added with different percentage of flesh of yellow pike conger with rating and ranking tests.

Fish Percentage	Volumetric expansion (%)	Crispiness	
		Rating	Ranking
0	374^a	6.85^a	1
25	308^b	6.65^b	2
40	281^{bc}	5.85^c	3
50	252^c	5.45^d	4

Note: The same notation indicates statistically not different (P>0.05).

Based on the crispiness rating test an increase of fish flesh percentage resulted in a decrease in cracker crispiness. The highest crispiness was obtained from control (6.85) followed by addition of 25, 40 and 50% fish flesh with score 6.65, 5.85 and 5.45 respectively (Table 6). Yu (1991b) reported that increase of protein content can decrease expansion volume and crispiness.

d. Effect of Fish Flesh Percentage on the Fish Cracker Taste

From single stimulus test by 20 judgements on the crackers without addition of fish flesh it was found that 5 judgements agreed that control has fish taste, but 15 judgements denied that it had fish taste. Fortified with 25% fish flesh, 19 judgements indicated that the crackers had fish taste. When 40% and 50% fish flesh was added, all judgements indicated that the crackers had fish taste (Table 7).

Table 7. Influence of percentage of yellow pike conger on the crackers taste using single stimulus test.

Judgment	Fish Percentage			
	0	25	40	50
1	0	1	1	1
2	0	1	1	1
3	0	1	1	1
4	0	1	1	1
5	0	1	1	1
6	1	1	1	1
7	1	1	1	1
8	0	1	1	1
9	0	1	1	1
10	1	1	1	1
11	1	0	1	1
12	0	1	1	1
13	0	1	1	1
14	0	1	1	1
15	0	1	1	1
16	0	1	1	1
17	1	1	1	1
18	0	1	1	1
19	0	1	1	1
20	0	1	1	1
Total	5	19**	20**	20**

Note : 0 = fish taste not detected
1 = fish taste detected
** 15-17 significantly different P>0.05 and P>0.01

Intensity of crackers taste added with 0, 25, 40 and 50% fish flesh are 0.6, 2.6, 3.5 and 3.9 respectively (Table 8). Fortification with 25% fish flesh gave fish taste an intensity of 2.6; it means a judgment agreement of between soft and slightly strong taste. Crackers containing 25% fish flesh has 5.08% protein content, which fulfills the crackers standard of 5% based on Indonesian Industrial Standard 0272-90 (SII, 1990).

Table 8. Influence of yellow pike conger percentage on crackers intensity taste from 20 judgments.

Judgment	Fish Percentage			
	0	25	40	50
1	0	2	4	3
2	0	3	3	4
3	0	3	3	4
4	0	3	2	5
5	0	3	2	3
6	1	2	3	4
7	1	3	3	4
8	0	3	4	3
9	0	4	3	4
10	2	3	4	3
11	4	0	4	4
12	0	3	4	5
13	0	3	5	4
14	0	1	3	5
15	0	1	4	3
16	0	3	3	3
17	3	3	4	4
18	0	2	3	4
19	0	3	4	5
20	0	3	4	4
Total	11	51	69	78
Mean	0.6	2.6	3.5	3.9

Note: 5 = very strong; 4 = strong; 3 = slightly strong;
2 = soft; 1 = very soft

Results from this research show that yellow conger pike can be used as a substitute for the featherback fish to prepare fish cracker, based on the expansion volume and crispiness. There are many beneficial factors in the use of yellow pike conger to make crackers compared to featherback fish with regards to price and resources. Price of yellow pike conger in September 1994 in Angso Duo Fishing Port, Jambi (South Sumatera) was only Rp. 1,500/kg and price of featherback fish was Rp. 12,000/kg.

2. Effect of Food Additive as Leavening Agents and Thickness

Addition of sodium bicarbonate as food additive made the dough very compact and elastic, but use of ammonium bicarbonate, by comparison resulted in lower compactness and elasticity. Addition of sodium polyphosphate made the dough more soft, compact and elastic. Sodium bicarbonate increased the pH of the dough compared with ammonium bicarbonate and sodium polyphosphate. Low pH made the dough softer (Ockerman, 1983).

a. Cracker Characteristics

Results of the use of food additives and thickness on the colour of the cracker is shown in Fig.1. Kinds of food additives and the thickness influence the cracker's colour. Thicker product results in a darker colour. Sodium bicarbonate also made the crackers more dark in colour and less transparent compared to use of ammonium bicarbonate. The best colour resulted from use of sodium polyphosphate where the colour was close to the control.

b. Fried Cracker Characteristics

Adding of sodium bicarbonate made the crackers more porous, have bigger pore size, darker, coarser surface than crackers with ammonium bicarbonate and sodium polyphosphate. Treatment with sodium polyphosphate resulted in fried crackers with softer texture, containing smaller bubbles and whiter appearance; these are close to the characteristics of the control crackers (Fig.2).

The effects produced as a result of CO_2 released by the food additives are different. Sodium bicarbonate produced bigger hollow spaces than ammonium bicarbonate and sodium polyphosphate. This made the crackers with sodium bicarbonate more porous, big pored and dark. Since sodium polyphosphate was able to bond strongly with water during kneading, on its release during cooking, the excess water vapor pressure creates the hole spaces and make the crackers more porous (Soekarto and Muliawan, 1990).

c. Expansion Volume of the Fish Crackers

The influence of food additives and thickness on the expansion volume are shown in Table 9.

Table 9. Mean values of fish crackers expansion volume as influenced by food additives and thickness.

Food Additives	Thickness		
	2 (mm)	3 (mm)	4 (mm)
Control	309	132	95
Sodium bicarbonate	674	279	170
Ammonium bicarbonate	328	165	127
Sodium polyphosphate	445	243	103

Treatment with sodium bicarbonate resulted in the largest volume increase followed by sodium polyphosphate and ammonium bicarbonate for crackers of 2 and 3 mm thickness, except for the 4 mm thickness. The biggest volume increase was from sodium bicarbonate treatment on the 2 mm crackers. It was observed that an increase in cracker thickness resulted in lower volumetric expansion, this is probably because the oil penetrates more slowly into the insides of the crackers than the thin ones. This case hardening occurs before the oil has penetrated into the deeper parts (Matz, 1984). It has been reported that the value of absorbed oil at the core of sago crackers with the thickness 1, 2 and 3 mm are 34.1, 19.0 and 11.2 % respectively (Yustica, 1994).

d. Cracker Crispiness

The results of sensory evaluation with rating and ranking tests for acceptability are presented in Table 10. The rating test showed that higher crispiness resulted from use of sodium bicarbonate followed by ammonium bicarbonate, sodium polyphosphate and control. Based on ranking test the use of ammonium bicarbonate and control received a lower score and were also unacceptable.

Table 10. Mean values of expansion volume and crispiness as influenced by different food additives and 2mm thickness of the crackers.

Food Additives	Volumetric expansion (%)	Crispiness	
		Rating	Ranking
Control	309^{c}	7.1^{d}	4
Sodium bicarbonate	674^{a}	7.6^{a}	1
Ammonium bicarbonate	328^{b}	7.4^{b}	3
Sodium polyphosphate	445^{bc}	7.2^{c}	2

Note: The same notation indicates statistically not different (P>0.05).

From Table 11 it can be seen that cracker crispiness by ranking test is in the order of sodium bicarbonate, sodium polyphosphate, ammonium bicarbonate and control. Influence of thickness on the crispiness based on rating and ranking test on acceptability of the crackers showed that 2 mm thickness has high score and expansion volume.

Table 11. Influence of food additives on the crispiness of fried crackers with 2mm thickness for 20 judgments.

Ranking No.	Food Additives			
	Control	Sodium bicarbonate	Ammonium bicarbonate	Sodium poly-phosphate
1	3	8	2	7
2	4	6	5	5
3	5	4	7	4
4	8	2	6	4

Conclusion

This study has shown that increase of fish flesh percentage causes a decrease in the cracker expansion volume and crispiness is depressed by an increase in protein content. Yellow pike conger fish could be used as a substitute for featherback to produce cracker. The expansion volume was in the order of yellow pike conger (304%) snapper (257%) and featherback (213%). In terms of crispiness the order was yellow pike conger, featherback and snapper. Addition of 25% fish flesh imparts a distinct fish taste to the cracker, which also meets the standard of 5% protein content as required by Indonesia.

Addition of sodium bicarbonate resulted in the highest expansion volume (674%) followed by sodium polyphosphate (445%) and ammonium bicarbonate (328%) with the crispiness ranking 1, 2, and 3. Thickness of the cracker influences the cracker expansion volume. The best cracker was obtained from treatment with 25% yellow pike conger fish flesh with 2 mm thickness and addition of 0.2% sodium bicarbonate.

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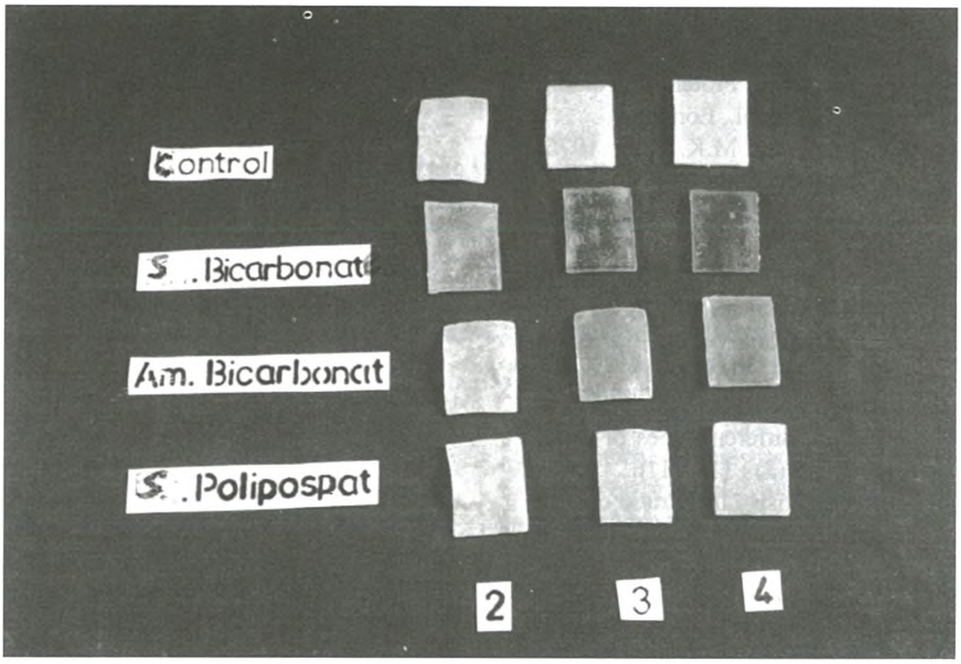

Fig. 1. Effect of food additives and thickness on the raw cracker characteristics.

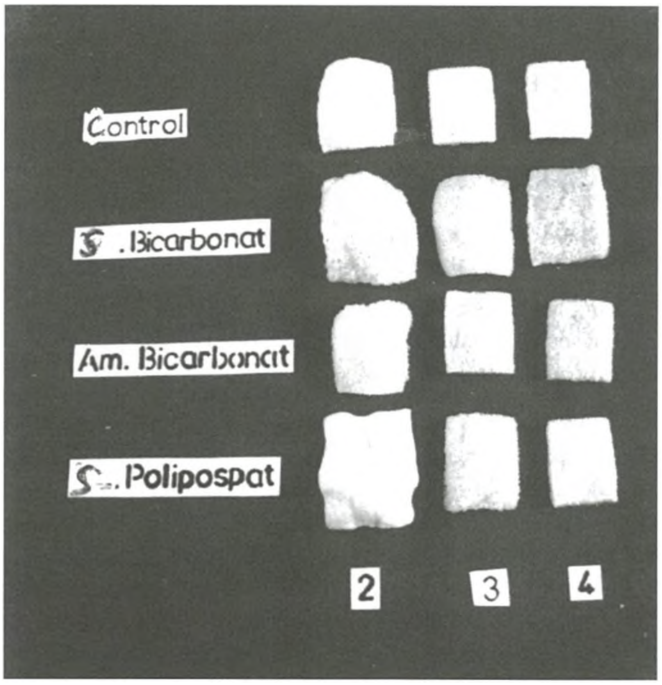

Fig. 2. Influence of food additives and thickness on the fried cracker characteristics.

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Discussion

During the discussion, Ms Rosmawaty clarified that during the conduct of sensory evaluation, the 20 sensory panelists were properly trained on senaory evaluation.

Optimising Quality Retention in Processing of Salted-Boiled Fish Based on Kinetic Organoleptic Quality Degradation

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Abstract

Time-temperature dependence of sensory quality factors in relation with thermal processing of salted-boiled product prepared from milk fish (*Chanos-chanos*) was investigated. Organoleptic z-values for the product of 19, 26, 24, 19 and 23°C were found for appearance, odour, taste, flesh texture and bone texture respectively. Based on a level of 50% bone texture change as the most important quality criterion, various processing conditions to optimise other quality factors could be established by computer simulation. The results indicated that in order to obtain optimum quality, retort processing condition set at temperatures between 115 to 120°C were favoured. The results also demonstrated that higher quality retention could be obtained by using smaller fish sizes. Based on microbial sterility evaluation it can be suggested for possible application that hermetically retortable plastic package be used in the processing in order to increase shelf life of the product.

Introduction

Salted-boiled fish (called *pindang* in Indonesia) is a heat processed fish product commonly produced in Southeast Asia. In traditional *pindang* production, fish is simply boiled with salt. The amount of salt used and the duration of heating varies considerably depending on the size of fish used, shelf life required and local preference. A new type of salted-boiled fish called *pindang presto* or simply *presto* has become increasingly popular in Indonesia and has commercial potential in other countries.

Presto is processed at higher temperatures by using pressurized steam. The product is easily distinguished from traditional *pindang* with characteristic soft bones, reminiscent of canned fish. Unlike canned fish, *presto* is not hermetically sealed and is not a microbiologically sterile product so that its shelf life is very short. The main purpose of the heating process is to produce changes in the organoleptic properties of the fish; notably the texture of the flesh and bone, the colour and lustre of the skin and flesh, and flavour.

Historically, microbial safety has been the primary concern of thermal food processors. More recently the loss of nutrients and changes in the organoleptic properties of the food have become increasingly important in determining process conditions. Kinetic microbial destruction by heating is commonly expressed in terms of the rate of isothermal change (i.e. the decimal reduction time, or D value) and the relationship between the rate of isothermal change and temperature (i.e. thermal destruction time, or z-value). Kinetic degradation rates for nutrients and organoleptic factors may employ zero or first order for isothermal chemical reaction and Arrhenius equation to express temperature dependence of the reaction. However, both methods of expression are also often used.

The data on kinetic degradation of food quality factors (microbes, nutrients and organoleptic properties) and heat transfer in food during thermal processing are used to evaluate quality of the thermally processed food. The present experiment was aimed at investigating kinetic degradation rates of various organoleptic factors (colour, appearance, texture and flavour) of fish to be used for optimizing quality retention during thermal processing of *presto*.

Materials and Methods

Milk-fish (*Chanos chanos*) between 300-350g were obtained from Muara Karang, Jakarta. Fish were harvested and transported in ice to the Research Institute for Marine Fisheries (RIMF) laboratory in Jakarta. The fish were cut along the bottom of their abdominal cavities to remove the guts and internal organs and were thoroughly washed and allowed to drain.

A 25% (W/V) brine was prepared (using salt obtained from a local market) and the dressed fish were immersed for two hours. The fish were then stored in a chill store overnight. The fish were filleted and deskinned. Each fillet was further cut into thin slices (2 mm thickness) and made to a rectangular shape (30x20 mm). Each slice was individually placed in retortable pouches, evacuated and sealed. The pouches were placed in a single layer on the shelves of a batch laboratory retort and were processed at various temperatures for different lengths of time. In order to facilitate better panelist judgement to distinguish different levels of heated samples, an interval heating time at one particular temperature should be large enough. For the same reason degrees of heating for other temperatures should be close to each other. Equation (1) could be used to estimate degrees of heating at various processing conditions by taking temperature 120°C as a reference temperature. Table 1 shows times required for various heating temperatures calculated by the equation.

$$t = t_r \times 10^{(T_r - T)/z} \quad \text{.............. (1)}$$

where t is the heating time (minutes) needed to obtain the same degree of heating at reference temperature T_r for heating time t_r by assuming z = 25°C.

Table 1. Heating times (minutes) at various temperatures

T=110°C	T=115°C	T=120°C	T=125°C
50.2	31.7	20.0	12.6
100.5	63.4	40.0	25.2
150.7	95.1	60.0	37.9
200.9	126.8	80.0	50.5

Note : T-120°C was taken as reference temperature.

These samples were assessed by an objective taste panel made up of 13 researchers at the RIMF in Jakarta. Appearance, flavour, odour, flesh texture and bone texture were assessed on an open format, unclassed scale which ranged from "uncooked" to "overcooked".

D-values and z-values of each organoleptic factor were calculated from decimal reduction time curves and thermal destruction curves respectively. The thermal effect for each organoleptic factor was evaluated based on theoretical heat transfer and kinetic degradation of organoleptic factors obtained from the experiment. As fish has an irregular shape, heat transfer in this type of object is difficult to trace accurately by mathematical procedure. Therefore in calculating heat transfer the fish is assumed to be an infinite cylinder where the maximum thickness was taken as the diameter of the cylinder.

The heat transfer calculation is derived from a Gourney-Lowry chart for an infinite cylinder (Jackson and Lamb, 1981). Other assumptions such as thermophysical properties were also made in order to be able to evaluate heat transfer by this mathematical method as described by Suparno (1989) for his study on thiamin losses in this type of product. The quality factors degradation was calculated by following the microbial sterility evaluation (Equations 2 and 3) although other methods of evaluation such as the so-called "cook value" (C-value) may also be used (Ohlsson, 1979; Dagerskog, 1977). A computer program was prepared to facilitate rapid calculation in the sterility evaluation by taking the 3 cm thickness of fish for this study, unless otherwise specifically mentioned.

$$F = \int_{t_o}^{t_a} L \, dt \quad \text{..................... (2)}$$

where

$$L = 10^{(T_i - T_r)/z} \quad \text{................... (3)}$$

and F = the equivalent in minutes at some given reference temperature of all heat considered, with respect to its capacity to destroy quality factors, L = lethal rate, T_i = retort operating temperature, T_r = reference temperature.

Results and Discussion

The z-values and the D-values at 100°C and 121°C for each quality factors are shown in Table 2. These values are consistent with those reported in the range of 13-35°C for other foods (e.g. Lund, 1975; Dagerskog, 1977; Ohlsson, 1980; and Hayakawa *et al.*, 1977). The D-values at 100°C are presented as they are commonly used in evaluation of cook values of thermally processed foods.

Table 2. Kinetic thermal destruction of organoleptic quality factors.

Organoleptic factors	D_{121} (min)	D_{100} (min)	z (°C)
Appearance	129	1644	19
Odour	199	1278	26
Taste	178	1335	24
Meat-texture	142	1809	19
Bone-texture	111	909	23

Cook values are similar to F-value of microbial sterility. For convenience of comparing between organoleptic quality and microbial sterility due to effect of thermal process, the cook value was not used. Instead, quality retention based on microbial sterility evaluation was performed in this study.

In order to evaluate quality retention of processed *presto*, a certain basis of calculation should be chosen. For this purpose initial bone texture degradation rates at various processing temperatures were found. This is in accordance with the fact that acceptability of the product was first judged for bone texture to distinguish it from traditional *pindang*. Thus it is the main target in this processing. Fig. 1 demonstrates an organoleptic quality degradation profile for bone softening during the process as obtained from data generated by running the computer programme. It is obvious that bone softening occurs at faster rates at higher processing temperatures. Similar profiles for other organoleptic factors could be easily drawn.

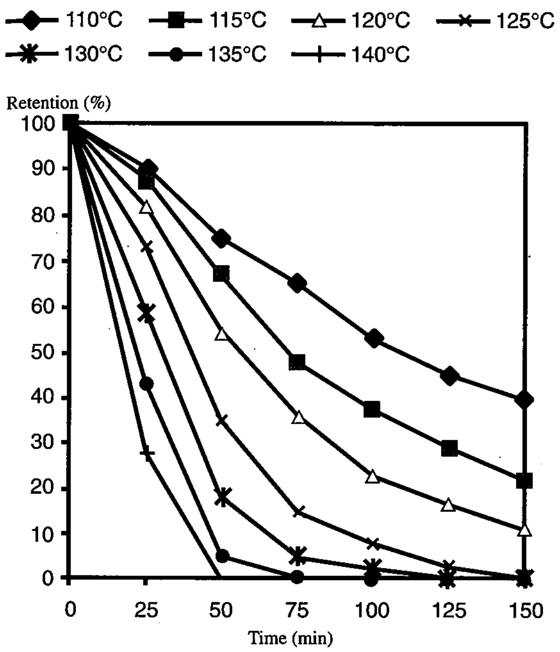

Fig. 1. Thermal degradation of bone at various processing temperatures.

By taking into account bone texture as the first important key factor determining the quality of this product, the minimum level acceptance for bone texture should be found. Suparno (1989) has indicated that at least a 50% bone texture change should be achieved in the process to be acceptable. Then time-temperature relationship in *presto* processing to obtain this bone texture level could be computed for various quality factors including sterility. In the computation, thermal effects on organoleptic factors should be considered based on practical quality assessment as well as the mechanism of heat transfer. For this reason bone texture was taken as the central geometric position and appearance was taken on the surface. Flesh texture, odour, and taste as well as microbial destruction were taken as mass average.

Fig. 2 shows quality factors (appearance, odour, flavour and flesh texture) changes and microbial sterility achieved for various processing conditions on the basis of a 50% bone texture change in the thermal process. It suggests that *presto* processing favours lower processing temperatures when surface appearance is considered as the second (*viz*, after bone) important factor affecting acceptability of the product. A drastic reduction in appearance retention was observed as processing temperatures increased. Only a relatively small reduction was observed for flesh texture. Interestingly, odour and taste increase their retentions at higher processing temperatures. It seems that meat texture, odour and taste contribute only to relatively small changes over various processing conditions. Therefore they do not cause any critical constraints in processing. In contrast to appearance, microbial sterility significantly favours higher processing temperatures.

Microbial sterility is not a primary concern in commercial processing of *presto* as it is not hermetically packed during the process. Consequently its shelf life is very short, *viz* 1-2 days. But in some commercial practices *presto* is often vacuum packed in plastic pouch after processing as an attempt to increase its shelf life. This presents a possible botulism outbreak. In relation to this problem, a quantitative evaluation of product sterility could provide precise information on shelf life extension through packaging in retortable plastic pouches. In recent years retortable plastic pouches received attention due to the fact that higher quality retention could be achieved in thermal sterilisation of food if this type of packaging is used (Teixeira *et al.*, 1975). Based on common commercial sterility practices for thermal processing of low acid foods, a D_{12} concept could be taken as the basis for consumer safety (Stumbo, 1973). Therefore F_o-value of 12 (F_{12}) was used as a basis in the next stage of evaluation.

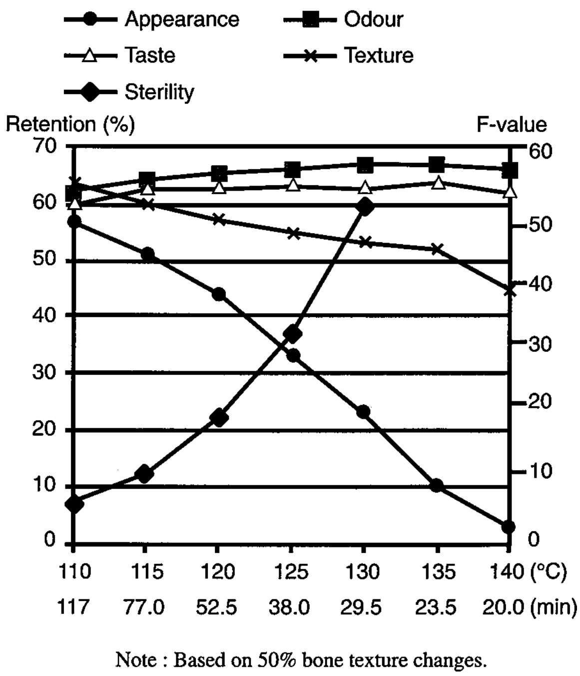

Fig. 2. Organoleptic quality retention and microbial sterility at various processing conditions.

Fig. 3 clearly shows the two important quality factors (bone texture and surface appearance) for various processing conditions on the basis of F_{12} for two sizes (3 and 6 cm thickness) of fish. From this figure there are two interesting phenomena related to behaviour of bone texture and flesh appearance during the thermal process. The first phenomenon is shown by different patterns of destruction between these most important organoleptic factors.

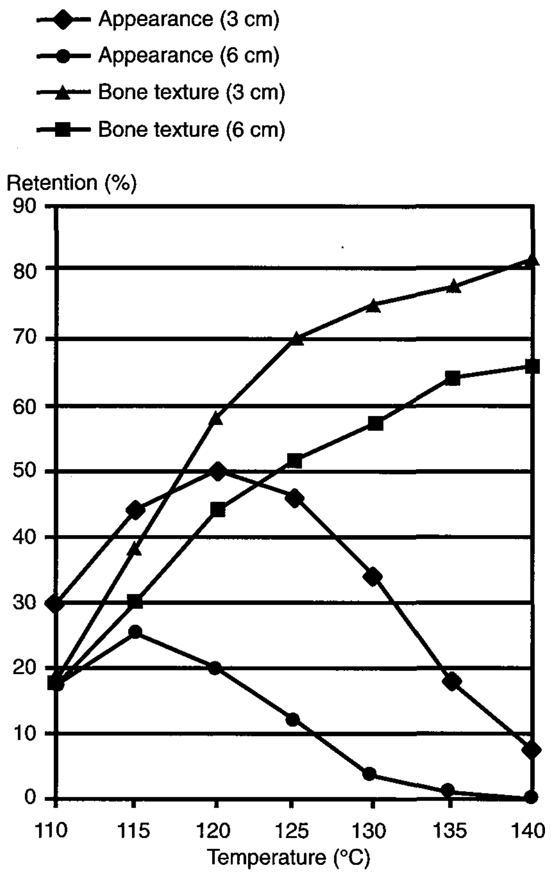

Fig. 3. Bone texture and meat appearance changes during processing at sterilising value F_{12} for different sizes of fish.

Bone texture increases its retention as processing temperature increased and no maximum temperature is observed. It should be mentioned that higher bone texture retention means lower level of bone softening. It also suggests that to achieve a minimum level of 50% bone texture change, the processing temperatures should not exceed 118°C for small fish and 125°C for big ones. On the other hand flesh appearance retention initially increases to a certain maximum temperature and then it gradually decreases. This indicates that flesh appearance could be optimised over a range of processing temperatures. The maximum processing temperatures for appearance are approximately 120°C (50% retention) and 115°C (25% retention) for small and big fish respectively. However, the desirable appearance tolerance limit of this product which is acceptable to consumers should be investigated for this purpose.

The second interesting phenomenon is shown by the effect of fish size on quality retention. It is very obvious that bigger fish have lower appearance and bone texture retentions. There is a shift of maximum appearance retention towards lower processing temperatures as fish size increases. Similarly bone softening increases as fish size increases. This can be explained by the fact that bigger fish requires higher thermal process (by increasing processing time for each temperature) in order to achieve the same sterility. Thus optimising organoleptic quality retention depends significantly on kinetic degradation of each organoleptic factor. In case of *presto* processing, based on microbial sterility as well as on bone texture changes, appearance plays a significant role compared to odour, taste and flesh texture.

In general it may be concluded that optimum processing could be performed at temperatures between 115-120°C. This range of processing temperatures have been widely used in commercial *presto* production. Processing at these conditions are also microbiologically acceptable when hermetic retortable plastic pouches are used in the processing to increase shelf life of the product. The results also indicate that a higher quality product could be obtained by using smaller fish. Similar results were obtained for thiamine retention in this product (Suparno, 1989). This is also in agreement with findings by other researchers for nutrient retention in canned foods of different geometric shapes (Teixeira *et al.*, 1975; Lund, 1977).

Conclusion

Organoleptic z-values for salted-boiled fish of 19, 26, 24, 19 and 23°C have been determined for appearance, odour, taste, flesh and bone texture respectively. Bone texture and appearance are the most important organoleptic qualities of *presto* and they play important roles in optimising the process. On the hand odour, taste and flesh texture do not show any significant role in this type of processing. The optimum processing conditions based on bone texture, appearance and microbial sterility lie in the range of 115-120°C. It has also been shown that higher organoleptic quality could be obtained from smaller fish size.

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Discussion

Regarding the conversion of sensory scores to z-values, Dr Suparno informed the Seminar that a scale was used to compute the values. He also added that there is a potential health hazard when packing and processing is done at room temperature.

Chilled Storage of Malaysian Fishballs and Hazards and CCP Analyses

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Abstract

Fishballs from six local factories were stored at 5°C for 1, 2, 3, 4, 7 and 10 days. There were no changes in texture at 3 days of storage but bacterial spoilage rendered the fishballs unacceptable by the fourth day. Most of the bacteria were non-halophilic. The main genera isolated were Aerococcus, Acinetobacter, Pseudomonas, Staphylococcus, Corynebacterium, Micrococcus, Streptococcus, and Enterobacteria. Hazards and critical control points have been identified at various stages of fishball processing.

Introduction

Fishballs are a popular food in much of the Asian region. Made by mixing fish mince with starch, salt, sugar, monosodium glutamate and spices into a ball-shaped dough, they are cooked to a gel which is consumed with rice, noodles or as a snack. They are usually sold in local wet markets, unchilled and with little or no packaging. Being a high moisture food (>80%) they are highly perishable with a short shelf life. Thus, data on their spoilage characteristics is necessary before monitoring and control systems can be implemented.

Materials and Methods

1. Raw Material

Freshly-produced fishballs were purchased from the six largest factories in Kuala Lumpur. The samples were packed in aseptic plastic bags and transported immediately to the laboratory. Upon arrival at the laboratory, the fishballs were transferred using aseptic forceps into sterile plastic bags (200g per bag), sealed in a laminar-flow chamber, and stored at 5°C. Samples were analysed at 0, 1, 2, 3, 4, 7 and 10 days of storage. Two samples from each factory were tested for each parameter on each day except for the folding test, when 5 samples were tested.

2. Physical tests

The Folding and Teeth-cutting Tests of Hasegawa (1987) were used. The Folding Test measures resilience and the Teeth-cutting Test measures springiness of the fishballs. Samples were boiled for 5 mins. and then cooled to room temperature (28°C) before testing.

a. Folding test

Five slices, each 5mm thick and 20mm in diameter, were cut from five fishballs. Each was then folded in half and if there was no tear or breakage, further folded into quarters. The grading was as follows : AA, no breakage in any of five samples when folded in quarters; A, slight tear in any one of five samples when folded in quarters; B, slight tear in any one of five samples when folded in half; C, breakage (but 2 pieces still connected) when folded in half; D, breaks completely into 2 pieces when folded in half.

b. Teeth-cutting test

This test gives a subjective assessment of the resistance experienced by a trained panel of 10 when the test piece is bitten between the upper and lower incisors. Two slices of 5mm in thickness and 20mm diameter were tested. Scores were attributed as follows : 10, extremely strong springiness; 9, very strong springiness; 8, strong springiness; 7, quite strong springiness; 6, acceptable springiness; 5, acceptable, slight springiness; 4, weak springiness; 3, quite weak springiness; 2, very weak springiness; 1 mushy texture, no springiness.

3. pH measurement

A 10g sample was homogenized in 90ml of distilled water and the pH measured using a combination electrode with a Ag/Ag C1 reference system (Model HI 1911B, Hanna Instruments SpA, Padova, Italy).

4. Microbial Analyses

a. Aerobic plate count

Whole fishballs were ground in a sterile Waring Blender flask, using two samples from each factory. The method as described by the American Public Health Association (1976) was used. Plates containing 25-250 colonies were counted after incubation at 35°C for 48h, and 5°C for 144h.

b. Halophilic and non-halophilic bacteria

Samples from the plate count were inoculated onto nutrient agar containing 0%, 5%, 10% and 15% NaCl and incubated at 5°C, and 35°C, for 48 and 24h, respectively. Results were obtained by counting the number of colonies on the media.

c. Generic characterization

Colonies from the plate count and nutrient agar were isolated and identified using the Primary Characterization tests of Cowan (1975).

d. Hazard & CCP's identification

Visits were made to all the 6 factories and a detailed study of the processing methods used was carried out. Fig. 1 shows the hazards and CCP's identified in the processing line.

Results

1. Physical changes in fishballs during storage

No significant changes in the pH and the resilience measured by a Folding Test were detected after 10 days of storage at 5°C (Table 1). All samples were graded to AA. There were no changes in the Teeth-cutting score after 3 days. However, in terms of appearance and odour, the fishballs became unacceptable on the fourth day of storage. An unpleasant odour associated with spoilage was detected and the surface of the fishballs were covered with slime. The presence of a turbid and viscous exudate was also noticed.

2. Effect of storage on bacterial flora

The average number of mesophiles (measured at 35°C) after one day storage (Table 2) would be considered unsafe for human consumption if they were consumed without re-cooking. By day four the mesophile numbers reached an unacceptable level. The number of psychrotrophs (measured at 5°C) at day four also indicated spoilage of the product.

No halophilic psychrotrophs and few halophilic mesophiles were detected (Table 3) indicating that most of the spoilage organisms were of land origin. The non-halophilic psychrotrophs increased with time whilst the non-halophilic mesophiles remained virtually constant. Initially, there were twice as many mesophiles as psychrotrophs, but by day three they were approximately equal and thereafter the psychrotrophs predominated.

Table 1. Physical changes of fishballs during storage at 5°C*.

Day	pH	Teeth-cutting test	Appearance/Odour
0	7.23 ± 0.09	8.0 ± 0.7	Fresh, shiny and glossy, smooth. Fishy.
1	7.27 ± 0.12	8.0 ± 0.5	Fresh, shiny and glossy, smooth. Fishy.
2	7.25 ± 0.13	8.0 ± 0.4	Slight exudate, a bit milky, less glossy and shiny. Fishy, slightly pungent odour.
3	7.24 ± 0.08	8.0 ± 0.5	Slightly milky exudate, glossy and wet. Stronger fishy odour.
4	7.22 ± 0.11	- -	Slimy, milky and viscous exudate, glossy and wet. Slightly unpleasant odour.
7	7.18 ± 0.10)	-	Slimy. Yellow-milky exudate. Patches of yellow on fishballs. Unpleasant odour.
10	7.30	± 0.08	Slimy. Yellow-milky exudate. Very unpleasant odour.

* Average values of samples from 6 factories. Numbers in brackets are standard deviations of the mean.

3. Generic characterization tests

Results of the characterization tests are shown in Table 4. The eight dominant species isolated were classified under the terms of genus *Aerococcus, Acinetobacter, Pseudomonas, Staphylococcus, Corynebacterium, Micrococcus, Streptococcus* and *Enterobacteria.*

Table 2. Aerobic plate counts (organisms g^{-1} sample) of fishballs during storage at 5°C*.

Day	Aerobic Plate Count (APC/g) Sample	
	5°C	35°C
0	2.2×10^4 ± 1.0	2.6×10^5 ± 0.9
1	7.5×10^5 ± 2.1	5.4×10^6 ± 1.8
2	2.6×10^6 ± 1.7	6.6×10^6 ± 2.0
3	2.2×10^7 ± 1.5	3.6×10^7 ± 1.7
4	8.1×10^7 ± 2.7	1.0×10^8 ± 1.5
7	1.1×10^8 ± 2.3	2.0×10^8 ± 1.8
10	1.2×10^8 ± 1.5	2.2×10^8 ± 2.2

*Average values of samples from 6 factories. Numbers in brackets are standard deviations of the mean.

Table 3. Halophilic and non-halophilic bacteria during storage of fishballs at 5°C*.

Days of storage	Number of colonies			
	Halophilic		Non-Halophilic	
	Psychro (5°C)	Meso (35°C)	Psychro (5°C)	Meso (35°C)
0	-	1	8	14
1	-	-	9	19
2	-	-	11	21
3	-	1	19	18
4	-	-	21	17
7	-	1	23	16
10	-	-	22	15
Total (%)	0	3 (1.3%)	113 (47.9%)	120 (50.8%)

*Average values of samples from 6 factories.

Table 4. Generic characterisation of bacterial flora isolated from fishballs*

Genera	Shape	Gram Stain	Motility	Catalase Test	Oxidase Test	Oxidative or Fermentation
Aerococcus	C	+	-	W	-	F
Acinetoba cter	C	-	-	+	-	O
Pseudomonas	R	-	+	+	+	O
Staphylococcus	C	+	-	+	-	F
Coryne-bacterium	R	+	-	+	-	F
Micrococcus	C	+	-	+	-	O
Streptococcus	C	+	+	-	-	F
Enterobacteria	R	-	+	+	-	F

Note : C = Cocci; R = Rod; W = Weak Reaction
*Based on analyses of samples from 6 factories.

Discussion

Fishballs produced in Malaysia have a high initial bacterial contamination and although there were no changes in texture, bacterial spoilage rendered the fishballs unacceptable by the fourth day of storage. Most of the fishballs are produced by cottage-scale industries dependent upon manual labour and using a minimum of equipment. The short shelf life of fishballs may be due to a combination of some or all of the following points : raw materials that are not fresh and are heavily contaminated due to poor handling after catch; slow processing at ambient temperatures (30-35°C) and poor personal hygiene result in further deterioration of raw materials; use of dirty processing equipment; cooked products are left to cool in rattan baskets on the floor for long periods; packaging is done manually; packed products are often distributed in non-refrigerated vans and lorries; fishballs are sold at ambient temperatures in the market.

Malaysian law does not permit the use of preservatives in fishballs. Despite this, many processors have been known to use common preservatives such as sodium benzoate to extend the shelf life of their products. This illegal practice is also harmful to consumers. The shelf life of fishballs might be improved by reducing the initial and subsequent microbial counts through the use of simple refrigerators and improving sanitary working conditions.

In view of the high bacterial contamination and short shelf life of fishballs produced in Malaysia, a system of quality control must be implemented to improve product quality. Hazards and CCPs have been identified at various stages of fishball processing. Follow-up studies will focus on control measures, target level and tolerance, monitoring procedures and corrective action.

Although many large factories have been set up to produce surimi-based products in recent years, there is still a niche for the small-scale processor of fresh fishballs to be sold on the day of production in wet markets. Consumers should be advised not to store fishballs for more than three days and should cook them thoroughly before consumption.

Acknowledgement

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Disucssion

Ms Yu clarified that the salt content of fish balls was 2-3%. The representative from Thailand noted that the implementation of CCP could be prerequisite to HACCP in order not to shock the fishball processors. The representative from the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II suggested that the criteria may be divided into safety and non-safety factors, so that when the actual HACCP is used, there is surely a factor of safety.

PROCESS	HAZARD
RAW MATERIAL*	Microbial Foreign matter
↓ Heading & gutting*	Microbial
↓ Meat-bone separation	Microbial
↓ MINCED MEAT	
↓ Leaching	Microbial
↓ Dewatering	Microbial
↓ LEACHED MEAT	
↓ Straining	Microbial
↓ Mixing	Microbial Chemical
↓ Forming	Physical
↓ Setting 1	Physical
↓ Setting 2	Physical
↓ Packaging*	Microbial
↓ FISHBALLS	
↓ Storage*	Microbial
↓ Distribution*	Microbial

Fig. 1. Hazards and CCPs in fishball processing.
*CCP

Critical Control Points in the Processing of Fish Snacks in Malaysia

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Abstract

Fish remains an important source of protein for the Malaysian people regardless of their economic status and background. This commodity is an important export earner as well as providing employment to the nation. A substantial percentage of the total marine fish landing and aquaculture produce is processed into various products, namely reduction products, dried and/or salted fish, fish snacks, fermented products, surimi and surimi-based products, frozen and smoked products.

About 7,000 tonnes of fish snacks are produced annually by small-scale processors throughout the country. This comprise mainly of intermediate products and puffed crackers from fish, prawns and cuttlefish and ready-to-eat fish satay, a spiced snack made mainly from yellow goatfish. Some of the problems relating to quality that resulted from improper control of processes are discussed.

This paper outlines and discusses the critical control points in the production of fish crackers namely freshness of raw material, mixing, forming, cooking and the drying processes. This paper also emphasises on the use of simple machinery and processes that can greatly improve the quality of fish crackers for better acceptance by its consumers. These include the use of deboning machines for more efficient flesh recovery, use of the stuffer for better forming of the dough, the use of mechanical/solar driers for better control of temperature and air flow during the drying process and proposes the use of suitable packaging materials to extend the shelf life of the product.

Introduction

The fishing industry contributes significantly to the Malaysian economy with respect to foreign earnings and provision of employment opportunities. It contributed 1.61 percent to the national gross domestic production in 1994. Fish is an important source of protein in the Malaysian diet, especially so to those dwelling in rural areas. The total fish production was 1,181,763 tonnes in 1994 (Department of Fisheries, 1995) of which more than 90 percent comprised of marine landings. This figure was valued at RM 2.99 billion and this sector provided employment to 97,945 fishermen.

Out of the total marine fish landed in the years 1992 to 1994, an average of about 70 percent was consumed in the fresh state whilst the remainder was processed into numerous products, both traditional and non-traditional. Figures for 1994 indicated the production of manure and fish meal (66.6 percent), salted and/or dried fish (11.5 percent), fish snacks (7.9 percent), surimi and surimi-based products (6.4 percent), fermented produce (6.2 percent) and the remainder (1.4 percent) of boiled and smoked items.

In 1994 a total of 29,797 tonnes of marine fish landed were processed into dried/salted and smoked products. In the same year 6,743 tonnes of fish snacks were processed. These comprise mainly of crackers made from fish and fishery products (94 percent) whilst the remainder is the production of ready-to-consume satay fish, a spiced snack made mainly from yellow goatfish (Wan Rahimah, 1983, and 1983).

Processing of Fish Crackers

Statistics show that 6,315 tonnes of fish crackers, locally known as *keropok ikan* and 22 tonnes of crackers made from prawns and cuttlefish were produced in 1994. These products were produced by small-scale to medium scale processors using some form of mechanization to assist in the production. These were sold in many forms - for example, unfried rolls that are dipped in a special sauce and consumed; as intermediate products that range greatly in colour, shape, thickness and taste; and in the fried form that has limited shelf life.

The processing technology for fish crackers comprise the following steps - fish flesh recovery, mixing with starch, salt, flavour enhancer and water/ice water, forming into rolls, cooking, cooling, slicing, drying and packing. The intermediate products are then puffed in hot oil for about 3 to 5 seconds prior to consumption.

This paper discusses the critical control points identified in the processing of fish snacks and the quality problems associated with inappropriate technology usage. Research findings that can alleviate these problems are also cited with the aim of improving the overall performance of the industry.

1. Raw Materials

Due to the variability of raw materials and techniques, the fish crackers produced by the traditional processors are inconsistent in quality in terms of physical, organoleptic and chemical attributes. This variability is also attributed to seasonal changes and the supply of raw materials suitable for fish cracker processing.

The freshness and type of raw material used in the production of the fish cracker greatly determine the quality of the end product. The use of dark meat species such as the herrings will yield dark coloured crackers with a very strong flavour whereas species such as the wolf herrings/dorab will give lighter coloured crackers with a milder flavour.

Improper control of flesh recovery led to poor yield coupled with loss of quality. Manual deboning was found to give a lower recovery rate (40 to 55 percent) when compared to mechanical deboning. The incorporation of bones, connective tissues and minute scales would result in poor texture of the end product. Furthermore improper icing of the deboned flesh would subject the raw material to possible contamination from the surrounding and utensils, e.g., during the time lag between deboning and mixing.

The Malaysian Food Regulations 1985 stipulates that the unpuffed crackers made from fish should contain no less than 15 percent protein whereas that prepared from other fishery resources should not be less than 6.9 percent. Research has shown that for most species a ratio of 1 part fish mince to 1 part flour (w/w) would meet this requirement.

2. Mixing and Shaping

The use of an unsuitable mixer will lead to improper mixing of fish, starch and the other ingredients. This will lead to non-uniform mixing and thus the linear expansion and texture of the final product is beyond the control of the processor. Manual forming is subjective and will lead to uneven shapes and the formation of air pockets which will expand during frying of the product, leading to texture loss.

Research in adapting the use of the sausage stuffer to shape the mixed dough with the use of zip fibrous or cellulose casings has contributed to uniform shaping. Other than contributing to non-uniformity of rolls manual forming involves a lot of handling. This improved method minimises the incidence of contamination as well as increase the variety of end products. The air bubbles can also be eliminated to produce a uniform texture.

3. Cooking and Cooling

The formed dough is cooked until the internal temperature reaches 70°C after which time the rolls are scooped out and cooled overnight prior to slicing. Traditionally, cooking is achieved by boiling in large cemented vats or by steaming. Boiling would undoubtedly result in loss of solubles due to leaching. Steaming is the recommended practice because of ease of handling; it also reduces the leaching of solubles from the rolls.

Cooling is essential in order to achieve a more solid state so that the cooked dough is easy to handle and this will result in a reduction of losses during slicing. There is a need to mention that great care has to be taken at this juncture to ensure that all surfaces coming in contact with the cooked rolls are free of contamination. Research has shown that the bacterial load increase occurs at this stage due to manual handling and lack of hygiene of premises and workers.

4. Slicing and Drying

The cooked, cooled rolls are sliced into 2.0 to 2.5mm thickness, arranged on bamboo trays and dried to an acceptable moisture level. The use of mechanical slicers, both manual and automatic, have replaced manual slicing since the early 80s and this is both time-saving as well as contribute to better product control.

However the use of the sun as the primary source of heat for drying is highly prevalent amongst the processors in Malaysia for obvious reasons. Research has shown that the drying of wet crackers from the initial moisture content of about 50 percent to achieve the final 8 to 12 percent moisture level takes a minimum of one day, subject to the weather. Often the sliced rolls are redried the following day. This practice often leads to fungal growth and thus quality loss. To make matters worse, crackers that are sun-dried are exposed to various forms of contamination such as insects, rodents and dust.

Systematic drying of crackers using mechanical or solar driers equipped with proper control of temperature and air flow can greatly enhance the quality of the end product. The use of driers solves the problem of space, exposure to contamination, natural hazards and reduces handling. The drier varies with capacity, building material, degree of sophistication, temperature control and safety features. The cabinet drier can have an air speed of 0.4 to 0.6 meter per second and have a capacity of 120 kilogram wet product. They are also equipped with thermostatic temperature control. Research has shown that 100 kilogram of wet crackers can be dried to 11 percent moisture content in 5 hours (Mohd. Zainal *et al.*, 1985).

Studies have indicated that drying to a moisture level of less than 8 percent is both uneconomical as well as detrimental to quality. This is because these over-dried crackers will brown too fast during frying resulting in a burnt flavour. The upper limit for moisture content of crackers is 12 percent, above which the product is prone to fungal attack.

Packaging

Packaging and presentation of products have always been an essential item of consumer appeal as well as product protection. Proper packaging materials are used to protect the fish crackers against moisture absorption, infestation by insects, and other contamination, and to reduce oxidation. In a tropical country like Malaysia with a relative humidity and temperature of about 85 percent and 27°C respectively, reabsorption of water vapour from the atmosphere would lead to quality deterioration (loss of crispiness for fried products) as well as fungal growth. As a result of fat oxidation, rancidity (of fried products) will result. This and coupled with improper handling, would greatly lead to overall quality loss. The unpuffed fish crackers have sharp edges and would tend to pierce the packaging materials; the importance of appropriate packaging materials should be realised.

Researchers at the Food Technology Centre of the Malaysian Agricultural Research and Development Institute (MARDI) have come up with suggestions for proper packaging materials to prolong the shelf life of the product. These are the use of 0.1 to 0.12 mm polypropylene pouches for the local market. The low density polyethylene bag in the box concept and the thermoform packaging are recommended for both local and export markets.

Conclusion

The fish cracker processing industry in Malaysia has progressed from manual to a partly mechanised state. Nevertheless technical skills essential in understanding the processes involved in fish cracker production are still lacking amongst many small-scale processors in the country. This could lead to improper control of processes, thereby resulting in inconsistency of products reaching the consumers. Various breakthroughs have been cited and some have been transferred to interested parties with the hope of upgrading the fish cracker processing industry in the country.

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Discussion

Ms Wan Rahimah informed the seminar that Malaysia has yet to come up with a generic HACCP for its fish crackers. On the other hand, the Codex Alimentarius Committee for Asia is in the progress of putting up standards for fish crackers in Asia.

Effects of Processing on the Quality of Salted-Dried Fish of Different Species

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Abstract

The quality of salted dried fish processed under certain processing conditions were compared. Similar parameters used in the production gave different quality products. Salt uptake was very rapid and highest in shark (Notogaleus rhinophanes) followed by morwong (Nemadectylus macropterus) and sardine (Sardinops neopilchardus). Lightly salted products were preferred in all species ($p<0.01$). However, drying conditions affected different drying rates and product quality. Squid attained the highest drying rates amongst all species and at 50°C its rate was the highest followed by shark, morwong and sardine. A drying temperature of 50°C gave a compromise between product quality and drying rates. The effects of processing were demonstrated by the decrease in protein solubility, disappearance and decreased intensity of some bands in the IF pattern of water soluble proteins. Thermal studies by Differential Scanning Calorimeter on the muscle showed that shark, threadfin bream and sardine had two endothermic peaks in their thermogram while squid had three peaks at 37, 43 and 80°C. The effects of salting and drying on the myosin (146-150°C) and actin peaks (72-80°C) were manifested either by the disappearance or decreased peak areas (DHD) and T_{max} of the peaks. But changes in in vitro protein digestibility and amino acid contents were not significant. Changes in pH and total volatile bases were also studied. Scanning Electron Microscopic examination of the fish tissues showed the effects of disruption due to salting and the reduction in compactness due to drying.

Introduction

Salted fish processing started in antiquity (Cutting, 1955, 1962; Kruezer, 1974). However it persists till today for reasons of preservation, in parts of the world where infrastructures of transport and handling are poor, as well as a speciality product where the lightly cured product, such as Gaspe cure is a big business. This is in contrast to its earlier image which is exemplified by a quote from Cutting (1955) that "they are left in a condition that demands the greatest efforts by the stomach to extract the food value from the fibrous masses". In Asia where consumption is the highest, dried salted fish is also an important source of low-cost dietary protein (Poernomo *et al.,* 1992). However, much is left to be desired in terms of quality. The properties and stability of any salted dried fish depends very much on the final moisture and salt content. Many processors disregarded these criteria, aiming instead for greater yield at the expense of high moisture content in the product.

Each country has its own standard as to the amount of salt and moisture desirable in their products (Tapiador & Carroz, 1963). Levels of salt in the products vary enormously. For example, salted herring may range in salt content from 16-35% depending on the method of salting, the ratio of salt to fish, the condition of the fish at the time of harvest and the chemical composition of the salt used (Voskressensky, 1965). In Asian countries where most of the processing and trade in salted dried fish takes place the problem of incorrect moisture and salt content is widespread and accounts for heavy losses of the products (Zain & Yusuf, 1983). Despite established standards, Sripathy (1983) reported that the majority of market samples do not conform to any of the specifications; this was also observed by Gopakumar and Devadesan (1983).

This paper will compare the quality of different species of salted dried fish which were prepared under specified conditions. The effects of the processing conditions on the chemical properties of the product will also be discussed.

Materials and Methods

1. Processing conditions

Four types of fish were bought fresh from the market; threadfin bream or morwong (*Nemadectylus macropterus*), shark (*Notogaleus rhinophanes*), sardine (*Sardinops neopilchardus*) and squid (*Nototodarus gouldi*). Filleted threadfin bream, shark and whole sardines were immersed in saturated brine with a fish/brine ratio of 1:2 (w/v) at controlled temperature (26±2°C) over a period of time. Fish were removed at intervals.

One lot was taken for drying and another for analyses. For the drying studies, the fish were dried at a range of temperatures from 30°-70°C in a custom-made tray dryer at ambient relative humidity. No attempt was made to control the relative humidity. Squid, without salting, was also dried at these temperatures. The wet bulb temperatures were recorded. Weight losses were monitored by weighing at suitable intervals.

2. Analyses

Fish were analysed at regular intervals during salting for salt uptake and moisture loss. Total volatile bases in the fish were examined at all intervals. Effects of salting and drying on the properties of protein such as solubility, digestibility and its total amino acid content were examined. These were followed by isoelectric focusing technique as well as thermal studies. The structural changes in the product was examined by a scanning electron microscope. The products were subjected to reconstitution and quality evaluation by a panel of taste testers.

3. Analytical Procedures

a. Moisture content was carried out by the vacuum oven method.

b. Sodium chloride was determined by titration with silver nitrate (FAO, 1981).

c. A_w was determined on the Novasina AG Hygrosensor (Model en ZFBA - 3(4) EPP) with an A_w range of 0.1-1.00.

d. Total volatile bases (TVB) and trimethylamine (TMA) were determined by steam distillation of a trichloroacetic acid extract of the sample under alkaline conditions followed by titration with 0.005M sulphuric acid.

e. Solubility studies were conducted according to Obanu *et al.* (1975a).

f. Isoelectric focusing (IEF) in the pH range 3-10 on agarose gels was used to examine the effects of processing conditions on protein extracted from the fish tissue. The procedures for gel preparation, running conditions, fixing, stain and destaining were as described in 'Isoelectric focusing, Principles and Methods' by Pharmacy Fine Chemicals. A Pharmacy flat bed electrophoresis it BE-3000 and a constant power supply PCPs 2000/300 were employed throughout.
Samples were prepared for IEF by mixing 2g of the previously ground sample with 18 ml distilled water for 10 min. on a magnetic stirrer. The unfettered solution was dialysed against distilled water at 5°C for 24 h with five changes of water to remove salt. The dialysed solution was centrifuged at 0°C, 9000xg for 1h on a Damon/IEC refrigerated centrifuge model b-20A. The supernatant was kept refrigerated for no longer than 2 days prior to IEF.

g. Scanning Electron Microscopy (SEM)
Samples were freeze-dried and kept in a dissector prior to examination by scanning electron microscopy (SEEM). Representative surface areas and deep tissues were placed onto double-sided adhesive tape on aluminium stubs. The samples were coated with gold using a vacuum evaporator type Gee-4B (Electron Optics, Japan). The coated samples were viewed under a scanning electron microscope model ISI-100 International Scientific Instruments), fitted with an environmental cell modification, at various magnifications. Representative areas were photographed.

h. Differential Scanning Calorimetry (DSC)
Analysis was performed on Du Pot Series 190 Differential Scanning Calorimeter. This instrument was calibrated using biphenyl, AR grade. Approximately 10 mg of accurately weighed samples were sealed in a volatile sample pan. A sealed empty pan was used as a reference pan. The samples were scanned at a heating rate of 10K/min over the range 274-374 K at an instrument sensitivity of 0.05 mcal/sec. Peak transition temperatures were taken as peak maxima (T_{max}).

Results and Discussion

1. Processing factors

a. Salt Uptake and Moisture Loss

During brining salt penetrates the fish flesh with accompanying loss of moisture. Under ideal conditions salt uptake will continue until salt concentration in the aqueous phase of the tissue becomes equal to that in the brine. Factors such as brine concentration, time in the brine, temperature and size of fish will influence salt penetration (Graham *et al.*, 1986). Figs. 1 & 2 demonstrate the inverse relationship between salt uptake and water content during brining. Rapid rate of salt uptake is observed in the first 12h. This was similarly observed by Poernomo *et al.* (1992). Shark attained the highest salt content amongst the three species, possibly because of its coarser fibres (Ronsivalli, 1978) and large surface area. This is followed by morwong fillets (length 19.7 ± 3.6 cm, max. thickness 1.4 ± 0.4 cm) which also presented a large surface area although salt uptake was restricted by skin on one side of the fillet. It's thickness would also slow down salt uptake (Crean, 1961) reaching equilibrium only after 8h when it contained 12% (wb) salt and 69% moisture. Both rate and total salt uptake for sardine (Fig. 1) were lower than for morwong and shark. The two observations could perhaps be explained by the following reasons: (a) because sardine was salted whole, therefore its skin would act as a barrier between the muscle and the brine thus slowing down the salt front, (b) being a fatty fish the fat content can act as a barrier to both the entry of salt and the withdrawal of moisture, (c) sardine protein is characterised by its low pH after death; when very fresh, 20-30% of its myofibrillar protein is already denatured, losing some of its water (Suzuki, 1981). Thus being in this state, it may not be able to absorb as much salt. These factors acted in combination to result in a slower rate and lower uptake of salt.

Fig. 3 shows that moisture loss is rapid in the first 12h. It is least in morwong followed by shark and then sardine. Although sardine started out with the lowest initial moisture content (Fig. 2; 74.5%) amongst all the three species, it showed a higher loss of moisture than the other two species (Fig. 3). Its salt uptake was also the least among all the three species (Fig. 1). This could perhaps reflect a specie-specific characteristic, which is related to its water holding capacity, which in turn is dependent on its post rigor conditioning.

b. Drying Rates

Each species of fish, except for squid, were salted to its equilibrium value under the given conditions and were subjected to drying studies at temperatures between 30°-70°C. In each study (Figs. 4-7) the rate of drying was obviously faster ($p<0.01$) at 70°C than at other temperatures. This was followed by 60°, 50°C and lastly by 40°C and 30∞C which in most cases were very similar with each other. When comparing the drying rate profile, temperature by temperature, for each species, sardine dried slowest. The presence of skin and its fat content could contribute to the slow drying rates. On the other hand the drying rates for squid were high at all temperatures, with that at 50°C significantly higher ($p<0.01$) than at other temperatures. Although rates are generally highest when drying at 60° and 70°C, the products obtained were often of burnt appearance, with brittle texture and the appearance of salt crystals visible on the surface.

When comparing the rates of drying at 50°C (Fig. 8) squid was seen to dry significantly faster at 50°C ($p<0.01$) compared to all the other fish. This is presumably because the squid were cut open and laid flat exposing a large surface area for a small volume (the mantle thickness ranged from 0.4-0.8 cm); high rates of drying resulted at all temperatures. Shark had the second fastest rate, drying significantly faster ($p<0.01$) than sardine and morwong. The large surface area and the fibrous nature of shark meat encouraged fast drying. Even though morwong presented a large surface area for evaporation, its drying rate at 50°C is the second slowest, although still significantly faster than sardine. This is presumably because of the presence of skin on one side of the fillet, restricting drying from occurring from this side. Furthermore salt content in morwong is high (40%, db) and as reported by Waterman (1976), this would slow down drying rate.

Although a drying temperature of 43°C was reported to be suitable with an inlet RH of about 45-50% giving a good product (Waterman, 1976) in tropical countries, 50°C is considered the optimum temperature for all the four species in this study after considering both product quality and rates of drying.

2. Chemical Analyses

a. Effect of salting on pH

During salting, pH was observed to decrease steadily from its initial value in the first 4h after which its value seemed to rise ever so slightly till the 8th hour and then remained more or less constant till the end of the salting period (Fig. 9). In shark, the leaching of urea into the curing brine, as much as 71% at the end of brining in some cases (Yang *et al.*, 1981), may contribute to the drop in pH. Kida and Tamoto (1969); and Regenstein *et al.*, (1984) have also demonstrated that when fish are in a medium containing sodium chloride or potassium chloride, reduction in pH will also be accompanied by the loss of water holding capacity.

A slight rise in pH during the course of salting may indicate development of bases possibly due to microbial degradation, which would be limited by the salt concentration higher than 12%. This concentration was only attained after 8h salting. Malle, Eb and Taillez (1986) found that the high pH in a culture medium used to study the level of contamination in fish muscle with 10% salt in the aqueous phase of the fish was sufficient to start the denaturation (Beatty and Fougere, 1957).

b. Effect of salting on TVB and TMA

In sardine and morwong, both TMA (Fig. 10) and TVB (Fig. 11) were observed to increase in the first 4h of salting. The rise observed in sardine, for both TVB and TMA, were higher than in morwong. The initial rise may be due to microbial degradation before the fish could acquire the necessary salt concentration to retard spoilage. At least more than 5% salt was required to retard the formation of TMA in mackerel homogenates (Ishida *et al.*, 1976). Besides, dark-fleshed fish is noted for higher contents of TMA than white-fleshed fish (Suzuki, 1981) and it also contains enzyme to reduce TMAO to TMA. After the initial rise the TVB and TMA contents decreased gradually till the end of salting.

In shark, the TVB content decreased rather sharply in the first 8h from 73 mgN/100g to 42 mgN/100g and it continued decreasing and levelling off till the end of salting. These decreases are attributed to the leaching of amines into the brine (Gordievskaya, 1973), including urea, which is broken down by urease to ammonia and is also leached into the brine on salting (Zaitsev *et al.* 1969). Similar observation was made by Yang *et al.* (1981). A similar trend was observed for TMA.

c. Effect of drying on TVB and TMA

TMA and TVB content in all the fish (Figs. 12, 13, 14) were found to increase on drying, more so at higher temperatures. These results concur with previous observations on development of amines in dried products (Spinelli and Koury, 1979; Hebard *et al.*, 1982). This increase was attributed to the instability of TMAO to heat (Sigurdson, 1947; Nakamura *et al.*, 1985), whose rate of decomposition varied with species (Tokunaga, 1975) and whose development is greatly affected by the rate of drying and the processing conditions (Spinelli and Koury, 1979) apart from being much greater in dark-fleshed fish than in white-fleshed fish.

3. Effect of Processing

a. Protein Solubility

Effect of Salting on Protein Solubility

Protein solubility decreased during brining. Solubility is very poor in KCl at 25°C but it improved slightly at 77°C (Figs. 15 & 16). Meinke *et al.*, (1972) observed similarly. Although as much as 50% extractable protein in shark has been reported by Waller (1980), the solubility observed in this study is much lower (Fig. 17); the extractability of sardine protein is the lowest (Fig. 16). Poor solubility was expected as Duerr and Dyer (1952) observed that when fish muscle was immersed in concentrated brine, the total myofibrillar protein rapidly became inextractable. When the average salt content reached 10%, i.e. when the concentration of the electrolytes reaches 2M, there is a decrease in bound water and a change in hydration which may result in precipitation (Kinsella, 1982). However this will not happen throughout the fish tissue until salt penetration is complete, i.e. at about 10% (wb) salt content (Crean, 1961). Complete inhibition of the fish muscle proteolysis occurs at 12% NaCl (Bilinski and Fougere, 1959). When the proteins have denatured, extraction by solubilising agents such as the ionic detergent, SDS, is necessary to dissolve the proteins. Solubility in SDS+b mercaptoethanol was found to be high: 72% for morwong, 67% for shark and 61.5% for sardine at the start of brining and declined gradually till the end of salting. Generally the solubility in SDS+B mercaptoethanol is higher than in the two other extracting media used. This observation concurs with that of Rehbein and Karl (1985). The salt soluble fraction consists mostly of myofibrillar protein and some sarcoplasmic protein (Poulter *et al.*, 1985). The myofibrillar fraction is highly sensitive to changing conditions (Aitken and Connell, 1979). In sardine, about 20-30% of the myofibrillar proteins in unsalted sardine is inextractable due to physiological changes (Suzuki, 1981). Thus, further changes, such as salting out would cause reduction in water holding capacity of the proteins, which in turn become increasingly insoluble (Kinsella, 1982).

Effect of Drying on Protein Solubility

Howgate and Ahmed (1972) observed that the effects of heating and drying on the extractability of fish proteins differed between species. Generally, the solubilities in KCl at 25°C and in KCl at 77°C of fish dried at different temperatures were quite poor (Figs. 17, 18, 19, 20). The solubilities decreased when dried at higher temperatures. The solubilities of fish protein improved tremendously in SDS, but the solubilities also decreased with higher drying temperatures.

Decrease in solubility was observed by Migita *et al.*, (1960) in fish dried at 5-10°C. These workers reported that solubility of myofibrillar protein was lowered while the denaturation of sarcoplasmic protein took place slowly and its solubility was lowered slightly. Suzuki (1981) reported that the heat coagulative sarcoplasmic protein adhered to myofibrillar protein when fish is heated. This leads to insolubilisation of the latter. Actin is also soluble in KCl solution and is most probably not changed by low heating. However actin cannot be extracted out if myosin becomes inextractable (Howgate and Ahmed, 1972). Parsons and Patterson (1986) and Poulter *et al.*, (1985) also observed decreases in protein solubility in heated fish samples. The denaturing effects of both salting and drying processes reduced solubility of the products perhaps by changes in the number and distribution of SH groups, formation of cross-linking S-S bands, aggregations, or even partial loss of hydration and interaction with other components (Sikorski *et al.*, 1976). All these could contribute to the loss of protein solubility deserved in this study.

b. IEF

After brining

Figs. 21, 22 and 23 shows the IEF patterns of water-soluble proteins extracted from morwong, shark and sardine respectively. Six major bands each were observed in morwong and shark and about seven were observed in sardine. As brining time increased the intensity of most bands decreased, even more so in sardine. Only the very anodic and some cathodic bands persist. In shark and sardine some secondary bands were observed to appear in more cathodic positions. However, some bands appeared unaffected by the brining process such as band E and F in morwong and also E and F in shark.

After drying

Figs. 24, 25, 26 and 27 clearly demonstrates the effects of salting and drying on the IEF of water-soluble proteins of morwong, shark, sardine and squid. It can be seen that most bands start disappearing even at a drying temperature of 30°C. At higher drying temperatures almost all the bands have disappeared, except for a few which remain faintly visible even at higher temperatures.

c. Thermal studies

Thermogram of the fresh fish

Fresh shark meat has two distinct endothermic peaks in its thermogram (Fig. 28), the first and the smaller of the two displays a peak maximum (T_{max}) at 50° ± 2°C and the second and larger peak has a T_{max} at 72° ± 2°C. These represent thermal denaturation of the proteins. The thermogram lacks the basic three peak profile previously observed for fresh fish (Poulter *et al.*, 1985) and mammalian meat (Wright *et al.*, 1977) which were due primarily to transitions involving myosin (T_{max} 60°C), the second possibly due to sarcoplasmic protein transition at T_{max} 67°C and the third due to actin at T_{max} 80°C (Wright *et al.*, 1977). However there are fish species such as tilapia which display only two distinct peaks (Poulter *et al.*, 1985) whilst Davies *et al.*, (1988) working on intact muscle of cod and snapper noted that Peak II on the typical thermogram was not always present. Thus the first peak (T_{max} 50°C) in the shark thermogram could be that of both myosin and sarcoplasmic proteins, and the second peak (T_{max} 72°C) could possibly be actin.

Morwong also exhibited a two-peak thermogram (Fig. 29); the first has a transition temperature T_{max} at 46° ± 2°C and the second, larger peak has a T_{max} at 73° ± 1°C. Sardine on the other hand shows two very distinct peaks at 50° ± 1°C and 80° ± 1°C and a slight inflection at 32°C (Fig. 30) which may represent the transition of collaganeous material as the sardine sample was macerated whole.

Effect of salting on the thermogram of fish

The effects of salting on thermogram of fish proteins are shown in Figs. 28, 29, 30. In shark (Fig. 28) the transition temperature of the second largest peak (actin) decreased with increasing salting time from 72°C in the unsalted sample to 64°C ± 4°C in the 8h salted sample and 45°C ± 2°C in the 36h salted samples. Secondly, at longer salting times peak broadening was noted. The peak temperature of the first transition (myosin) also decreased to 46°C, and in the longer salted samples it disappeared altogether. The salt content in the unsalted, 8h and 36h samples were 3.1, 48.3 and 56.1% (db), and this, no doubt played a major role in changing the peaks. Ionic strength effects were proposed to be the causes of the changes observed (Quinn *et al.*, 1980), whilst Weinber *et al.* (1984) also showed that Cl destabilised the actin molecules.

Fig. 29 illustrates the effects of salting time on morwong protein. Transition temperature in both peaks decreased (from 73°-70°C for the first peak and 46° to 42°C) and peak broadening was also noted in the 4 and 12h samples. However, thermograms of the longer salted samples of morwong were poorly reproducible in terms of peak areas and temperatures. This is attributed in inhomogeneity of samples in terms of both moisture and salt contents.

Similar problems were encountered with longer brined sardines. After brining sardines were macerated whole, the T_{max} of the major peak were 80° and 64°C in the unsalted and the 12h salted sampled (Fig. 30) respectively, and these decreased substantially ranging from 41-55°C in the 24-48h samples.

Effect of drying on the thermogram of fish

Figs. 31-34 show the thermograms of morwong, sardines, shark and squid after drying. The general observation was that the first peaks that were seen in the thermogram of all the fresh unsalted fish were only observable in morwong and sardine samples which were dried at 30°C. They were absent in samples dried at higher temperatures and also in any of the other species examined. The second peak which was the major one (actin) was still observable in samples dried at 30-70°C. However as the drying temperature increased the peaks broaden and the peak area decreased in size. Changes in myofibrillar proteins start at approximately 50°C whereas denaturation of the sarcoplasmic proteins start at much lower temperatures (Hamm, 1966). Judging by the shape of the thermograms at the same drying temperature for all the species examined in this study, shark and squid seem to have experienced more severe effects of heat denaturation than either morwong or sardine. This is confirmed by the enthalpy (DHD) data in Table 1. Even though the samples contained different moisture contents decreasing DHD reflects the energy changed associated with protein denaturation during drying. Although squid dried faster at 50°C than the other fish species, the effect of heat treatment on squid was more severe than in the other species. Squid textural qualities change rapidly with increasing cooking temperatures up to 60°C (Otwell and Hamann, 1979b). This was associated with sarcoplasmic protein coagulation, destruction of myofibrils (Otwell and Hamann, 1979a) and thermal gelatinisation of the large amount of connective tissue in squid (Stanley and Smith, 1984). Parson and Patterson (1986) noticed a correlation between maximum heating temperature and the onset of denaturation, and that the length of heat treatment is reflected in peak areas of the thermogram. However, in this study it seems that heating temperatures gave smaller peak areas even though drying rate is faster at higher temperature and was conducted for shorter times. Duration of heating must affect the thermograms although this aspect was not investigated.

4. Nutritional implication

a. *In vitro* digestibility

Digestibility remained high throughout the salting period (Table 2) and changes in the digestibility over the salting period are negligible. Digestibility therefore was not negatively affected by salting. Table 3 illustrates the effect of drying temperature on *in vitro* digestibility of morwong, shark, sardine and squid. The digestibility ranged high between the fresh sample to the 70°C dried product. The digestibility of squid meat improved on drying. One possible reason for the improved digestibility is that the prepared squid meat was held at 3-5°C while awaiting drying. Self proteolysis may have occurred (Sikorski and Kolodziejska, 1976), leading to protein solubilities. Squid muscle contain proteinases, active at slightly alkaline pH and have maximum activity at 60°C (Rodger *et al.*, 1984a).

b. Amino Acids

Effect of salting on total amino acids

In all the three species of fish salted, variations in the amounts of individual amino acids was observed, however no trends were discernible. Most changes were not significant except for histamine in morwong ($p<0.01$) (Table 4). Histamine has been observed to form during curing of pickled sardine (Wada and Koizumi, 1986). In shark, a decrease in cystine was significant at ($p<0.05$). Decreases were also observed in glycine and histidine occuring in sardine although these were not significant. Lysine did not seem to have been affected at all and it appears that salting does not affect amino acid content. Salting up to 48h therefore does not incur significant nutritional damage to the proteins of salted fish. This observation concurs with that of Takama *et al.* (1985) who also found no effect on the amino acids during salting and pickling of *masu* salmon.

Effect of drying on amino acids

Drying did not adversely affect the total amino acid content in all the species. This concur with most previous reports (Tarr, 1962; Anon 1973; Aitken and Connel 1979). Yang *et al.* (1981) found no effect of drying at 105°C but at 170°C available lysine fell by 20%. Specific trends are not discernible in this study, however decreased are seen in cystine and lysine, both of which are known to be heat sensitive. Table 5 illustrate the effects of drying on amino acids in morwong.

5. Scanning Electron Microscopic Examination (SEM)

SEM was used to examine the appearance of the product during brining and drying. Plates la,b,c and d demonstrates the effects of brining on the structure of morwong flesh. As brining time increases, the surface is disrupted increasingly and more salt is evident. This trend continues with longer brining (Plates 2 a,b,). Corresponding SEM micrograph of the deep tissue are shown in Plate 3. The fibres became more disrupted and greater quantities of salt are visible as brining time was increased (Plate 4). The disruption of the fibres could possibly be caused by withdrawal of water to the outside of the fibres, thus increasing salt concentration. This is turn could decrease water holding capacity and allow shrinkage of neighbouring fibres away from each other.

The micrographs of the surface and deeper tissues of fillets dried at 30°, 40°, 50° and 60°C are presented in Plates 5 & 6 respectively. Both series of micrographs indicate a decrease in compactness of the tissue structure as drying temperature in increased. This is reflected ultimately by the fragmentation of products dried at 60°-70°C during reconstitution. Decreased protein solubilities indicate some damage to the proteins in the dried products, and this is further echoed in the rehydration behaviour of the dried fish. Similar observations were made with shark, salted and dried at different temperatures and sardine. The SEM of squid showed that fresh squid have 'loosely' bound fibres which became bound or fused together at higher temperatures (Plate 7).

6. Quality Evaluation

a. Moisture and salt content

The stability of any dehydrated foodstuff is closely related to A_w rather than the total moisture content. A dry foodstuff will absorb moisture depending on ambient RH and also its intrinsic properties (Muslemuddin *et al.* 1984). Drying at 30° and often 40°C produced products with rather high moisture content and A_w of approximately 0.80. Morwong products dried at temperatures 50°C and above had reasonable moisture contents and their A_w are below 0.80. Growth of mould is inhibited at 0.80 and below whilst halophilic bacteria do not grow at 0.75 and below (FAO, 1981).

In Table 6, the predicted shelf life of morwong dried at 30° was only 1 week. The predicted shelf lives of products dried at 40°, 50° and 60° were 1 Ω - 2 months while that dried at 70°C was one year. Although microbial attack will be retarded at such low A_w browning reaction and lipid oxidation may be accelerated (Labuza *et al.*, 1970).

The moisture contents in dried salted shark (Table 7) varied between 26.8% (dried at 60°C) and 44.5% (dried at 30°C). A_w ranged from 0.65-0.72. The product was creamy white which was most attractive in products dried at 30°-40°C. However at 30°C the moisture content was high (44.5%). Drying at 50°C gave slightly yellowish products which were still quite attractive. Products dried at 60°C had a slight browning tinge while at 70°C, the products became brown. Similar colour changes were observed by Bose *et al.* (1958). The predicted shelf life for the shark products ranged from 1 week for the 30°C sample to longer than 2 months for the 60°C sample.

Commercial products of moisture content 30-35% and salt content of 16-17% were reported by Jinadatharaya and Vernekar (1979) to last less than 6 months.

Sardines dried at 30° and 40°C has an attractive appearance and did not suffer from severe shrinkage although some browning was apparent around the belly region. Products dried at 50°C were slightly more brown than those at 30° and 40°C. The browning was apparent along the belly and tail region on the central side. Browning was more severe in the 60° and 70°C dried samples (under the skin the meat also appeared brown), shrinkage was apparent and products had jarred texture. Table 8 shows the moisture content and A_w of sardines dried at different temperatures. The moisture ranged from 22.2% for samples dried at 70°C to 47.9% for those dried at 30°C. The A_w in the 30° and 40°C samples were >0.75. This means that the products required longer drying time to achieve microbial stability. Being a fatty fish the products are also liable to fat oxidation leading to rancidity and browning from lipid-protein reactions. Products dried at 50°, 60° and 70°C had A_w of 0.67-0.70 which were indicative of better microbial stability although still subject to rancidity problems. The products dried at 50°, 60° and 70°C were predicted to have shelf life of between 2-4 months and those dried at 30° and 40°C, because of high moisture and low, salt content, are expected to last only for a week.

The moisture content and A_w in squid products obtained were <15% and between 0.51-0.65 respectively. The products will therefore not have microbial problems unless they subsequently access moisture. It will also be prone to lipid oxidation although lipid is low in squid. With such figures for moisture content and A_w, the shelf life is predicted to be longer than a year.

b. Sensory evaluation

Irrespective of chemical or physical properties and storage life, organoleptic properties of a product determine its acceptability to the consumer. The production of dried marine products in this study involved a period of time in saturated brine (except for squid) and drying at various temperatures. Thus brining time and drying temperatures were individually examined for their effects on acceptability of the dried products. Lightly salted products, those salted for

2 and 4 hours were significantly preferred ($p<0.01$) over sample brined for longer times because of lower saltiness (Table 10).

Table 11 shows that aroma did not vary significantly with drying temperature for morwong. However, colour varied significantly with drying temperatures. The lightest coloured products were obtained by drying at 30° and 40°C and these were preferred over the other products. Texture scores did not vary significantly between drying temperatures. Based on colour preferences, drying rate and overall product quality appraisal, 50°C was chosen as a suitable drying temperature for morwong.

For shark the saltiness for the 2, 4 and 8h products did not differ significantly, although the mean scores were highest for the 4h product (Table 12). Samples dried at 70° and 60°C were significantly different in aroma to those dried at 50°, 40° and 30°C which were not significantly different from each other (Table 12). For colour, samples dried at 30° and 40°C had the highest scores and were significantly preferred ($p<0.01$) over the other samples. The 40°C sample scored the highest for texture, was not significantly different to the 50° and 60°C samples, but differed significantly from the 70°C sample. For overall acceptability, the 30°, 40° and 50°C samples scored the highest but did not differ significantly. They were however preferred ($p<0.01$) over the 60° and 70°C samples which were significantly different ($p<0.01$) from each other. Therefore based on acceptability, shark could be dried at 30°, 40° or 50°C but 50°C is chosen because of its faster drying rate.

Like the other two products, lightly salted sardines (salting time 2 and 4h) were preferred over the rest of the products on the basis of saltiness. The 8h product was ranked third and was significantly less preferred ($p<0.01$) to the 2 and 4h products. The 8 and 12h products were not significantly differentiated. Sardines brined for 8h were dried at 30°, 40°, 50°, 60° and 70°C to a moisture content of approximately 30%. Aroma did not vary significantly for these products (Table 13). The colour of the 30°, 40°, 50° and 60°C products did not differ significantly but 40°C differed significantly ($p<0.01$) from the 60° and 70°C products. Textures did not vary significantly amongst the products but for overall acceptability the 30°, 40° and 50°C products were significantly preferred ($p<0.01$).

Squid was fried in oil at 200°C for 2 min. and served to a panel of untrained assessors. Table 14 shows the mean scores for each attribute evaluated. There was no significant difference among the treatments for aroma, texture and overall acceptability. However the 30°C scored significantly less ($p<0.01$) for colour. Eventhough the 50°C sample scored the highest for colour, it was not significantly different from the others except for the 30°C and 40°C samples. The products dried at 50°C is recommended based on the high drying rate.

Conclusion

Different species demonstrated different rates and maxima of salt uptake during brining. However, no benefits were observed in lengthening the salting time beyond that required for maximum uptake, namely 8h for morwong and sardine and 4h for shark. The disadvantages of longer brining were demonstrated clearly in the poor appearance of salt encrusted products, evidenced visually as well as by SEM studies and by poor acceptance.

Drying temperature between 30°-70°C were applied to products salted for their optimum time. Squid was also dried without salting. A drying temperature of 50°C was found to be the best compromise between rate and product quality.

Overall effects of salting included a decrease in soluble proteins, a decrease in intensity and number of IEF bands and pronounced changes to the flesh structure as shown by SEM. Salting did not adversely affect either *in vitro* protein digestibility or amino acid levels. Drying had similar effects on the above parameters. Protein denaturation during both salting and drying was also exemplified in DSC studies of thermograms of the fish samples.

During salting there were also changes in pH and volatile bases, while during drying increase in volatile bases was also observed.

The products obtained from the above salting and drying procedures had sufficiently low A_w to ensure microbial stability; however, deterioration via browning reaction and oxidation rancidity could limit storage life.

The acceptability of freshly prepared products was limited by higher salt level, brittle texture and browning reaction products. In the product obtained using minimum brining times to reach maximum salt level and a drying temperature of 50°C, none of these factors were found to be a problem. Thus, on the basis of acceptability and nutritional considerations the above salting and drying conditions are recommended for production of salted dried fish products.

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Discussion

Dr Noriyati informed the Seminar that the study was conducted in Australia and shark was used in the study because of its abundance.

Table 1. Changes in enthalphy of denaturation (ΔHD) during drying.

Drying temperature (°C)	Morwong		Sardine		Shark		Squid	
	Moisture content (%)	ΔHD kJ/g	Moisture content (%)	ΔHD kJ/g	Moisture content (%)	ΔHD kJ/g	Moisture content (%)	ΔHD kJ/g
Fresh	80.7	13.17	74.4	19.19	79.4	18.85	80.8	16.00
30°	47.2	10.32	47.9	11.54	44.5	3.74	13.5	4.05
50°	29.6	9.74	22.7	8.74	34.1	1.09	10.7	2.17
70°	11.9	6.90	22.2	5.94	37.7	0.21	14.9	0.25

Table 2. *In vitro* digestibility of salted fish.

Salting time (h)	Digestible Protein (%)		
	Morwong	Shark	Sardine
0	98.4[a]	99.4[a]	99.5[a]
4	99.6[a]	99.6[a]	99.3[a]
8	99.6[a]	97.7[a]	99.2[a]
12	99.5[a]	97.4[a]	99.4[a]
18	99.4[a]	99.4[a]	98.6[a]
24	99.5[a]	99.3[a]	98.6[a]
36	99.5[a]	99.1[a]	98.5[a]
48	99.7[a]	98.2	98.1[a]

Table 3. *In vitro* digestibility of dried fish.

Drying temp. (°C)	Digestible Protein (%)			
	Morwong	Shark	Sardine	Squid
Fresh Sample	98.4[a]	99.3[a]	99.5[a]	88.1[a]
30°	99.6[a]	99.9[a]	98.5[a]	98.3[b]
40°	99.8[a]	99.7[a]	97.5[a]	96.7[b]
50°	99.7[a]	99.5[a]	97.0[a]	97.9[b]
60°	99.8[a]	99.6[a]	97.4[a]	97.1[b]
70°	99.8[a]	99.5[a]	94.0[b]	97.7[b]

Note : Different superscripts down the column indicate significance at 99% confidence level.

Table 4. Total amino acid content in salted morwong.

Amino acid (g/16 gN)	Salting time (h)			
	0	12	24	48
Aspartic acid	9.91	10.63	10.07	10.59
Threonine	4.80	4.88	3.37	3.58
Serine	4.11	5.98	5.41	4.21
Glutamic acid	12.76	18.01	14.34	16.48
Proline	4.18	4.84	4.47	4.05
Glycine	3.99	5.41	5.72	5.91
Alanine	5.96	7.05	6.68	6.17
Cystine	0.50	0.56	0.85	0.53
Valine	5.04	5.70	5.95	5.44
Methionine	3.33	2.86	3.14	2.68
Isoleucine	4.28	4.30	5.23	5.39
Leucine	6.77	3.18	8.48	6.59
Tyrosine	4.50	2.51	4.11	3.78
Phenylalanine	4.21	2.67	3.47	3.48
Lysine	9.47	9.89	8.86	9.19
Histidine*	6.79[a]	3.46[b]	2.43[c]	1.82[c]
Arginine	9.39	8.42	7.42	8.56

* Amino acid showing a decreasing trend, significant at 99% confidence level.

Table 5. Total amino acid composition in dried morwong.

Amino acid	Drying temperature °C			
	Fresh fish	30°C	50°C	70°C
Aspartic acid	9.91	10.65	10.36	9.12
Threonine	4.80	5.25	3.93	4.10
Serine	4.11	4.76	3.58	3.88
Glutamic acid	12.76	13.97	12.32	12.37
Proline	4.18	4.66	2.89	2.87
Glycine	3.99	7.11	4.78	6.40
Alanine	5.96	8.71	6.95	7.39
Cystine	0.50	0.78	0.57	0.58
Valine	5.04	5.95	5.295	4.75
Methionine	3.33	2.89	3.07	2.63
Isoleucine	4.28	3.94	4.73	4.13
Leucine	6.77	6.39	8.10	7.56
Tyrosine*	4.50[a]	3.13[a]	2.57[c]	2.65[c]
Phenylalanine*	4.21[a]	2.61[a]	2.28[b]	2.49[b]
Lysine*	9.53[a]	9.47[a]	9.48[a]	9.14[b]
Histidine*	6.79[a]	2.22[a]	2.58[c]	2.89[c]
Arginine*	9.39[a]	7.43[b]	6.54[c]	5.05[d]

* Amino acid showing decreasing trend. Different superscripts denote significance at 99% level.

Table 6. A_w and moisture contents in dried morwong.

Drying temp. (°C)	A_w	Moisture (%)	Salt (% wb)	Predicted shelf life
30	0.83	47.2	21.3	1 week
40	0.79	37.2	25.3	1H months
50	0.74	29.6	28.3	2 months
60	0.71	24.7	30.3	2 months
70	0.69	11.9	35.5	1 year

Table 7. A_w and moisture contents in dried shark.

Drying temp. (°C)	A_w	Moisture (%)	Salt (% wb)	Predicted shelf life
30°	0.72	44.5	24.6	1 week
40°	0.72	29.8	31.1	2 months
50°	0.71	34.1	29.2	1H months
60°	0.65	26.8	32.4	2 months
70°	0.70	37.7	27.6	1H months

Table 8. A_w and moisture contents in dried sardine.

Drying temp. (°C)	A_w	Moisture (%)	Salt (% wb)	Predicted shelf life
30	0.86	47.9	9.14	1 week
40	0.77	38.4	11.7	1 week
50	0.67	22.7	13.7	2 months+
60	0.70	29.2	12.3	2 months+
70	0.70	22.2	12.0	4 months

Table 9. A_w and moisture contents in dried squid.

Drying temp. (°C)	A_w	Moisture (%)	Salt (% wb)	Predicted shelf life
30	0.43	13.5	8.0	1 year +
40	0.38	12.1	8.2	1 year +
50	0.31	10.7	8.3	1 year +
60	0.41	14.9	7.9	1 year +
70	0.44	15.0	7.9	1 year +

Table 10. Mean scores for saltiness in dried products.

Products	Salting time (h)				
	2	4	8	12	18
Sardines	(15.6)	(20.8)	(26.4)	(29.1)	(30.2)
	7.97[a]	7.67[a]	5.57[bc]	5.49[c]	3.69[d]
Morwong	(23.2)	(28.0)	(43.5)	(44.4)	(42.4)
	7.95[a]	6.95[ab]	6.76[bc]	5.32[c]	3.95[d]
Shark	(43.6)	(43.2)	(45.6)	(48.3)	(46.6)
	7.21[a]	6.82[a]	6.41[a]	4.50[b]	3.42[c]

Note : Figures in parentheses denote salt content (% db) in the samples. Different superscripts along horizontal column indicate significance at 99% confidence level.

Table 11. Mean sensory scores for salted dried morwong.

Attributes	Drying temperature (°C)	Mean Score
Aroma	70	7.31[a]
	60	7.23[a]
	40	6.76[a]
	30	6.26[a]
	20	5.98[a]
Colour	70	3.43[c]
	60	6.80[b]
	50	6.85[b]
	40	6.92[a]
	30	7.20[a]
Texture	70	7.33[a]
	50	6.87[a]
	60	6.85[a]
	40	6.13[a]
	30	5.60[a]
Overall acceptability	70	7.22[a]
	60	6.92[a]
	50	7.07[a]
	40	6.30[a]
	30	5.82[a]

Note : Different superscript along horizontal column indicate significant difference at 99% confidence level

Table 12. Mean sensory scores for dried salted shark.

Attributes	Drying temperature (°C)	Mean Score
Aroma	70	6.17[b]
	60	6.14[b]
	50	7.66[a]
	40	7.60[a]
	30	7.21[a]
Colour	70	5.21[a]
	60	5.55[b]
	50	6.65[b]
	40	7.80[ab]
	30	7.49[a]
Texture	70	5.09[a]
	60	6.09[a]
	50	6.45[a]
	40	6.56[a]
	30	6.41[a]
Overall acceptability	70	5.70[a]
	60	5.84[b]
	50	7.22[a]
	40	6.90[a]
	30	7.32[a]

Table 13. Mean sensory scores for salted dried sardines.

Attributes	Drying temperature (°C)	Mean Score
Aroma	70	6.91[a]
	60	7.21[a]
	50	7.13[a]
	40	-
	30	6.60[a]
Colour	70	5.63[b]
	60	6.27[b]
	50	6.67[ab]
	40	7.43[a]
	30	6.42[ab]
Texture	70	5.46[a]
	60	7.13[a]
	50	6.93[a]
	40	6.90[a]
	30	5.85[a]
Overall acceptability	70	4.65[c]
	60	6.12[ab]
	50	6.87[ab]
	40	7.33[a]
	30	6.81[ab]

Note : Different superscript indicate significance at 99% confidence level.

Table 14. Mean sensory scores for salted dried squid.

Attributes	Drying temperature (°C)	Mean Score
Aroma	70	6.83[a]
	60	6.69[a]
	50	5.65[a]
	40	6.69[a]
	30	5.56[a]
Colour	70	6.46[a]
	60	6.29[a]
	50	6.69[a]
	40	6.41[a]
	30	3.45[a]
Texture	70	5.99[a]
	60	6.62[a]
	50	6.38[a]
	40	5.57[a]
	30	4.95[a]
Overall acceptability	70	6.53[a]
	60	6.01[a]
	50	5.84[a]
	40	6.51[a]
	30	5.32[a]

Note : Different superscripts denote significance at 99% confidence level.

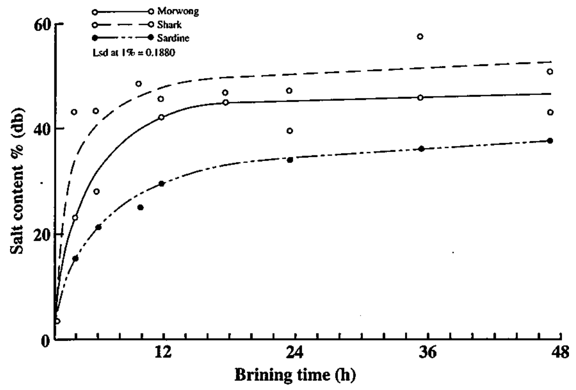


Fig. 1. Salt uptake by different species of fish during brining.

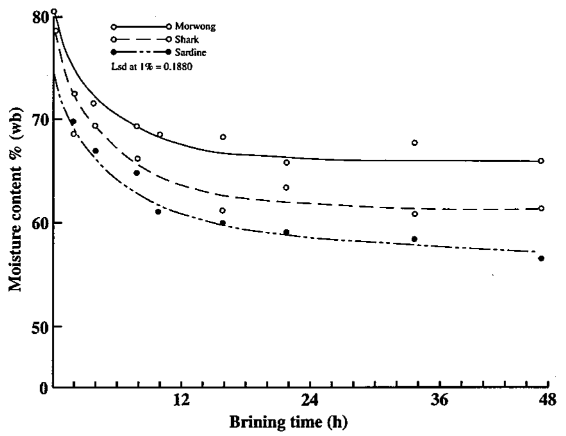


Fig. 2. Changes in moisture content during brining.

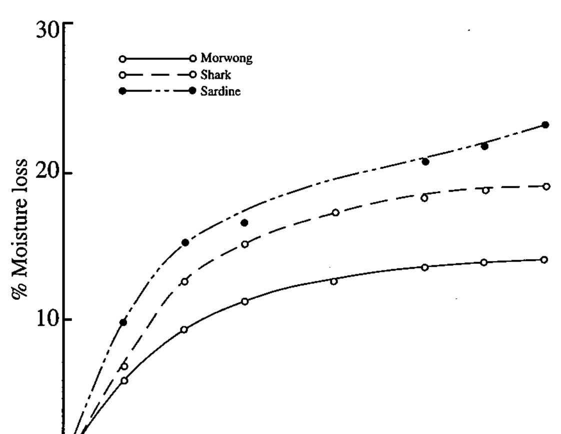


Fig. 3. Percentage moisture loss in fish during brining.

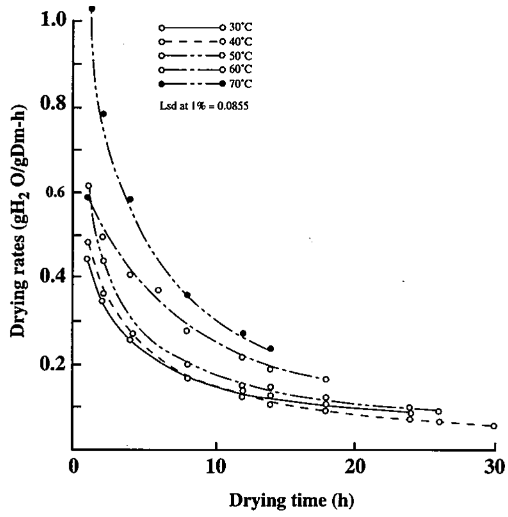


Fig. 4. Effect of temperature on the drying rates of salted morwong.

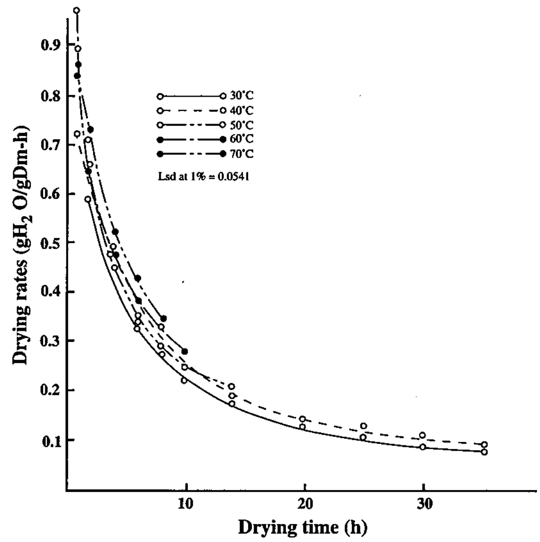


Fig. 5. Effect of temperature on the drying rates of shark.

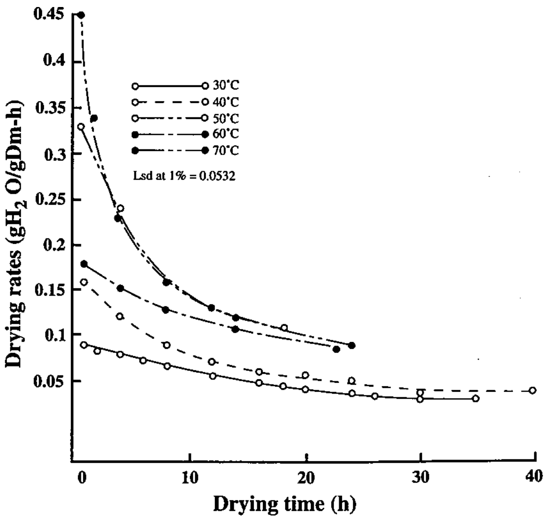


Fig. 6. Effect of temperature on the drying rates of salted sardines.

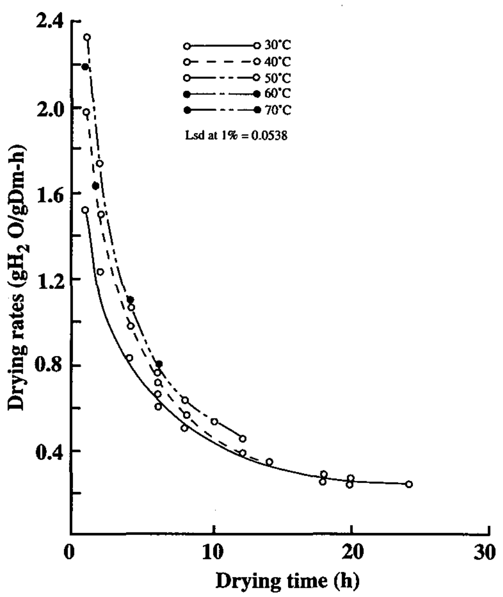


Fig. 7. Effect of temperature on the drying rates of squid.

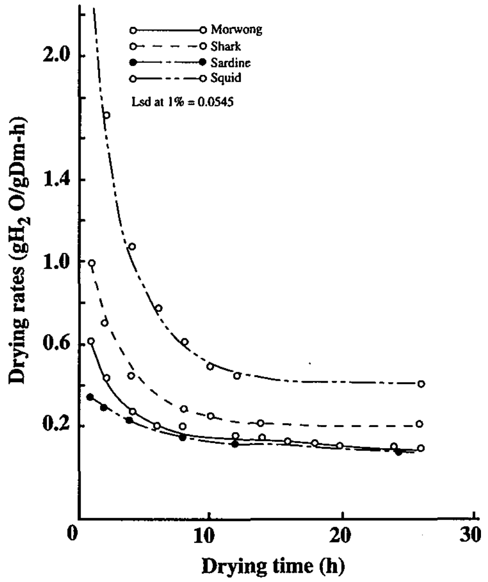


Fig. 8. Relationship between drying rates and drying time for different species at 50°C.

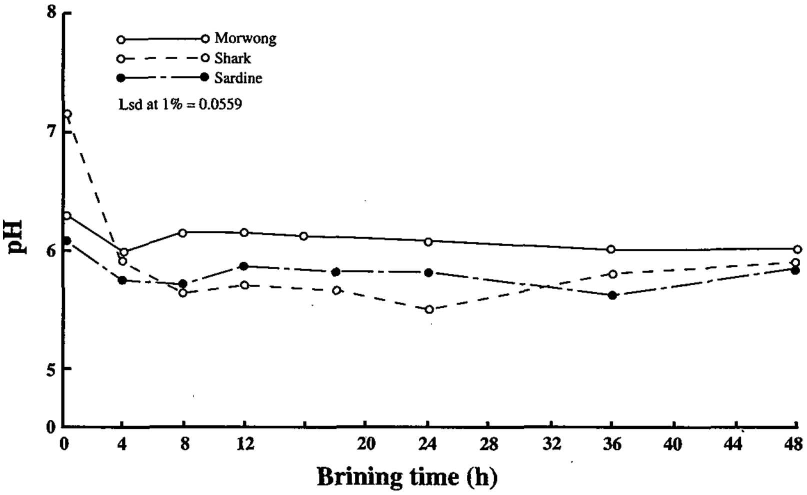


Fig. 9. Changes in pH of fish during brining.

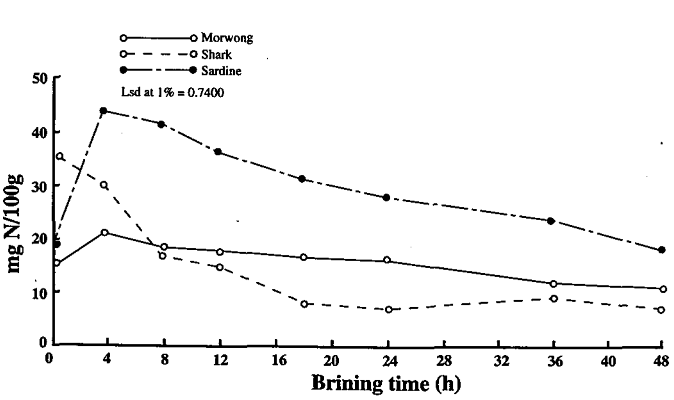


Fig. 10. Changes in TMA content of fish during brining.

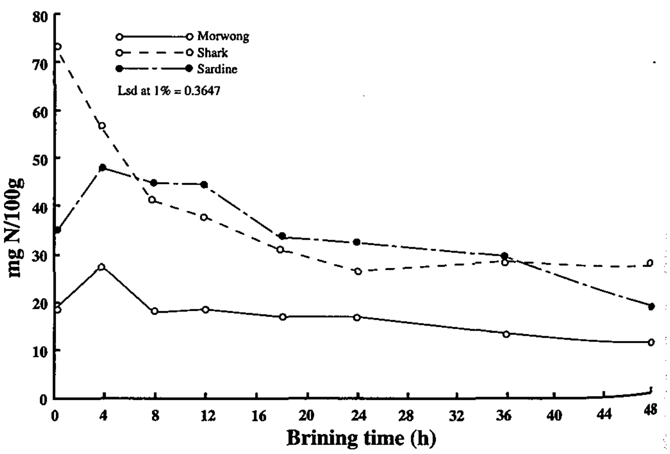


Fig. 11. Changes in TVB content of fish during brining.

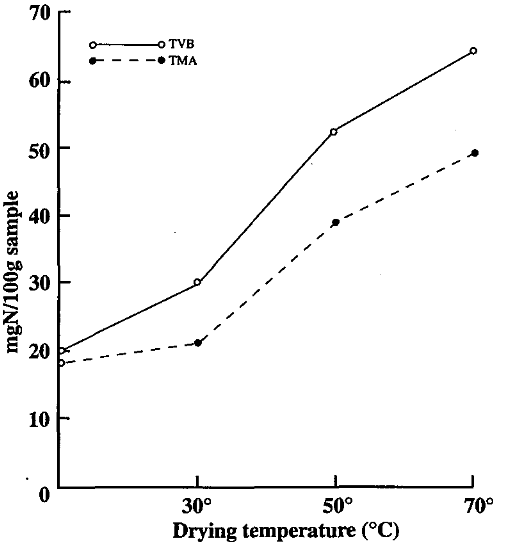


Fig. 12. TVB and TMA content in morwong dried at different temperatures.

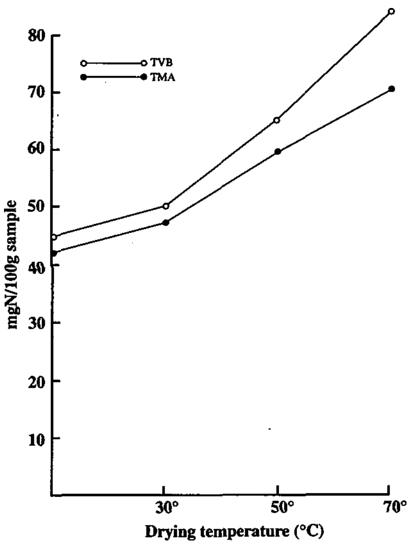


Fig. 13. TVB and TMA content in sardines dried at different temperatures.

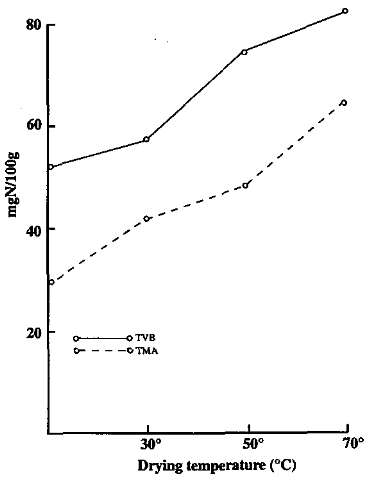


Fig. 14. TVB and TMA content in shark dried at different temperatures.

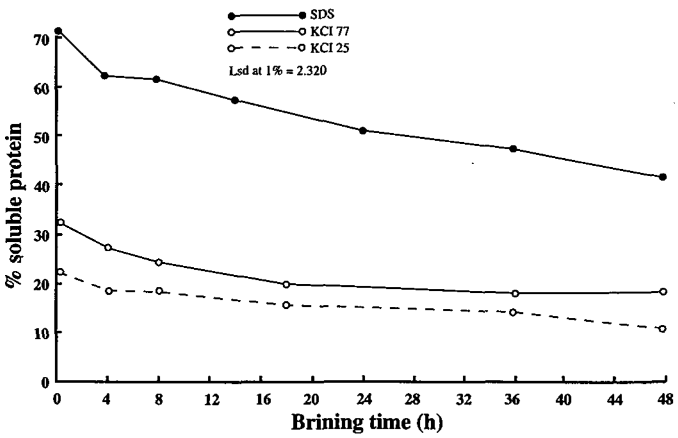


Fig. 15. Solubility of morwong proteins in different media on salting

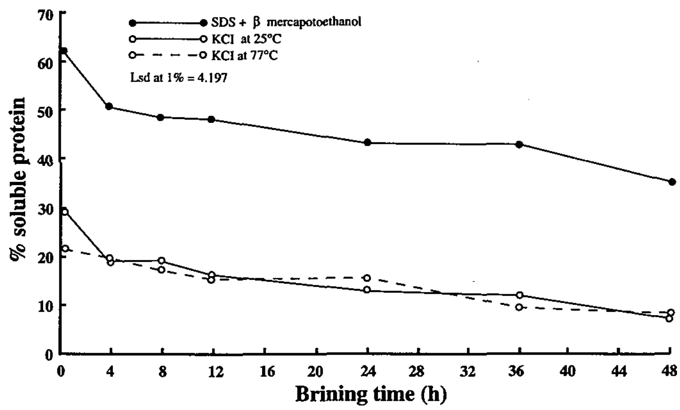


Fig. 16. Effect of salting time on protein solubility of sardine.

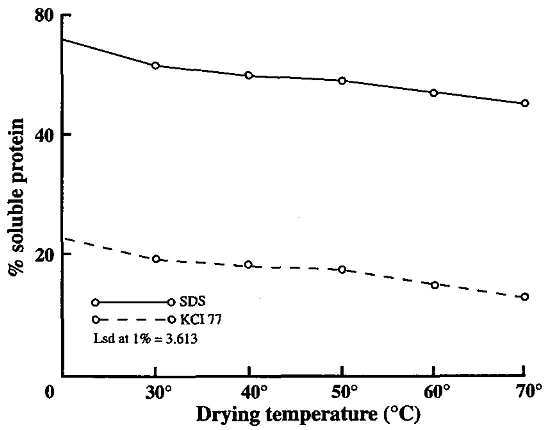


Fig. 17. Effect of drying temperature on the solubility of shark proteins.

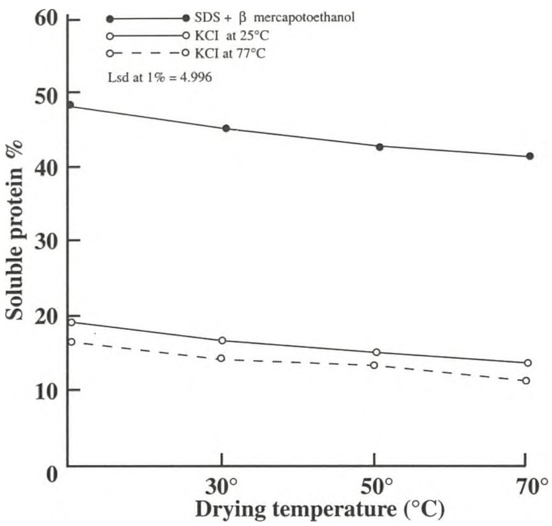


Fig. 18. Effect of drying temperature on the solubility of proteins of sardine.

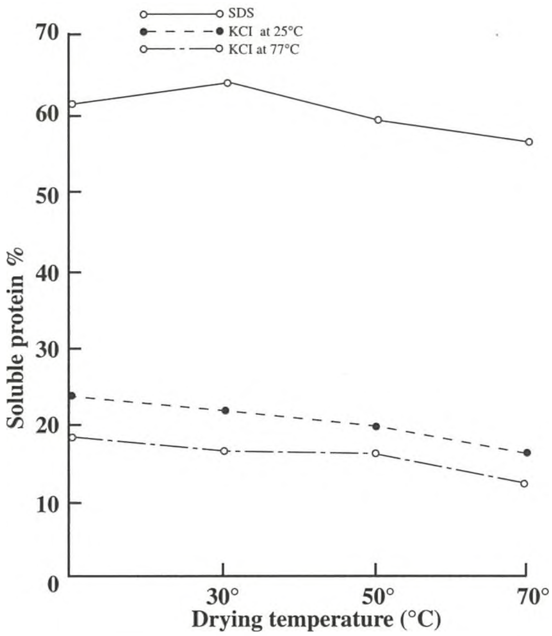


Fig. 20. Solubility of morwong proteins in different media on drying at different temperatures.

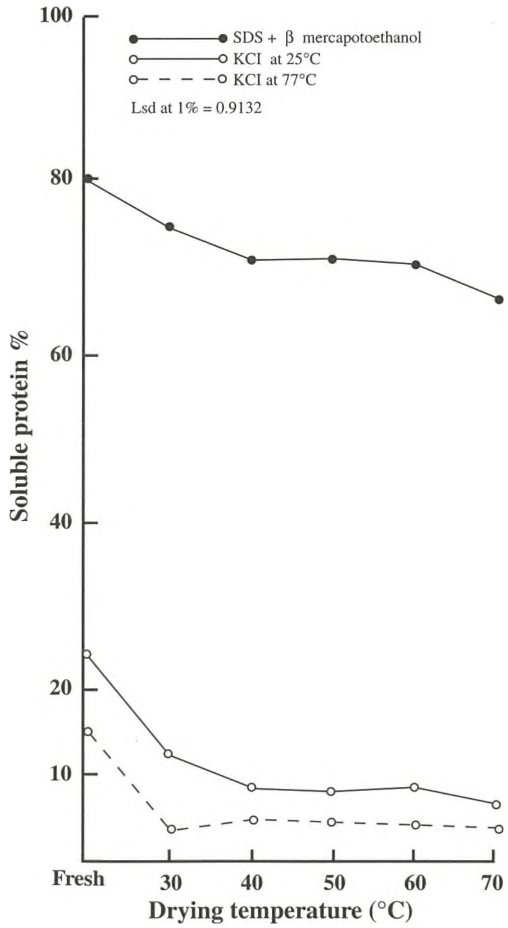


Fig. 19. Effect of drying temperature on the solubility of proteins of squid.

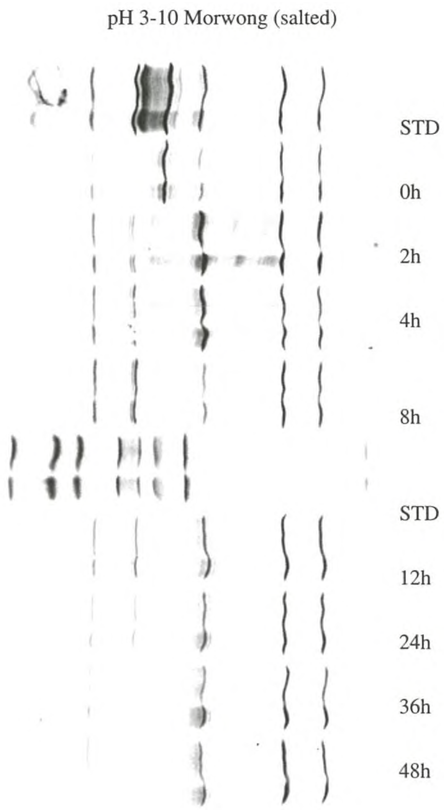


Fig. 21. IEF patterns of water soluble proteins of morwong fillets after brining for 0,2,4,8,24,36 and 72h.

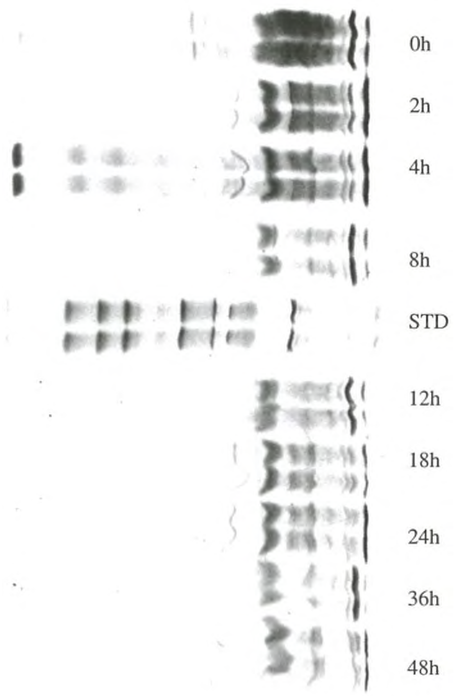


Fig. 22. IEF patterns of water soluble proteins of shark fillets after brining for 0,2,4,8,12,24,36 and 48h.

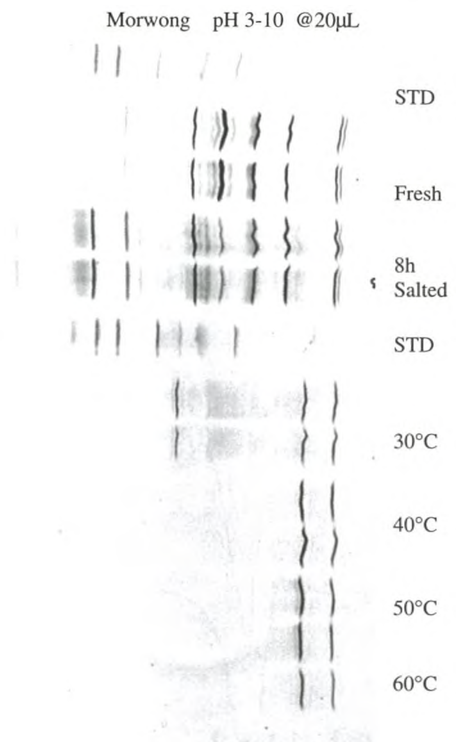


Fig. 24. IEF patterns of water soluble proteins of morwong fillets brined for 8h and dried at 30°, 40°, 50° and 60°C.

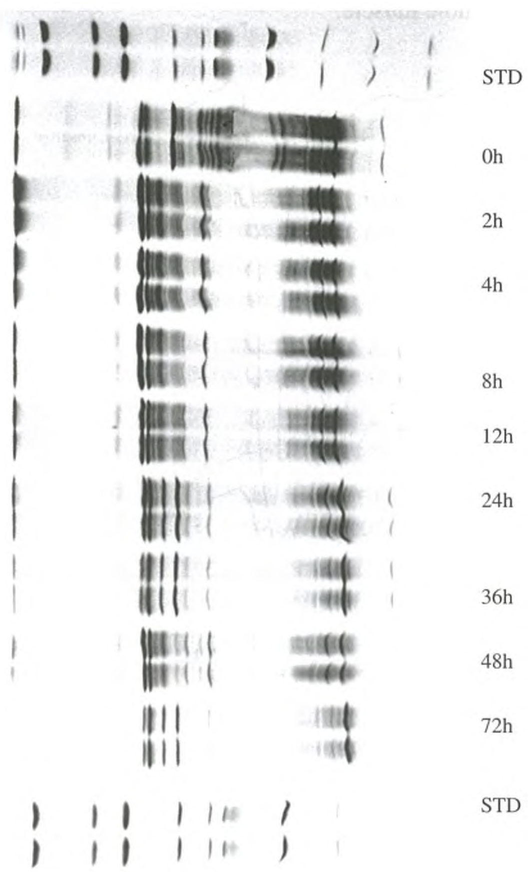


Fig. 23. IEF patterns of water soluble proteins of sardine after brining for 0,2,4,8,12,24,36,48 and 72h.

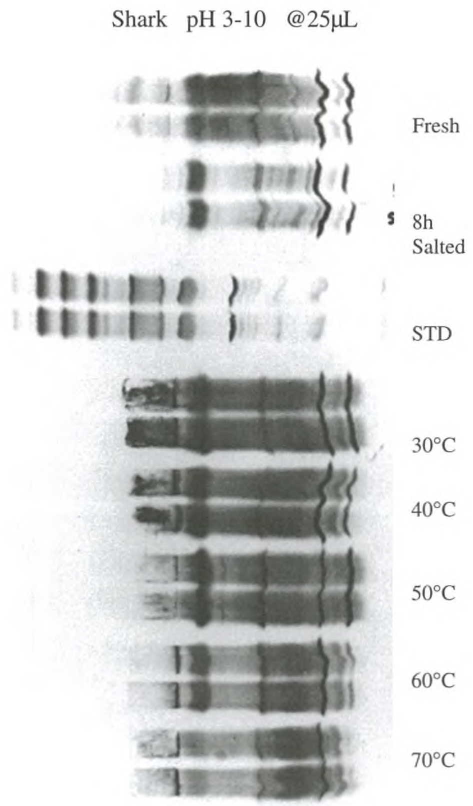


Fig. 25. IEF pattern of water soluble proteins of shark fillets brined for 4h and dried at 30°, 40°, 50°, 60° and 70°C.

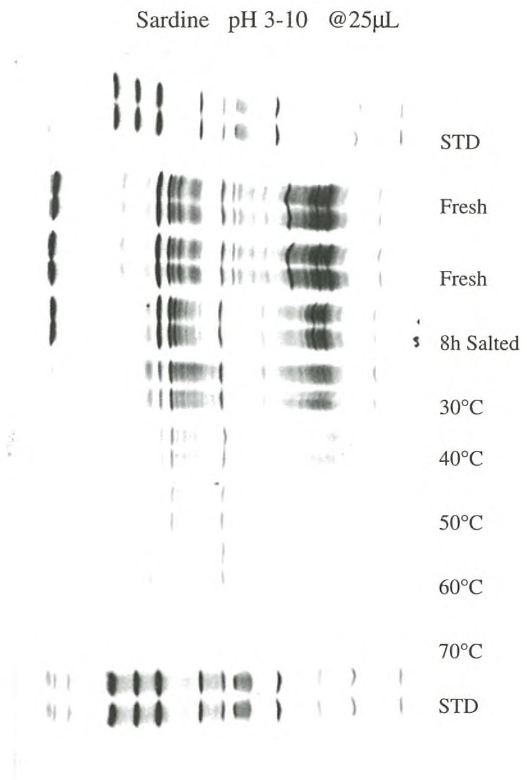


Fig. 26. IEF pattern of water soluble proteins of sardine brined for 8h and dried at 30°, 40°, 50°, 60° and 70°C.

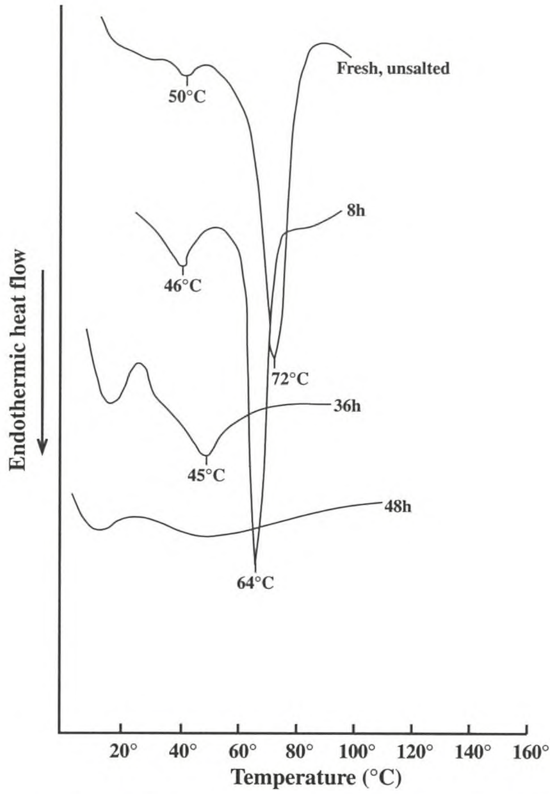


Fig. 28. DSC thermogram of salted and unsalted shark whole muscle.

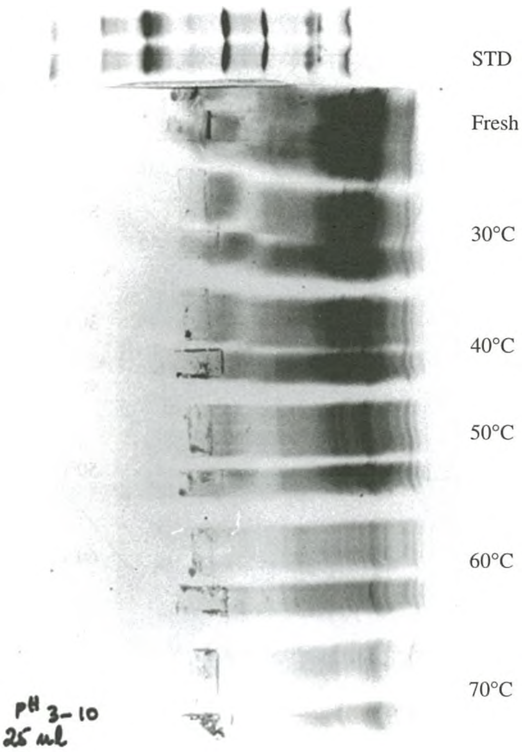


Fig. 27. IEF pattern of water soluble proteins of squid dried at 30°, 40°, 50°, 60° and 70°C.

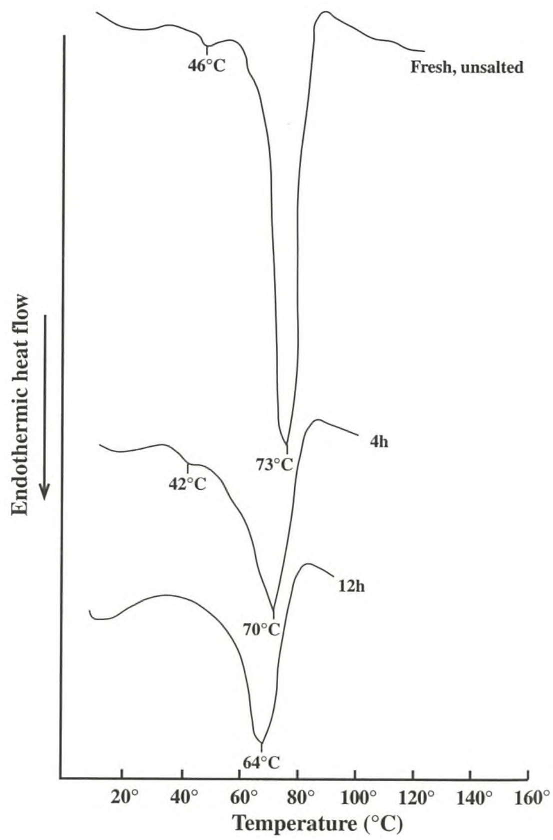


Fig. 29. DSC thermogram of salted and unsalted morwong whole muscle.

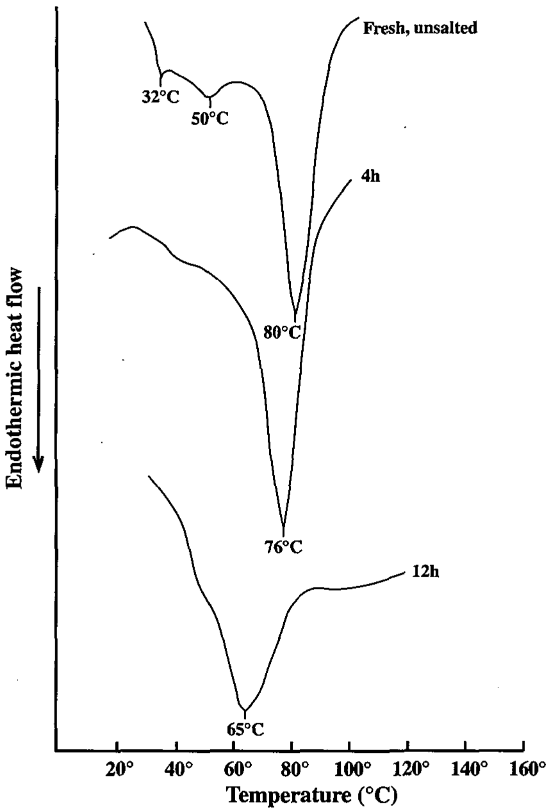


Fig. 30. DSC thermogram of salted and unsalted sardine whole muscle.

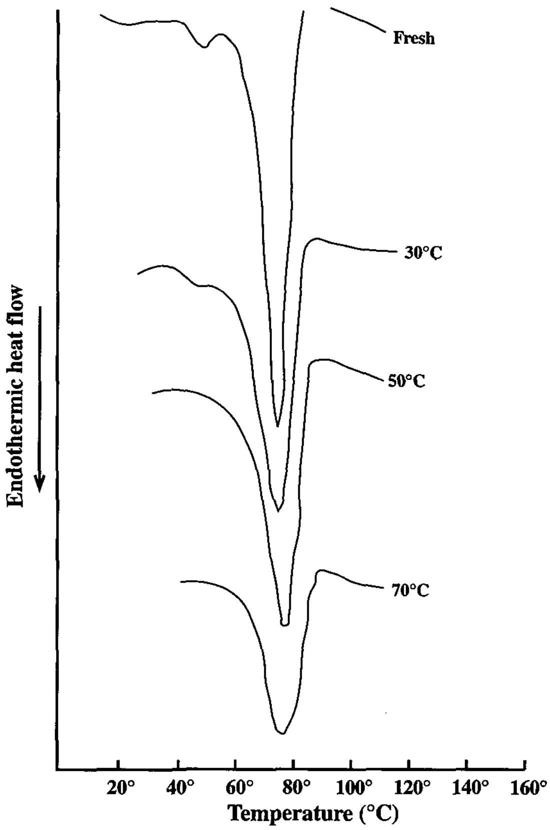


Fig. 32. DSC thermogram of dried, salted sardine previously dried at different temperatures.

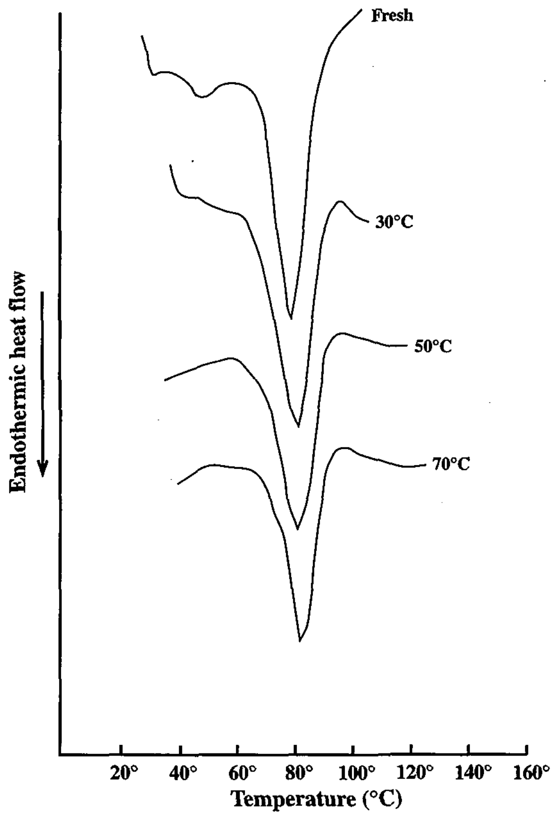


Fig. 31. DSC thermogram of dried, salted morwong previously dried at different temperatures.

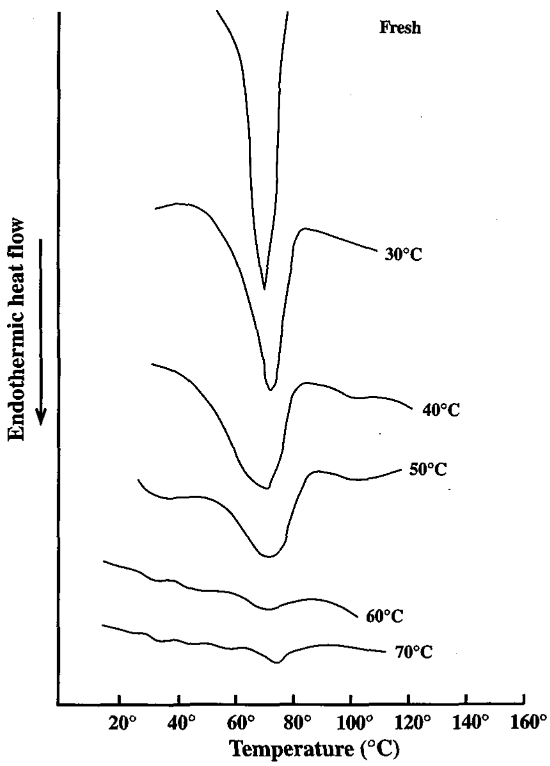


Fig. 33. DSC thermogram of dried shark previously dried at different temperatures.

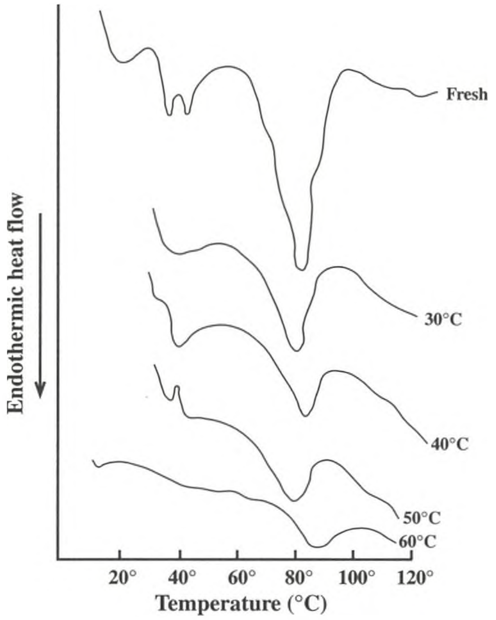


Fig. 34. DSC thermogram of dried squid previously dried at different temperatures.

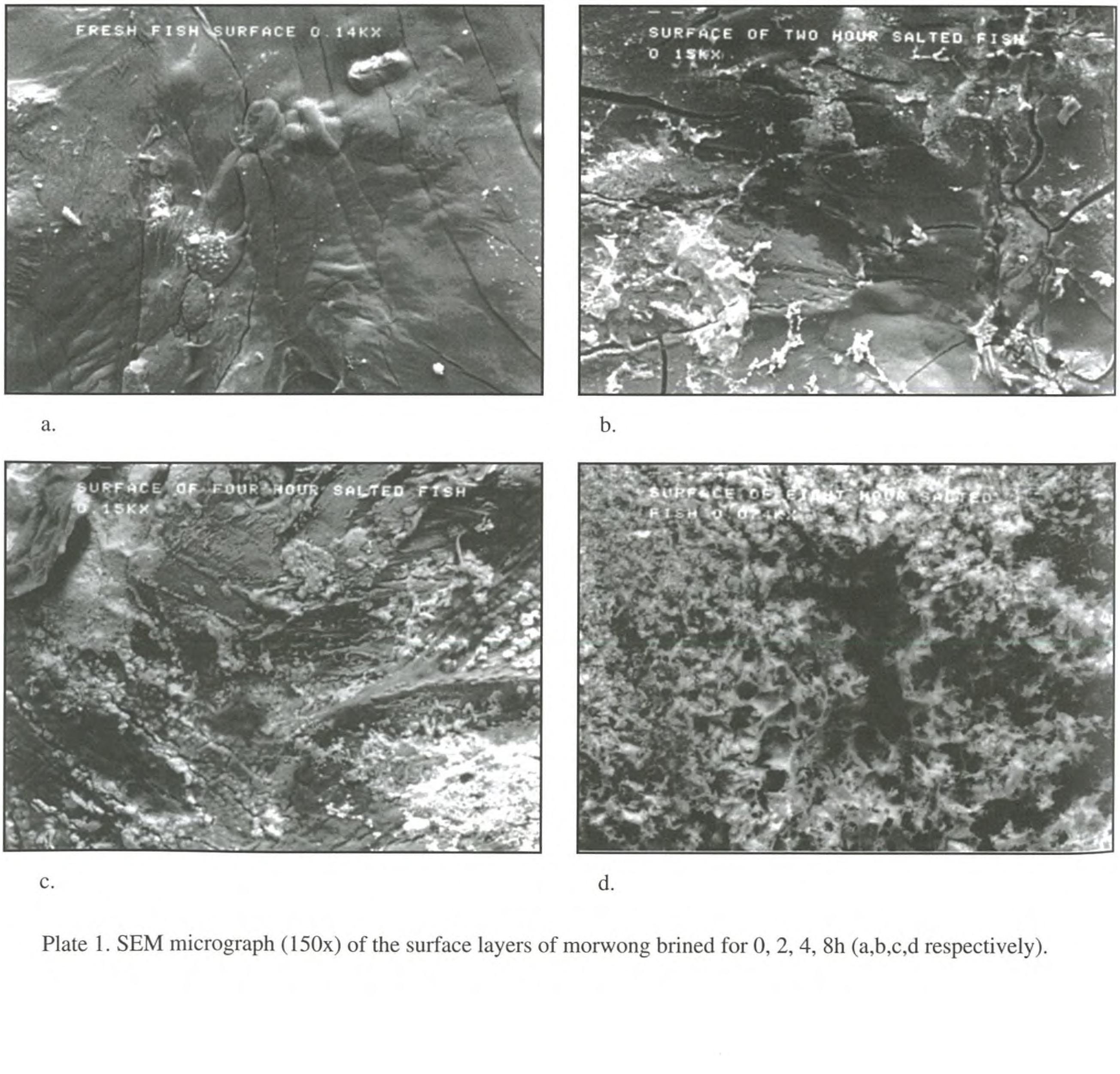
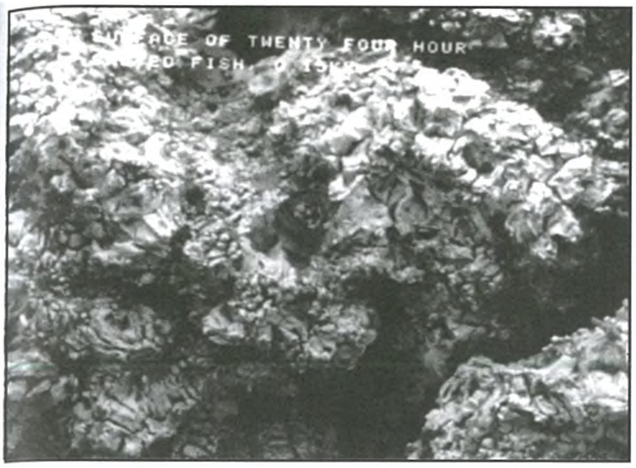


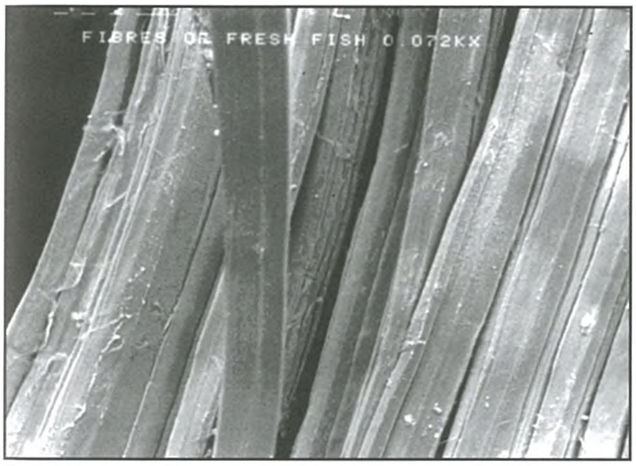
Plate 1. SEM micrograph (150x) of the surface layers of morwong brined for 0, 2, 4, 8h (a,b,c,d respectively).



a.

b.

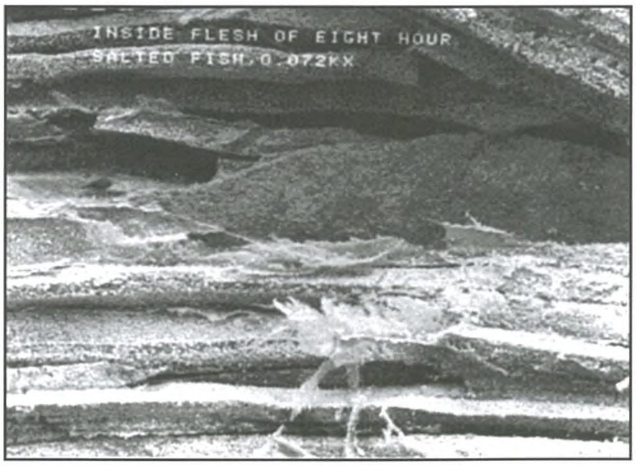
Plate 2. SEM micrographs (150x) of the surface layers of morwong brined for 24 and 48h (a,b respectively).



a.

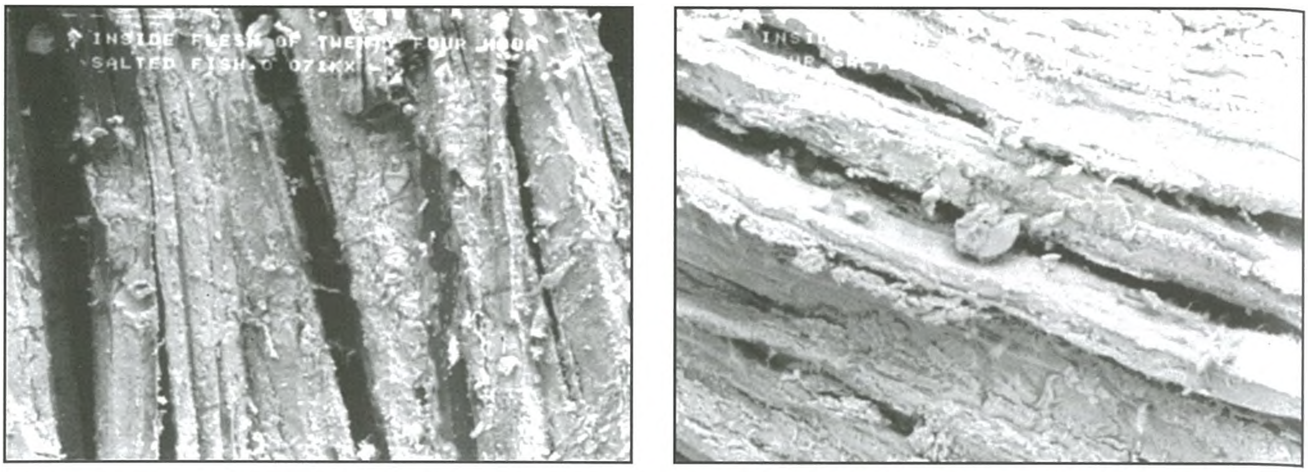
b.

c.



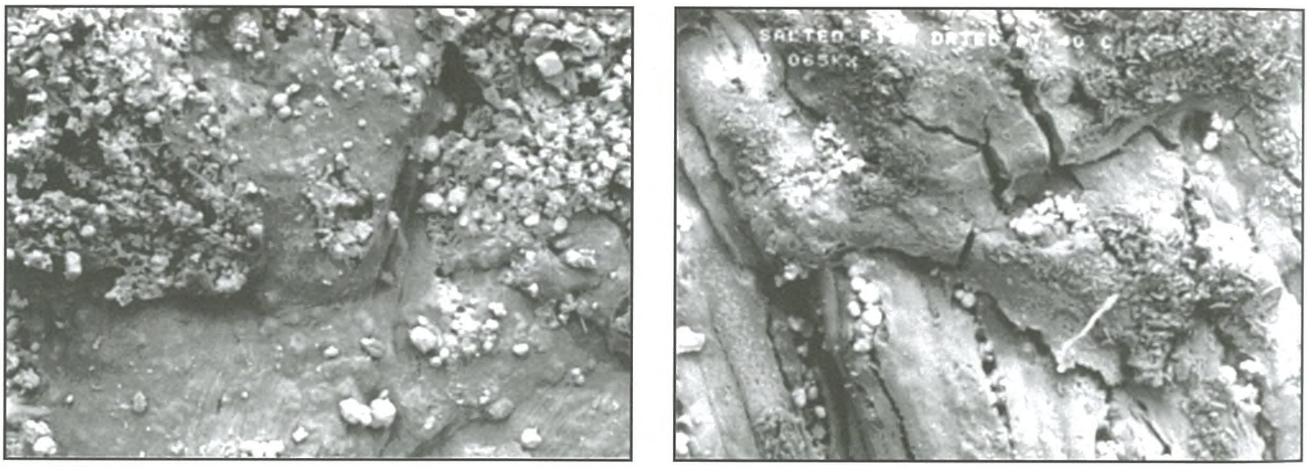
d.

Plate 3. SEM micrographs of deep tissue of morwong brined for 0, 2, 4 and 8h (a,b,c,d respectively).

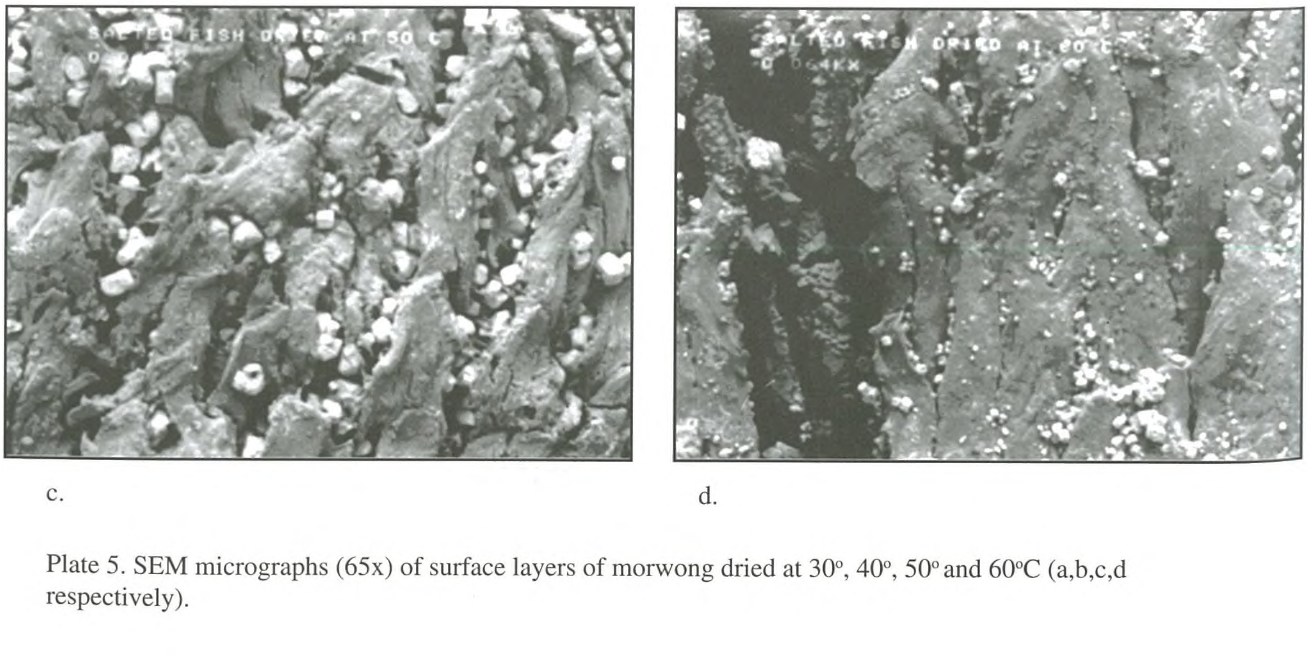


a. b.

Plate 4. SEM micrographs of deep tissue of morwong brined for 24 and 48h (a and b respectively).

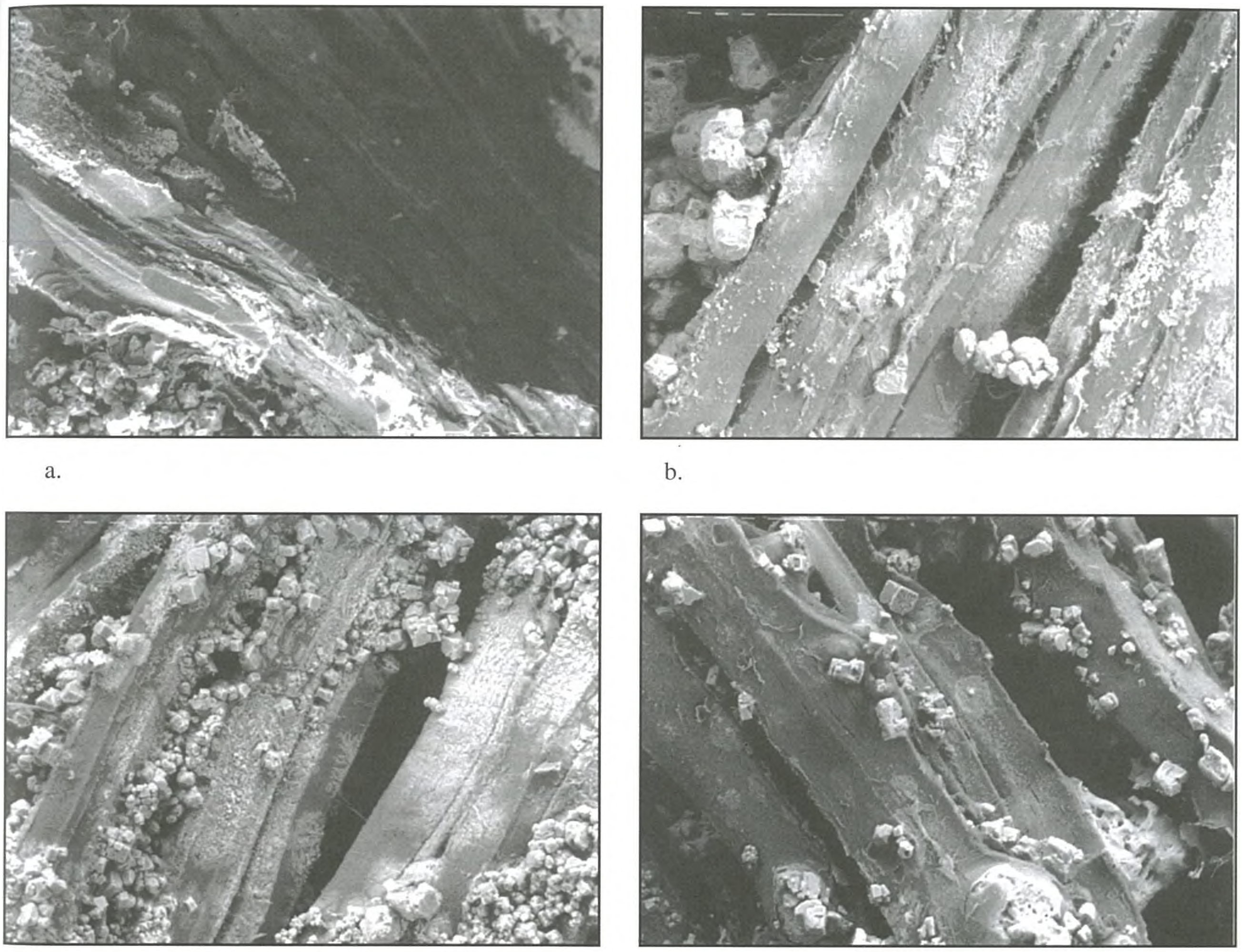


a. b.



c. d.

Plate 5. SEM micrographs (65x) of surface layers of morwong dried at 30°, 40°, 50° and 60°C (a,b,c,d respectively).



a. b. c. d.

Plate 6. SEM micrographs (125x) of the deep tissue of morwong dried at 30°, 40°, 50° and 60°C (a,b,c,d respectively).

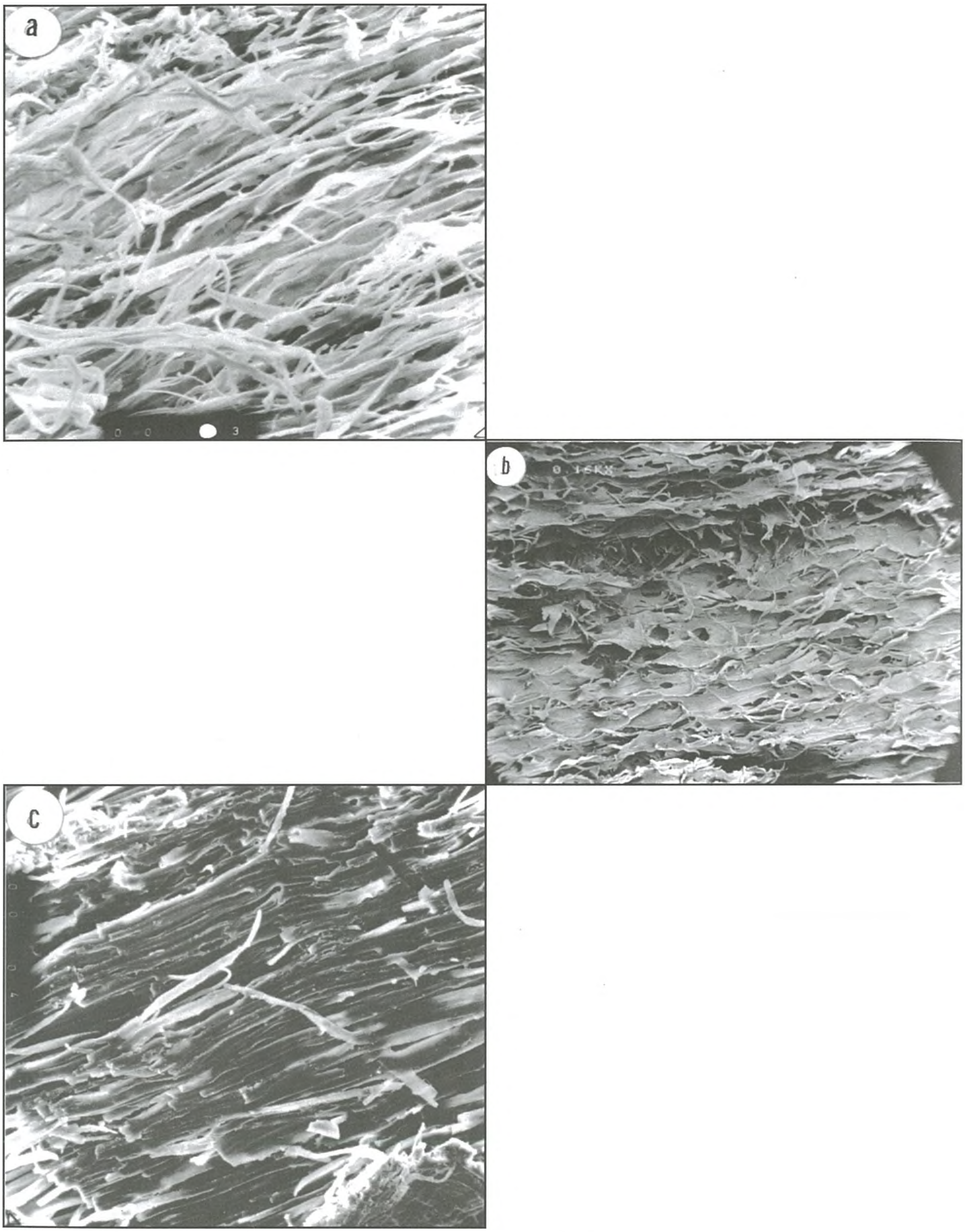


Plate 7. SEM micrographs of fresh squid tissue and those dried at 40° and 70°C (a,b,c respectively).

Development of Value-Added Fishery Products

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Abstract

Studies on the development of value-added products using arrow squid (Loligo sp.) and bullet tuna (Auxis rocheii, R.) were conducted. The recommended steps in new product development were systematically followed while establishing control to all steps in these product development studies to ensure that the requirements for quality fishery products are met.

New product concepts were generated, evaluated, and refined. The most plausible concepts were then advanced to the product optimization stage wherein samples were subjected to a series of sensory evaluations to come up with the standardized formulations. Three (3) squid products, namely squid nuggets, squid loaf, and squid rolls, and two (2) bullet tuna products, namely tuna loaf and dried seasoned tuna, were then subjected to either accelerated or actual shelf life testings, consumer acceptability testings, and cost analyses.

In collaboration with a private company, the most promising technologies generated from the preceding activities were advanced to pilot-scale production in which the HACCP-concept of quality assurance was applied, and the hazards and critical control points associated with each step in the production of the new products were established. The resulting products were finally subjected to consumer testing at the Japan Food Expo '95 which proved their acceptability to the export market as well as the products' feasibility for commercialization.

Introduction

A stream of new and varied food products are continuously being introduced to the consumers. Clearly, the demand for these new products is strong and growing while conventional processed products have been gradually creating an old-fashioned image among consumers. It becomes necessary, therefore, for seafood processors to direct their efforts towards better utilization of seafood through the development of value added products.

As a rule of thumb, new product development should be approached systematically. The usual "*hit or miss*" process of new product development must be replaced by a system which involves a process of developing an investment opportunity (Pearson, 1983), a consumer-oriented product development scheme (Fishken, 1983; Kraft, 1981), a "*step-by-step risk reduction*" process and lastly, a scheme that requires the combined effort of an interdisciplinary team (Meyer, 1984).

Interestingly, the introduction of such a system for new product development decreases the financial risks while enhancing the financial rewards of the undertaking. In addition, it takes into account innovative ideas that utilize one's clear concept of the consumer consumption pattern, the market demands, and more importantly, the concept of quality management. Needless to say, a company has to implement a quality management scheme in order to improve the efficiency and profitability of its operation and to enable the production of quality products which are globally competitive.

With all these in mind, studies on the development of value-added fishery products were conducted using the recommended steps in new product development. Specifically, these aim to:

1. develop quality, convenient, and shelf-stable value-added products through the application of the advances made in fish post-harvest technology;
2. establish the storage stability and consumer acceptability of the newly formulated products through actual/accelerated shelf life testing and consumer testing respectively;
3. use the Hazard Analysis Critical Control Point (HACCP)-concept of quality assurance to enable the development of quality and globally competitive fishery products; and
4. assess the commercial feasibility of the new products through a collaborative project with a private company in the conduct of pilot scale production, consumer acceptability testing and cost analyses of the new products.

Materials And Methods

New value-added fishery products were developed using the recommended steps in new product development.

1. Generation, evaluation and refinement of product concepts

A ten-man focus group was formed for the generation of new product concepts. These concepts were then evaluated based on their respective commercial feasibility. Subsequently, the concepts were refined by defining the specific attributes that the target products should possess.

2. Translation of product concepts into optimized prototypes

The most plausible concepts were translated into optimized bench-top product prototypes by conducting a search for possible model products, screening of ingredients and a series of sensory evaluation of quality.

Raw Materials

Arrow squid (*Loligo* sp.), weighing about 50 to 100 g each, were purchased at the Iloilo Fishing Port Complex, Tanza, Iloilo City, Philippines, iced with ice:squid ratio of 1:1, and immediately transported to the laboratories of the UPV College of Fisheries. The squids were washed, cleaned, and the heads and internal organs were removed. The squid mantle were then skinned, splitted in half, frozen in polyethylene bags, and stored at -20°C until needed.

Bullet tuna (*Auxis rocheii*, R.), on the other hand, weighing 100 to 150 g each, were purchased at the wet market in Miagao, Iloilo, iced with the ice: fish ratio of 1:1 and immediately transported to the laboratory.

Product Formulation

The organoleptic properties of the products were optimized through variations on the levels of high impact ingredients/spices (for flavor and odor), processes (for texture and appearance), and color additive (for appearance). The samples were prepared and subjected to sensory evaluation of semi-trained panelists.

The sensory scores were statistically analyzed as a function of treatment and the interaction factor for the analysis of odor and flavor, texture, and appearance. The data were subjected to the Analysis of Variance (ANOVA) and to the Duncan's Multiple Range Test (DMRT) whenever differences exist between samples. Treatments were considered significantly different when $p \leq 0.05$.

Shelf life Testing and Package Development

Packaging materials and methods specific to each of the products were used during shelf-life testing. Accelerated shelflife testing (ASLT) of squid nuggets (SN) and squid loaf (SL) were done using the procedure of Labuza and Schmidl (1985) whereas actual shelflife testing of squid rolls (SR), tuna loaf (TL), and dried seasoned tuna (DST) were conducted.

Samples were analyzed using : (1) the Thiobarbituric Acid (TBA) Test (Lemon, 1975), to determine the extent of lipid oxidation in the samples; (2) moisture content (MC) determination (AOAC, 1975), to characterize the moisture changes during storage; and sensory evaluation of quality.

For products subjected to ASLT, their respective Q_{10} values were obtained to enable the prediction of shelf life of these products at different storage temperatures.

Consumer Testing

Four consumer testings were conducted in an attempt to determine the acceptability of the products to local consumers. The frequency distribution of the responses were analyzed accordingly.

3. Collaboration with a private company

At this point, collaboration with Josephine Marine Trading Corporation (JMTC), a privately owned exporting company with its plant located at the Iloilo Fishing Port Complex, Tanza, Iloilo City, was made possible through a Memorandum of Agreement between the University, JMTC and the Department of Science and Technology. Included in the agreement were the pre-feasibility studies for the products.

4. Cost analyses

Cost analyses were conducted in an attempt to establish the pricing scheme for the new products.

The prevailing retail prices of the ingredients were used in the computations as well as the average price at source of the raw material.

5. HACCP-concept in product development

The Hazard Analysis Critical Control Point (HACCP)-concept of quality assurance was applied in these new product development activities. The hazards and preventive measures in the production of each of the newly-formulated products were established, together with the degree of control necessary for each of the hazards identified.

6. Consumer testing of value-added products

To determine the commercial feasibility and the effect of the application of the HACCP-system, the new value-added products manufactured in pilot scale were subjected to consumer testing at the Japan Food Expo '95.

Results And Discussion

1. New product concepts

Table 1 lists the concepts generated by the focus group. It can be noted that most of these concepts are influenced by the current market trends, and the consumption patterns as affected by the consumers' food habits and attitudes. These concepts were evaluated based on marketability or market potential, product competitiveness, product advantages, feasibility as a business proposition and the technical requirements in concretizing these concepts. Based on these evaluations, the most feasible concepts were refined, as shown in Table 2, through the definition of the specific attributes of each of these concepts, or simply the specific characteristics the target products should possess. These concepts were then advanced to the next steps.

2. Product formulation and optimization

In this stage, the optimum levels and combinations of high impact ingredients/spices that significantly affect odor and flavor, and the most appropriate textural properties of the products were obtained. At least three (3) levels of each of the ingredients were methodically and systematically tested. Processes which affect the texture of the products were likewise varied to come up with texturized products. Through a series of sensory evaluations and appropriate statistical analyses of results, the optimized formulations were achieved. Table 3 shows an example of a standardized formulation of one of the newly-formulated fishery products.

Table 1. List of new product concepts.

Raw material	Product concepts
Squid (*Loligo* sp.)	Squid Noodles
	Squid Rings
	Squid Sticks
	Squid Nuggets
	Squid Franks
	Squid Patties
	Squid Jerky
	Squid Loaf
	Squid Longganisa
	Squid Rolls
Bullet Tuna (*Auxis rocheii*, R.)	Seasoned Tuna Jerky
	Tuna Ham
	Tuna Loaf
	Dried Seasoned Tuna
	Canned Tuna Flakes with Vegetables
	Canned Pet Foods

Table 2. Specific attributes of the new fishery products.

New fishery products	Specific attributes
1. Squid Nuggets	Pre-fried; frozen; crunchy; spicy; convenient ovenable/microwaveable; ideal for snacks and meals
2. Squid Loaf	"Cold-cuts"; ready to eat; spicy; texturized; ideal for sandwiches and meals
3. Squid Rolls	Frozen; ready to cook; convenient; ideal for snacks and meals; economical and healthy alternative to pork rolls
4. Tuna Loaf	"Cold-cuts"; texturized; spicy; ideal for sandwiches and meals; economical and healthful alternative to meat loaves
5. Dried Seasoned Tuna	Spicy; ready to cook (fried or broiled); ideal for meals; sprinkled with sesame seeds for added appeal

Table 3. Standardized formulation of Tuna Loaf.

Ingredient	Percent (%) weight
	(% weight of minced fish)
Flour	10.00
Pork Fat	10.00
Water	5.00
	(% weight of minced fish + flour, pork fat, water)
Sugar	7.50
Salt	3.00
Black Pepper	1.25
Onion Powder	1.00
Garlic Powder	1.00
Annato Powder	0.80
Monosodium Glutamate	0.50
Praque Powder	0.40

3. Shelf-life testing

The optimized products, packed as specified in Table 4, were subjected to shelf life testing wherein the changes in some quality factors were determined. These changes were monitored using different physico-chemical tests and sensory evaluation of quality. Correlation of values obtained from these evaluations enabled the determination of their respective shelf-life at different temperatures, as shown in Table 5.

The Q_{10} values of SL and SN are reported in Table 6. These data clearly indicate that SL is relatively more temperature sensitive than SN; thus implying that any drastic change in storage temperature of SL results to a significant increase or decrease in its shelf-life.

Table 4. Packaging materials/methods for the different value added fishery products.

Product	# of pcs/pack; Weight/pack	Packaging material and method used
Squid Nuggets	10 pcs (150 g) / pack	Pre-fried, frozen nuggets vacuum packed in polyethylene (PE) bags; bags packed in laminated cartons
Squid Loaf	6 pcs (110 g) / pack	Stored as "cold-cuts" slices; lined in styrofoam trays (12"x5"); vacuum packed in PE bags
Squid Rolls	10 pcs (100 g) / pack	Frozen rolls layered in PE bags (2 layers); heat sealed
Tuna Loaf	6 pcs (110 g) / pack	Stored as "cold-cut" slices; lined in styrofoam trays; vacuum sealed in PE bags
Dried Seasoned Tuna	1 pc (35-100 g) / pack	Cut as butterfly fillets; head off; sprinkled with sesame seeds; vacuum packed in PE bags

Table 5. Shelf life (days) of value-added fishery products at different temperatures.

Product	-14°C	0°C	35°C
Squid Nuggets	56	19	2
Squid Loaf		48	2
Squid Rolls	59		
Tuna Loaf		49	
Dried Seasoned Tuna		15	6

Table 6. Q_{10} values of value-added fishery products.

Product	Q_{10} values
Squid Nuggets	1.35
Squid Loaf	1.66

4. Consumer Testing of value-added fishery products

The squid products were subjected to a series of consumer testing. The average frequency distribution of the responses in these testing are reported in Table 7.

It can be noted that of the three products tested, SN obtained the highest *"like very much"* mark of 70.14%; thus suggesting that this product is more preferred by the respondents, relative to the other two (2) products. One may also say that this could also mean that SN has the most potential for commercialization because of the respondents' preference to it. On the other hand, SL and SR received fairly good rating of 51.30% and 39.71% *"like very much"* score, respectively.

Clearly, the consumer testing proved the acceptability of the products to the local consumers. This preference is in the following order: SN, SL, and SR. Interestingly, such observation was further backed up by the comments on the potential for commercialization of SN, SL, and SR, as perceived by the panelists, which received the ratings of 67.89%, 50.53%, and 39.47%, respectively.

Table 7. Frequency distribution (%) of the responses of the local consumers to the products (n=345).

Preference scale	Squid nuggets	Squid loaf	Squid rolls
Like very much	70.14	51.30	39.71
Like	23.77	32.17	40.58
Slightly like	4.93	10.72	11.30
Neither like nor dislike	-	2.03	3.48
Slightly dislike	0.29	2.03	2.80
Dislike	0.58	-	0.58
Dislike very much	-	-	-
No Answer	0.29	1.74	1.45

5. Cost analyses

The suggested retail prices of the products are presented in Table 8. These prices were based on the average price of P58.00/kg squid (USD 2.21/kg) and P30.00/kg bullet tuna (USD 1.14/kg), and on the retail prices of the ingredients. Labor cost was included in the computation of prices of squid products, which was done together with the private counterpart of the project.

Table 8. Prices of value added fishery products.

Product	Quantity	Value (PHP)	Value (USD)*
Squid nuggets	250 g	38.18	1.45
Squid loaf	110 g	23.39	0.89
Squid rolls	100 g	16.45	0.63
Tuna loaf	110 g	13.39	0.51
Dried seasoned tuna	150 g	9.40	0.35

* FOREX : 1.00 USD = PHP 26.25

6. HACCP-concept in product development

An important element of a quality system, as specified in the ISO 9000 standards is the requirement which is necessary for any product development activity (Huss, 1994). This specifies that plan should be established to control and verify all phases of any product development activity in order to ensure that the specific requirements for a particular product are met. As such, it becomes necessary to apply in this study the recommended system for new product development which, in effect, not only increases the financial reward of the undertaking but also ensures that quality products are produced.

Likewise, the application of HACCP-concept of quality assurance in this study is very important. As a result, the hazards and preventive measures in the production of each of the new products were established; these are reported in Tables 9 and 10.

7. Consumer testing at the Japan Food Expo '95

Samples of SN, SL and SR were prepared in pilot scale, with the application of the HACCP-concept. These were brought by the JMTC and were subjected to product exposition and consumer testing at the Japan Food Expo '95, which was held in Tokyo, Japan in March 1995.

According to JMTC, the products were exhibited side-by-side with other food products brought to the said fair by the Philippine Food Mission. Based on the consumer testing conducted on site, the products have the potential for commercialization and can, therefore, be potentially marketed to Japan and other countries. However, general comments included the following: too spicy for the Japanese taste, the SN has too much bread crumbs, SL should have less fat. With these comments at hand, the products were reformulated accordingly.

This consumer testing proved the efficiency of the HACCP-system applied to the products. It clearly showed that using such system, the quality of the products are ensured, and in order to come up with globally competitive products, such system must be used.

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Discussion

Ms Santos-Yap explained that the products were subjected to various temperatures in order to obtain the Q_{10} value. As for shelf life testing, various storage temperatures were used. The products stored under these temperatures were then tested for physico-chemical changes, microbiological indices and evaluated for their sensory attributes.

Table 9. General safety hazards and preventive measures during processing and distribution of value-added squid products.

Product flow	Hazard	Preventive measure	Degree of control
Live squid	Contamination	Monitoring of environment	CCP 2
Catching			
Chilling	Growth of bacteria	(Txt) control	CCP 1
Transport	Growth of bacteria	(Txt) control	CCP 1
Receipt at plant	Growth of bacteria	(Txt) control	CCP 1
<u>Processing steps</u> :			
Washing/Cleaning	Growth of bacteria Contamination	(Txt) control Water quality	CCP 1 CCP 1
Skinning/Beheading			
Mincing	Contamination Growth of bacteria	Hygiene/Sanitation (Txt) control	CCP 2 CCP 1
Prep. of ingredients			
Mixing of meat and ingredients			
For SN / SL :			
Molding	Growth of bacteria	(Txt) control	
Steaming			
Slicing	Growth of bacteria Contamination	(Txt) control Hygiene/Sanitation	CCP 1 CCP 2
Breading/Battering			
For SR :			
Wrapping of paste	Growth of bacteria Contamination	(Txt) control Hygiene/Sanitation	CCP 1 CCP 2
Packaging	Growth of bacteria	Packaging material Hygiene/Sanitation	CCP 1
Chilling (for SL)	Spoilage (oxidation) Growth of bacteria	(Txt) control (Txt) control	CCP 1 CCP 2
Freezing (for SN, SR)	Spoilage	(Txt) control	CCP 1
Distribution	Growth of bacteria	(Txt) control	CCP 1

Table 10. General safety hazards and preventive measures during processing and distribution of value-added bullet tuna products.

Product flow	Hazard	Preventive measure	Degree of control
Live bullet tuna	Contamination	Monitoring of environment	CCP 2
Catching			
Chilling	Growth of bacteria	(Txt) control	CCP 1
	Histamine formation	(Txt) control	CCP 2
Transport	Growth of bacteria	(Txt) control	CCP 1
Receipt at plant	Growth of bacteria	(Txt) control	CCP 1
Processing steps :			
Washing/Cleaning	Growth of bacteria	(Txt) control	CCP 1
	Contamination	Water quality	CCP 1
For TL :			
Skinning/Loining	Contamination	Hygiene/Sanitation	CCP 2
	Growth of bacteria	(Txt) control	CCP 1
Mincing	Contamination	Hygiene/Sanitation	CCP 2
	Growth of bacteria	(Txt) control	CCP 1
Mixing of meat and ingredients	Growth of bacteria	Hygiene/Sanitation	CCP 2
Molding			
Steaming	Growth of bacteria	(Txt) control	CCP 1
Slicing	Contamination	Hygiene/Sanitation	CCP 2
	Growth of bacteria	(Txt) control	CCP 1
For DST:			
Splitting/Eviscerating	Growth of bacteria	(Txt) control	CCP 2
	Contamination	Water quality	CCP 2
Marinating			
Drying	Growth of bacteria	(Txt) control	CCP 1
	Contamination	Hygiene/Sanitation	CCP 2
Packaging	Growth of bacteria	Packaging material	CCP 1
		Hygiene/Sanitation	CCP 2
Chilling	Spoilage (oxidation)	(Txt) control	CCP 1
	Growth of bacteria	(Txt) control	CCP 1
Distribution	Growth of bacteria	(Txt) control	CCP 1

Sensory Quality Attributes of Crab Analogue and Squid Balls from Bighead Carp (*Aristchthys Nobilis* Richardson)*

* An excerpt from a dissertation for Ph.D major in Food Science "Utilization of bighead carp (*Aristichthys nobilis* Richardson) for surimi production" presented to the UPLB Graduate School, October 1995.

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Abstract

Surimi from bighead carp was used in the production of crab analogue and squid balls. Crab analogue using sweet potato starch and crab flavour powder resulted in better flavour, odour, texture and general acceptability than those using potato starch.

Squid balls were also produced from bighead carp surimi and compared with commercial squid balls. Sensory evaluation showed that the formulated squid balls were comparable with the commercial sample in terms of odour, texture and flavour. The commercial squid balls exhibited better colour and general acceptability than the formulated squid balls.

Introduction

Comminuted products prepared from minced meat and surimi are produced and consumed in many countries. These include fish jelly products, fish and prawn sausages, and burgers, among others.

Ideally, surimi should be processed from white fish with good gel forming ability to achieve an elastic texture, good taste and a white appearance. Surimi is usually prepared from Alaska pollock and other species like threadfin bream, blue whiting, hoki and hake. Arrowtooth, flounder and several species of small pelagics are also used. Surimi is usually kept frozen for the manufacture of fabricated food products.

Freshness of the raw material is a critical factor in determining the quality of the final product. The proximity of the source of the raw material may favour the use of freshwater fishes which are readily harvested from ponds, pens and cages.

In the Philippines, developed culture techniques of freshwater fishes resulted in increased production of bighead carp in Rizal, Laguna, Bulacan, Cagayan, Batangas and other neighboring provinces.

Like most fish species, bighead carp is a good protein source. Its protein content is comparable with beef, pork and poultry. It can also be processed like big fishes in many ways, thus making it a suitable raw material for the development of various fish products.

Therefore, this study was conducted to explore the possibility of using bighead carp as a raw material for the processing of surimi, crab analogue and squid balls.

Materials And Methods

Bighead carp (*Aristichthys nobilis* Richardson) was procured from markets in Los Baños and nearby towns. Fish was cleaned thoroughly, scales were removed and then deheaded, degutted, and washed several times in water. Samples were passed through meat grinder. The resulting product was used as the raw material for the production of surimi.

1. Production of Surimi

A 1% sodium chloride (NaCl) washing solution was used in the preparation of surimi from bighead carp. The fish meat was soaked in 1% NaCl at the rate of 5:1 (solution:fish) for 15 min with occasional stirring. The temperature during soaking was maintained at 2-5°C. After soaking, the liquid was removed from the fish meat by squeezing the mixture through a nylon net. Sodium pyrophosphate and sodium bicarbonate were added to the washed fish residue at the rate of 0.1% each and then mixed thoroughly. The samples were packed in polyethylene bags (0.003 mm thickness) and frozen at -18°C. This product will be referred to as surimi in the rest of the text.

2. Processing of Crab Analogue

Table 1 shows the different formulations for crab analogue used in the study. The ingredients for each surimi formulation were mixed well, portioned into a crab moulder and then steamed for 30 min, cooled and then frozen. The crab analogue was re-heated in steam prior to sensory evaluation.

Table 1. Formulation for crab analogue using bighead carp surimi.

Ingredient	Formulation			
	A	B	C	D
Surimi (g)	100.00	100.00	100.00	100.00
Raw egg white (g)	16.00	16.00	16.00	16.00
Starch (g)				
Potato	8.00	8.00	-	-
Sweet potato	-	-	8.00	8.00
Salt (g)	2.80	2.80	2.80	2.80
MSG (g)	1.60	1.60	1.60	1.60
Flavour :				
Crab liquid (ml)	0.007	-	0.007	-
Crab powder (g)	-	0.02	-	0.02
Flavour enhancer (g)	1.50	1.50	1.50	1.50
Chilled water (ml)	50.00	50.00	50.00	50.00

Table 2. Formulation for squid balls using bighead carp.

Ingredients	Formulation	
	A	B
Surimi (g)	100.00	100.00
Raw egg white (g)	16.00	16.00
Starch (g)		
Sweet potato	8.00	-
Potato	-	8.00
Salt (g)	2.80	2.80
MSG (g)	1.60	1.60
Flavour		
Freshly prepared squid flavour extract (ml)	0.007	0.007
Flavour enhancer (g)	1.50	1.50
Chilled water (ml)	50.00	50.00

3. Processing of Squid Balls

Table 2 presents the formulation for squid balls used in the study. Surimi from bighead carp was mixed with starch and freshly prepared squid flavour extract. The extract was prepared by squeezing out the liquid from the fresh squid mantle/meat by hand. The mixtures were portioned and formed into balls, deep fried in vegetable oil for 5 min or until light brown in colour, and subjected to sensory evaluation. A popular commercial squid ball sample was used as the control.

4. Sensory Evaluation

The samples were coded with three-digit random numbers and randomly served to each panelist. The evaluation of the sample was carried out in individually separated booths. A glass of water was given to each panelist for rinsing their mouths in between samples. Quality scoring was employed to assess sensory quality attributes of each sample.

5. Statistical Analyses

Data obtained were subjected to analysis of variance (Snedecor and Cochran, 1967) to evaluate treatment effects. Where treatment effects were found significant, Duncan's Multiple Range Test (Duncan, 1955) was used to locate significant means.

6. Cost and Return Implications

The cost implications of the production of the formulated crab analogue and squid balls from bighead carp surimi were calculated.

Results And Discussion

1. Crab Analogue

To determine the best formulation for the production of crab analogue, different ratios of crab flavour and starch were added to surimi made from bighead carp muscle. Formulations were abbreviated as: A (liquid crab flavour and potato starch), B (crab flavour powder and potato starch), C (liquid crab flavour and sweet potato starch) and D (powder crab flavour and sweet potato starch). These abbreviations were adapted in the succeeding studies, where applicable.

In the formulation, egg-white was added to improve the texture of the product. According to Chang-Lee *et al.* (1989), the use of egg-white produced acceptable gel strengths of surimi prepared from pacific whiting. This also provided a sulfhydryl enrichment which intensified the sulfhydryl disulfide interchange in surimi. Egg-white also inhibited the proteases in whiting (Haga, 1980; Nagahisa *et al.*, 1983).

To complement the action of egg-white on the final texture of the product, starch was added. Commercial potato starch is usually used in the preparation of crab analogue. The high cost of this starch, however, became a consideration in its utilization.

To lower the production cost, use of locally available starchy materials was explored. Potato (*Solanum tuberosum* Linn) and sweet potato (*Ipomea batatas* (Linn Poir) were used as source of starch. Based on the yield of the extracted starch, sweet potato starch cost less than potato starch. Due to its high yield during extraction and low cost, utilization of sweet potato starch was compared with potato starch. Chang-Lee *et al.* (1989), however, observed that the action of egg-white was complemented by potato starch in improving the hardness and elasticity of heat-set gels of surimi from whiting.

Synthetic food colours were not used in the formulation of crab analogue. This was done to retain the original colour of the product. Soup (1977) stated that in many food systems, the use of synthetic colors are limited by heat, light and other factors.

Commercial crab flavour, however, was used in product formulation. The quantity of use of crab flavor used was based on the recommended level of use by the local manufacturer. About 0.7% liquid crab flavour and 2.0% crab flavour powder were used in the study.

To further enhance the crab flavour of the product, flavour enhancer, disodium 5-inosinate commercially labelled as IMP was added.

Crab analogue of different formulations were steamed at the same time and temperature before subjecting to sensory evaluation.

2. Sensory Evaluation of Crab Analogue from Bighead Carp Surimi

The mean sensory scores of crab analogue developed from bighead carp surimi using different formulations subjected to -18°C is presented in Table 3.

Based on colour intensity, it was noted that the degree of whiteness of samples (A & B) using potato starch increased as storage time progressed. Samples using sweet potato starch (formulations C and D) decreased in whiteness when stored at -18°C for 30 days. This showed that potato starch improved the whiteness of the crab analogue more than sweet potato starch. The whiteness of the crab analogue may be attributed to the leaching and grinding processes during surimi preparation. According to Hsu (1990), the whiteness of the fish sausage from whiting was affected by leaching and the interaction of leaching and grinding processes. Furthermore, the difference in colour between the surimi using of potato and sweet potato starch is partly attributed to the presence of yellow pigment known as beta-carotene in sweet potato. This result was significantly influenced by using different formulations but not affected by storage time.

The flavour intensity of crab analogue using formulations C and D increased, while formulations A and B decreased it, when stored at -18°C for 30 days. As expected, the use of liquid and powdered crab flavours evidently intensified the flavour of crab analogue. Though all formulations were added with monosodium glutamate (MSG) and disodium 5-inosinate (commercially labeled as IMP) as flavour enhancer, differences in flavour intensity were observed. Differences in flavour intensities of crab analogue may be attributed to the differences in the formulation. Lagua (1984) observed that the quality of surimi is affected by the method of processing. Distinct flavour of crab analogue, however, was better perceived in samples using sweet potato than potato starch. These differences, however, were not significant.

As perceived by the panelists, the fishy odour of crab analogue using formulations A and B became more evident when stored at -18°C for 30 days. The use of sweet potato starch and liquid crab flavour decreased the fishy odour of the crab analogue samples. Fishy odour differences in crab analogue may again be due to the method of preparation of the surimi. The washing or leaching process removes undesirable or off-odours in surimi (SEAFDEC, 1987). Improperly washed surimi, when used in the fabrication of food products, may affect the odour of the final product. Differences in the odour intensity of the crab analogue, however, were not significantly affected by using different formulations and storage time.

Table 3. Mean[1] sensory scores[2] of crab analogue from bighead carp surimi developed using different formulations subjected to -18°C.

Quality attribute	Storage time at -18°C (day)	Formulation[3] A	B	C	D
Colour	0	5.3[a]	4.0[a]	5.4[a]	4.7[a]
	3	5.9[a]	4.1[a]	3.8[a]	2.9[a]
Flavour	0	4.7[a]	5.1[a]	4.4[a]	5.0[a]
	30	3.8[a]	4.7[a]	4.9[a]	5.6[a]
Odour	0	4.2[a]	4.9[a]	3.4[a]	4.7[a]
	30	3.3[a]	3.8[a]	4.6[a]	4.2[a]
Texture	0	4.5[bc]	5.6[ab]	4.3[bc]	4.6[bc]
	30	3.3[c]	3.6[c]	5.1[ab]	6.0[a]
General acceptability	0	4.4[a]	5.8[a]	4.3[a]	5.2[a]
	30	4.4[a]	5.2[a]	5.2[a]	5.2[a]

[1] N = 10. Means followed with the same letter within a sensory attribute are not significantly (P<0.05) different from each other.
[2] Range of scores : Colour : 7, white; 1, off-white. Flavour : 7, very strong crab flavour; 1, absence of crab flavour. Odour : 7, absence of fishy odour; 1, fishy odour. Texture : 7, firm; 1, soft. General acceptability : 7, acceptable; 1, unacceptable.
[3] Formulation : A (0.7% liquid crab flavour + potato starch); B (2.0% crab flavour powder + potato starch); C (0.7% liquid crab flavour + sweet potato starch; D (2.0% crab flavour powder + sweet potato starch).

The firmness of crab analogue using formulations C and D increased when stored at -18°C for 30 days. Formulations A and B, however, reduced the firmness of crab analogue when subjected to the same condition. The texture of crab analogue may have been affected by cooking time and/or temperature. According to Raj (1986), improper cooking affect the quality of the final product. Patashnik *et al.* (1982) reported that rapid heating of the flesh to 70°C (158°F) for 10 min completely inactivated the protease and preserved its textural properties. Results further showed that sweet potato starch improved the texture of crab analogue more than using potato starch. Significant differences in the textural quality were influenced by the interaction of formulations and storage time.

A more acceptable crab analogue using formulation C was obtained than using other formulations as storage time progressed at -18°C. The use of potato starch, however, decreased the general acceptability of crab analogue under the same conditions. The use of different formulations and storage time did not influence the general acceptability of crab analogue.

Sensory evaluation showed that crab analogue using formulation C resulted in better flavour, odour, texture and general acceptability than using other formulations. Sensory evaluation of crab analogue from bighead carp surimi showed that the method of processing/preparation of surimi may affect the final quality of the crab analogue. The leaching, grinding, setting, heating processes and their two-way interactions affect the quality of surimi (Hsu, 1990). Lagua (1984) also stated that the quality of surimi is affected by species, season of harvest, handling and method of processing.

Crab analogue using formulation C resulted in better flavour, odour and general acceptability as storage time progressed at -18°C, but was not significantly different from samples using potato starch. A better textured crab analogue was noted in samples using sweet potato starch. The appropriate method of preparation and the nutrients present in sweet potato showed an improved quality of crab analogue. The presence of the yellow pigment, beta-carotene, in sweet potato may partly contribute to the improved flavour, odour, texture and general acceptability of the crab analogue.

3. Economic Potential of Crab Analogue from Bighead Carp Surimi

At present, Japan is still the major producer, consumer and exporter of surimi-based seafoods. Alaska pollock, a marine fish, is still the major fish used in the preparation of surimi, which is being used in the manufacture of imitation crab sticks, shrimp and lobster products.

With the reduced supply of this fish in the country and the decline in the production of marine fish, possibilities exist in the exploitation of cultured fishes.

The Philippines, a noted aquaculture producing country in the world, has increased the production of freshwater fishes due to the availability of improved aquaculture techniques. Global expansion of the fish processing industry may be possible with the use of freshwater fishes like bighead carp.

Carps are abundant in Binangonan, Cardona, Jalajala and Tanay, Rizal; Mandaluyong and Alabang, Metro Manila; Bay, Calauan, Pila, Mabitac and Sta. Maria, Laguna; San Miguel, Bulacan; Cagayan; Batangas; and in nearby areas. Due to advanced aquaculture techniques, carp is abundant all year round.

Based on a previous study, characterization of the bighead carp muscle proved its viability for the production of surimi and crab analogue.

Following the law of supply and demand, bighead carp costs less. The continuous production of bighead carp coming from the lakes, rivers and ponds all year round make them a potential substitute for marine fish in surimi and crab analogue production.

Table 4 presents the cost and return analysis of crab analogue from bighead carp muscle.

It is expected that this type of product will be sold daily. The capital investment on the production of crab analogue can be used over again within a week or a month. On a laboratory scale, a fish processor can operate with less than 30,000 as a revolving budget. The capital investment for the purchase of utensils and equipment is P26,815 but these will last for many years (Table 5).

To operate on a larger economic scale, technical adjustments will be required. The number of equipment will be increased, size of equipment has to be enlarged to meet the target production, and labour and other inputs have to be increased.

Bighead carp proved to be a potential raw material for the production of surimi and crab analogue. Profitability is ensured from the manufacture of surimi from bighead carp. Better or additional earnings, however, are expected if crab analogue will also be produced. The import of intermediate products for local consumption can also be reduced.

4. Formulation of Squid Balls from Bighead Carp Surimi

Squid balls were prepared and compared with the commercial squid balls to test the viability of bighead carp surimi for the production of "ready to serve foods" or "fabricated food products".

In the formulation of squid balls from bighead carp surimi, the formulation for crab analogue was used but modified. Crab flavour used in crab analogue preparation was changed to squid flavour.

Squid flavour extract was prepared from fresh squid unlike the crab flavours (liquid and powder) which are both commercially available. Other ingredients were also used in squid ball preparation.

Treatments applied were designated as: A (freshly prepared squid flavour extract and potato starch); B (freshly prepared squid flavour extract and sweet potato starch); and C (control or commercial squid balls).

5. Sensory Evaluation of Squid Balls

Sensory evaluation was conducted to determine the quality differences between the formulated and commercial squid balls. The mean sensory scores of formulated and commercial squid balls are presented in Table 6.

Based on colour intensity, the commercial squid balls had whiter colour than formulated samples. Samples using formulation B, however, had better colour than samples using formulation A. These differences may be attributed to the species differences of the raw material, degree of freshness, added ingredients, and the processing method employed in the product preparation. The differences in the colour intensity of the formulated samples, however, were not statistically significant. Significant differences were noted between the bighead carp products and the commercial samples. Hsu (1990) observed the effect of leaching and the interaction of leaching and grinding on the whiteness of the fish sausage from whiting. The processing methods employed in both formulations were the same, thus differences in the colour intensity of the formulated samples were not significant. Since the processing methods employed in commercial samples were already standardized, significant differences of the formulated samples were noted with the commercial ones. There was difficulty in comparing the samples since the history of the commercial squid balls was unknown.

Absence of fishy odour was noted in formulated and commercial squid balls. Though squid balls using formulation B had lower sensory scores for odour, these were not significant. The differences in the starch used, the degree of freshness of the surimi and the process of preparation did not affect the odour intensity of the samples. This showed that leaching or washing process for the squid balls preparation was good. Leaching improved the odour of the final product (SEAFDEC, 1987).

Noting the differences in the raw material used (i.e., bighead carp for samples A and B, and marine fish of unknown species for sample C), the textural qualities of the products were assessed. Texture of the products was noted to be neither soft nor firm. No significant differences in the textural qualities among samples were noted. Though there was variation in the raw materials used, their textural qualities were not affected. Results showed that the cooking time and temperature of squid balls were appropriate. Patashnik *et al.* (1982) and Raj (1986) stated the effect of cooking on the textural properties of the final product.

Samples A and B used freshly prepared squid flavour extract while sample C had the commercial ones. Sample C had more evident squid flavour than the formulated samples. These, however, resulted in insignificant differences in the flavour of samples. The intensity of use or level of flavour and flavour enhancers differed but was not found to affect the flavour intensity of the samples. Results further showed that the method of preparation of squid flavour did not affect the quality of the final product.

The general acceptability of squid balls showed significant differences among samples. Sample C had better acceptability than samples A and B. Differences in the colour of the samples seemed to affect the general acceptability of samples. Differences in species composition of raw material, degree of freshness, quantity of flavour and flavour enhancers, and processing method employed, which were unknown in the commercial samples, also seemed to affect the general acceptability of samples. Lagua (1984) stated that the quality of the final product is affected by species, season of harvest, handling and method of processing.

6. Cost and Return Analysis of Formulated Squid Balls from Bighead Carp Surimi

Table 7 presents the cost and return analysis of formulated squid balls from bighead carp surimi. Based on computations, squid balls from bighead carp surimi seemed not to be a profitable business. A loss was incurred due to the ratio of raw material (surimi) to the final product, unlike the commercial squid balls, where more ingredients like starch and flavourings could have been added to reduce the amount of fish. Fish could be substituted by other ingredients like starch or flour. This showed that the formulations of squid balls from bighead carp surimi should be further modified to be competitive with the commercial ones. The processing site should be close to the production areas. The formulation should also be further improved to generate better profit and encourage a technology user.

Conclusion

Bighead carp, *Aristichthys nobilis* Richardson, purchased from Los Baños and nearby markets was used in the preparation of surimi. Surimi was used in the preparation of crab analogue and squid balls which were further subjected to sensory evaluation.

Results showed that crab analogue using sweet potato starch and crab flavour powder had an improved texture. No significant differences in flavour, odour and general acceptability, however, were noted among samples as storage time progressed at -18°C.

Squid balls were also developed from bighead carp surimi. These were subjected to sensory evaluation and compared with the commercial squid balls.

Commercial squid balls resulted in better colour than the formulated squid balls. However, there were no significant differences in odour, texture and flavour of the formulated squid balls from bighead carp surimi and the commercial squid balls. Commercial squid balls had better general acceptability than the formulated ones.

Squid balls using the developed formulation with bighead carp purchased from the market were not competitive with the commercial ones. The formulation has still to be modified to compete with the price of the squid balls in the local market. The processing site should be located close to the production areas to reduce the cost of the raw material.

Given the adequate supply, available aquaculture technology to boost the supply of bighead

Table 4.Cost and return[1] analysis on the preparation of crab analogue from bighead carp muscle.

Item	Quantity	Cost (Peso)
I. Fixed cost (Depreciation cost) :		
A. Utensils		
Steamer	1	18.75
Plastic basin	4	3.67
Chopping board	1	2.92
Knife	1	7.08
Wooden spoon	1	2.08
B. Equipment		
Freezer	1	75.00
Microwave	1	250.00
Electric stove	1	41.67
Meat grinder	1	97.22
Sub-total		498.39

Item	Qty/day	Unit cost (Peso)	Total cost (Peso)
II. Variable cost :			
A. Fresh bighead carp[2]	20 kg	50/kg	20,000.00
B. Sodium pyrophosphate	20 g	800/100g	3,200.00
C. Sodium bicarbonate	20 g	391/500g	312.80
D. Egg	6 pc	2.50/pc	300.00
E. Sweet potato	1 kg	7/kg	140.00
F. Salt	0.2215 kg	6.50/kg	2.80
G. MSG	0.1266 kg	85/kg	21.60
H. Liquid crab flavour (cost = US$40/kg; at US$1=25 Peso)	0.0055 kg	1,025/kg	1.20
I. IMP	0.1167 kg	950/kg	225.60
J. Water	395.55 ml	58/m^3	0.40
K. Electricity	9.13 kwh	2.36/kwh	431.00
L. Plastic bag (P.E.)	10 pc	0.35/bag	70.00
M.Detergent	1 box/month	31.00/box	31.00
N. Labour	-	-	3,000.00
O. Contingencies	-	-	1,411.74
		Sub-total	29,148.14
		TOTAL COST	29,646.53
III.Returns :			
Gross income (from sales) 206.22 pc/d at 8.50 Peso/pc			35,057.40
Less : Total cost			29,646.53
Net Income			5,410.87
Return on investment			18.25%
Payback period			5.48 mo

[1] Based on: 1995 prices; 5 days operation/week = 20 days/month.

[2] Based on 1995 market price. The farm gate price ranges from P10-25/kg, depending on size and season.

Table 5. Life span and cost of utensils and equipment in the preparation of surimi and crab analogue from bighead carp.

Item	Life span (year)	Cost/unit (Peso)	Total cost (Peso)
A. Utensils			
1 steamer	2	450.00	450.00
4 plastic basins	5	55.00	220.00
1 chopping board	1	35.00	35.00
1 knife	1	85.00	85.00
1 wooden spoon	1	25.00	25.00
		Sub-total	815.00
B. Equipment			
1 freezer	10	9,000.00	9,000.00
1 microwave	4	12,000.00	12,000.00
1 meat grinder	3	3,500.00	3,500.00
1 electric stove	3	1,500.00	1,500.00
		Sub-total	26,000.00
		TOTAL	26,815.00

Table 6. Mean[1] sensory scores[2] of the commercial and the formulated squid balls from bighead carp.

Quality attribute	Sample[3]		
	A	B	C
Colour	3.70[b]	4.00[b]	5.50[a]
Odour	5.00[a]	4.00[a]	4.90[a]
Texture	4.10[a]	4.00[a]	3.80[a]
Flavour	3.60[a]	3.60[a]	5.00[a]
General acceptability	4.60[b]	4.40b	5.90[a]

[1] N= 10. Means followed with the same letter within a sensory attribute are not significantly ($P<0.05$) different from each other.
[2] Range of scores : Colour : 7, white; 1, off-white. Odour : 7, absence of fishy odour; 1, fishy. Texture : 7, firm; 1, soft. General acceptability : 7, acceptable; 1, unacceptable.
[3] Legend : A = freshly prepared squid flavour extract and potato starch; B = freshly prepared squid flavour extract and sweet potato starch; C = commercial squid balls (manufactured by Yenmei Foods Corporation).

carp and the short payback period to prospective processor, economic returns in the manufacture of crab analogue are bright and encouraging. However, further formulation studies on squid balls and other fabricated food products should be done. Improved processing methods and strict quality control procedures should be enforced to boost the production of processed fish products from freshwater fishes.

In conclusion, the development of surimi and crab analogue from bighead carp showed bright opportunities for the manufacture of fabricated food products. Other value-added products from bighead carp should be further developed to increase the variety of processed fish products in the local market. In the production of a processed product, however, the raw material should be maintained at its freshest stage/condition to develop a good quality processed product. More so, to reduce the cost of the raw material, it should be purchased direct from fish producers.

Table 7. Cost and return analysis[1] on the preparation of squid balls from bighead carp surimi.

Item	Quantity	Cost (Peso)
I. Fixed cost (Depreciation cost) :		
A. Utensils		
Steamer	1	18.75
Plastic basin	4	3.67
Chopping board	1	2.92
Knife	1	7.08
Wooden spoon	1	2.08
B. Equipment		
Freezer	1	75.00
Microwave	1	250.00
Electric stove	1	41.67
Meat grinder	1	97.22
Sub-total	-	498.39

Item	Qty/day	Unit cost (Peso)	Total cost (Peso)
II. Variable cost :			
A. Fresh bighead carp[2]	20 kg	50/kg	20,000.00
B. Sodium pyrophosphate	20 g	800/100g	3,200.00
C. Sodium bicarbonate	20 g	391/500g	312.80
D. Egg	6 pc	2.50/pc	300.00
E. Sweet potato	1 kg	7/kg	140.00
F. Salt	0.2215 kg	6.50/kg	2.80
G. MSG	0.1266 kg	85/kg	21.60
H. Squid	0.0014 kg	60/kg	1.68
I. IMP	0.1167 kg	950/kg	225.60
J. Water	395.55 ml	58/m^3	0.40
K. Electricity	9.13 kwh	2.36/kwh	431.00
L. Plastic bag (P.E.)	10 pc	0.35/bag	70.00
M. Detergent	1 box/month	31.00/box	31.00
N. Labour (2 man-day)	-	-	3,000.00
O. Contingencies	-	-	1,411.74
		Sub-total	29,148.64
		TOTAL COST	29,647.03
III. Returns :			
Gross income (from sales)			8,248.88
206.22 pc/d at 2.00 Peso/pc			
Less : Total cost			29,647.03
Net Loss			(21,398.15)

[1] Based on: 1995 prices; 5 days operation/week = 20 days/month.

[2] Based on 1995 market price. The farm gate price ranges from P10-25/kg, depending on size and season.

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Discussion

Dr Fernandez informed the seminar that oil is extracted from bighead carps for use in the manufacturing of food additives and cosmetics. She suggested that the muscle and bone waste should be utilized and processed into other by-products, such as fish meal from the bones. The bighead carp, a reasonably priced fish would then serve well as a raw material in fish processing. She took note of the suggestion that results from the sensory evaluation could be compared with those from texture profile analysis.

Colour and Quality Assessment of Tuna for *Sashimi*

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Abstract

The colour of tuna is the main criterion for quality assessment of sashimi. In Japan, the general rule is "The brighter the red, the better the quality". The colour of fresh meat is due to the occurrence of myoglobin in its different chemical states; in oxidized meat, the predominant chemical state is met-myolgobin. In this study, the main objective is to correlate the amount of myoglobin with the quality of yellowfin tuna (Thunnus albacares). The tuna samples in this study were subjected to 0°C storage and their colour and myoglobin values were monitored over 14 days. The value of met-myoglobin for 0-day is 10.0% and on the 14th day, the value increased significantly to 95.9%. For chemical tests, significant spoilage occurred during the time between the 9th and 12th day of storage when met-myoglobin values increased from 67.5% to 83.4%. For sensory evaluation, all panelists rejected the tuna samples as unsuitable for sashimi when the value of met-myoglobin increased to 70%.

Introduction

The main criterion for the acceptance of tuna meat for *sashimi* depends mainly on the appearance of its colour. For consumers in Japan, the general rule is "the brighter the red, the better the quality". The colour of meat is due mainly to the occurrence of reduced myoglobin (Red-Mb), oxy-myoglobin (Oxy-Mb) and met-myoglobin (Met-Mb). The colour for 100 % Red-Mb in meat is dark purplish red, for 100% Oxy-Mb in meat is bright red and for 100 % Met-Mb is brown. It is therefore necessary to analyze the amount of these three states of myoglobin for the determination of meat colour. The main objective for this study is to determine the correlation between the content of myoglobin and quality of yellowfin tuna by comparing results of colour with spoilage indices as well as sensory evaluation .

Definitions

R(λ) : Reflectance of a sample at an arbitrary wavelength;
ꓤ(λ) : Reciprocal of reflectance of a sample at an arbitrary wavelength = 1/R(λ);
$_{blc}$(λ) : Reciprocal reflectance of an achromatic, matrix sample;
ꓤ'(λ): The function equal to ꓤ (λ) - ꓤ$_{blc}$(λ);
K An absorption coefficient;
S : A light scattering coefficient;
r : Correlation coefficient; and
R^2 : Reliability of the trendline; $R^2 = 1$ when line or curve fits data points perfectly.

Theory

The fundamental property of this study is spectral reflectance which is proportional to the myoglobin content. According to Kubelka and Munk (1931), it is considered that ꓤ (the reciprocal of reflectance) has the same numerical property as K/S. ꓤ$_{blc}$ is the value of the achromatic meat matrix without any myoglobin and the ꓤ spectrum of meat containing myoglobin is higher than the ꓤ$_{blc}$ spectrum. With decreasing myoglobin content, the value of ꓤ would finally approach the spectrum of ꓤ$_{blc}$. The ꓤ$_{blc}$ spectrum is the baseline for the myoglobin free meat so that the ꓤ' corresponds to the spectrum of the solution. Thus the following equation is derived:

ꓤ' = ꓤ - ꓤ$_{blc}$

When meat is first cut, reduced myoglobin (Red-Mb) content is the most dominant of all three forms. This is due to the high Myoglobin Reducing Activity (MRA) present in all fresh tuna. When the meat is exposed to gaseous oxygen, the oxygen molecule would attach itself to the myoglobin, resulting in the formation of oxy-myoglobin (Oxy-Mb) leaving the meat bright red. On exposure to air or oxidizing agent, the myoglobin present in the meat will be oxidized into met-myoglobin (Met-Mb), giving the undesirable brown colour. This is due to the oxidation of Fe(II) ion to Fe(III) ion in the myoglobin molecule.

The characteristics of the spectra for all 3 forms are unique to each, as shown in Fig. 1. For the case of Red-Mb, the 1/R spectra peaked at 480 nm and a valley occurs at 560 nm. In this spectra, the reduced form was characterized by the slope between 480 nm and 520 nm. Thus the following function is determined:

$$P_r = ꓤ'_{480} / ꓤ'_{520} \text{ ———— } (1)$$

where P_r is the parameter that is inversely proportional to reduced-myoglobin content. In this region of the spectra, P_r is at its minimum for Red-Mb and maximum for the other two forms.

The P_o value for the Oxy-Mb form is directly proportional to its content. In the spectra, the ꓤ slope is positive between 560 nm and 570 nm while the ꓤ slope for the other two forms are negative. Thus the following equation is derived :

$$P_o = ꓤ'_{570} / ꓤ'_{560} \text{ ———— } (2)$$

The decreased P_o value will be accompanied by a decrease in the oxy-myoglobin content, finally reaching a minimum.

The spectral characteristic of met-myoglobin is significant at 640 nm as the direction of the curvature is opposite to the other two forms. This is represented by the following equation :

$$P_m = (ꓤ'_{640} - ꓤ'_{660}) / (ꓤ'_{600} - ꓤ'_{660}) \text{ ——— } (3)$$

When P_m value was a maximum for met-myoglobin and it was a minimum value for the other two forms (Table 1). This function was confirmed to be the best according to Professor Izumimoto (1992). As in the case of oxy-myoglobin, a decrease in P_m will result in an increase in met-myoglobin content and a decrease in the oxy-myoglobin content.

All P_o, P_r and P_m functions are dependent on the oxy-, reduced- and met-myoglobin forms respectively but they are independent of each other. For the case of oxy-myoglobin form, when the P_o value indicates 100% content, the lower values occurring in both reduced- and met-myoglobin forms indicate the absence of the pigment. This also applies to P_r of reduced-myoglobin and P_m of the met-myoglobin form (Table 1).

The required parameters for yellowfin tuna were determined prior to this experiment and the calibration data is stored in the Myoglobin Analyzer Programme of the Qbasic software. The parameters determined are shown in Table 1. From these values, it is possible to plot the calibration curve for the three forms of myoglobin. The programme will then be able to automatically calculate and show the value of the myoglobin of the yellowfin tuna on the computer screen once reflectance measurement is taken.

Materials and Methods

A 30 kg deheaded and degutted yellowfin tuna (*Thunnus albacares*), was purchased from a fish supplier located at Pandan Loop. The fish was caught in the Indian Ocean and stored in ice on board the fishing vessel for 14 days prior to arrival at Singapore. The fish was collected one day after its arrival. The fish was iced and transported to Marine Fisheries Research Department in an insulated box. On arrival, the fish was cut into rectangular blocks, each piece with a size of 5 x 9 x 0.5 cm. The tuna blocks were then immediately stored in a 0°C refrigerator over a period of 14 days. The samples were also divided into 3 groups for colour and myoglobin studies, chemistry, and sensory evaluation. The chemical parameters included pH, moisture, K-value, volatile basic nitrogen (VB-N) and trimethylamine nitrogen (TMA-N). Before each tuna sample was taken for chemical and sensory evaluation tests, colour and myoglobin contents were first measured and and then each sample was photographed.

1. Colour and myoglobin

The colour and myoglobin determinations were possible with the use of a program called Myoglobin Analyzer Program designed by Mr. Yoshishige Mori on the Qbasic software. A Minolta 508-d reflectance spectrophotometer was attached to the computer. The colour measurement was done throughout 14 days on 5 pieces of tuna each labelled A to E. The *L*, *a* and *b* values which indicates the whiteness, redness and the blueness respectively of the tuna meat was measured together with the myoglobin values. The spectral readings obtained for each of the tuna loin were taken from three separate points of measurements on the meat surface. At the instant when spectral reflectance values were recorded by the meter, the software programme immediately converted the reflectance readings into reduced myoglobin, oxy-myoglobin and met-myoglobin percentage values. These readings were taken everyday except for Sundays and public holidays.

2. pH

The pH values of the tuna samples stored at 0°C were monitored over a period of 14 days. The method used was according to Lim (1992).

3. Moisture

Moisture was determined according to Ng M.C. (1992).

4. Volatile basic nitrogen (VB-N) and trimethylamine nitrogen (TMA-N)

VB-N and TMA-N tests were conducted to find out how bacterial freshness as indicated by VB-N and TMA-N can be correlated to the colour changes of the tuna. For both analyses, the Conway's microdiffusion method used was as described by Yamagata and Low (1992).

5. K-value

This test was conducted to find out how enzymatic freshness can be correlated with the colour of the tuna. Upon its death, ATP and related compounds are broken down by endogenous enzymes. K-value thus measures the extent of this breakdown (Equation 4). The method used for this determination is the ion-exchange chromatography as described by Ng C.S. (1992).

$$K(\%) = \frac{[HxR]+[Hx]}{[ATP]+[ADP]+[AMP]+[IMP]+[HxR]+[Hx]} \times 100 \quad (4)$$

where ATP = adenosine triphosphate; ADP = adenosine diphosphate; IMP = inosine monophosphate; HxR = inosine or hypoxanthine riboside; Hx = hypoxanthine

6. Sensory Evaluation

This study was conducted over a period of 12 days and 10 untrained sensory panelists from the Department were invited to test the tuna samples for their visual appearance, mainly colour, taste, smell and texture. The tuna samples were kept chilled in an ice box prior to sensory evaluation. This test was terminated when all of the panelists had rejected the tuna samples as *sashimi*.

Results and Discussion

1. Colour and myoglobin

The 5 tuna samples were monitored until their met-myoglobin content was almost 100%. Fig. 2 shows the change in myoglobin, which includes the three chemical states, with time. The results showed that the changes correlated very well (r = 0.9867). It was found statistically that the overall met-myoglobin increase with storage days was significant (P<0.05).

Fig. 3 shows that redness was significantly correlated with oxy-myoglobin (r = 0.942). However, the change in met-myoglobin content had a smaller correlation coefficient with redness (r = 0.8912) compared to oxy-myoglobin. The results for the relationship between redness of tuna using the *a* values and storage period is shown in Fig. 4. It was noted that the tuna samples achieved maximum redness between 2-5 days of storage. The increase in redness between 0 to 2 days is due to the increase in oxy-myoglobin in the tuna samples. As the formation of met-myoglobin increases, the redness decreases because of the decrease in oxy-myoglobin. Thus the samples would turn more brownish towards the end of the curve. On the 14th day, there was a slight increase in the redness which was consistent with the increase in reduced myoglobin originating from the reducing enzyme from *Lactobacillus*.

As seen in Fig. 2, reduced myoglobin value for the 0-day sample was low, indicating that the initial freshness of the sample was not that of high quality tuna. For very fresh, high quality tuna, the reduced myoglobin value should normally be about 90-100% on the cut surface. This may be due to improper handling on board after the catch which resulted in some oxidation occurring before the fish was even cut open.

2. pH

The overall increase in pH (Table 2) was significant (P<0.05) and the changes in pH was highly correlated with the changes in met-myoglobin (r = 0.842). During the initial stage of storage, the pH remained quite stable ranging from 5.97 to 6.08 until on the 12th day of storage when the value was increased to pH 6.28. This increase was accompanied by the increase in met-myoglobin content from 67.5% to 83.4% and spoilage with regards to a significant (P<0.05) increase in volatile basic nitrogen from 35.60 to 54.16 mg/100g on the 9th and 12th day of storage respectively (Table 2).

3. Moisture

The change in moisture during the storage period ranged from 74.12% to 75.31% (Table 2). Although the change throughout the storage period was significantly (P<0.05) different, there was apparently little correlation (r = 0.4033) with the met-myoglobin content.

4. VB-N and TMA-N

The overall increase of VB-N over the 14 days was significant (P<0.05, Table 2). There was a significant increase in VB-N from 9 to 12 days of storage which was accompanied by a significant increase in met-myoglobin from 67.5% to 83.38%. The values did not vary much during the beginning and at the end of the storage period. Fig. 6 shows that the change in met-myoglobin was highly correlated (r = 0.9075) with the changes in VB-N.

The range of values of TMA-N during the 14 days of 0°C storage was between 0 to 2.79 mg/100g. The results of these values did not correlate directly with the increase in met-myoglobin (correlation coefficient, r = 0.7023) as TMA-N contents differed when sampling was done in different parts of the fish muscle.

The rate of increase in TMA during spoilage of fish depended on storage temperature and was quite pronounced at room temperature, but absent or negligible at sub-zero temperatures. At low temperatures such as refrigeration above 0°C, TMA formation slows down noticeably (Ishida *et al.,* 1976). Thus, the values obtained were not very high in this experiment and were irregular. This was actually consistent with the findings of Horie and Seine (1956) when they compared TMA formation between ordinary muscle of white meat fish to that of the dark meat fish. They concluded that the formation was greater and more regular in the former than the latter. They also reported that white meat fish contained larger amounts of trimethylamine oxide (TMAO), the precursor of TMA, about 35-60 mg / 100g, whereas dark meat fish contained smaller amounts of about 2-10 mg/100g.

One other reason for the irregularity of the TMA-N values may be due to the fact that the rate of spoilage varies with meat from different parts of the fish. It was reported that for yellowfin tuna, the TMA formation was faster in the tail as compared to the head and the middle portion; the TMAO content was higher in the tail end muscle than in muscles near the head (Koizumi *et al.*, 1967).

6. K-value

The K-value of yellowfin tuna muscle increased significantly (P<0.05) during storage (Table 2). The K-value changed significantly (P<0.01) when met-myoglobin ranged from 9.17% to 34% and it became slightly stabilized when met-myoglobin values ranged between 34% to 67.5%. The values then increased significantly (P<0.05) between the 9th and 14th day of storage (Fig. 7). The changes in K-value was highly correlated (r = 0.91119) with the changes in met-myoglobin content. From the value of 31.59% of the 0-day sample, it was obvious that enzymatic spoilage has already occurred before the fish was sampled. According to Japanese standards, the acceptable K-value for fresh fish for *sashimi* should be below 20%. However, the 0-day iced sample at the laboratory was already 15 days after harvesting.

7. Sensory Evaluation

The sensory evaluation tests on *sashimi* tuna samples, stored at 0°C, were conducted over a 12 day period of 0°C storage. The results are shown from Figs. 8-11 and the table which summarizes the corresponding myoglobin contents and their acceptability is in Table 3.

All panelists rejected tuna as *sashimi* when met-myoglobin values reached the value of 70% on the 12th day. This was consistent with the significant increase in pH, VB-N and K-value of the samples stored from 9 to 12 days of storage when met-myoglobin increased from 67.5% to 83.4%.

Fig. 8 shows the change in colour of the tuna samples as judged by the sensory panelists. The trend towards the right is from the bright red to brown. It was noted that some tuna samples have become progressively brown from the 7th day of storage onwards.

Fig. 9 shows the trend of the overall appearance of the tuna samples. From the figure, it was also noted that the optimum appearance of the tuna is on the 2nd day and that some of the panelists had already rejected the samples as suitable for *sashimi* from the 7th day onwards.

Fig. 10 shows the trend of the odour of tuna as the storage days progressed. Many of the panelists find the odour non-offensive during the first few tests. It was from the 7th day onwards that they found the samples fishy which led to rejections of the tuna as *sashimi.*

Fig. 11 shows the trend in texture over the number of storage days. The texture of the samples did not change significantly over the storage period and most of the comments are "slightly soft" to "soft". Although all panelists rejected the samples as *sashimi* on the 12th day, the results from the texture tests show that texture is not one of the factors contributing to the rejection.

From 0-day to 7-day storage, most of the panelists commented that the tuna samples were bland and did not have much flavour but there were no strange offensive flavours as well. It was after the 9th day that they found the taste to be more fishy and repulsive.

Conclusion

The results of this study showed that the software program Myoglobin Analyzer designed by Mr. Yoshishige Mori gave met-myoglobin values which correlated very well with the changes in K-value, VB-N and sensory evaluation results (r = 0.9119, r = 0.9075 and r = 0.9742) for the yellowfin tuna during iced storage. The changes in met-myoglobin was fairly well correlated with the changes in redness, a-value (r = -0.8912). This shows that it is possible to manage the quality assessment of *sashimi* tuna in the field with a more objective method using the Minolta 508d Spectrophotometer and the Myoglobin Analyzer software Program.

Majority of the sensory panelists rejected the tuna for *sashimi* consumption on the 7th day of iced storage based on the colour, appearance and odour. At this point, the K-value was 49.11%, VB-N was 36.06 mg/100g, TMA-N was 2.32mg/100g and the met-myoglobin content ranged between 34.47% for the chemistry sample and 40.63% for the sensory sample.

When all the sensory panelists rejected the tuna samples on the 12th day of iced storage at the laboratory (27 days after catch), the K-value was 52.32%, VB-N was 54.16 mg/100g, pH was 6.28 and the met-myoglobin ranged between 71% for sensory sample and 83.38% for the chemistry sample. Thus, once the met-myoglobin content is greater than 70%, the tuna meat was not acceptable for *sashimi.*

The chemical data showed that the sample upon arrival at the laboratory was not of premium quality as the K-value was already 31.59%. Thus, the authors recommend that further work should be carried out with better quality yellowfin tuna. In future studies, attempts will be made to try and match the met-myoglobin content with the colour of the tuna meat to produce a colour chart for field use.

Acknowledgment

The authors would like to thank Mrs. Tan-Teo Poh Hong and Mdm Ng Ah Gek for their assistance in carrying out chemical tests for the tuna samples.

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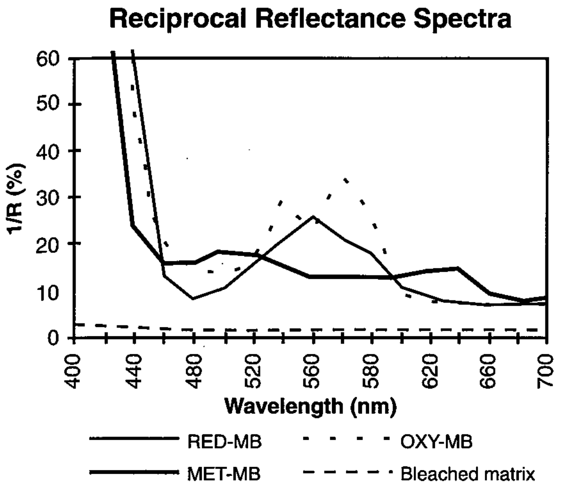

Note : These spectra were obtained from a previous experiment to set the basic parameters for the different states of myoglobin in yellowfin tuna for use in the computation of the software program.

Fig. 1. Reciprocal reflectance () spectra of yellowfin tuna.

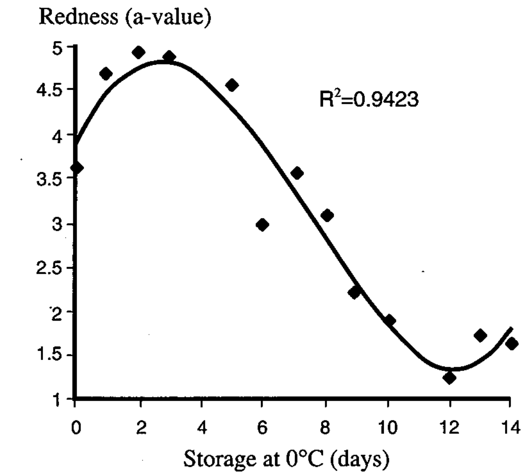

Fig. 4. Changes in the redness (a-value) of yellowfin tuna with storage time (0°C).

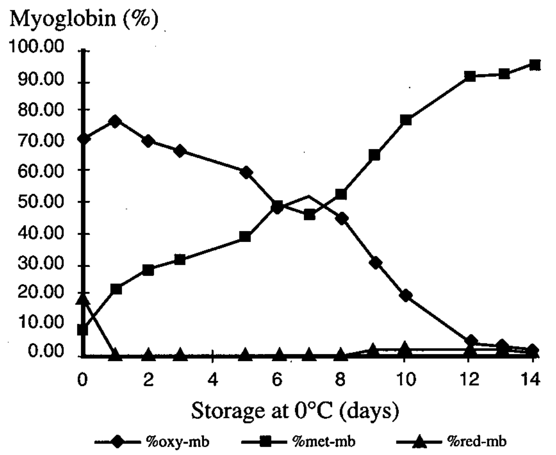

Fig. 2. Changes in oxy-, red- and met-myoglibin (%) content of yellowfin tuna during storage (0°C).

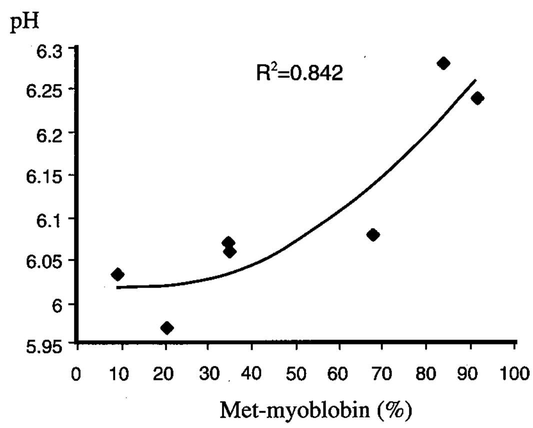

Fig. 5. Relationship between changes in pH and met-myoglobin content of yellowfin tuna.

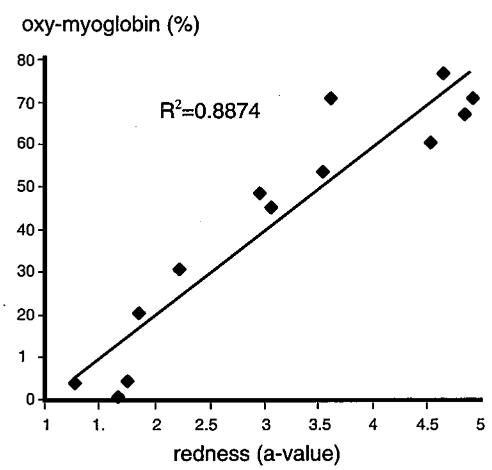

Fig. 3. Relationship between redness (a-value) and oxy-myoglobin content of yellowfin tuna.

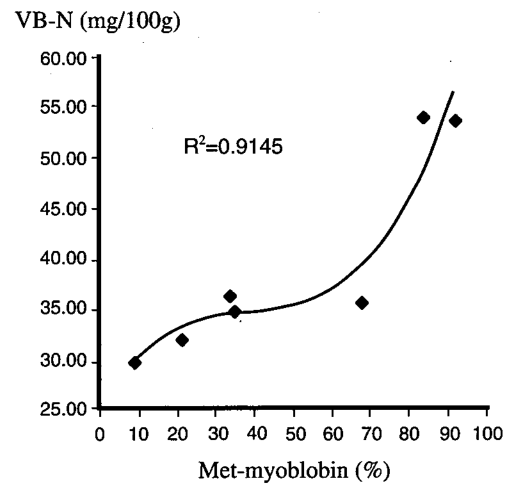

Fig. 6. Relationship between changes in VB-N and met-myoglobin content of yellowfin tuna.

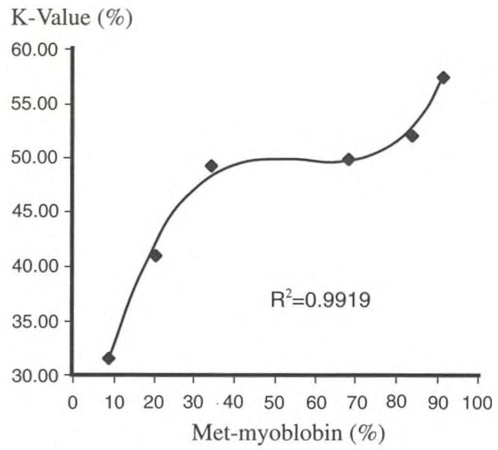

Fig. 7. Relationship between changes in K-value and met-myoglobin content in yellowfin tuna.

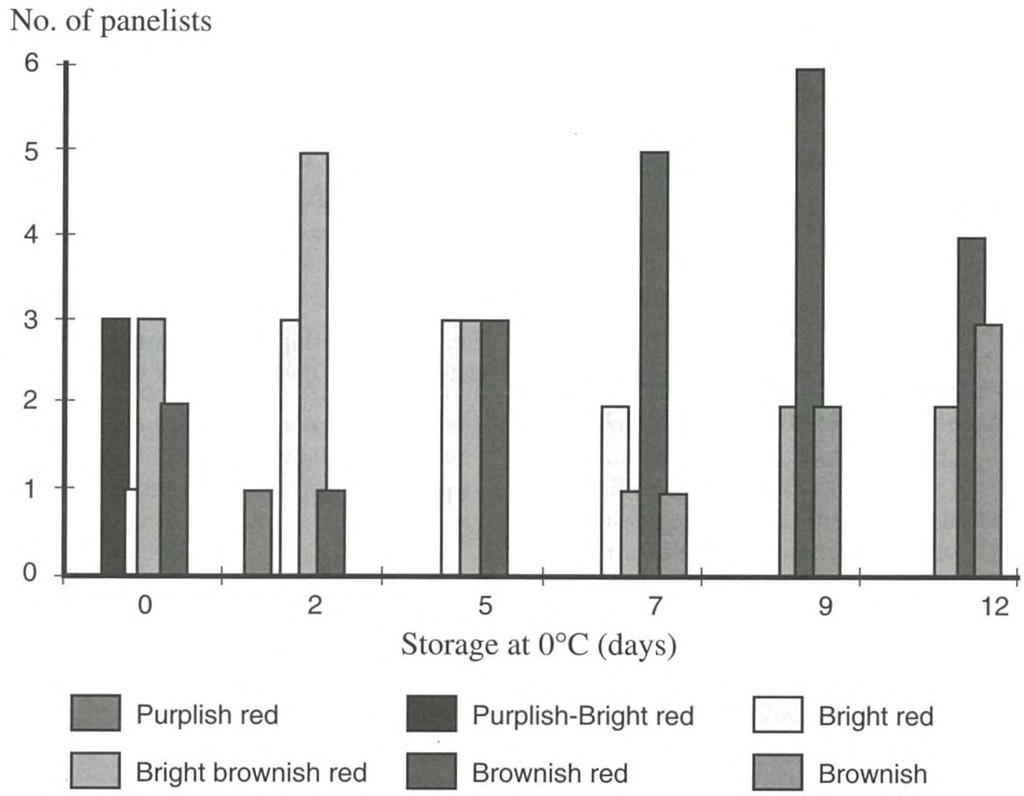

Fig. 8. Sensory panelists' evaluation of the changes in colour of *sashimi* yellowfin tuna during storage at 0°C.

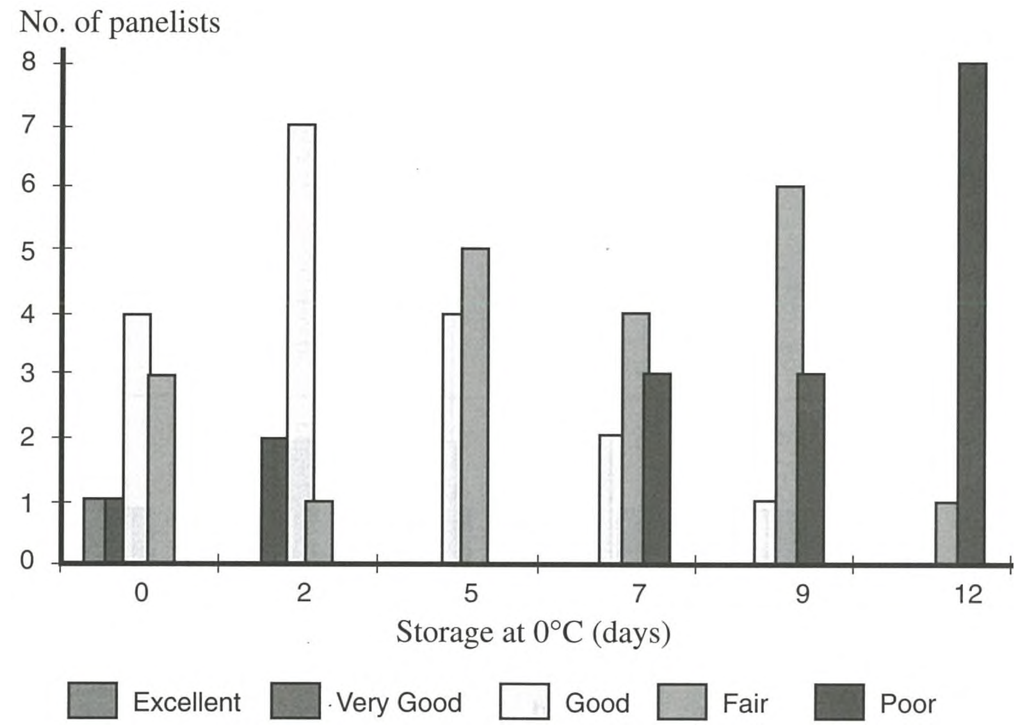

Fig. 9. Sensory panelists' evaluation of changes in appearance of yellowfin tuna during storage at 0°C.

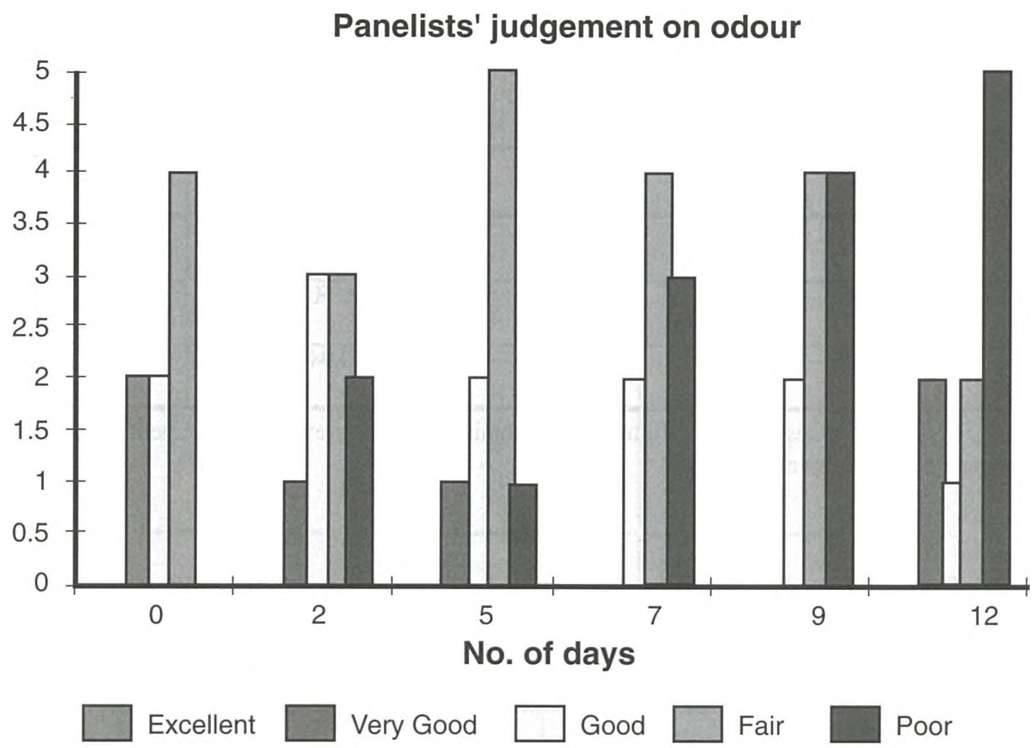

Fig. 10. Sensory panelists' evaluation of changes in odour of yellowfin tuna during storage at 0°C.

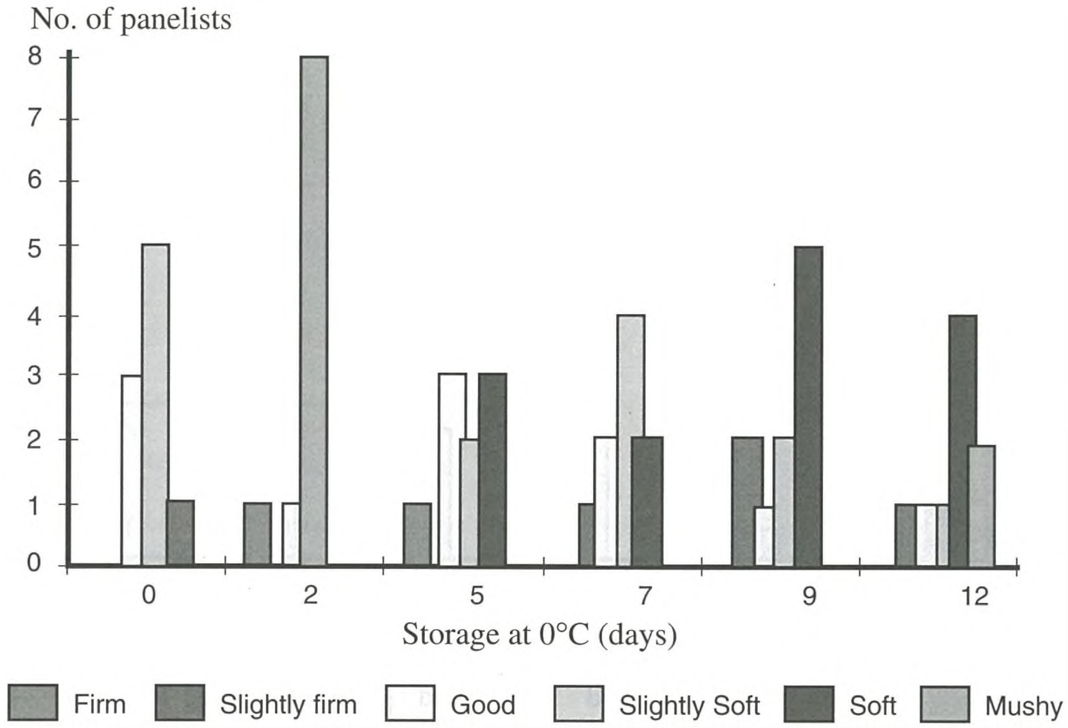

Fig. 11. Sensory panelists' evaluation of the changes in texture of raw yellowfin tuna stored at 0°C.

Table 1. Parameters (P_r, P_o and P_m) for the three states of myoglobin.

Form	P_r	P_o	P_m
100% red-Mb	0.597	0.9453	0.1756
100% oxy-Mb	0.8697	1.5075	0.1756
100% met-Mb	0.8697	0.9453	1.8248

Note : The P_r, P_o and P_m values of yellowfin tuna were obtained from a previous experiment conducted to set the basic parameters for the software program.

Table 2. Chemical test results with corresponding myoglobin and redness values

Storage days	Red-Mb %	Oxy-Mb %	Met-Mb %	Redness (a*)	pH	Moisture %	K-value %	VB-N (mg/100g)	TMA-N (mg/100g)
0	19.71±7.70*	71.13±7.98	9.17±3.80	3.61±0.50	6.03±0.006	74.58±0.18	31.59±0.42	29.69±0.98	0.50±0.48
2	0.00±0.00	79.03±8.02	20.97±8.02	4.30±0.53	5.97±0.02	74.12±0.16	40.86±3.01	31.97±0.78	0.00±0.00
5	0.00±0.00	65.07±2.22	34.93±2.22	3.90±1.46	6.06±0.01	74.35±0.08	42.30±1.07	34.70±1.22	0.40±0.35
7	0.00±0.00	65.53±3.65	34.47±3.65	4.21±0.35	6.07±0.01	74.94±0.06	49.11±2.98	36.06±1.84	2.32±0.32
9	11.03±4.84	21.43±11.93	67.50±9.81	2.65±0.62	6.08±0.00	75.31±0.06	49.90±0.83	35.60±1.74	2.57±1.15
12	10.83±3.26	5.78±3.14	83.38±2.05	1.66±0.39	6.28±0.006	74.26±0.16	52.32±1.10	54.16±1.61	1.32±0.18
14	6.30±12.13	2.60±6.79	91.13±11.44	0.66±0.55	6.24±0.01	75.09±0.10	57.48±0.91	53.84±2.03	2.79±0.76

* Mean ± Standard deviation

Table 3. Sensory evaluation of yellowfin tuna for *sashimi* (total number of panelists=10).

Day	Reduced-Mb %	Oxy-Mb %	Met-Mb %	Number of panelists who accept samples as *sashimi*
0	19.70	71.13	9.17	10
2	0.00	73.46	26.44	6
5	0.00	65.73	34.27	6
7	0.00	59.37	40.63	6
9	0.40	49.50	50.10	4
12	8.25	20.75	71.00	0

Utilization of Lizardfish, *Saurida tumbil*, for Surimi Production

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Abstract

Lizardfish, Saurida tumbil, is an abundant resource that is relatively underutilized. It is a potential raw material for surimi processing. Characterized by its ability to produce formaldehyde endogenously after catch, the lizardfish tends to have comparatively higher levels of formaldehyde, which is known to accelerate protein denaturation. As such minced meat from lizardfish has to be treated to enhance its gel-forming ability.

The objective of this project is to improve the gel-forming ability of surimi made from fresh and frozen lizardfish by sodium pyrophosphate leaching (PL), and the use of egg white and beef-plasma protein concentrate. This was compared against the usual leaching (UL) method.

Pyrophosphate leaching (PL) resulted in better gel-forming ability. Two-times of leaching using 0.2% sodium pyrophosphate resulted in the production of reasonably good quality fish jelly products from fresh and frozen lizardfish. Both egg white and beef-plasma protein concentrate improved the gel-forming ability of surimi from lizardfish. However, if the frozen raw material is of poor quality, neither pyrophosphate leaching nor the addition of egg-white or beef-plasma could improve the gel-forming ability of the surimi. The critical control point for raw material quality is its formaldehyde level. The best quality surimi is obtained when the formaldehyde level is below 15 ppm.

Introduction

The surimi production of Thailand is primarily based on threadfin bream (*Nemipterus* spp) and bigeye snapper (*Priacanthus* spp). There are 15 surimi processing plants in Thailand which operate intermittently throughout the year. From January to August 1993, the amount of Thai surimi exported to Japan, especially those made from threadfin bream, was 16,126 tonnes (*Minato Shinbun*, 21 Oct 1993). However, threadfin bream and bigeye snapper resources are expected to decrease in the future. On the other hand, the demand for surimi-based products has been increasing, not only in Japan, but also in western countries, particulary the United States of America (Wu, 1992).

Lizardfish is considered a low market value fish in this region. It has long been considered a good raw material for the manufacture of fish jelly products in Japan, particularly for *kamaboko*. The annual catch of lizardfish from the South China Sea area ranged from 45,000 and 65,000 tonnes for the period between 1985 and 1991, reaching 74,355 tonnes in 1992. In Thailand, the amount of lizardfish landed in 1991 was 23,677 tonnes and valued at US$7.127 million (Fishery Statistical Bulletin for the South China Sea Area, 1991). In 1992, it was 38,312 tonnes valued at US$10.588 million *(ibid*, 1992). The wholesale prices of the lizard fish at landing ports in Thailand varied from US$ 0.29-0.48 per kg for the period between 1985 to 1990 (*ibid*, 1990), and is about half to one third the value of threadfin bream.

In view of the relatively large landing and low price of lizardfish, and the decline in the supply of other fish species, lizardfish should be considered as a potential source of raw material for the surimi industry. The advantages of using very fresh lizard fish are that the surimi produced is very white with good flavour and has very high gel-forming ability. However the gel-forming ability decreases drastically even with ice storage of the raw material, although the freshness did not change much. Hence, utilization of this fish in this region is presently limited to dried products or used as a filler with other good gel quality fish to reduce costs of production.

Generally, frozen lizardfish cannot be used for frozen surimi (Holmes *et al.*,1992) because it does not produce surimi with good gel-forming ability. Nozaki and co-workers (1978) reported the formation of dimethylamine and formaldehyde by trimethylamine oxide (TMAO) decomposition during low temperature storage of the fish. Formaldehyde is known to denature muscle protein, and subsequently reduce its gel-forming ability.

Theoretically, if TMAO and its breakdown components can be removed from the flesh, for example through leaching of minced meat, gel-forming ability should be improved. The improvement of gel-forming ability of lizardfish by washing minced meat with sodium pyrophosphate solution have been reported by many researchers (Oka *et al.*, 1985; Oka *et al.*, 1988 and Oka and Ono, 1987).

The textural quality is an important functional property of surimi-based products. The use of ingredients such as egg white, beef-plasma protein, and other additives to increase the gel strength of the products are now widely practiced. The purposes of using these additives in the preparation of surimi-based products is to improve both the water-binding capacity and the textural properties. Egg white and beef-plasma protein serve as protease inhibitors and thereby prevent gel softening. Moreover, egg white also imparts a whiter and glossier appearance to the gel (Lee *et al.*, 1992). Several studies on the use of ingredients to inhibit the lowering of gel strength in surimi at various cooking temperatures were reported (Burgarella *et al.*, 1985; Chung and Lee, 1990; Hamann *et al.*, 1990). They all concluded that when these ingredients are added into surimi-based products, they improved the gel strength of the products.

The objectives of this study are to improve the gel forming ability of surimi made from iced and frozen lizardfish by pyrophosphate leaching, and the use of additives such as egg-white powder and beef-plasma protein concentrate to improve the textural properties of surimi-based products.

Materials and Methods

1. Experiment 1 : Effects of sodium pyrophosphate leaching on gel-forming ability of surimi from iced lizard fish.

Fresh lizardfish (*Saurida tumbil*), 27.6 ± 0.9 cm length and 220 ± 90 g by weight were purchased from Punggol Fish Market and transported in ice in an insulated box to MFRD. The fish were labelled as Day-0 fish. However, the fish had been kept in ice on-board for 3 days before landing at Punggol Fish Port. The fish were repacked in ice *viz* fish layer alternating with ice layer and stored in an insulated box. The fish were removed for processing and chemical analysis on Day-0, Day-2, Day-4 and Day-6. Six whole round fish were sampled on the same days as the processing trials, packed in plastic bags and kept at -80°C for further chemical analysis for formaldehyde (FA) and K-value.

The processing procedures for obtaining fish jelly products from three treatments are shown in Fig. 1.

Treatment 1.1 : Unwashed minced meat (MM)

Treatment 1.2 : Minced meat which were washed 2 times in iced water and the 3rd time in iced water with 0.3% salt; called Usual Leaching (UL)

Treatment 1.3 : Minced meat which were washed 3 times leaching in iced water, with 0.2% sodium pyrophosphate during 1st leaching and with 0.3% salt in the 3rd leaching; called pyrophosphate leaching (PL)

The percentage of sodium pyrophosphate (tetra-sodium diphosphate decahydrate, $Na_4P_2O_7.10H_2O$) used was calculated based on the weight of leaching water used. The moisture content of MM, UL and PL was measured immediately after the samples were dehydrated by hydraulic press.

The fish paste samples were prepared from the leached meat by mixing with 2% salt and the necessary amount of iced water, to adjust the moisture to 82% for MM and 85% for UL and PL. The mixing process was done in a vacuum bowl cutter for 1 min 20 sec in order to maintain the temperature of the meat at below 10°C during mixing.

The fish paste was then filled into sausage casings and set at 40°C for 20 min and boiled at 90°C for 20 min. It was then immediately cooled in iced water, then placed under running water for 20 min (Fig. 1). The cooked gel samples from the three treatments were then cut into cylinders of 1 inch height for the determination of gel strength, whiteness, folding ability and teeth cutting score.

2. Experiment 2 : Effects of frequency of leaching on gel-forming ability of surimi from iced lizardfish.

Two batches of lizardfish were bought from Punggol Fish Market on different days. Six whole fish were collected for K-value and formaldehyde determination. Minced meat were prepared from the fish and treated as follows :

Treatment 2.1 : Minced meat washed twice by usual leaching (UL-2)

Treatment 2.2 : Minced meat washed twice by pyrophosphate leaching (PL-2)

Treatment 2.3 : Minced meat washed three times by usual leaching (UL-3)

Treatment 2.4 : Minced meat washed three times by pyrophosphate leaching (PL-3)

For UL-2 and PL-2, 0.3 % of salt was added to the leaching water at second washing. The concentration of sodium pyrophosphate used for PL-2 and PL-3 was 0.2%. Preparation of samples and determination of chemical and physical properties were as described in Experiment 1.

3. Experiment 3 : Effects of various sodium pyrophosphate concentration on gel-forming ability of surimi from iced lizardfish.

Two batches of iced lizardfish were purchased from Punggol Fish Market on different days. Six whole fish were collected for K-value analysis. The minced meat prepared from the meat-bone separator was collected for formaldehyde analysis and measurement of moisture and pH. Leaching water with three different concentrations of sodium pyrophosphate were used for the first leaching process, as follows :

Treatment 3.1 : 1st leaching water with 0.1 % sodium pyrophosphate
Treatment 3.2 : 1st leaching water with 0.2 % sodium pyrophosphate
Treatment 3.3 : 1st leaching water with 0.3 % sodium pyrophosphate

Preparation of samples and determination of chemical and physical properties were as described in Experiment 1.

4. Experiment 4 : Effects of sodium pyrophosphate leaching on gel-forming ability of surimi from frozen lizardfish.

Frozen headed and gutted lizardfish were purchased from a Thai fishing boat equipped with freezing facilities. Two batches from the same lot of fish were processed on different days. Frozen fish were left to thaw overnight at 10°C (approximately 16-17 hours) before further processing. Preparation of samples, determination of chemical and physical properties were as described in Experiment 1.

Treatment 4.1 : Unwashed minced meat from frozen lizardfish (MMF)
Treatment 4.2 : Minced meat from frozen lizardfish washed twice by usual leaching (ULF)
Treatment 4.3 : Minced meat from frozen lizardfish washed twice by pyrophosphate leaching (0.2% sodium pyrophosphate) during 1st leaching

5. Experiment 5 : Effects of various sodium pyrophosphate concentration on the gel-forming ability of surimi from frozen lizardfish.

Two batches of frozen lizardfish, from the same lot as in Experiment 4, were washed twice in iced water with three different concentrations of sodium pyrophosphate. Preparation of samples and the determination of chemical and physical properties were as described in Experiment 1.

Treatment 5.1 : Minced meat washed twice in iced water with 0.1% sodium pyrophosphate (0.1PL)
Treatment 5.2 : Minced meat washed twice in iced water with 0.2% sodium pyrophosphate (0.2PL)
Treatment 5.3 : Minced meat washed twice in iced water with 0.3% sodium pyrophosphate (0.3PL)

6. Experiment 6 : Effect of egg-white powder and beef-plasma protein concentrate on the gel-forming ability of frozen stored surimi made from iced lizardfish.

Commercial egg-white powder and AMP 600N beef-plasma protein concentrate (Wee Hoe Cheng Chemicals Pte Ltd., Singapore) were used.

Six to ten fish were sampled for chemical analysis for formaldehyde, K-value, moisture content and pH. 100 kg of lizardfish was used for making surimi. The surimi were prepared as shown in Fig. 2. The treatments were as follows :

Treatment 6.1 : Minced meat washed twice by usual leaching (UL)
Treatment 6.2 : Minced meat washed twice in iced water with 0.2% sodium pyrophosphate during first leaching (PL)

The surimi (UL and PL) were prepared from iced lizardfish. After the preparation of surimi, one lot was analysed for its gel-forming ability (Day-0 sample). The other lots of surimi were frozen and kept at -20°C and sampled for gel-strength testing after 4, 11, 18 and 32 days at -20°C storage.

7. Experiment 7 : Effects of egg white and beef - plasma protein concentrate (AMP600N) on the gel-forming ability of surimi made from frozen lizardfish.

Lizardfish which were kept in frozen storage for two months were used in this experiment. They were headed, gutted and frozen on board. The frozen fish were delivered to MFRD and kept in cold storage at -20°C. Prior to the making of surimi, they were thawed overnight in a chiller room (15°C). The surimi was prepared according to Fig. 2. After the preparation of the surimi, the moisture content of the surimi was measured.

For preparing the fish jelly product samples (Fig. 3), the frozen surimi was thawed at ambient temperature (25-28°C) and cut into smaller pieces. The surimi pieces were chopped in a Stephan (UM 5 Universal) vertical cutter/mixer with 3% NaCl, 0.5% of egg-white powder or 1.0% of beef-plasma protein concentrate (AMP600N) and water to adjust to a moisture of 85%. The mixing time was about 1 min 20 sec with a maximun temperature of 10°C. The resulting paste was stuffed into 25 mm diameter sausage casing of approximately 150 mm length and heated at 40°C for 20 min followed by 90°C for 20 min. The samples were then cooled immediately under running water. The samples of cooked gel were kept overnight at 5°C in the refrigerator (5°C).

Before measuring the gel strength, whiteness, folding test and teeth cutting test as previously mentioned, samples were put under running water for about 20 min until their temperature was stabilized.

8. Determination of chemical and physical properties.

The pH, K-value, formaldehyde, gel strength, whiteness, folding test and teeth cutting test was conducted according to the procedures listed in the Laboratory Manual on Analytical Methods and Procedures for Fish and Fish Products (Miwa and Low, 1992).

For moisture determination, 5g of minced meat was spread evenly on an aluminium-foil dish. The dish was placed in an infra-red moisture meter (Mettler LP 16) for about 30-35 min and the moisture content was determined.

The grading for the folding test as in Miwa and Low (1992) are as follows :

M : No breakage when folded in quarter
A : Slight tear when folded in quarter
B : Slight tear when folded in half
C : Breakage (but 2 pieces still connected) when folded in half
D : Break completely into 2 pieces when folded in half

The grading for the teeth cutting test as in Miwa and Low (1992) is as follows :

10 Extremely strong springiness
9 Very strong springiness
8 Strong springiness
7 Quite strong springiness
6 Acceptable springiness
5 Acceptable, slight springiness
4 Weak springiness
3 Quite weak springiness
2 Very weak springiness
1 Mushy texture, no springiness

Results and Discussion

1. Experiment 1 : Effects of sodium pyrophosphate leaching on gel-forming ability of surimi from iced lizardfish.

As the raw material was 3 days after catch on arrival at the laboratory, it was fairly fresh with a K-value of 12.81% (Fig. 4). As it was stored in ice, the K-value increased significantly ($P<0.05$) to 23.52% after 6 days in ice at the laboratory (or 9 days after catch). The pH remained relatively unchanged for the minced meat sample. However, the leaching process led to an increase in the pH for both UL and PL samples (Fig.5). As expected PL samples had the highest pH ranging from 6.84 - 6.98. The leaching process also increased the moisture of the leached meat for both UL and PL. Usual leaching resulted in a lesser increase in moisture than pyrophosphate leaching.

Fresh lizardfish, upon arrival at MFRD, had formaldehyde levels of 7.12 ppm and increased significantly ($P<0.05$) to 44.97 ppm at Day-2 (Fig. 6). It continued to increase to 81.29 ppm on Day-6. In this experiment, the white meat fillets of the fish was used for formaldehyde determination instead of the minced meat. Minced meat produced after the fish has passed through the meat bone separator is expected to have a higher level of formaldehyde. This is because the mincing process probably results in increased enzymatic activity, converting trimethylamine oxide (TMAO) in the fish meat to dimethylamine and formaldehyde. This is shown in the higher formaldehyde levels found in the leached meat samples at Day-0. However, as the quality of the fish deteriorated during iced storage, the leaching process would then be more effective in removing the TMAO as well as some of the formaldehyde formed from the minced meat. This is shown in the significantly ($P<0.05$) lower formaldehyde values of UL and PL samples compared with the fillet samples (Fig. 6). Lim and Yasui (1987) studied the effects of usual leaching and alkaline leaching in lizardfish and concluded that leaching was effective in washing out most of trimethylamine oxide (TMAO) in the minced meat, resulting in an increase of meat sol and salt soluble protein extraction. However, leaching not only remove formaldehyde and enzymes responsible for gel degradation (Suwansakornkul *et al.*, 1993), but the process also weakens the firm bond between myosin and actin in fish muscle resulting in improved gel forming ability (Nishioka and Tokunaga, 1990).

The leaching process significantly ($P<0.05$) increased the whiteness (Fig. 7) of the leached meat (both UL and PL) as blood and other water soluble pigments were washed away by leaching. However, sodium pyrophosphate does not result in any improvement in the whiteness of the leached meat as compared with UL.

Although the gel strength continued to drop with the decrease in the quality of the raw material during ice storage, the leaching process significantly ($P<0.05$) enhanced the gel-forming ability (Fig. 8). The effect of pyrophosphate leaching in significantly ($P<0.05$) enhancing the gel-forming ability of the surimi (PL) as compared with surimi from usual leaching (UL) was only observed in surimi made from raw material that were stored in the ice for 4 days. However, when the raw material has been stored in ice for 6 days (or 9 days after catch), the leaching process (both UL and PL) did not enhance the gel-forming ability. Oka and Ono (1987) concluded from their study that lizardfish stored at 5°C for 4 days could be used to make good quality *kamaboko* by leaching in pyrophosphate solution. However, if the lizardfish was stored for 8 days at 5°C, it could not be used to make surimi with good gel.

Folding and cutting scores rated by experienced panelists showed that leaching in pyrophosphate solution gave higher scores due to better springiness (Fig. 8). However, on the sixth day of storage, no difference between UL and PL was observed. Oka *et al.* (1985) stated that the elasticity of *kamaboko* made by leaching lizardfish meat in fresh water was weak, but strong elasticity was formed by leaching in 0.2 % pyrophosphate solution. The results (Fig. 8) showed that throughout the ice storage, except on Day-6, the panelists agreed that PL gave better springiness to the products in terms of teeth-cutting scores. This is especially so for surimi made from Day-4 fish, where folding ability of UL was rated A and B whilst PL's was rated AA. There is a trend that PL always gave higher gel strength and springiness compared to UL even though they were not statistically different .

Therefore,. the use of lizardfish for surimi processing is highly dependant on the freshness of the raw material, which in turn depends very much on handling on-board. Our results showed that even though the fish was fairly fresh upon arrival and well iced throughout its post-harvest storage, the lizardfish which are 9 days after harvesting could not produce surimi with good gel-forming ability. From this study, pyrophosphate leaching was effective to a limited extent, when the freshness of the fish has only deteriorated somewhat. However, once the lizardfish has reached its threshold value, when the formaldehyde formed was above about 50ppm, leaching is not able to enhance the gel-forming ability of its surimi.

2. Experiment 2 : Effects of frequency of leaching on gel-forming ability of surimi from iced lizardfish.

The K-value and formaldehyde levels of the 2 batches of raw material (Table 1) used were different. The first batch was of better quality with a K-value of 15.3% and formaldehyde level of 10.45 ppm. The second batch had a K-value of 22.51% and a formaldehyde level of 20.61 ppm upon arrival at the laboratory. This resulted in Batch 1 producing surimi with better gel forming ability than Batch 2. The results showed that once the raw material quality has dropped below a certain level, e.g., when formaldehyde level was above 20 ppm, the leaching process could not produce surimi with good gel-forming ability (Fig. 9).

The gel strength (Fig. 9) of Batch 1 with two times leaching increased significantly (P<0.05) from 730 (UL-2) to 1,102 g.cm (PL-2). This is in agreement with the findings of Oka *et al.* (1985) regarding the gel-strength enhancing effect of leaching with a 0.2% sodium pyrophosphate solution. However, in Batch 2 there was no difference in gel strength amongst the various treatments; this could be attributed to the lower freshness of the raw material. In never-frozen raw material, pyrophosphate leaching may not be as effective if the raw material quality is low. More experiments should, however, be conducted to confirm the effects of pyrophosphate leaching made from lizardfish of different freshness.

In both batches, there was no significant difference in the number of leaching times on the gel strength of the jelly product. Folding-test and teeth-cutting scores correlated well with the gel strength in both batches. Pyrophosphate seemed to give slightly higher scores in folding test,and springiness in both batches. In Batch 1, the number of times of leaching did not affect the gel-forming ability of the surimi, whilst in Batch 2, made from poorer quality lizardfish, three-times leaching in pyrophosphate solution resulted in surimi with a slightly better gel-forming ability, although the difference was not significant (Fig. 9).

Whiteness of the products depended on initial quality of raw material. Slightly lower whiteness was found in Batch 2 due to inferior freshness, however the various treatments did not result in a significant difference in the whiteness.

When the minced meat was washed twice, the recovery of the minced meat based on the original weight used ranged from 71.67 - 72.99% for UL-2 and 73.66 - 75.99% for PL-2. However, when a third wash was introduced, the recovery dropped by 9-13% for usual leaching and 12-16% for pyrophosphate leaching (Fig. 10).

3. Experiment 3 : Effects of various sodium pyrophosphate concentration on gel-forming ability of surimi from iced lizardfish.

The raw material for both batches were similar in freshness with K-values of 13.54% for Batch 1 and 14.54% for Batch 2. The formaldehyde levels were 23.34 ppm for Batch 1 and 30.62 ppm for Batch 2. The moisture content (Fig. 11) and pH (Fig. 12) increased as the amount of pyrophosphate used was increased. Thus, it can be concluded that pyrophosphate enhanced water absorbing and holding capacity of fish meat; and resulted in higher pH because of its natural alkali property.

In this experiment, minced meat after passing through the meat bone separator was used for formaldehyde analysis. A significant decrease (P<0.05) in formaldehyde content from 10.45 ppm in MM to 16.22 ppm in UL-2 and 14.43 ppm in PL-2 for Batch 1, and from 20.61 ppm in MM to 14.90 ppm in PL-2 for Batch 2. It can be concluded that formaldehyde in the fish meat was removed by the leaching process. However, the results showed that different concentrations of pyrophosphate used had no significant effect on the amount of formaldehyde removed.

Fig. 13 shows the effects of pyrophosphate concentration on gel strength. In Batch 1, leaching solutions containing various concentrations of pyrophosphate showed no significant difference in its effect on whiteness, gel strength, folding ability and teeth cutting scores of the products. In Batch 2, however, higher gel strength and whiteness was obtained when the minced meat was leached in 0.2% and 0.3% sodium pyrophosphate solutions. The panelists however, could not differentiate springiness among the samples. Nishioka and Tokunaga (1990) concluded from their findings that gel strength of kamaboko depended on concentration of sodium pyrophosphate and optimum concentration for sardine meat was 0.15-0.2%. The results of this study also showed that the highest gel strength was obtained in surimi made from 0.2% sodium pyrophosphate leached meat. Thus 0.2% sodium pyrophosphate solution is suitable for use as a leaching solution for the preparation of surimi from lizardfish.

4. Experiment 4 : Effects of sodium pyrophosphate leaching on gel-forming ability of surimi from frozen lizard fish.

For this experiment, the minced meat was washed twice and 0.2% sodium pyrophosphate was used as one of the treatment (PLF), comparing with usual leaching (ULF) and non-leached minced meat (MMF). The fish from Batch 1 and Batch 2 were of similar quality. They were quite fresh and the K-values were 13.73% for Batch 1 and 12.11% for Batch 2. However the initial formaldehyde content in the unwashed minced meat was very high, 52.90 ppm for Batch 1 and 60.57 ppm for Batch 2. It has been reported that during frozen storage, the TMAO in gadoid fishes break down into dimethylaine (DMA) and formaldehyde (Regenstein *et al.*, 1982). There apparently is an enzyme present in some species of fish (Watson, 1939; Amano and Yamada, 1964; Yamada and Amano, 1965). Lizardfish may also have such an enzyme system.

The gel strength of the surimi made from these two batches was very poor as shown in Fig. 14 and the fish jelly product prepared from the unwashed minced meat (MMF) was even lower. This is due to the freezing denaturation of protein in the fish meat caused by the presence of formaldehyde. From this trial, it can be concluded that though the samples were fresh, the poor gel strength was due to the high level of formaldehyde present. Therefore, the gel-forming ability of surimi from lizardfish is highly dependent on the level of formaldehyde present, especially if the lizardfish was frozen.

Fig.14 shows the effect of pyrophosphate leaching on the gel strength of surimi made from frozen lizardfish, resulting in a surimi with comparable gel-forming ability as those prepared from iced fish. These results compared well with those from folding test and teeth cutting scores rated by the panelists. Folding ability was improved from D to AA by leaching in both batches. It can be concluded that pyrophosphate leaching (PLF) was effective in improving the gel-forming ability of surimi from frozen lizardfish compared to usual leaching (ULF) and unwashed minced meat (MMF). The same observation was reported by Oka and Ono (1987) who concluded that lizardfish stored at -35°C for 3 months could still be used to produce good quality kamaboko by leaching in pyrophosphate solution.

The physical appearance of the raw material (headed and gutted block frozen fish) in both batches were not good with the presence of a yellowish taint and rancidity. Whiteness of the products is highly dependent on initial fish quality. The poor quality of the frozen lizardfish gave a darker coloured final fish jelly product compared to those produced from iced fish. Leaching significantly improved the whiteness (Fig. 15).

5. Experiment 5 : Effects of various sodium pyrophosphate concentration on the gel-forming ability of surimi from frozen lizardfish.

The results (Fig. 16) showed that a 0.2% sodium pyrophosphate solution was significantly effective in improving the gel-forming ability of surimi made from frozen lizardfish as compared to a concentration of 0.1%. However, further increases in the strength of the sodium pyrophosphate solution to 0.3% did not significantly increase the gel strength as compared with the effect of 0.2% sodium pyrophosphate. Therefore 0.2% sodium pyrophosphate was suitable for use in leaching solution. Folding and cutting scores showed the same trend in Batch 1, whereas for Batch 2, the panelists could not diflerentiate springiness amongst three samples (0.1%, 0.2% and 0.3% sodium pyrophosphate).

The use of 0.2% and 0.3 % sodium pyrophosphate in Batch 2 resulted in significantly whiter fish jelly products than 0.1%. It can be concluded that 0.2 and 0.3 % pyrophosphate are the optimum concentrations for improving gel-forming ability of frozen lizardfish. Therefore, 0.2 % should be the reasonable concentration for industry point of view.

6. Experiment 6 : Effect of egg-white powder and beef-plasma protein concentrate on the gel-forming ability of frozen stored surimi made from iced lizardfish.

The iced lizardfish (3 days after catch) had K-value of 18.62 ± 4.30%, formaldehyde levels of 11.15 ± 3.05 ppm, pH 6.34 and moisture of 78.68%. These lizardfish were rather fresh. Suwansakornkul *et al.*, (1993) also found that moisture content and pH of iced lizard fish *(S. undosouamis, S. wanieso* and *S. elonnata)* ranged from 77.03 - 81.72% and pH 6.53 - 6.71 respectively.

At the beginning of the storage period for frozen surimi, a significantly higher ($P<0.05$) gel-forming ability was found in UL than PL of frozen surimi made from the iced lizardfish (Fig. 17). The gel strength of UL and PL surimi decreased with the length of frozen storage. However the decrease was not significant. Pyrophosphate leaching did not result in a significant increase in the gel-forming ability of the surimi as compared with UL surimi. However, the quality of both the UL and PL surimi was still acceptable as shown by the folding and teeth cutting scores of AA 5-6. A slightly rough texture, springy-firm gel and dull appearance were observed in samples made from UL surimi, but a smooth texture, springy-soft gel and glossy appearance were observed in PL surimi samples (Table 2).

Theoretically, actomyosin is the main component contributing to kamaboko gel. During the leaching process, actomyosin was probably broken down into myosin and actin as a result of homogenization. In addition, pyrophosphate can dissociate actomyosin into myosin and actin besides enhancing the water holding capacity, protein solubility and improving textural properties. The texture of final product made from myosin was slightly softer than that of actomyosin (Thammarutwasik, 1988). It could be concluded that lower gel strength of PL surimi as compared with UL surimi can be attributed to the formation of myosin gel. In addition, pyrophosphate plays an important role as a cryoprotectant (Suzuki, 1981). Therefore the gel strength of PL surimi during storage at -20°C decreased slower than that of UL surimi (Fig. 17). Thammarutwasik (1988) also concluded that alkaline pyrophosphate leaching of minced sardine meat produced surimi with gel-forming ability that was not significantly different from surimi made by usual leaching.

After the surimi, which were made from iced fish, were frozen stored for 11 days, egg white and beef-plasma protein concentrate were added into both the UL and PL lizardfish surimi in the proportion of 0.5% egg-white and 1.0% beef-plasma protein concentrate (based on weight of surimi used) during the process of gel preparation. Both additives resulted in a slight improvement in the gel forming ability of the surimi as compared with the control (Fig. 17). Beef-plasma protein concentrate showed a higher effectiveness than egg white in the gel strength but the differences between them were not significant, as in folding test, teeth cutting test and sensory evaluation (Table 2).

Both egg-white and beef-plasma protein concentrate are known to inhibit the activity of protease which causes textural degradation of surimi gels (Lee *et al.*, 1992). Moreover, the effects of egg-white and beef-plasma protein concentrate on the setting ability of surimi seemed to be dependent upon the species of fish as well as the temperature and length of cooking (Hamaan *et al.*, 1990, Chung and Lee, 1990 and Shimizu *et al.*, 1981). Hamaan and co-workers (1990) reported that addition of egg-white solid and beef-plasma hydrolysate in low grade Alaska pollack and menhaden surimi increased torsional shear stress and strain for all gels precooked at 60 °C and with a final cook at 90°C, and decreased the density of the myosin heavy chain as observed by electrophoresis. Chung and Lee (1990) reporting on the thermal effects of the gel-forming additives, concluded that the compressive force of surimi gels containing lactalbumin, egg white and wheat gluten increased markedly when the fish paste was initially cooked at 40°C and subsequently at 85°C.

7. Experiment 7 : Effects of egg-white and beef-plasma protein concentrate (AMP600N) on the gel-forming ability of surimi made from frozen lizardfish.

The 2-month old frozen lizardfish used in this experiment had a K-value of 20.29% and a rather high formaldehyde level of 66.90 ppm. In addition, after thawing, the fish meat was fibrous and dehydration was also observed. These physical characteristics observed in the raw material indicated that the fish protein of this batch of 2-month frozen lizardfish had already undegone denaturation during the course of freezing and frozen storage on board. Therefore, the quality of surimi made from this frozen fish was very poor regardless of the various additives used.

At Day-0, or the day the frozen lizardfish arrived at MFRD, the gel strength of UL and PL frozen lizardfish surimi were less than 100 g.cm. Sensory scores were also very low, at a score of D2. Even though egg-white and beef-plasma protein concentrate were added into these surimi (UL and PL) after 4 days storage (-20°C), there was no improvement in the gel forming ability of the surimi (Fig. 18). Therefore, the experiment was terminated. These results showed that if the initial quality of the raw material was too low, additives cannot enhance the gel-forming ability of the surimi. Therefore, it is very important to use good quality raw materials and to ensure that the formaldehyde level is preferably below 25 ppm. From Experiment 6, it was clearly demonstrated that frozen surimi made from good quality iced lizardfish (K-value 18.62% and formaldehyde level 11.15 ppm) had reasonably good gel-forming ability even after about 1 month in frozen storage (-20°C); and that egg-white and beef-plasma protein concentrate were able to increase the gel strength of the 1-month stored surimi.

Conclusion

The results showed that a two-time leaching in 0.2% sodium pyrophosphate solution was effective in enhancing the gel-forming ability of lizardfish surimi under certain conditions. When the iced lizardfish raw material was of good quality (K-value < 20.0%; formaldehyde < 25 ppm) pyrophosphate leaching did not result in a significant increase in the gel-forming ability of the surimi. However, when the raw material quality has dropped (K-value ranged from 21-23%; formaldehyde 30-50 ppm), pyrophosphate leaching was effective in enhancing the gel-forming ability of surimi from lizardfish. But, when the fish was of very poor quality (K-value > 23%; formaldehyde > 50 ppm), pyrophosphate leaching was ineffective.

When using frozen lizardfish as raw material, two times leaching using 0.2% sodium pyrophosphate solution, and the use of additives such as egg-white or beef-plasma concentrate were effective in enhancing the gel forming ability only when the frozen fish was of good quality (K-value < 20%; formaldehyde < 50 ppm). However, once the raw material was not of good quality, pyrophosphate leaching and addition of egg-white or beef-plasma protein concentrate were not effective in enhancing gel forming ability.

The critical point in management of raw material quality for production of surimi from lizardfish is the control of the formaldehyde level. The formaldehyde level must not exceed 50 ppm. Moreover, the best quality surimi from lizardfish is obtained when the formaldehyde level was less than 15 ppm.

Recommendations

The following is a list of recommendations for future research into the use of lizardfish for surimi production :

1. The effect of formaldehyde on the degradation of lizardfish protein should be further studied.
2. The development of formaldehyde in lizardfish during frozen storage should be studied to find the maximum period of frozen storage for the lizardfish raw material, so that surimi with good gel forming ability can be produced.
3. The effect of storage period on the gel forming ability of frozen stored lizardfish surimi should be studied.

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Discussion

Ms Ng added that the critical point in the management of raw material quality for production of surimi from lizard fish is the control of the formaldehyde levels which should not exceed 50 ppm. She emphasized that the best quality surimi from lizard fish was obtained when the formaldehyde level was less than 15 ppm.

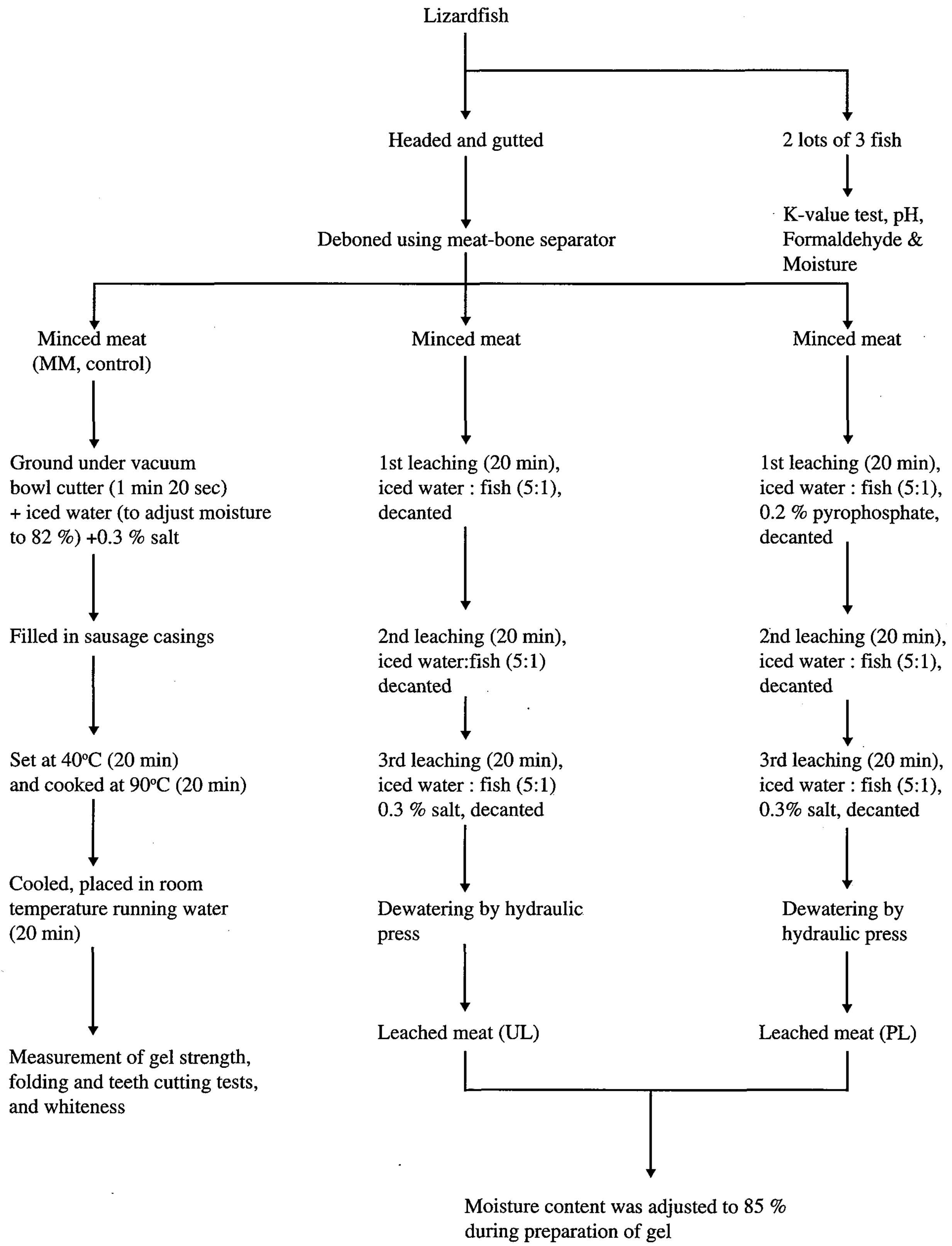

Fig. 1. Preparation of samples for Experiment 1.

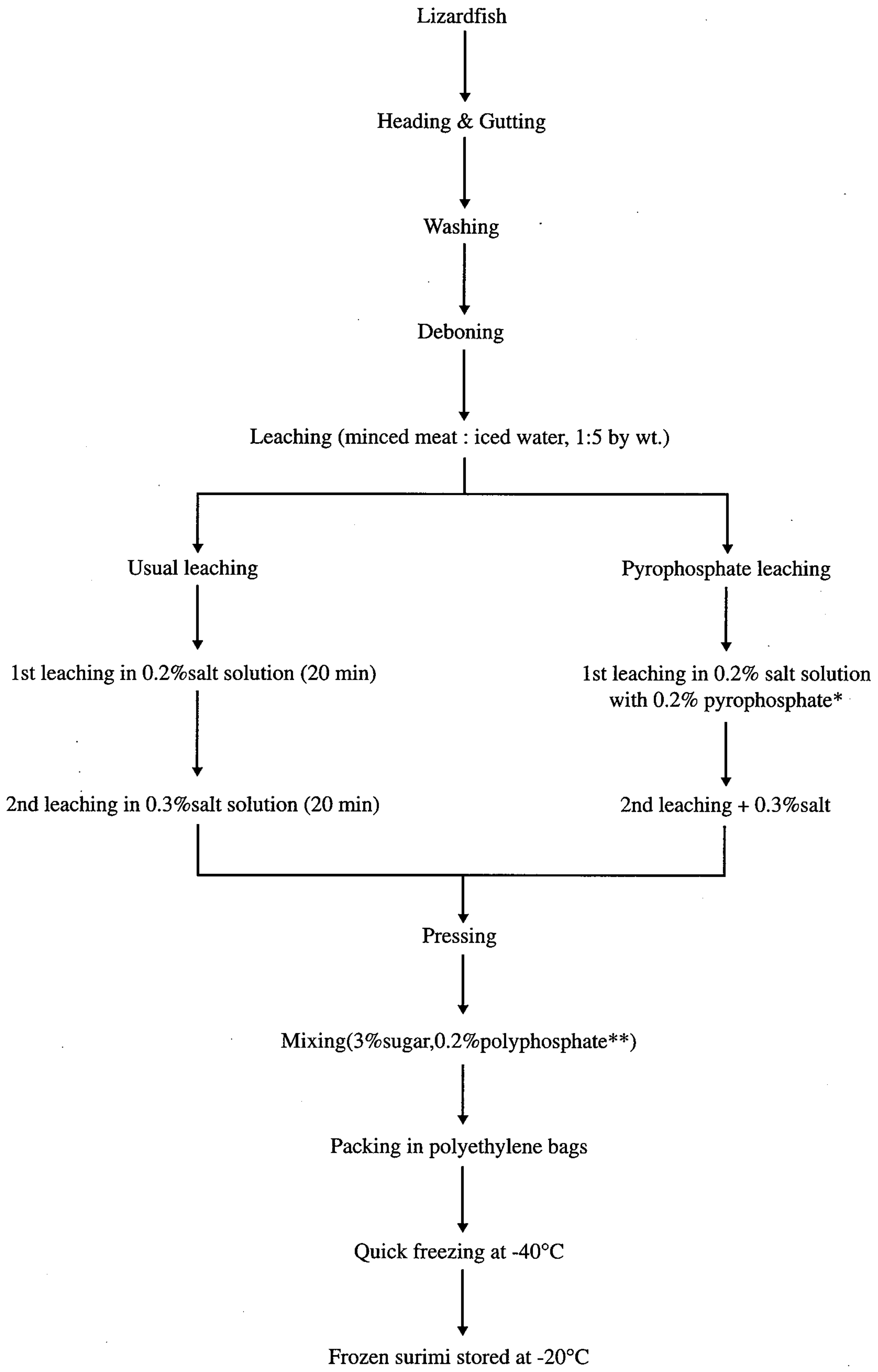

Fig. 2. Diagram showing the production of frozen surimi.

* tetra-Sodium-diphosphate decahydrate ($Na_4P_2O_7 \cdot 10H_2O$)
** 50% pyrophosphate and 50% tripolyphosphate

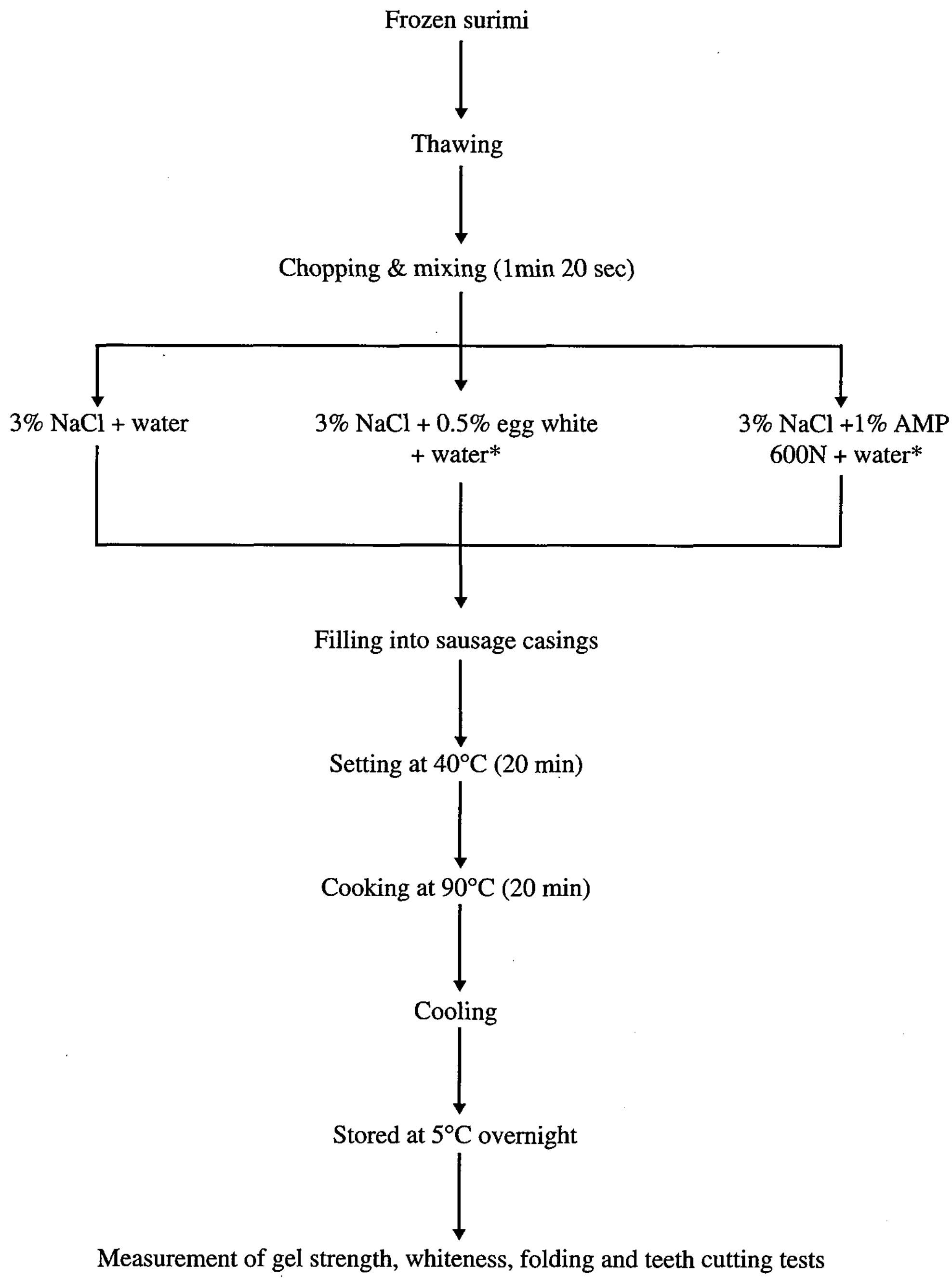

Fig. 3. Diagram showing preparation of samples for testing gel strength.

* Moisture content adjusted to 85%.

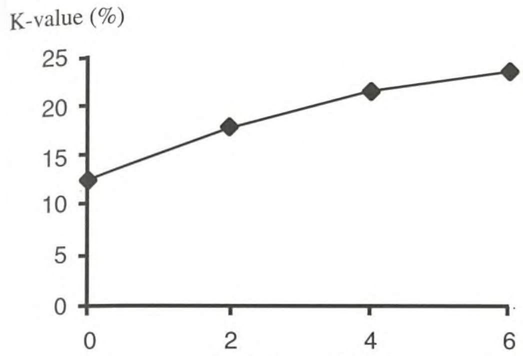

Fig. 4. K-value (%) of lizardfish used for preparing surimi during iced storage. (Day-0 is 3 days after catch.)

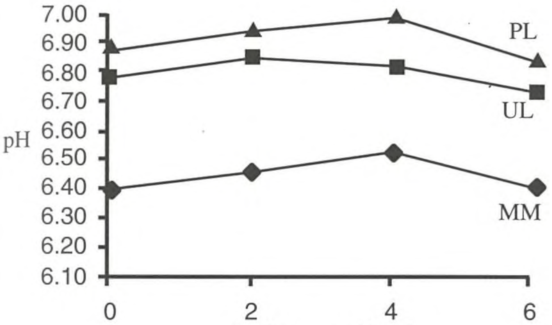

Fig. 5. Changes in pH of minced meat (MM), usual leached meat (UL) and pyrophosphate leached meat (PL) made from iced lizardfish.

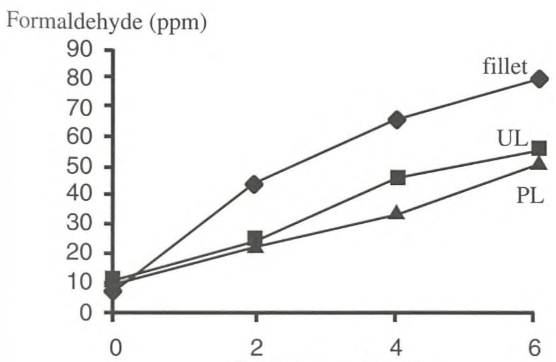

Fig. 6. Changes in formaldehyde levels (ppm) of lizardfish fillet, usual leached meat (UL) and pyrophosphate leached meat (PL) made from iced lizardfish.

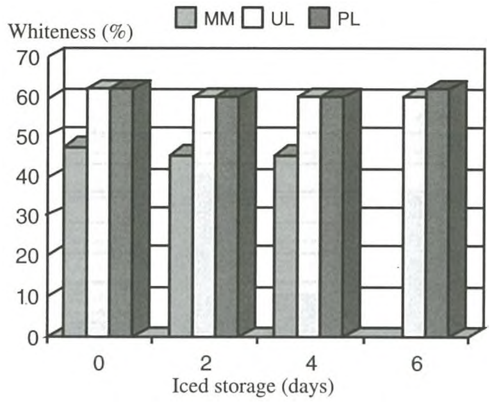

Fig. 7. Changes in whiteness (%) of minced meat (MM), usual leached meat (UL) and pyrophosphate leached meat (PL) made from iced lizardfish.

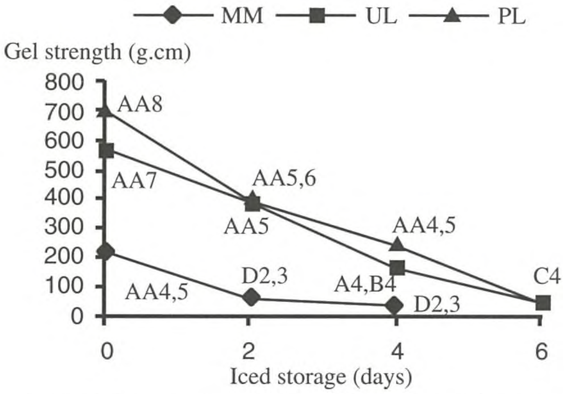

Fig. 8. Changes in gel strength, teeth cutting and folding tests scores of minced meat (MM), usual leached meat (UL) and pyrophosphate leached meat (PL) made from iced lizardfish.

(e.g. AA=Folding test score; 8=teeth cutting test score)

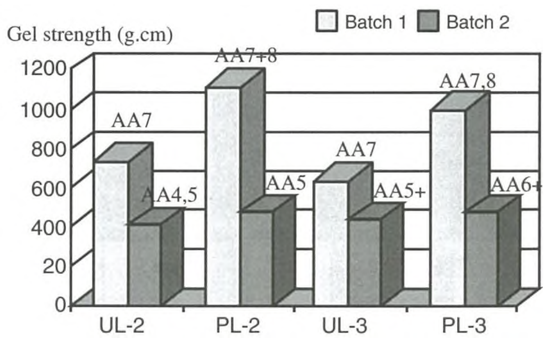

Fig. 9. Changes in the gel strength of surimi made from iced lizardfish which were subjected to different types and times of leaching.UL-2 = Two leaching times by usual leaching without sodium pyrophosphate; UL-3 = Three leaching times by usual leaching without sodium pyrophosphate; PL-2 = Two leaching times by 0.2% sodium pyrophosphate leaching; L-3 = Three leaching times by 0.2% sodium pyrophosphate leaching. (e.g. AA=Folding test score; 8=teeth cutting test score)

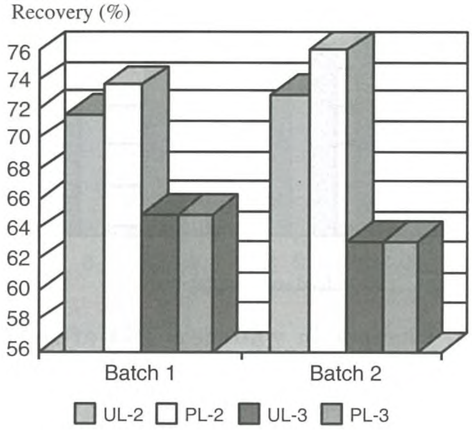

Fig. 10. Percentage recovery of leached minced meat after washing by usual leaching (UL) and pyrophosphate leaching (PL).
UL-2 = Two leaching times by usual leaching without sodium pyrophosphate
UL-3 = Three leaching times by usual leaching without sodium pyrophosphate
PL-2 = Two leaching times by 0.2% sodium pyrophosphate leaching
PL-3 = Three leaching times by 0.2% sodium pyrophosphate leaching

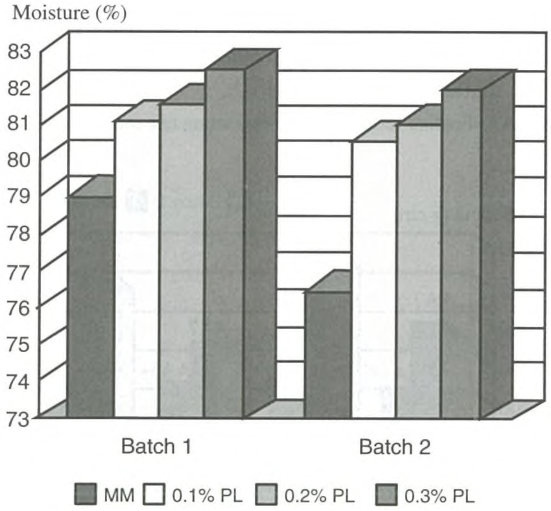

Fig. 11. Effect of different concentration of pyrophosphate leaching on the moisture content (%) of leached meat from iced lizardfish as compared to the minced meat control (MM).

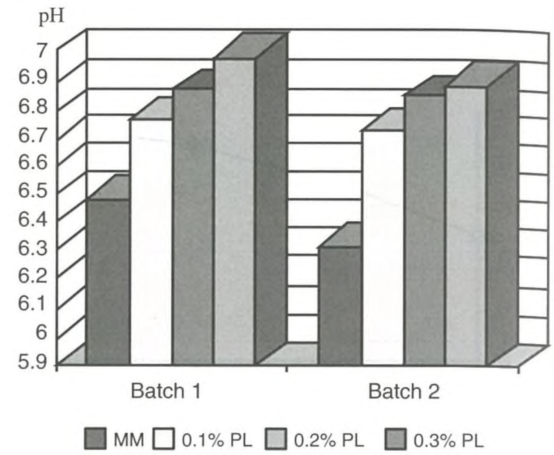

Fig. 12. Effect of different concentration of pyrophosphate leaching on the pH of leached meat from iced lizardfish as compared to the minced meat control (MM).

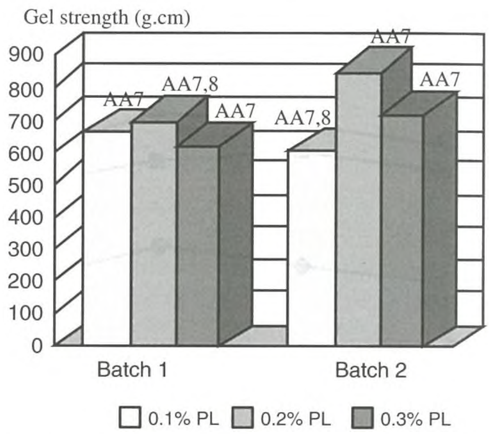

Fig. 13. Gel strength, folding test and teeth cutting test characteristics of lizardfish meat leached in different concentrations of pyrophosphate solution. (e.g. AA=Folding test score; 8=teeth cutting test score)

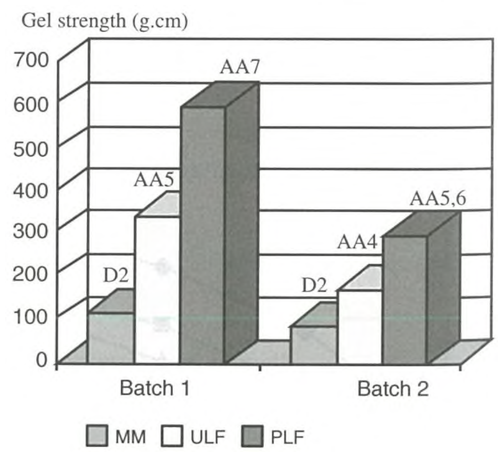

Fig. 14. Gel strength, folding test and teeth cutting test characteristics of surimi from frozen lizard fish after usual leaching (ULF) and pyrophosphate leaching (PLF) as compared with unwashed minced meat (MMF). Pyrophosphate leaching was done using 0.2% sodium pyrophosphate and two leaching times. (e.g. AA=Folding test score; 8=teeth cutting test score)

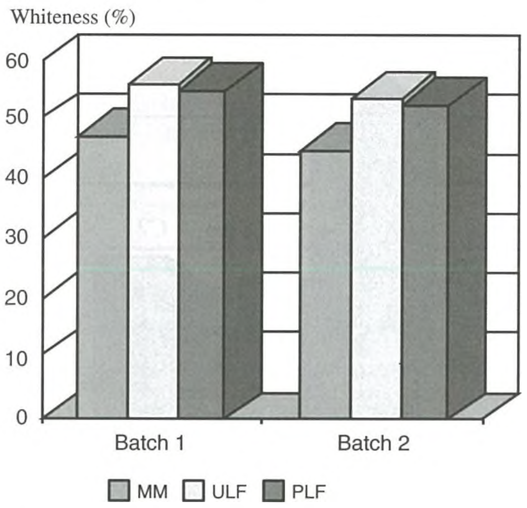

Fig. 15. Whiteness reading of jelly product made from frozen lizardfish after usual leaching (ULF) and pyrophosphate leaching (PLF) compared with unwashed minced meat (MMF).
Pyrophosphate leaching was done using 0.2% sodium pyrophosphate and two leaching times.

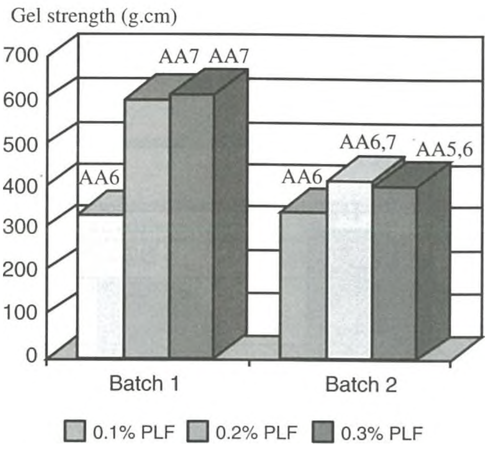

Fig. 16. Gel strength, folding test and teeth cutting test characteristics of surimi made from frozen fish leached with different concentrations of sodium pyrophosphate solution.
0.1% PLF = leaching using 0.1% sodium pyrophosphate solution
0.2% PLF = leaching using 0.2% sodium pyrophosphate solution
0.3% PLF = leaching using 0.3% sodium pyrophosphate solution
(e.g. AA=Folding test score; 8=teeth cutting test score)

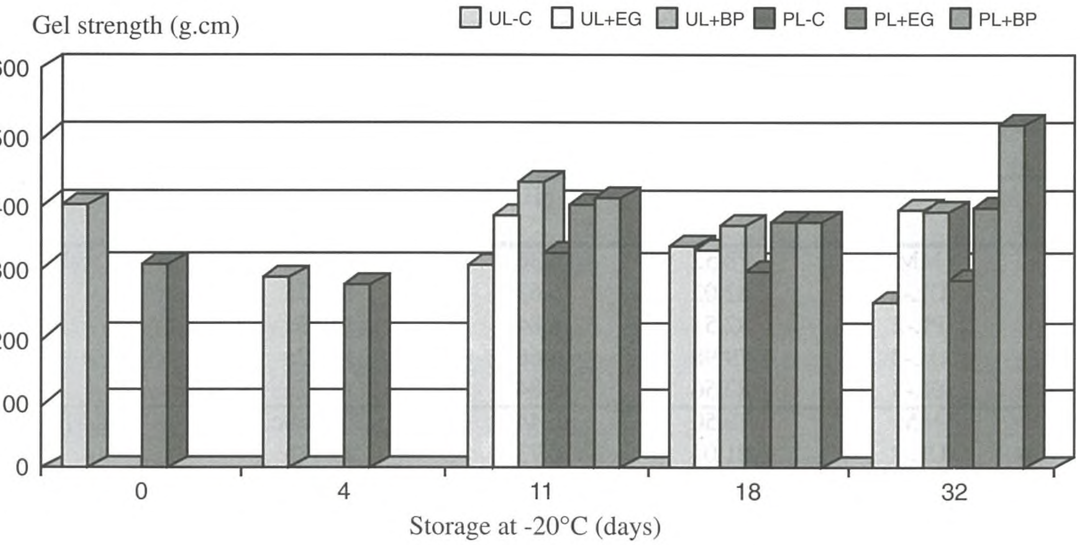

Fig. 17.The effect of leaching and additives on changes in gel strength of surimi made from iced lizardfish and kept under frozen (-20°C) storage.
UL-C = Usual leaching control
UL-EG = Usual leaching and 0.5% egg white used in gel preparation
UL-BP = Usual leaching and 1.0% beef-plasma protein concentrate used in gel preparation
PL-C = Pyrophosphate leaching control
PL-EG = Pyrophosphate leaching and 0.5% egg white used in gel preparation
PL-BP = Pyrophosphate leaching and 1.0% beef-plasma protein concentrate used in gel preparation

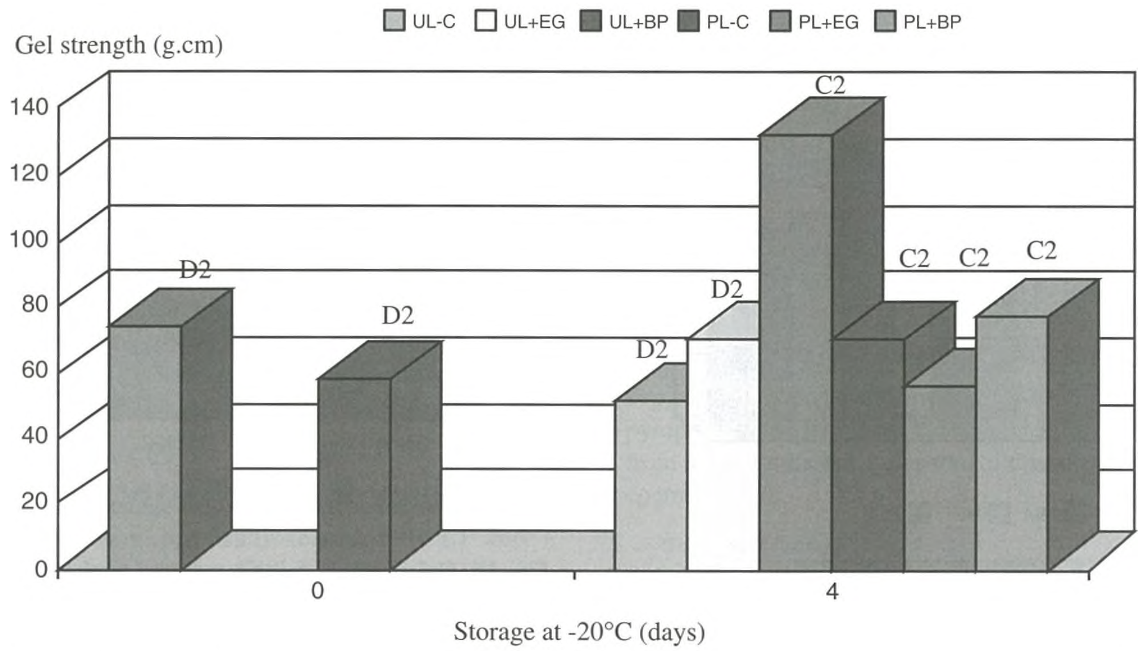

Fig. 18. Effect of leaching and additves on the gel forming ability, folding test and teeth cutting test results of surimi made from 2-month old frozen stored lizardfish.
UL-C = Usual leaching control
UL-EG = Usual leaching and 0.5% egg white used in gel preparation
UL-BP = Usual leaching and 1.0% beef-plasma protein concentrate used in gel preparation
PL-C = Pyrophosphate leaching control
PL-EG = Pyrophosphate leaching and 0.5% egg white used in gel preparation
PL-BP = Pyrophosphate leaching and 1.0% beef-plasma protein concentrate used in gel preparation

Table 1. Chemical properties of minced meat (MM), usual leached meat (UL) and pyrophosphate leached (PL) meat made from iced lizardfish.

Batch	Treatment	Moisture (%)	pH	Formaldehyde (ppm)	K-value (%)
1	MM	78.52	6.36	10.45a	15.30
	UL-2	82.02	6.63	16.22a	-
	PL-2	82.51	6.84	14.43a	-
	UL-3	79.98	6.66	15.52a	-
	PL-3	82.56	6.84	12.27a	-
2	MM	78.50	6.44	20.61abc	22.51
	UL-2	81.04	6.73	23.18b	-
	PL-2	83.00	6.94	14.90c	-
	UL-3	80.50	6.79	17.41c	-
	PL-3	82.99	6.90	16.80c	-

MM = Minced meat
UL-2 = Two leaching times by usual leaching without sodium pyrophosphate
UL-3 = Three leaching times by usual leaching without sodium pyrophosphate
PL-2 = Two leaching times by 0.2% sodium pyrophosphate leaching
PL-3 = Three leaching times by 0.2% sodium pyrophosphate leaching
a,b,c Means of the same trial followed by identical letters are not significantly different (P<0.05)

Table 2. Effect of leaching and additives on folding test, teeth cutting test and sensory evaluation results of surimi made from iced lizardfish and kept under frozen storage (-20°C).

Treatments	Storage days	Folding & teeth cutting tests	Sensory evaluation		
			Texture	Gel	Appearance
UL-control	0	AA 6	Slightly rough	Springy & firm	Dull
	4	AA 5-6			
	11	AA 5-6			
	18	AA 6			
	32	AA 5			
UL + 0.5% egg white	11	AA 6	Slightly rough	Springy & firm	Dull, white
	18	AA 6			
	32	AA 5-6			
UL + 1.0% beef plasma	11	AA 6	Slightly rough	Hard	Dull, dark
	18	AA 6			
	32	AA 5-6			
PL-control	0	AA 6	Smooth	Springy & soft	Glossy, white
	4	AA 5-6			
	11	AA 5-6			
	18	AA 5-6			
	32	AA 5-6			
PL + 0.5% egg white	11	AA 6	Smooth	Springy & soft	Glossy, white
	18	AA 6			
	32	AA 6			
PL + 1.0% beef plasma	11	AA 6	Smooth	Hard	Dark
	18	AA 6			
	32	AA 6			

UL = Usual leaching
PL = Pyrophosphate leaching (0.2% sodium pyrophosphate, leached twice)

Effect of Citric Acid on the Quality and Shelf-Life of Dried Shrimp

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Abstract

Dried shrimp was processed by soaking fresh shrimp in citric acid solution of 0, 0.1, 0.3, 0.5% for 20 minutes, then boiling in 5% brine to select appropriate concentration of citric acid. Shelf-life storage of dried shrimp under vacuum and air packed at 30 ± 2°C and 10 ± 2°C was studied. Chemical (astaxanthin, ammonia, moisture, NaCl, pH), microbiological (TVC, anaerobe, yeast and mould, E. coli, S. aureus, Salmonella, Vibrio), physical (A_w, colour using L. a, b system) analysis, and sensory evaluation were conducted. It was found that astaxanthin content and overall acceptability of samples soaked in 0.1, 0.3, 0.5% citric acid solution were not significantly different (P>0.05) but they were significantly better than samples without citric acid dipping. Therefore the lowest concentration of citric acid solution, 0.1% was selected for studying the changes of quality during storage under vacuum and air packed. The results showed that dried shrimp under all conditions of packaging stored at 10 ± 2°C had shelf life longer than 14 weeks, and had better quality than samples stored at 30 ± 2°C. Samples stored under air packed and vacuum at 30 ± 2°C had shelf life of 6 and 8 weeks, respectively. Moreover dried shrimp dipped in citric acid solution had better colour, higher astaxanthin content and higher acceptability score as well as lower ammonia content than samples without citric acid dipping (P<0.01) both stored under vacuum and air packed at 30 ± 2°C and 10 ± 2°C.

Introduction

Dried shrimp is a Thai traditional fishery product processed not only for domestic consumption but also for export to foreign countries. The major markets for export are Hong Kong, the United States and Japan (Department of Commerce, 1990). It is an intermediate moisture product with A_w 0.72-0.76. Generally, dried shrimp is produced from fresh shrimp boiled in 3-4% of salt and then sun dried. The main qualities of dried shrimp are colour and aroma which are normally unstable. That is the reason the producers prefer to add some colouring agents even though the Thai Food and Drug Administration Act forbids the addition of any colouring agent to exporting dried and salted fishery products. However, some countries still use them. Therefore, the problem is the misuse of colouring agents in this product, such as dyes etc.

Since colour of dried shrimp is a major characteristic, the method or other additives have been taken into account. Citric acid is the one widely used in processed foods. Its major advantages as an acidulant are its high solubility in water, the appealing effects on food flavour, and its potent metal-chelating action including water holding capacity. Citric acid has been used in foods in the United States for over 100 years (Lopez, 1981). It chelates trace metals which may cause haze or deterioration of colour or flavour. It is also employed to adjust the acidity of relishes, sauces, and other food products requiring flavour enhancement. In canned crab meat, lobster meat, scallops, and oysters, citric acid is used to prevent discoloration and development of off-flavours and odours (Lopez, 1981).

Therefore, the development of dried shrimp processing by using citric acid to stabilize the colour as well as modified packaging to extend the shelf life have been conducted.

The objectives of this study are to : 1) determine the suitable concentration of citric acid, and 2) study quality changes during storage of dried shrimp with and without citric acid in vacuum and atmospheric packaging.

Materials and Methods

1. Raw material : Fresh shrimp (*Metapeneaus* spp.).

2. Methods :

a. Determine the suitable concentration of citric acid (Fig. 1).

Fresh shrimp was washed and divided into 4 lots. Each lot was soaked in different concentration of citric acid at 0, 0.1, 0.3 and 0.5%, respectively for 20 minutes. The shrimp was then boiled in 5% brine at the ratio of brine to shrimp 1:1 for about 8-10 minutes, dried at 55°C for about 6-7 hours in a hot air oven (Torry kiln), and shelled. Then 100-gram lots were packed in low density polyethylene (LDPE) bags and stored at 30 ± 2°C. The packed dried shrimp was sampled for quality assessment by physical and chemical analysis (A_w, sensory evaluation, moisture contents, astaxanthin, ammonia and pH) once a week until unacceptable. The appropriate treatment was selected for further experiments.

b. Shelf-life study on the quality changes of dried shrimp in packages (Fig. 2).

Dried shrimp was produced by using the suitable concentration of citric acid from the previous step. Each 75 grams was vacuumed and atmospheric packed (air packed) in polyamide/low density polyethylene (PA/LDPE) bags. The samples were kept at 30 ± 2°C and 10 ± 2°C.

3. Physical analysis :

Sensory evaluation was conducted using hedonic rating scale (Larmond, 1970) 9 points with 10-20 trained panelists, comprising 25% men and 75% women. A_w using A_w meter (Novasina Thermoconstanter TH/RTD 733).

4. Chemical analysis :
   a. Astaxanthin (Biede, 1982);
   b. Ammonia (AOAC, 1990);
   c. Moisture (AOAC, 1990);
   d. Salt (FAO, 1981); and
   e. pH (Miwa and Low, 1992).

5. Microbial analysis :
   a. Total viable count (Miwa and Low, 1992);
   b. Yeast and mould (AOAC, 1984);
   c. *Staphylococcus aureus* (AOAC, 1984);
   d. *Escherichia coli* (AOAC, 1984);
   e. *Salmonella* (AOAC, 1984);
   f. *Vibrio cholera* (AOAC, 1990); and
   g. *Clostridium* spp. (AOAC, 1984).

6. Statistical analysis :

Split plot in randomized block design was used, and the SAS computer program version 6.03 was used to analyse the data from this experiment.

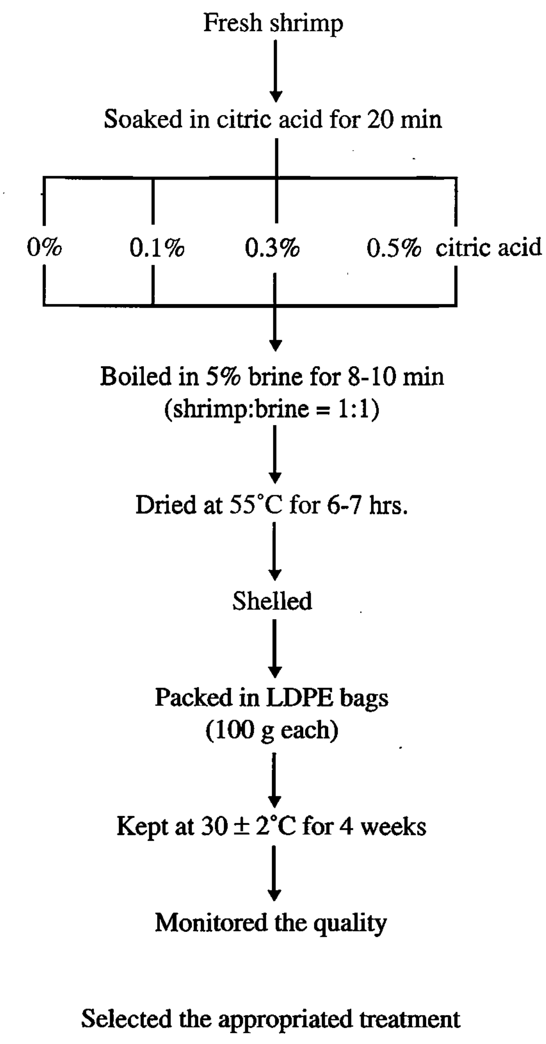

Fig.1. The suitable concentration of citric acid for dried shrimp.

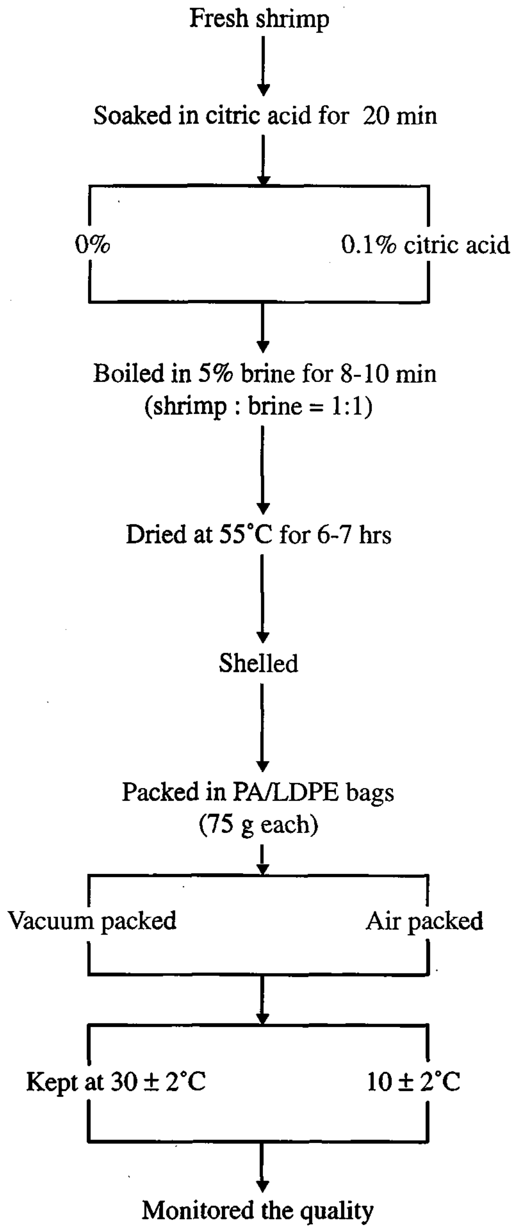

Fig.2. Dried shrimp in package during storage.

Results And Discussion

1. The suitable concentration of citric acid for dried shrimp.

Dried shrimp samples produced by citric acid soaking treatments at various concentrations of 0, 0.1, 0.3 and 0.5% were packed and stored at 30 ± 2°C. Quality assessment was carried out once a week until unacceptable. It was found that the sample of all treatments had moisture content in the range of 19-24% and A_w less than 0.95 which is able to inhibit the bacterial growth (Lesiture and Podel, 1976). The sample with 0.1% citric acid was the lowest in moisture content of about 19-20% (Table 1) and varied significantly (P< 0.05) among treatments throughout the storage (Tables 2&3). The initial pH of sample at week 0 was about 8.15-8.18. However, it could not be decided whether the variation of pH during storage was due to storage time or concentration of citric acid.

In addition, astaxanthin which is a good index for colour was higher in every sample of dried shrimp with citric acid than the untreated samples (P<0.05)(Table 4). Ammonia content of all treatments increased during storage but the lowest reading was also found in dried shrimp with 0.1% citric acid (Table 5). By sensory evaluation, no significant difference (P<0.05) was found in aroma, colour, flavour and texture of all treatments throughout the storage, although the dried shrimp with citric acid had higher acceptable scores than those without citric acid (Table 6).

According to the Thai Industrial Standard (TIS 1003-1990), the requirements of good quality of dried shrimp are moisture content ≤ 20%, NaCl ≤10% (dried weight), pH < 8.0, no colouring agents, TVC $\leq 10^5$/g, *Escherichia coli* < 10 (MPN/g), *Staphylococcus aureus* <100/g, no Salmonella in 25 g sample, no *Clostridium perfringen* in 0.1 g sample, mould $\leq 2x10^2$/g, no trace of decomposed-odour and no adulterant. It could be concluded that the quality of dried shrimp of all treatments met the requirements of TIS throughout the period of storage. However, the results of physical and chemical analysis showed that dried shrimp with citric acid had better quality than the samples without citric acid. In terms of astaxanthin, the colour index of good quality dried shrimp, those with 0.1% citric acid gave a higher reading throughout the period of storage. Therefore, this treatment was selected for the further experiments.

2. The quality changes of dried shrimp during storage.

a. At 30 ± 2°C

As an integral part of this experiment, dried shrimp was produced and packed by the method shown in Fig. 2. At this temperature, astaxanthin of both dried shrimp with and without citric acid in vacuum packed were higher than in air packed (P≤ 0.01) and decreased as storage time increased (Fig. 3). It means that oxygen in air packed causes oxidation of astaxanthin while vacuum packed slows down this reaction. (Biede *et al.*, 1982; Wibulset *et al.*, 1986; Braekkan, 1971).

Ammonia content, which is another good quality index of dried shrimp was recorded as in Fig. 4. The ammonia of all samples increased as the time increased but was still lower than 800 ppm which was the criteria for good quality dried shrimp (Chukpiwong, 1983; Worapong, 1988). However, there was no interaction of ammonia content between treatments, packaging conditions and storage time ($P \leq 0.01$); the readings in air packed were higher than in vacuum packed throughout the stroage.

In addition, there was not much difference in moisture content, A_w, pH and NaCl in all treatments during storage (Fig. 5). Dried shrimp with citric acid had a slightly higher moisture content than without citric acid due to the water holding capacity of citric acid (Sharma and Seltzor, 1979) and corresponded to A_w. It was found that both packaging conditions and storage time did not affect moisture content and A_w. The observed A_w of all samples were less than 0.76, indicating a safe condition from microorganisms.

Besides astaxanthin, colour measurement has been conducted by using Chroma meter (Minolta SR-300). Colour was read by L, a, b system (Fig. 6). The results corresponded to both the content of astaxanthin and sensory scores.

By sensory evaluation, the panelists accepted all treatments during 8 weeks of storage (Fig. 7). The colour and texture scores of dried shrimp with 0.1% citric acid were higher than without citric acid due to the higher moisture content. It was found that colour scores had a linear regression with astaxanthin of $R^2 = 0.63$.

According to microbial inhibitory effect of citric acid (Brannen *et al.*, 1990), no growth of microorganisms, and prolonged shelf-life in all treatments were found during 8 weeks of storage; but growth of mould was observed in dried shrimp without citric acid after 5 weeks of storage (Fig. 8). It could be concluded that microbial quality of dried shrimp in this experiment met the requirements of TIS 1003-1990.

Therefore, vacuum packed incorparated with citric acid gave better quality dried shrimp than air packed without citric acid.

b. At 10 ± 2°C

The changes of astaxanthin and ammonia content of dried shrimp in air and vacuum packed stored at this temperature showed the similar trend to that of 30 ± 2°C (Figs. 9,10). However, the vacuum packing had the advantage of slowing down the oxidation of astaxanthin and ammonia formation. These results corresponded with sensory scores of flavour (Fig. 11) - the panelists detected less ammonium odour from the samples in vacuum packed than in air packed at corresponding periods of storage. Moreover, the decrease of astaxanthin and increase in ammonia at 10 ± 2°C were slower than at 30 ± 2°C. Crook and Ritchie (1983) reported that the increase of ammonia content in fish flesh slowed down when stored at 4-5°C because decomposition of protein was slow. Not only astaxanthin and ammonia contents, but the other qualities (pH, moisture and A_w) were also more stable than those at 30 ± 2°C (Fig. 12).

The colour measurement using Chroma meter (Minolta SR-300) by L, a, b system (Fig. 13) gave results similar to the samples kept at 30 ± 2°C, and also corresponded with the content of astaxanthin. At both storage temperatures, a linear correlation equation using SAS computer program version 6.03 was obtained as

$$Y = 1.5 + 0.51a - 0.14b$$

and $R^2 = 0.855$ when Y = astaxanthin content, a = a value or hue, b = b value or chroma. In addition, bacterial analysis (Fig. 14) was lower than that of samples kept at 30 ± 2°C due to slower activity at lower temperature. The quality of dried shrimp stored at 10 ± 2°C was still acceptable during 14 weeks of storage.

Therefore, citric acid incorporated with vacuum package and low temperature storage at 10±2°C gave the best quality, and prolonged the shelf-life of dried shrimp for more than 14 weeks.

Conclusions

1. Citric acid was appropriated to produce the good quality of dried shrimp.
2. Shelf life of dried shrimp with 0.1% citric acid, vacuum packed and stored at 10±2°C was longer than 14 weeks. Whereas the shelf life of dried shrimp without citric acid, air packed and kept at 30±2°C was only 8 weeks.
3. Colour measurement (L,a,b system) could be applied for astaxanthin content by using the linear regression equation: $Y = 1.54 + 0.51a - 0.14b$, when Y= astaxanthin, a= a(hue), b= b (chroma).

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Table 1. Moisture content (%) of dried shrimp at various citric acid concentrations during 4 weeks.

Storage time (weeks)	Moisture content (%)			
	Concentrations of citric acid (%)			
	0	0.1	0.3	0.5
0	22.62^{de} ± 0.12	19.13^{j} ± 0.12	23.47^{bc} ± 0.10	24.47^{a} ± 0.03
1	21.94^{f} ± 0.21	19.01^{j} ± 0.15	23.54^{bc} ± 0.09	23.13^{ad} ± 0.11
2	21.06^{g} ± 0.16	20.15^{i} ± 0.29	24.68^{a} ± 0.18	23.25^{bc} ± 0.31
3	20.94^{gh} ± 0.29	19.18^{j} ± 0.16	23.31^{bc} ± 0.07	23.29^{bc} ± 0.24
4	20.43^{bi} ± 0.12	19.06^{j} ± 0.27	22.45^{ef} ± 0.21	23.73^{b} ± 0.19

a.....i are significantly different ($P \leq 0.05$).

Table 2. Water activity (A_w) of dried shrimp at various citric acid concentrations during 4 weeks.

Storage time (weeks)	Water activity (Aw)			
	Concentrations of citric acid (%)			
	0	0.1	0.3	0.5
0	0.78^{d} ± 0.02	0.76^{ef} ± 0.01	0.80^{ab} ± 0.01	0.08^{bcd} ± 0.01
1	0.77^{e} ± 0.02	0.75^{fg} ± 0.02	0.80^{ab} ± 0.01	0.78^{cd} ± 0.01
2	0.75^{fg} ± 0.01	0.76^{ef} ± 0.01	0.81^{a} ± 0.01	0.80^{ab} ± 0.01
3	0.75^{ef} ± 0.01	0.76^{fg} ± 0.02	0.81^{a} ± 0.01	0.79^{bc} ± 0.01
4	0.73^{h} ± 0.01	0.74^{gh} ± 0.01	0.79^{cd} ± 0.01	0.78^{cd} ± 0.01

a.....h are significantly different ($P \leq 0.05$).

Table 3. Astaxanthin content (unit per gram dried weight) of dried shrimp at various citric acid concentration during 4 weeks.

Storage time (weeks)	Astaxanthin content (unit per gram dried weight)			
	Concentrations of citric acid (%)			
	0	0.1	0.3	0.5
0	4.14^{b} ± 0.05	4.23^{a} ± 0.03	4.28^{a} ± 0.01	4.28^{a} ± 0.05
1	3.35^{c} ± 0.04	3.34^{c} ± 0.01	3.35^{c} ± 0.04	3.36^{c} ± 0.01
2	3.03^{f} ± 0.03	3.11^{e} ± 0.01	3.21^{d} ± 0.01	3.14^{e} ± 0.04
3	2.57^{i} ± 0.05	2.65^{h} ± 0.01	2.74^{g} ± 0.03	2.63^{h} ± 0.02
4	2.05^{l} ± 0.01	2.30^{j} ± 0.07	2.27^{j} ± 0.02	2.16^{k} ± 0.06

a.....l are significantly different ($p \leq 0.05$)

Table 4. Ammonia content (ppm) of dried shrimp at various citric acid concentrations during 4 weeks.

Storage time (weeks)	Ammonia content (ppm)			
	Concentrations of citric acid (%)			
	0	0.1	0.3	0.5
0	32.59^{g} ± 3.77	14.54^{hi} ± 4.41	20.28^{h} ± 4.14	11.37^{i} ± 2.94
1	62.49^{d} ± 1.96	31.82^{g} ± 1.17	51.94^{e} ± 1.31	41.83^{f} ± 2.64
2	100.05^{a} ± 1.06	40.56^{f} ± 1.88	60.01^{d} ± 1.10	59.82^{d} ± 1.48
3	98.65^{a} ± 2.62	42.05^{f} ± 3.80	70.52^{c} ± 2.21	71.96^{c} ± 3.15
4	95.00^{a} ± 3.07	44.29^{f} ± 2.06	79.20^{b} ± 3.15	78.72^{b} ± 3.96

a.....i are significantly different ($P \leq 0.05$).

Table 5. pH of dried shrimp at various citric acid concentration during 4 weeks.

Storage time (weeks)	pH			
	Concentrations of dried shrimp(%)			
	0	0.1	0.3	0.5
0	8.18^{d} ± 0.01	8.16^{d} ± 0.03	8.18^{d} ± 0.03	8.15^{d} ± 0.01
1	8.32^{b} ± 0.02	8.38^{ab} ± 0.05	8.34^{b} ± 0.02	8.33^{b} ± 0.01
2	8.44^{a} ± 0.01	8.49^{a} ± 0.01	8.51^{a} ± 0.02	8.48^{a} ± 0.02
3	8.31^{c} ± 0.06	8.25^{c} ± 0.09	8.24^{c} ± 0.07	8.33^{c} ± 0.04
4	8.38^{bc} ± 0.01	8.29^{bc} ± 0.01	8.33^{bc} ± 0.02	8.27^{bc} ± 0.03

a.....d are significantly different ($P \leq 0.05$).

Table 6.Sensory evaluation scores of dried shrimp at various citric acid concentrations

Storage time (weeks)	Overall acceptability scores			
	Concentrations of dried shrimp(%)			
	0	0.1	0.3	0.5
0	4.23[a]	4.47[a]	4.48[a]	4.60[a]
1	3.79[a]	4.18[a]	4.10[a]	4.42[a]
2	3.45[b]	3.76[b]	3.69[b]	3.84[b]
3	2.47[c]	2.75[c]	2.54[c]	2.83[c]

a.....c are significantly different (p≤0.05)

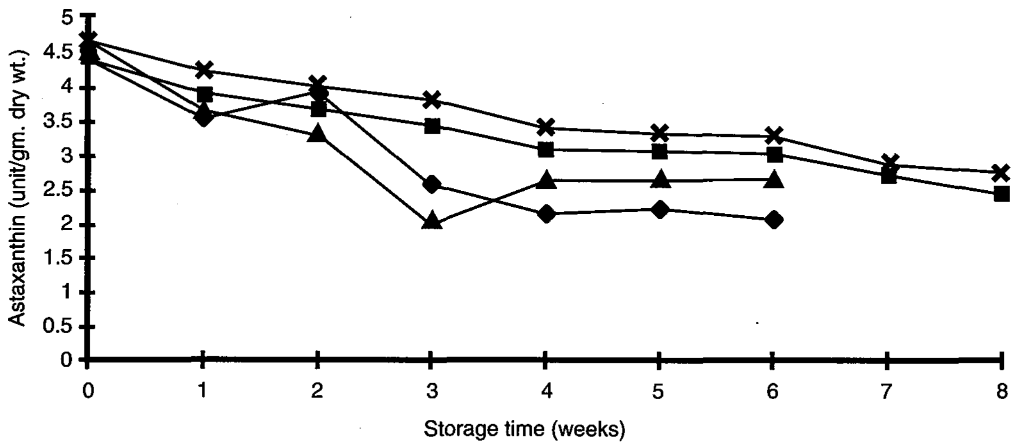


Fig. 3. Astaxanthin content of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 30±2°C.

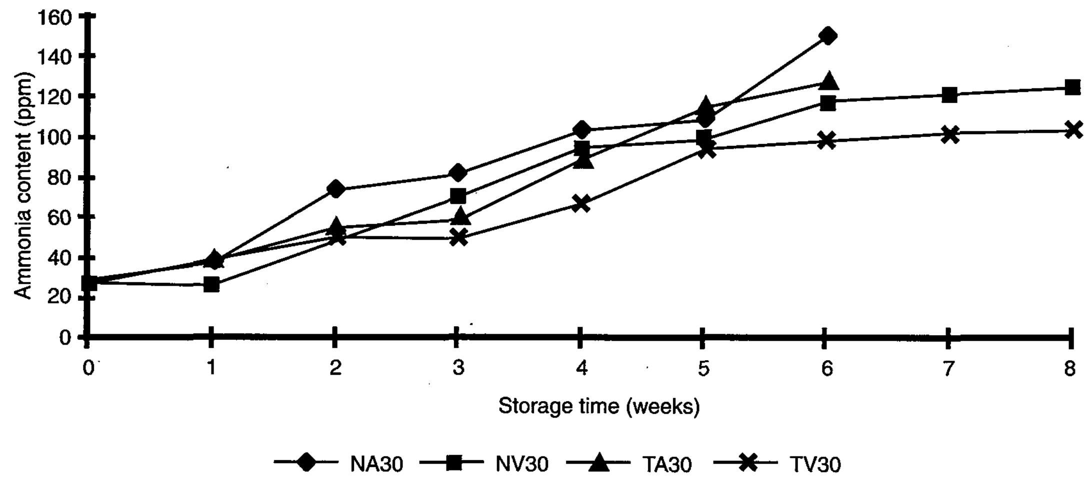


Fig. 4. Ammonia content of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 30 ± 2°C.

NA30 = No treatment, atmospheric condition, 30°C; NV30 = No treatment, vacuum condition, 30°C; TA30 = Citric acid treatment, atmospheric condition, 30°C; TV30 = Citric acid treatment, vacuum condition, 30°C.

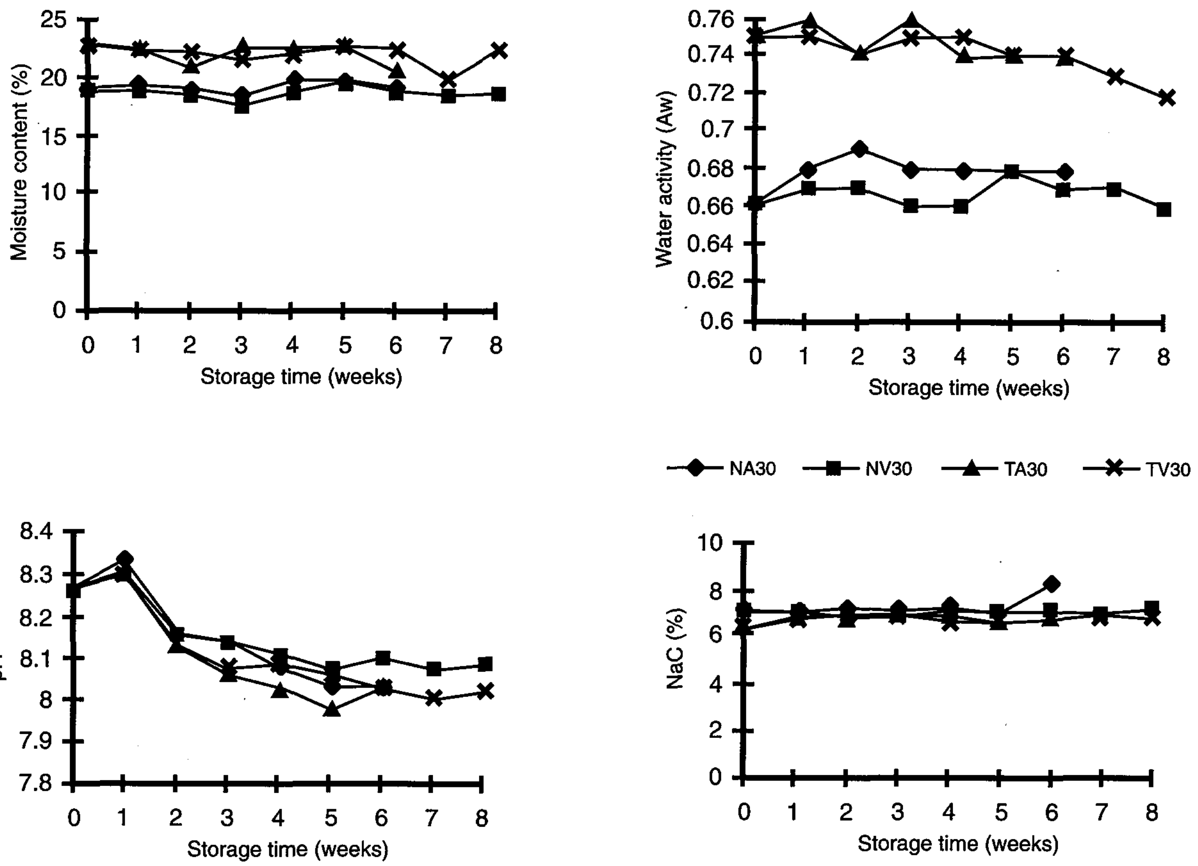
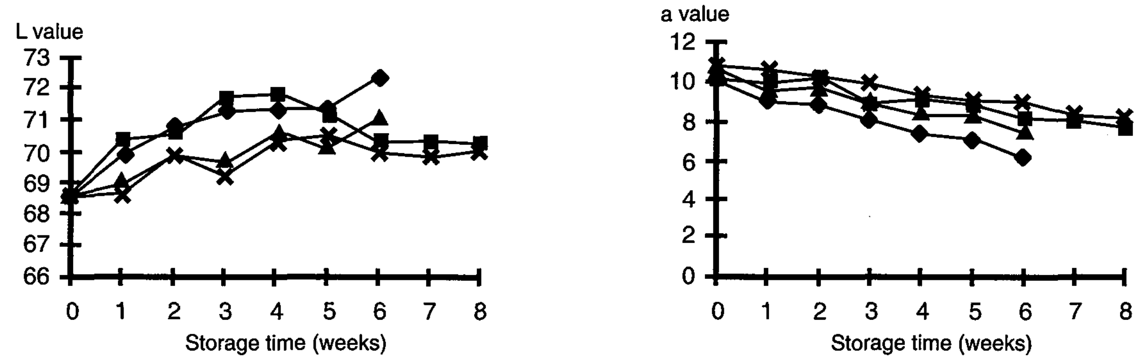


Fig. 5. Moisture, A_w, pH and sodium chloride content of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 30 ± 2°C.
NA30 = No treatment, atmospheric condition, 30°C; NV30 = No treatment, vacuum condition, 30°C; TA30 = Citric acid treatment, atmospheric condition, 30°C; TV30 = Citric acid treatment, vacuum condition, 30°C.



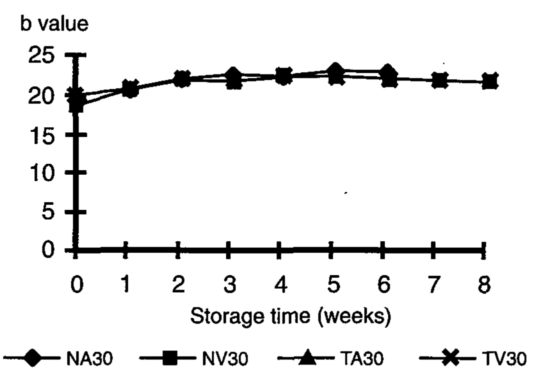


Fig. 6. L, a, b values of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 30 ± 2°C.
NA30 = No treatment, atmospheric condition, 30°C;
NV30 = No treatment, vacuum condition, 30°C;
TA30 = Citric acid treatment, atmospheric condition, 30°C;
TV30 = Citric acid treatment, vacuum condition, 30°C.

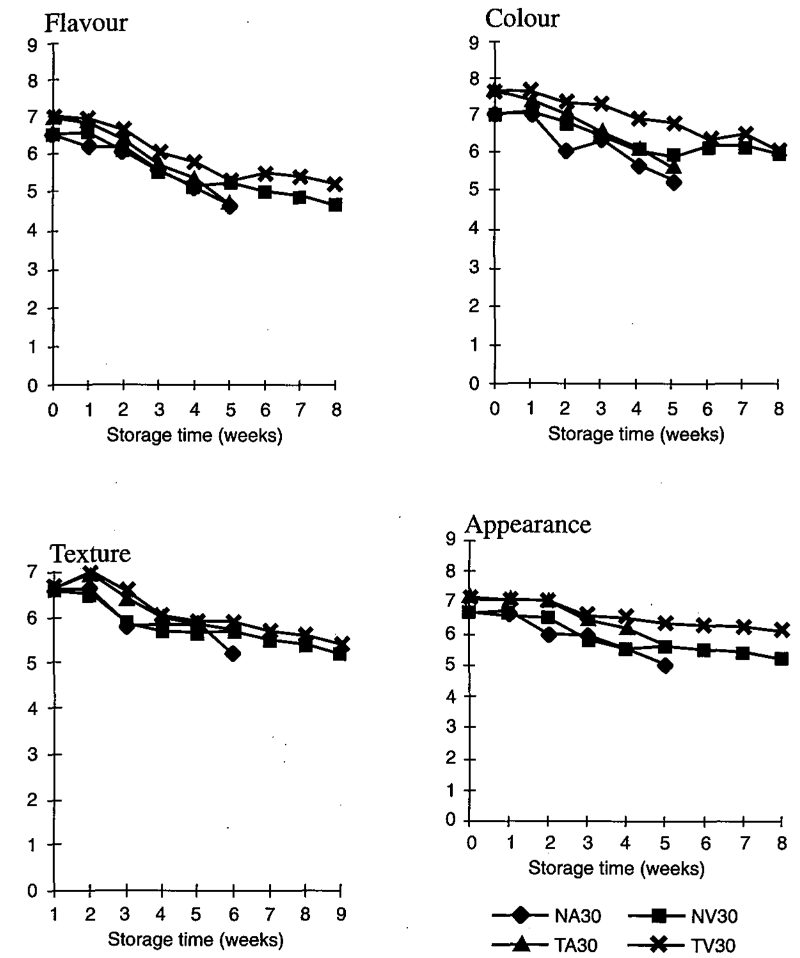


Fig. 7. Sensory score of dried shrimp with and with out citric acid packed in vacuum and atmospheric condition and stored at 10 ± 2°C.
NA30 = No treatment, atmospheric condition, 30°C;
NV30 = No treatment, vacuum condition, 30°C;
TA30 = Citric acid treatment, atmospheric condition, 30°C; TV30 = Citric acid treatment, vacuum condition, 30°C.

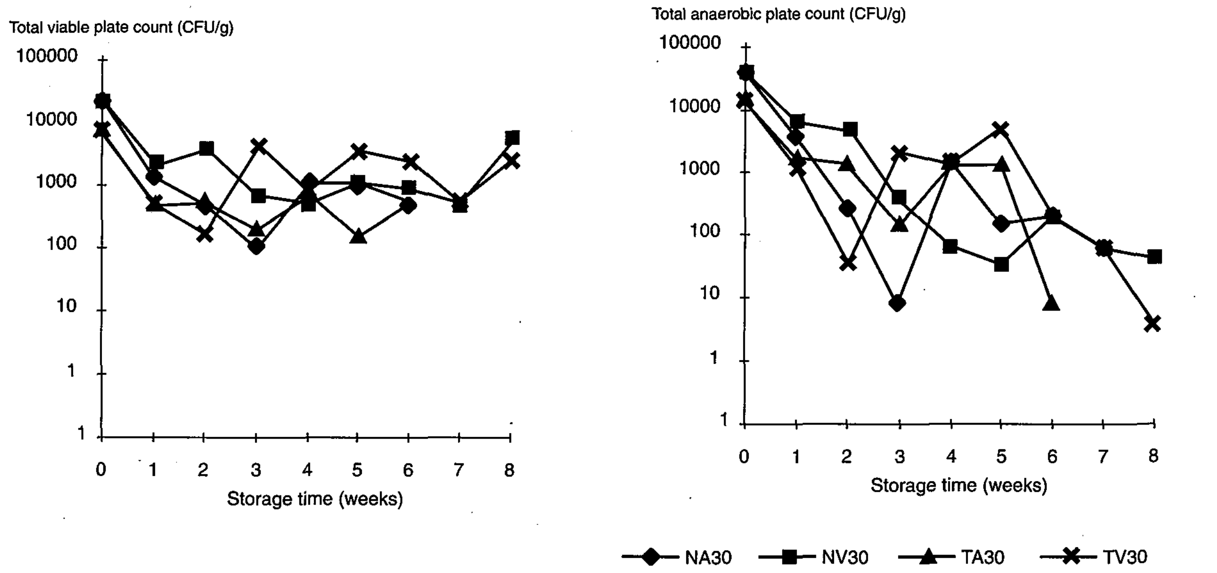


Fig. 8. Total viable plate count and anaerobic plate count of dried shrimp with and without citric acid packed in vacuum and atmospheric conditions and stored at 30 ± 2°C.
NA30 = No treatment, atmospheric condition, 30°C; NV30 = No treatment, vacuum condition, 30°C; TA30 = Citric acid treatment, atmospheric condition, 30°C; TV30 = Citric acid treatment, vacuum condition, 30°C.

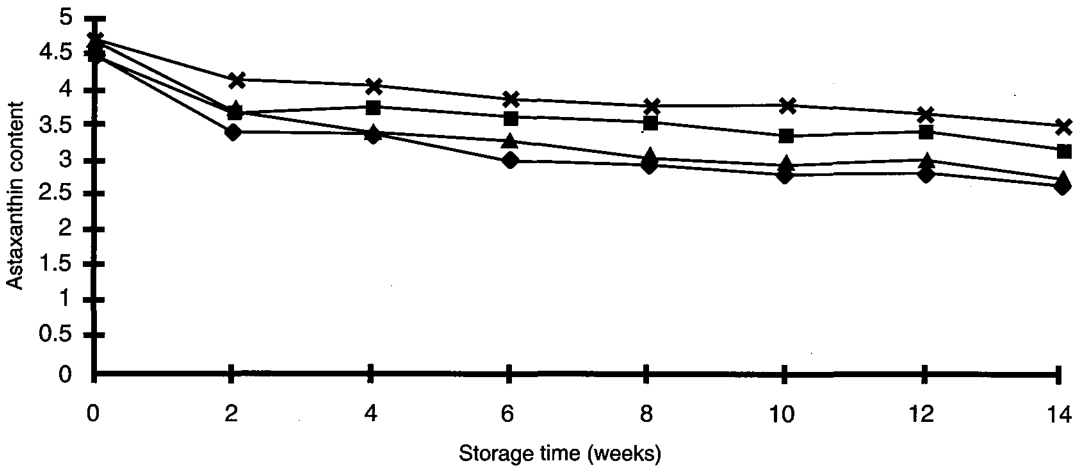


Fig. 9. Astaxanthin content of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 10±2°C.

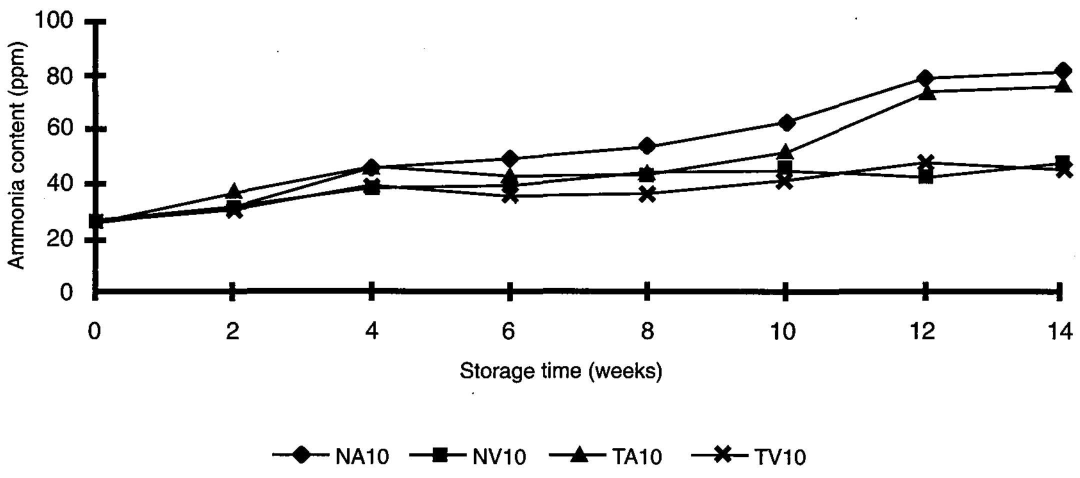
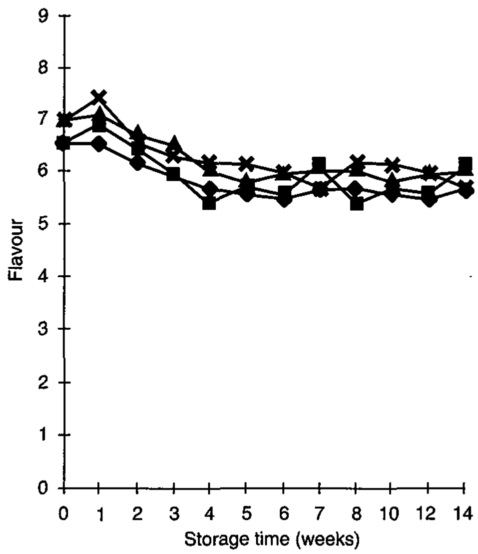
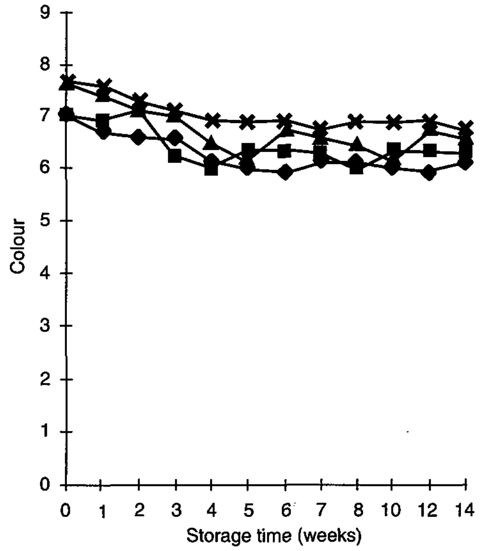
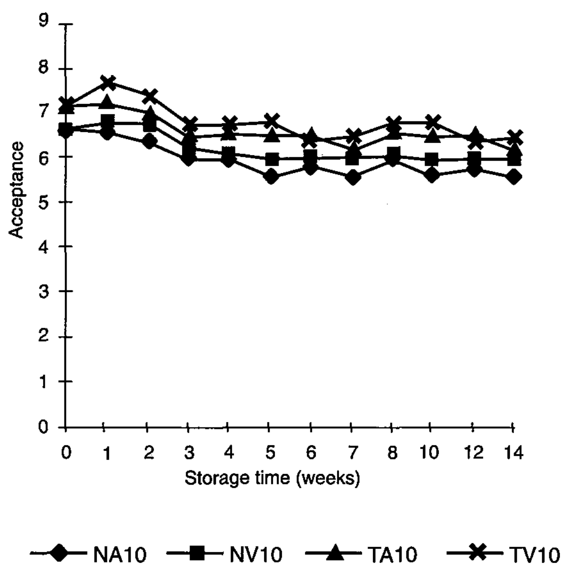


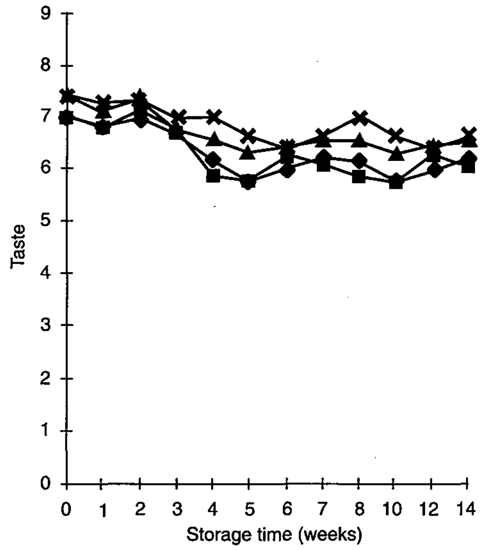
Fig. 10. Ammonia content of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 10 ± 2°C.

NA10 = No treatment, atmospheric condition, 10°C; NV10 = No treatment, vacuum condition, 10°C; TA10 = Citric acid treatment, atmospheric condition, 10°C; TV10 = Citric acid treatment, vacuum condition, 10°C.









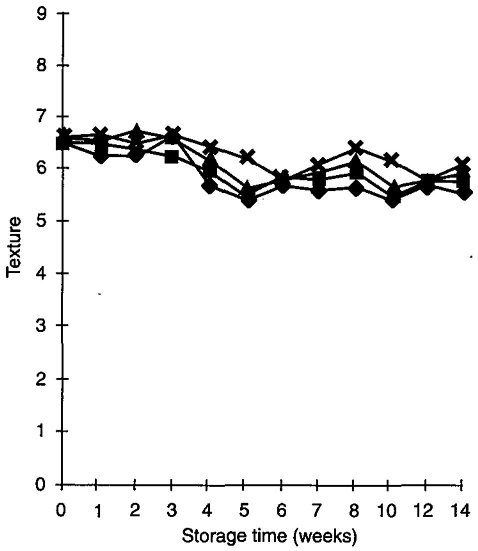


Fig. 11. Sensory score of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 10 ± 2°C.
NA30 = No treatment, atmospheric condition, 30°C;
NV30 = No treatment, vacuum condition, 30°C;
TA30 = Citric acid treatment, atmospheric condition, 30°C;
TV30 = Citric acid treatment, vacuum condition, 30°C.

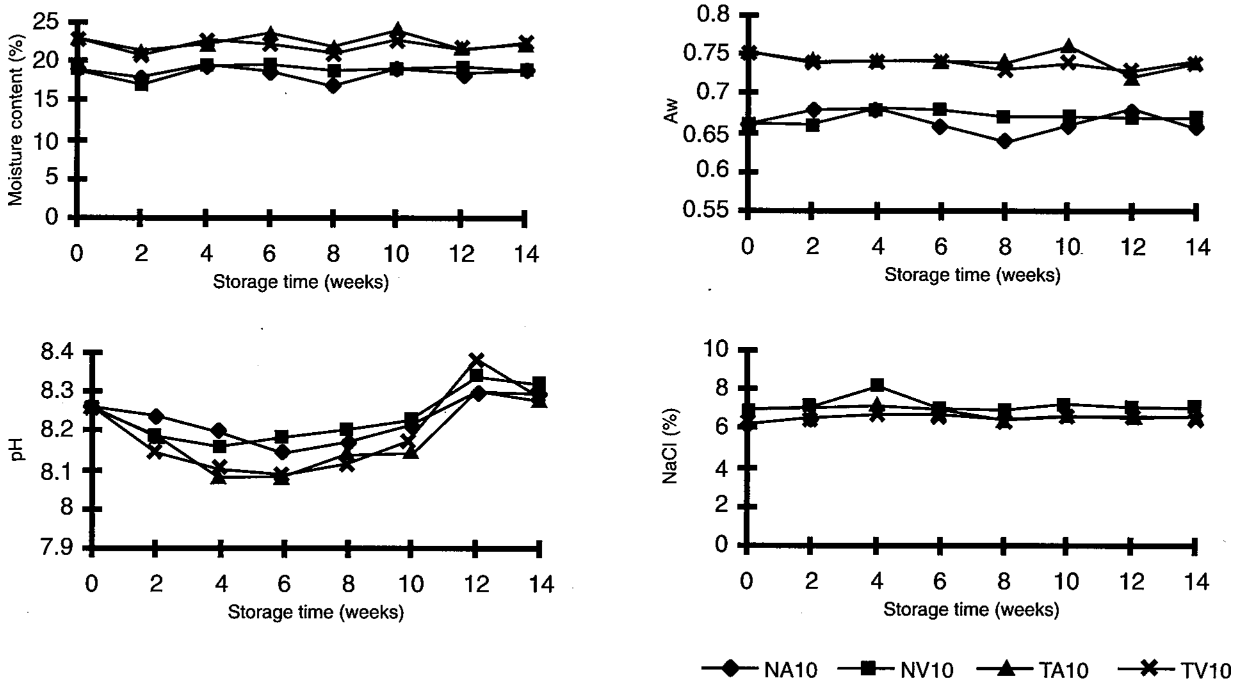
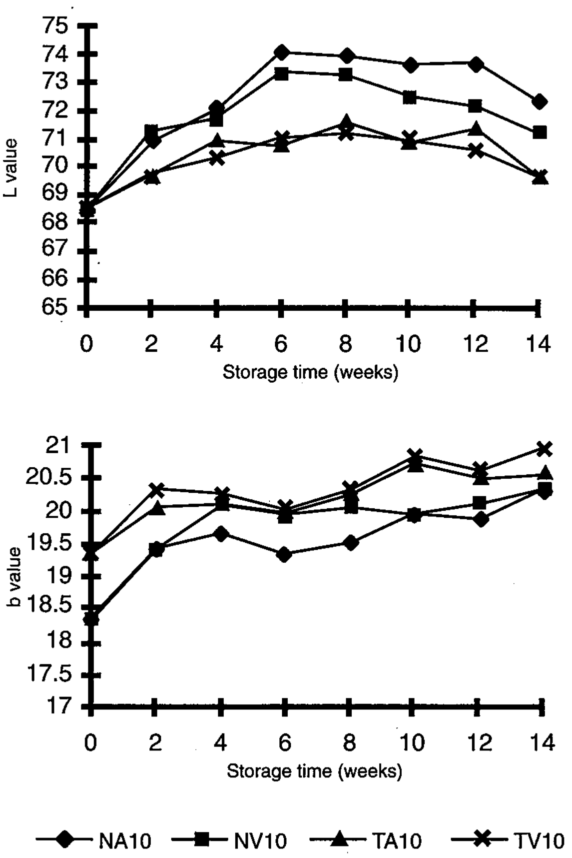


Fig. 12. Moisture, A_w, pH and sodium chloride content of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 10 ± 2°C.
NA10 = No treatment, atmospheric condition, 10°C; NV10 = No treatment, vacuum condition, 10°C; TA10 = Citric acid treatment, atmospheric condition, 10°C; TV10 = Citric acid treatment, vacuum condition, 10°C.



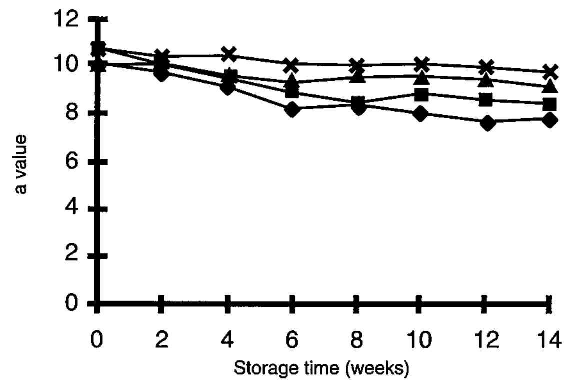


Fig. 13. L, a, b values of dried shrimp with and without citric acid packed in vacuum and atmospheric condition and stored at 10 ± 2°C.
NA10 = No treatment, atmospheric condition, 10°C;
NV10 = No treatment, vacuum condition, 10°C;
TA10 = Citric acid treatment, atmospheric condition, 10°C;
TV10 = Citric acid treatment, vacuum condition, 10°C.

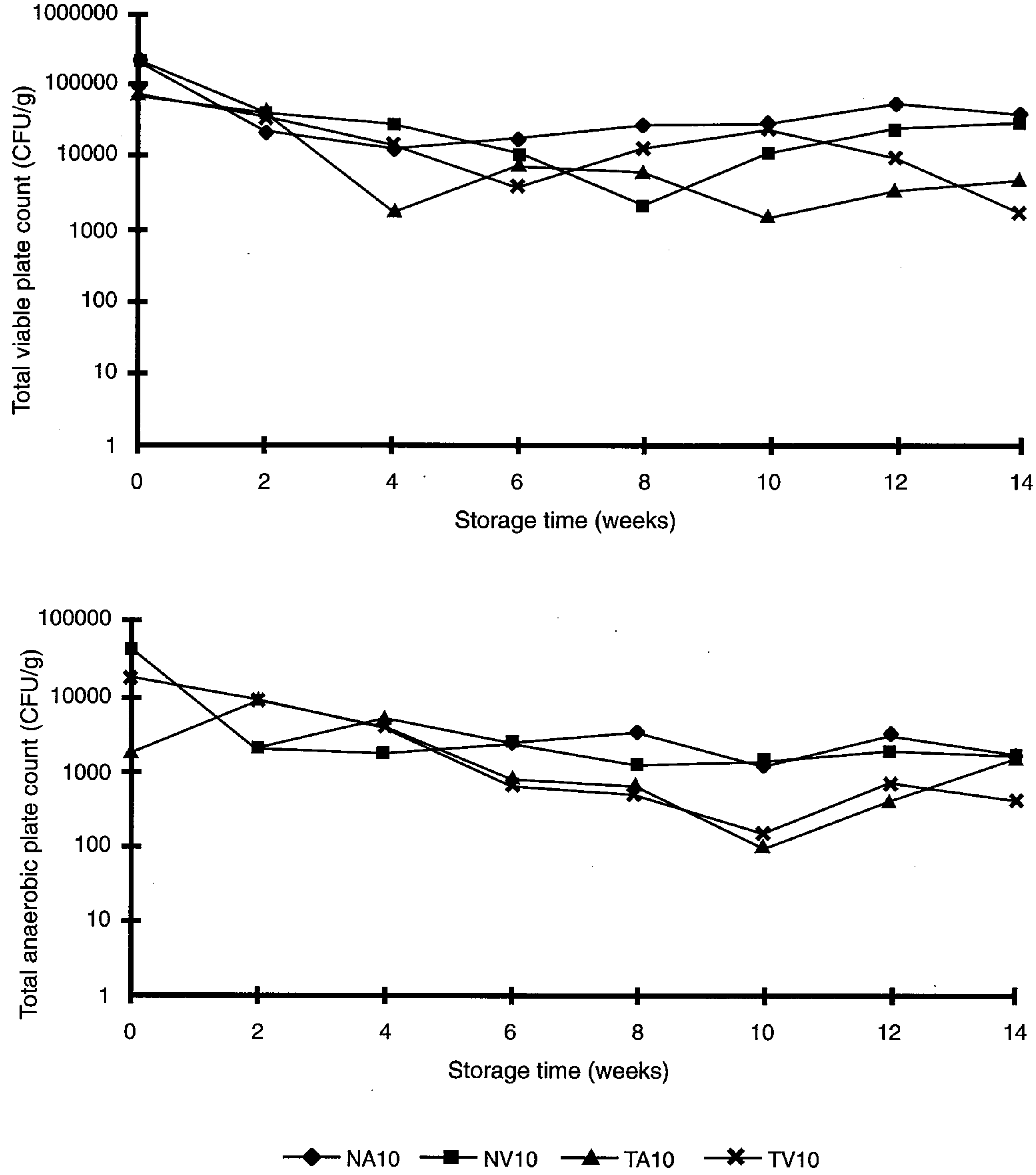


Fig. 14. Total viable plate count and anaerobic plate count of dried shrimp with and without citric acid packed in vacuum and atmospheric conditions and stored at 10 ± 2°C.

NA10 = No treatment, atmospheric condition, 10°C; NV10 = No treatment, vacuum condition, 10°C; TA10 = Citric acid treatment, atmospheric condition, 10°C; TV10 = Citric acid treatment, vacuum condition, 10°C.

Sensory Assessment of Frozen Prawns

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* Winner of the 1996 Amano Award for the best research paper.

Abstract

Sensory assessment is one of the inspection methods officially enforced on imported foods by USA and Canada. Though often said to be "subjective", an efficient assessment can be achieved through training. Sensory assessment is now recognised as an effective monitoring procedure to evaluate the quality of raw materials and in-process quality control in HACCP. The main purpose of this study is to define the sensory profile of black tiger prawn (Penaeus monodon) and banana prawn (Penaeus merguiensis), develop assessment techniques to be used by industry's laboratories and recommend suitable handling practice and storage time. In order to obtain samples of different quality levels, black tiger prawn and banana prawn were allowed to deteriorate at room temperature and on ice prior to processing into frozen products. Evaluation of sensory quality was performed by qualified prawn graders from USA and Canada. Chemical quality index "indole" was analysed on all samples. Training procedures and sensory profile of the products were developed. Thirty-one trained and qualified panelists, including inspectors from the Thai Department of Fisheries and quality control personnel from industry, participated in the sensory sessions. Storage time of not more than 32 hours at ambient temperature and 6 days on ice was recommended for black tiger prawn. Banana prawn should not be held for more than 12 hours at ambient temperature and 6 days on ice. The indole contents found in the rejected samples were way below the defect action level for prawn decomposition of 25 µg/100g suggested by USFDA. It is concluded that indole is not a good quality index for low temperature spoilage of prawn.

Introduction

Export of Thai frozen prawn amounted to US$ 6.9 billion or 450,278 tonnes in 1995. The marked expansion of black tiger prawn aquaculture since 1985 was the major contributory factor to Thailand becoming one of the world's largest frozen prawn exporters. Approximately 80% of the total export is cultured prawns. Wild catch decreased substantially due to over exploitation of natural resources. In addition, the quality of the catch is rather low due to poor handling practices and lengthy storage time onboard fishing vessels without proper icing. Major markets of Thai frozen prawns are USA and Japan. Although export to Canada amounted to 4% of Thailand's total exports, yet this accounted for 42% of Canada's market share.

Sensory assessment is officially enforced on imported food products by USA and Canada. Objective judgments can be achieved through extensive training especially by sensory experts of the import authorities. Sensory assessment is recognized as an effective monitoring procedure to evaluate quality of raw materials and in-process quality control in the Hazard Analysis and Critical Control Point (HACCP)-based program. Decomposition is a problem commonly found in low quality seafood products which results in rejection of the shipment. These characteristics can be directly perceived by way of sensory test. In order to confirm the initial sensory results, indole, a product of tryptophan degradation, is currently used by the US Food and Drug Administration (USFDA) to validate the sensory evaluation of prawn decomposition. Defect action level of 25 µg/100g is recommended.

The Department of Fisheries (DOF) of Thailand has invited 2 sensory experts from USA and Canada to train the Thai industry and DOF inspectors on sensory evaluation of frozen prawn. The samples used had been previously prepared under controlled spoilage. The purposes of this study were to define the sensory profile of frozen black tiger prawn (*Penaeus monodon*) and banana prawn (*Penaeus merguiensis*), develop assessment techniques and recommend suitable handling practices and proper storage time. All the samples used were also determined for indole contents so as to study correlations between sensory and chemical analyses.

Materials and Methods

The study was divided into 5 experiments depending on prawn species, storage conditions and final products as follows :

1. Experiment 1 : Black tiger prawn stored at ambient temperature - frozen raw prawn.

Live black tiger prawn, cultured in Satun Province, sized 36-40 count (per kg) were killed immediately after catch by plunging in iced water, and then drained. Twenty-five kg of prawn samples at 0 hour (right after death) were then drawn at this point, transferred into an insulated container and stored between ice layers. The rest were well iced in bigger insulated containers. All the samples were then transferred immediately by truck to a freezing plant in Had-Yai, Songkhla Province.

On arrival at the plant, the ice was removed but the prawn were left in the same containers. At intervals of 6, 9, 12, 16, 20, 27, 32 and 43 hours, samples were collected and processed into peeled headless tail-on and frozen in IQF (Individual Quick Frozen) form. The frozen prawn were packed in plastic bags, 200 g each, and stored at -18°C for 6 months prior to performing sensory and chemical analyses. These same conditions, viz IQF-peeled headless tail-on, packing size and storage time and temperature were used throughout the 5 experiments.

Though the room temperature during the study period was between 27-30°C, the prawn temperature was still as low as 10-20°C due to initial cooling effect of the ice. To hasten the spoilage and determine effects of temperature abuse, an additional sample was taken at 26 hours and immersed in tap water until the prawn temperature increased to 25°C, drained and maintained at room temperature for another 16 hours prior to processing, freezing and storage. This sample was called "TAS" (T=black tiger prawn, A=ambient, S=special).

2. Experiment 2 : Black tiger prawn stored in ice - frozen raw prawn.

Upon arrival of the iced prawn at the plant, the samples were transferred into insulated containers and packed in ice. The prawn were collected for further processing and storage at intervals of 0, 1, 3, 4, 6, 8 and 10 days.

3. Experiment 3 : Black tiger prawn stored at ambient temperature - frozen cooked prawn.

The prawn stored at ambient temperature for 0, 3, 6, 9, 20, 27, 32 and 43 hours as well as the raised temperature sample (TAS) were beheaded, peeled and cooked in boiling water for 3 minutes. The cooked prawn, TCS (T=black tiger prawn, C=cooked, S=specical), were immediately immersed in iced water prior to freezing and storage.

4. Experiment 4 : Banana prawn stored at ambient temperature - frozen raw prawn.

Banana prawn were caught from the Andaman Sea, stored in ice on board for 5 days prior to landing in Krabi Province. The prawn were transferred in ice to a freezing plant in the province by truck. The prawn (30-40 count per kg) were then sorted and packed without ice in insulated containers. Samples were drawn at 0 , 3, 9, 12, 15, 17 and 18.5 hours for further processing and storage. It should be noted that in experiments 4 and 5, the 0 hour sample was actually held 5 days in ice on board the fishing boat plus transportation time from the landing place to the plant.

5. Experiment 5 : Banana prawn stored in ice - frozen raw prawn.

Upon arrival at the plant, banana prawn were sorted and repacked in ice. At intervals of 0, 2, 4, 6 and 8 days, samples were removed for further processing and storage.

6. Sensory Assessment

The sample bags were immersed in room temperature water (20-25°C) for approximately 5 minutes. The thawed prawns were placed in a white-coloured plastic bowl for sensory examination by 2 experts and 31 participants. Samples were evaluated by product type. In the first session, samples were placed in order from best to lowest quality. The experts demonstrated sensory evaluation techniques and explained characteristics of acceptable, borderline and reject quality. Judgments were basically made based on odour of decomposition. The experts and participants subsequently drafted the sensory profile of frozen raw and cooked prawn using terms that corresponded well with sensory perception of all assessors. This profile was used to describe quality levels throughout the study. In the second session, samples were placed in random order and the participants examined the products and discussed their results with the experts. In the third session, which was a completely blind test, the experts and participants examined the products independently using their own opinions.

The assessors, comprising the sensory experts from the US and Canada and 31 Thai participants, indicated their judgment on quality of the samples by recording the "intensity" or "degree" of the pass/fail decision by placing a vertical mark on the 10-centimeter line scale provided on the evaluation ballot. Positions from the extreme left end of the line to the midpoint indicate that the sample is of acceptable quality (A) whereas those to the right of the midpoint indicate that the sample has been rejected (R). As one moves from the left to the right of the line, the quality of the sample becomes worse. The midpoint of the line must not be used in this exercise. The 10-centimeter scale represents 100 marks, where 0 means best quality and 100 means worst quality. Marks between 45-55 excluding 50 (midpoint) represents borderline quality. A description of the odour, flavour, appearance and texture which resulted in the decision taken should also be written in the appropriate space in the "comment" column.

7. Chemical Analyses

The frozen prawn were thawed and analysed for indole contents. The levels of indole were determined by AOAC method (AOAC, 1990) using Liquid Chromatograph.

8. Statistical Analyses

Linear regressions were calculated to determine correlations between sensory scores and indole contents.

Results And Discussion

Sensory profile of frozen prawn (Table 1) was the result of discussion among the experts and participants. The descriptions of different quality levels were based on group consensus on characteristics perceived and should be understandable to all. The profile was used to determine quality of the frozen prawn throughout the study.

1. Experiment 1 : Black tiger prawn stored at ambient temperature - frozen raw prawn.

Fig. 1 shows the changes of sensory scores and indole contents of frozen raw peeled headless black tiger prawn of various quality levels whilst Table 2 shows sensory characteristics of the samples. Indole content of 0.3 µg /100g was found in the prawn immediately after harvest. The assessors described the sensory quality of good quality prawn as firm and resilient texture, bright, glossy appearance, and grassy or seaweedy odour. When storage time increased, deterioration began and the following characteristics were found: discolouration, soft texture, slimy surface, milky appearance, stale, sour, musty and putrid odour. The discolouration, red or orange off-colour development in shrimp, is due to denaturation of astaxanthin-protein complex and oxidation of red astaxanthin to orange astaxin and/or to the presence of a cryptaxanthin-like yellow pigment (Larry and Salwin, 1966). Cobb III *et al.* (1977) concluded that off-odour development in the shrimp appeared to be divided into two categories: (a) musty and cooked shrimp odours due to chemical and/or enzymatic activity and (b) putrid and sour odours due to bacterial activities. Cooked shrimp and musty odours occurred in some samples which had little increase in bacterial levels, while putrid shrimp odours occurred only in shrimp with high bacterial levels.

During 32 hours of storage at ambient temperature, there was no significant change in indole contents. The values were between 0.1-0.6 µg/100g. Indole markedly increased to 5.6 µg/100g when the raw material were stored for 43 hours. The special sample (TAS) which was kept at alleviated temperature, contained extremely high indole of 93.6 µg/100g. The total storage time of the sample was 42 hours which was very close to the 43-hour sample. This study confirmed the conclusion of Shamshad *et al.* (1990) that handling and storage at elevated temperatures had a profound effect on the quality of shrimp. They concluded that the increase in number of bacteria causing indole development was more rapid at higher temperatures, especially at 25°C, 30°C and 35°C when compared to 0°C and 5°C and correlated with the rapid decrease in sensory quality of the shrimp.

The prawn samples of 32 hours were borderline-acceptable although the indole content was as low as 0.4 µg/100g. The assessors borderline-failed the samples stored for 43 hours because they were discoloured, opaque, musty, slightly putrid and ammonical. The sample possessed 5.6 µg/100g indole. This was much lower than the actionable level of 25 µg/100g established by USFDA. Although this study was designed to store the raw material at ambient temperature, the fact of the matter was that the temperature of the sample was maintained between 10-20°C due to residual effects of previous icing.

The special sample (TAS) was unanimously failed by all assessors due to its cooked appearance, opaque meat and putrid odour. Alleviation of storage temperature has effectively increased indole level. Chang *et al.* (1983) concluded that while indole levels indicate decomposition, decomposed shrimp may not necessarily contain indole. Indole is of value in assessing the history of shrimp if high temperature abuse is suspected. This is the reason why USFDA enforces sensory assessment as a principal method for seafood inspection. Confirmation by determining indole content is to be conducted if the product has been failed by the initial sensory test.

In this present study, it was found that sensory scores correlated very well with indole level, r = 0.88 (P < 0.01).

2. Experiment 2 : Black tiger prawn stored in ice - frozen raw prawn.

Prawn held on ice for 0-6 days prior to freezing contained approximately 0-0.4 µg/100g indole (Fig. 2). Quality of prawn stored for 6 days began to deteriorate since slight discolouration and milky appearance was present (Table 3). The assessors borderline-failed the prawns stored for 8 days though indole content was low as 1.7 µg/100g. When storage time of the raw material increased to 10 days, indole level drastically increased to 174.4 µg/100g or 100 times higher during the last 2 days of storage. The assessors unanimously rejected the samples due to soft texture, opacity, bleached colour, red discolouration and putrid odour. The significant change could be caused by substantial growth of indole-forming bacteria. *Proteus* was believed to be responsible for the formation of indole (Chang *et al.* 1983). Chang *et al.* (1983) also concluded that level of indole in frozen shrimp is an indicator of pre-freezing quality and not the result of a substantial increase during frozen storage.

Though the prawn sample containing 1.7 µg/100g indole which was much lower than the FDA actionable level was rejected by the assessors based on sensory quality, the correlation between sensory scores and indole contents was significant, r = 0.85 (P < 0.05). This was due to the fact that sensory scores increased with indole contents especially at the end of the storage.

3. Experiment 3 : Black tiger prawn stored at ambient temperature - frozen cooked prawn.

The sensory scores and indole levels and characteristics of frozen cooked black tiger prawn of which raw materials had been held at ambient temperature for 0, 3, 6, 9, 20, 27, 32, 43 hours and at alleviated temperature are shown in Fig. 3 and Table 4. The special raw material with raised temperature (TAS) when cooked prior to freezing was titled TCS. There was a slight change in indole content of raw material stored at ambient temperature for 32 hrs. The levels were somewhat stable between 0.2-0.7 µg/100g. The values significantly developed from 0.3 to 7.3 µg/100g between 32 and 43 hours of storage. The frozen cooked prawn sample produced from raw material stored at ambient temperature for 43 hours was of borderline- acceptable quality. The frozen raw prawn of the same storage condition was found borderline- failed. Thus, cooking should play an important role in removing some undesirable appearance, colour, odour, flavour and texture. It should be noticed that indole contents of the TAS (93.6 µg/100g) and TCS (47.2 µg/100g) were significantly different. Similar phenomenon has been reported by Chang *et al.* (1983) when shrimp samples containing 141 µg/100g indole lost approximately 60 µg/100g during a 5-minute boiling period. They concluded that the shrimp samples, *Penaeus setiferrus* and *Penaeus duorarum*, with < 25 µg/100g indole would not be altered during further processing. Higher indole levels may be reduced during boiling but would still be above the 25 µg/100g level.

In this experiment, sensory scores increased with time and indole content. There was a significant correlation (r = 0.89, P < 0.01) between sensory quality and indole level.

4. Experiment 4 : Banana prawn stored at ambient temperature - frozen raw prawn.

Fig. 4 and Table 5 show sensory scores and indole contents and characteristics of frozen banana prawn of which raw materials had been held at ambient temperature for 0, 3, 9, 12, 15, 17 and 18.5 hours. The 0-hour sample had actually been stored in ice on board a fishing boat for 5 days plus transportation time to the freezing plant. Hence, the initial indole was comparatively high at 8.7 µg/100g. However, the assessors still accepted the products though discolouration was found in some sample. This quality level of wild catch prawn is normally obtained due to long fishing trips made by small and medium-sized fishing boats. Prawn caught may remain on deck for several hours before icing. During handling on board, an inadequate quantity of ice is generally used.

During the first 12 hours of storage, indole contents fluctuated between 2.1-8.7 µg/100g. The assessors accepted the samples but found the 12-hour sample slightly stale in odour, slightly discoloured and not very good appearance. Freshness of cultured prawn is more controllable than that of wild catch. Cultured prawn are harvested and always iced immediately. This results in very low indole content developed in the samples. For banana prawn in this study, the prawn would have undergone temperature abuse or held without proper icing during sorting and handling on board. The shelf life was therefore rather short compared to black tiger. Chang *et al.* (1983) concluded that mesophilic organisms commonly found had the ability to convert tryptophan in prawn to indole. Thus, indole formation indicates high temperature abuse. The experts from USA and Canada failed the sample of 15-hour storage though the majority of the participants still borderline-accepted the samples. The experts described the samples as discoloured, sour odour and soft texture.

It should be noticed that indole level drastically increased within a few hours from 14.1 to 48.1 μg/100g between 15 and 17 hours and from 48.1 to 81.4 μg/100g between 17 and 18.5 hours. This indicated a rapid growth of indole forming bacteria after 12 hours of storage at ambient temperature. In the present study, raw materials stored at room temperature for more than 12-15 hours should not be processed into frozen raw products since there was a good chance the products could be rejected due to decomposition.

The correlation coefficient (r value) of the samples was 0.93 ($P < 0.01$) which means that sensory scores significantly correlated with indole content.

5. Experiment 5 : Banana prawn stored in ice - frozen raw prawn.

Fig. 5 and Table 6 show the change in sensory quality and indole contents of frozen raw banana prawn of which raw materials had been stored in ice for 0-8 days. The initial quality of the raw material was not of prime quality and this was indicated by initial 8.7 μg/100g indole on day 0. Though the indole quality index fluctuated during storage, sensory scores gradually increased with time. The frozen prawn were rejected unanimously by the assessors after the raw material had been stored for 8 days. Banana prawns possessed stronger sour and fermented odour when decomposed compared to black tiger. This keeping time seemed rather short when compared to the studies of Fatima *et al.* (1981). Fatima *et al.* (1981) assessed the sensory quality of banana prawn stored in ice and concluded that it was of high- quality for 8 days and was acceptable up to 16 days. However, the raw material of their study was received from a short fishing trip of less than 10 hours and sensory evaluation was conducted on cooked prawn which had been boiled for 5 minutes. Cooking could have removed the undesirable flavour, odour, colour and moisture in the samples.

In this study, both black tiger and banana prawns stored in ice prior to freezing had keeping quality of approximately 6 days although the initial freshness of each species was somewhat different. Shelf life of the raw prawn stored at ambient temperature was significantly different. Black tiger prawn had keeping quality of up to 32 hours while banana prawn should not be stored for more than 12 hours. Temperature abuse is the primary factor affecting decomposition in prawn as indicated by sensory quality and indole content. Poor initial quality was largely responsible for rapid deterioration in the products.

In this study, the indole content fluctuated throughout storage period. On Day 8 the samples were failed by all assessors due to soft texture, no resilience, putrid and fermented odour and discolouration. The indole level remained as low as 10.5 μg/100g. Hence, there was no correlation ($r = 0.57$, $P < 0.5$) between sensory scores and indole content.

Conclusion

Sensory evaluation of seafood products is a reliable method to describe quality. This is the reason why the method is well-recognised and widely used in many major importing countries. Training inspectors to recognise odour and flavour of acceptable and decomposed levels is the way to support a complete inspection and quality control system. Indole, though enforced by FDA to confirm decomposition in prawn, is a good quality index for raw prawn which have undergone high temperature abuse. However, the index is of less value if the spoilage has occurred in ice or at low temperature. It can be concluded that while indole levels indicate decomposition, decomposed prawn may not contain indole.

From this study, black tiger prawn should not be left at room temperature for more than 32 hours prior to processing into frozen raw products. Cooking process was able to remove some undesirable odour and flavour and improve colour and texture in raw prawn. This resulted in slightly prolonged shelf life from 32 hours to 43 hours. However, the quality was at borderline level which could be rejected by inspectors of USA and Canada. Black tiger prawn stored in ice had a keeping time at this condition of around 6 days, and so did the banana prawn. Banana prawn should not be stored at ambient temperature for more than 12 hours. Initial quality of the banana prawn were much lower than that of black tiger prawn, as indicated by indole levels. Storage temperature and initial quality are the major factors affecting shelf life and quality of the final products. However, to achieve the best quality products, raw materials should be kept at all times at low temperature, and strictly avoid any circumstances that may lead to temperature abuse.

In all experiments, sensory scores have shown good correlations with the formation of indole except in banana prawn stored in ice. The indole contents were somewhat consistent while the sensory scores increased with time. It should be concluded that indole is not a good quality index for deterioration of prawn at low temperature. Thus, sensory evaluation is still the most reliable method for quality control and from safety points of view. Characteristics of decomposed prawns of different species are somewhat different. Inspectors should be trained to recognise various spoilage characteristics of major species to ensure reliable judgment. Future studies should look at more varieties of spoilage patterns which imitate actual field practices, such as delay in icing on board fishing boat after catch, temperature fluctuation during landing, sorting or transportation.

Acknowledgment

The author would like to thank Ms. Sirilak Suwanrangsi, Chief, Fish Inspection Center (Bangkok), who initiated and coordinated this project. The project was partly funded by ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II and the Thai Department of Export Promotion. Special thanks go to Mr. Dick Throm, private consultant and former USFDA national expert, and Mr. Klaus Schallie, Canadian Department of Fisheries and Oceans (DFO) for providing sensory expertise to the Thai participants during training sessions. Finally, the author would like to thank Mr. David McLachlan, DFO, for chemical analyses of the prawn samples.

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Discussion

Ms Krissana stressed that the study was also designed to train Thai fish quality inspectors, that is why indole test was used as this is widely used in the U.S.A. There was no plan to use other index in the experiment. She clarified that poor quality shrimp samples were prepared by keeping them at room temperature for 32 hours.

Table 1. Sensory profiles of frozen prawn.

Quality level	Characteristics			
	Odour	Appearance	Texture	Colour
Passable	Fresh sweet, neutral, grassy-seaweedy	Translucent	Firm	Uniform, colour typical of species
Borderline to passable	Slightly stale, slightly yeasty, slightly fishy	Translucent	Slightly soft	Slightly discoloured
Borderline to fail	Musty, slightly sour, fishy, old sock odour	Slightly opaque, black spots	Tough, soft, dehydrated	Bleached or faded
Fail	Putrid, ammoniacal, faecal, chemical-fuel contaminants	Opaque, cooked appearance	Soft mushy	Discoloured

Table 2. Sensory characteristics of frozen raw balck tiger prawn of which raw materials had been stored at ambient temperature.

Storage period (h)	Characteristics
0	Firm, resilient, bright, glossy, grassy or seaweedy odour
6	Firm, resilient, uniform colour, fresh odour
9	Firm, slightly faded, slightly discoloured, fresh odour
12	Slightly soft, slightly slimy, slightly discoloured, slightly stale
16	Slightly opaque, slightly discoloured
20	Slightly discoloured, neutral odour
27	Firm, slightly discoloured, slightly stale
32	Not resilient, discoloured, opaque, musty, slightly putrid, slightly ammoniacal
43	Not resilient, discoloured, opaque, musty, slightly putrid, slightly ammoniacal
TAS*	Orange discoloured, opaque, strong putrid

*T=black tiger prawn, A=ambient temperature, S=special

Table 3. Sensory characteristics of frozen raw black tiger prawn of which raw materials had been stored in ice.

Storage period (days)	Characteristics
0	Firm, resilient, bright, and uniform colour, fresh sweet odour
1	Firm, resilient, slightly discoloured and sweet odour
3	Firm, slightly discoloured, slightly stale
4	Opaque, bleached, slightly discoloured, neutral odour
6	Slightly discoloured, milky appearance
8	Opaque, slightly discoloured, musty, slightly putrid
10	Soft, opaque, bleached, red discoloured, strong putrid

Table 4. Sensory characteristics of frozen, cooled black tiger prawn of which raw materials had been stored at ambient temperature.

Storage period (h)	Characteristics
0	Bright, uniform, fresh and sweet odour
3	Bright, uniform, fresh and sweet odour, slightly cold storage odour
6	Neutral odour
9	Slightly opaque, slightly stale, slightly musty
20	Opaque, slightly stale
27	Some translucent, some opaque, bleached, slightly stale
32	Slightly stale, slightly musty
43	Discoloured, stale, old odour, slightly musty
TCS*	Opaque, strong putrid and hydrogen sulphide odour

*T=black tiger prawn, C=cooked, S=special

Table 5. Sensory characteristics of frozen raw banana prawn of which raw materials had been stored at ambient temperature.

Storage period (h)	Characteristics
0	Firm, slightly discoloured, neutral odour
3	Firm, not uniform quality, neutral odour
9	Firm, not uniform quality, slightly stale
12	Slightly discoloured, slightly stale, not good appearance
15	Soft, discoloured, stale and sour odour
17	Discoloured, putrid, ammoniacal odour
18.5	Discoloured, strong putrid odour

Table 6. Sensory characteristics of frozen, raw banana prawn of which raw materials had been stored in ice.

Storage period (days)	Characteristics
0	Firm, slightly discoloured, neutral odour
2	Discoloured, naturally sweet odour
4	Milky colour, typical odour
6	Discoloured, slightly stale
8	Soft, discoloured, not resilient, putrid and fermented odour

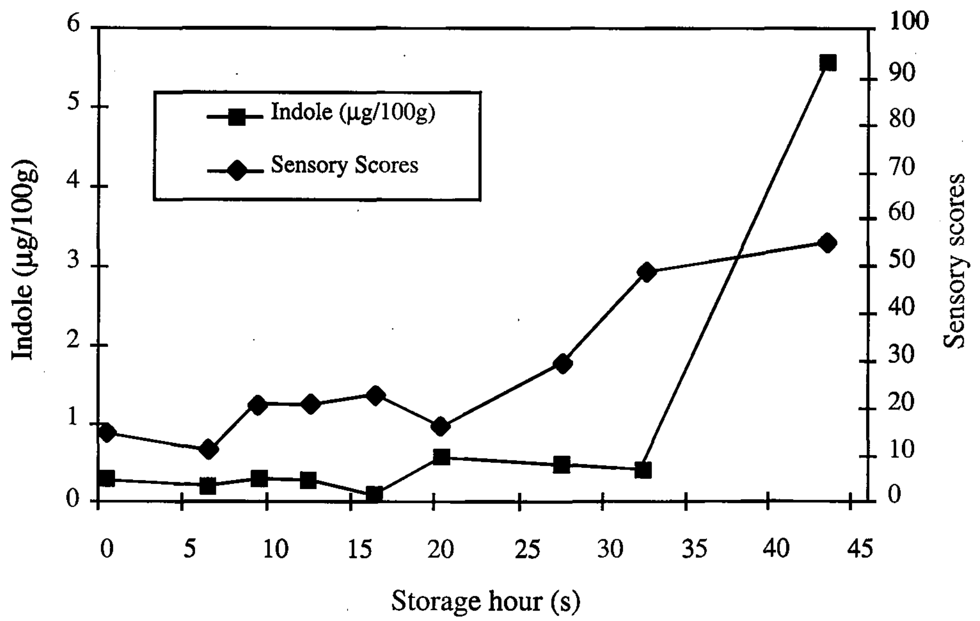

Fig. 1. Indole content and sensory score of frozen raw black tiger prawns of which raw materials had been stored at ambient temperature.

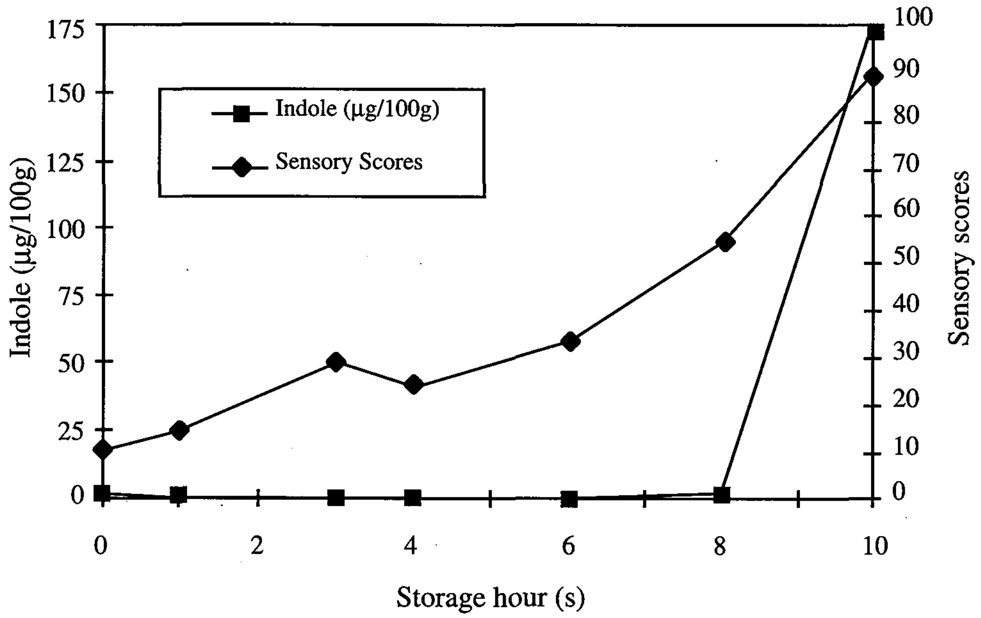

Fig. 2. Indole content and sensory score of frozen raw black tiger prawns of which raw materials had been stored in ice.

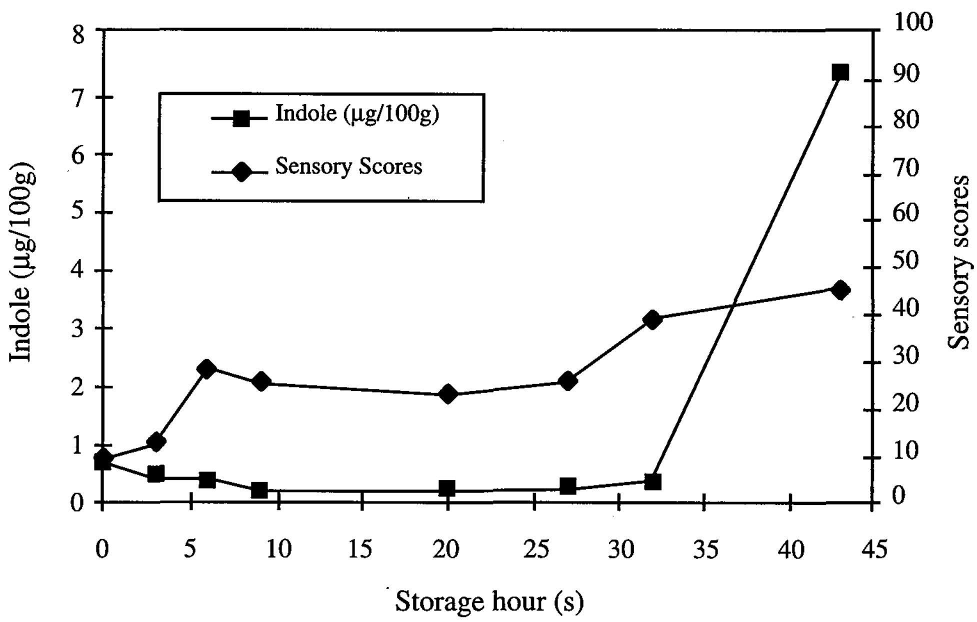

Fig. 3. Indole content and sensory score of frozen cooked black tiger prawns of which raw materials had been stored at ambient temperature.

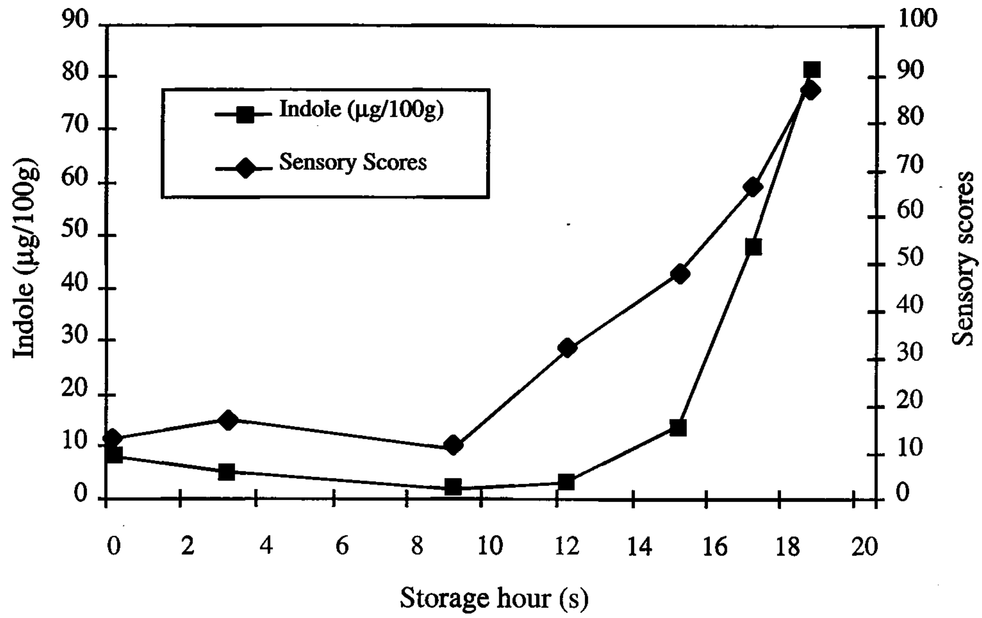

Fig. 4. Indole content and sensory score of frozen raw banana prawns of which raw materials had been stored at ambient temperature.

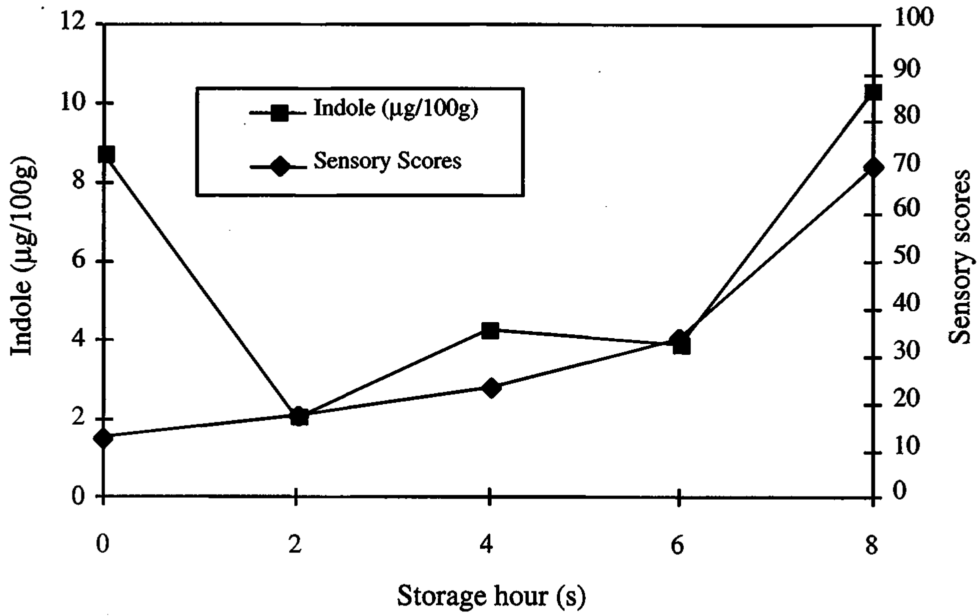

Fig. 5. Indole content and sensory score of frozen raw banana prawns of which raw materials had been stored in ice.

Quality Assurance Program for Frozen Surimi in Thailand

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Abstract

Frozen surimi has been a major export fishery product of Thailand for many years. Approximately 70% of its total production is exported to Japan, while the remaining is locally used and exported to France, Korea, Taiwan and Singapore. Although surimi is not categorized as a high risk item, as it is not a ready-to-consume product but prepared to serve as a raw material for a variety of surimi-based products, it still needs to meet the minimum requirements of product safety control. In this study, the quality assurance program is established for the Thai surimi industry. The guidelines are prepared and based upon risk assessment and potential health hazard identification associated with routine surimi production, from the point where raw material is received at the plant, through the line-processing steps, and ending with the finished product's transportation. Besides the Hazard Analysis and Critical Control Point (HACCP) principles applied in this program, Good Manufacturing Practices and sanitation standard operating program are also added to strengthen the aim of assurance in food safety.

Introduction

Frozen surimi is minced fish which is washed with water and mixed with cryoprotectants to prevent the product from denaturation during frozen storage (Suzuki, 1981). Surimi was originally developed and has been produced extensively in Japan to serve local consumers. The processing technology was first transferred to the Thai seafood industry in late 1970s when it was found that certain fish species abundant in Thai waters have good characteristics required in surimi. Frozen surimi was then developed into a major fishery export product of Thailand. Fish normally used are threadfin bream (*Nemipterus* spp.), croaker (*Otolithes* spp.) and purple-spotted bigeye (*Priacanthus tayenus*). Other fish like largehead hairtail (*Trichiurus lepterus*) and lizardfish (*Saurida* spp.) are sometines used, as their total landing is still small and insufficient for mass production.

Like any other fishery product, the processing lines could be exposed to a number of potential contamination sources, including sources such as human, equipment, machinery, or even the raw material itself. These contamination may lead to the loss of product safety and might eventually threaten consumer health. Although the intended use of surimi is to be further processed, and the process will undergo heat treatment, the presence of *Salmonella* or metal chips detected from surimi blocks are still not favourable to buyers and could cause rejection by authorities. Whenever these are present, this also reflects lack of food hygiene and safety control in processing lines.

Therefore, the implementation of a good quality assurance program including the standard of sanitation and methods of operation in the processing plant will impact on quality and safety. To ensure consistency of product quality, this program will be more effective than end-product inspection.

This paper discusses the application of a quality assurance program for frozen surimi, particularly in Thailand, and also covers the overall good manufacturing practice (GMP) and sanitation control that should be carried out, and finally conclude with implementation of Hazard Analysis and Critical Control Point (HACCP).

Materials And Methods

Five surimi processing plants; three from the Central region and two from the South, with production capacity ranging from 5 to 70 tonnes per day were selected for this study. The surveillance procedures were carried out as follows:

1. Plant inspections were carried out two times (every 6 months) in 1995 and focused on the general plant sanitation and good hygienic practice. The plant inspection forms of the Department, based on the Codex's Code of Hygienic Practice and the Canadian Department of Fisheries and Ocean's inspection guides, were used. In addition, in-plant quality control reports were also reviewed.
2. Plant performances were then evaluated with the surimi processors. Discussion carried out was focused on health hazard likely to occur in

the processing lines and also dealt with problems of surimi production concerned with food safety, quality and wholesomeness.
3. Plant inspection reports which were routinely done by the Department from 1994 to-date were reviewed for deficiencies found in the past.
4. Product lots inspected by the Department which did not meet with bacterial standards were gathered to assess the efficiency of the quality control program of the establishments.

Results And Discussion

1. Frozen Surimi Process

The inspection of the five surimi processing plants confirmed that surimi is made as follows: The commercial process is carried out almost entirely mechanically, except deheading and gutting. When fresh and iced fish arrives at the processing plant, it is first visually inspected for freshness. The acceptable fish is washed in the rotary washer to remove surface contamination before deheading and gutting takes place. After deheading and gutting, dressed fish is washed again with water to remove enzymes and other contamination, then put into the meat-bone separator to separate meat from skins, bones and scales. Subsequent washing steps of mince are done in tanks with mechanically stirring paddles. Throughout, mince meat is soaked in chilled water of 5-10°C and left to settle. The supernatant is removed and the washed mince is further dewatered in a rotary sieve machine. This cycle of washing and dewatering is repeated 3 times to remove blood, fat, water-soluble protein and any remaining undesirable substances from meat (Lee, 1984). The last washing cycle is followed by straining dewatered mince in a refiner to remove the residual tiny bones and black skin. Strained, minced fish is then finally dehydrated by using a screw press.

Washing of minced meat is one of the important steps in surimi production. Removing of fat and water-soluble protein during washing will strengthen gel-forming ability of the product which is a characteristic required for production of surimi-based products (Sonu,1986). The volume of washing water is normally up to 10 times of fish weight. However, excessive washing of the meat will cause it to swell from absorbing too much water. At the last washing step, chilled water is, therefore, generally added with 0.1-0.3% salt to minimise this and to aid in the removal of water (Lee, 1984). Besides this, the pH of the water is also important to improve the dewatering performance, and suitable pH ranges suggested are between 6.5 - 7.5 (Sonu, 1986).

Finally, the dehydrated, leached mince is mixed with anti-denaturants in a silent cutter. The additives used are sucrose (8%) and polyphosphate (0.2-0.3%). The amount of additives added varies according to the types of product to be made. Sorbitol is sometimes used as an alternative to sucrose to reduce the sweet taste and delay denaturation. The ratio of sorbitol to sucrose varies on specification. For example, 4%:4% or 6%:0%, etc. The surimi with additives is packed as a 10 kg block in polyethylene bags by a filling machine, frozen in a contact freezer at -40°C for 2 hr and packed in cartons, stored in cold storage at -18°C or lower until distribution takes place.

2. Good Manufacturing Practice (GMP) for Frozen Surimi Processing

Good manufacturing practice (GMP) is a code of practice involved with hygiene requirements, as well as steps taken to control the process. Since GMP would result in product safety, wholesomeness and good quality, its practice could prevent quality problems from arising.

The results of inspection surveys conducted in the five surimi processing plants revealed the following deficiencies which may lead to problems relating to wholesomeness, quality and safety of the products.

- Uncertainty of quality of incoming fish due to improper handling, eg. rough handling, high-temperature holding, etc.
- Inadequate washing of incoming fish before moving on to the next processing step.
- Inadequate sanitation control of equipment and machinery used in some sections.
- Inadequate personnel hygiene control in deheading and gutting section.

GMP practices recommended during group discussions with lead inspectors, production and quality managers of the plants were as follows:

a. Fish receiving

The quality of the fish used in making surimi is one of the important factors in determining the quality of the finished product. It has been accepted that high quality of surimi can be obtained only from fresh and clean fish. Therefore, fish should be well iced, properly handled upon arrival; each lot of fish should be inspected to determine its condition and quality. Incoming fish should be graded according to its quality and plant specification, so that no poor-quality fish is used. Rejected or unaccepted fish should be segregated from the area to prevent the use of that fish by accident.

After quality inspection is done, accepted fish should be passed to the next processing step without delay. When fish cannot be processed straight away, a sanitary storing area should be provided. Fish should be kept chilled (0-5°C) at all times.

Incoming fish should be thoroughly washed with clean water prior to deheading and gutting. The purpose of this washing is to remove dirt, slime, scales, and reduce bacterial load on the fish. The machine should be properly designed to give an effective wash. For this wash, water with normal temperature (24-28°C) is sufficient and effective for removing contamination. But attention should be paid not to allow fish to remain in the washer too long to prevent it from losing freshness; washing machine should therefore be kept running.

b. Mince preparation (deheading, gutting and mince separating)

In this step, carefully remove all viscera and head; any remaining visceral fragments in minced meat will be difficult to remove at subsequent steps and will affect the gel-forming ability and discolour the ended product. Besides that, if fish of unacceptable or questionable quality are still found, they should be separated and discarded. Fish temperature should be kept as low as 5 - 10°C while being processed on the gutting table to retard their deterioration. Water used in contact with fish must be of approved quality and changed frequently.

The operation area and equipment used should be cleaned and disinfected frequently. All waste material is to be disposed of as soon as possible.

Before headed gutted fish is fed into the meat-bone separating machine, it should be thoroughly washed again to remove bacteria, small pieces of viscera, enzyme remaining in belly cavity and other contamination. The meat-bone separator should be equipped with chilled water spray to keep mince temperature low. This machine should be regularly adjusted so that it can do an efficient job of separating meat from other impurities. Regular cleaning and disinfecting of meat-bone separator should be carried out to remove the build up of fish parts left behind which will otherwise become a source of contamination.

c. Meat washing and dewatering

Once minced meat comes out from the meat-bone separator, it is washed immediately with chilled water (5-10°C), since an increase in temperature could cause protein to denature and accelerate bacterial growth. During settlement of minced meat, water temperature in washing tanks should be controlled at not higher than 10°C.

The rotation speed of rotary sieve and screw press should be properly adjusted to allow for efficient removal of water. All the machines used in this operation (ie. washing tank, rotary sieve, refining machine and screw press) should be made of non-corrosive and impervious material such as stainless steel, particularly where their surface are in contact with the product.

d. Mixing with anti-denaturants and panning

All ingredients used should be inspected at receipt and stored in a separate room and in sanitary conditions. Rodent control devices should be provided. Food ingredients should be stored separately from disinfectants and pesticides to prevent cross contamination.

A separate clean area is provided for mixing in the anti-denaturants so as to prevent contamination to the product. Temperature of product during mixing and forming should be controlled at not over 13°C.

e. Freezing and packing

Product should be transferred to the freezers as soon as it is prepared. Contact freezers should be capable of reducing the product core temperature to at least -18°C as fast as possible and have adequate capacity for daily production; bottle-necks should not be caused by inadequate freezer capacity.

Packing is done properly so as not to cause any contamination to product. Separate facilities are provided for the storage of cartons and polyethylene bags in order to protect them against moisture, dust or other contamination.

f. Product storage and shipping

Cold storage temperatures should be maintained at a constant -18°C in order to preserve the quality and to extend the shelf-life of the product (to maintain its gel-forming ability). However, for long-term store in cold storage, such as longer than 6 months, temperatures between -20 and -25°C are recommended.

Cartons should not be stacked against walls or directly on the floor during cold storage. Unless an adequate air space (5-10 cm) is provided between wall/floor and the product, heating of the product can occur by conduction through the cold storage wall or floor. The temperature is to be maintained at not over -18°C during transportation from the processing plants to the customers.

3. Plant sanitation control

The inspection of processing establishments confirmed that sanitation control is an important basic practice; it keeps the processing area and the environment as a whole suitable for food processing and free of potential micro-organisms which can lead to food contamination. The quality of the final product will depend not only on the quality of the raw material but also on the state of the processing plant and equipment, its sanitary condition, and the processing methods used. Therefore, the processing premises and equipment must be in a condition to enable the processing of products to meet the standard requirements. That is to say, the construction of processing plant and equipment should be made of materials of proper quality and the plant must be kept in appropriate state of repair and condition to facilitate all sanitation procedures. In addition, an appropriate sanitation program should be set up for the entire processing plant to eliminate contamination to products.

In this paper, the general plant sanitation design requirements, including plant construction, equipment, water and ice quality, sanitary facilities and personnel hygiene will not be stated in detail, since the guidelines recommended are based on internationally recognized standards which are available in publications such as the Code of Hygienic Practice, General Principle of Food Hygiene of the Codex Alimentarius Commission, 1988.

The recommended sanitation program of plant construction and equipment set up for frozen surimi processing is as shown in Table 1. It is also necessary to make sure that cleaning procedures are effective in removing food residues and dirt which may be sources of contamination; monitoring of effectiveness of maintenance and sanitation program is therefore recommended along with the program.

Table 1. Recommended sanitation program of plant construction and equipment set up for frozen surimi processing.

Items	Frequency of cleaning
I. Construction	
1. Floors and walls	
1.1 Wet areas : Fish dressing areas, surimi process areas	At end of the work day, these areas should be free from all waste. Regular hosing is required during operation.
1.2 Dry areas : Dry store, loading area	At least twice a week.
2. Ceilings, pipes over work areas, lighting structures	At least once a week: ceilings and pipes should be free of debris and dust.
3. Drains	At end of work day; drain screen should be taken off and drains should be flushed to remove debris. Waste should not be left overnight in drainage lines.
II. Equipment/machinery	
1. Bins, fish baskets	After each use.
2. Heading & gutting tables	At lunch breaks and end of work day. Hosing down is required after each load of fish on tables is finished.
3. Cutting boards	Clean at lunch breaks and end of work day; soak the boards every night in 100 ppm chlorinated water. Hosing down during operation should be made whenever dirt is present.
4. Knives	Frequently dip in 100 ppm chlorinated water when dirt is visible during work. Properly clean at lunch breaks and end of work day.
5. Fish rotary washer	At lunch breaks and end of work day. Washer should be free of scales, slime and debris after cleaning.
6. Leaching tanks	Hose down after each use. Cleaning done at lunch breaks and end of work day.
7. Meat separator, rotary screen, press	Flush with high pressure water at lunch breaks and clean at end of work day.
8. Silent cutter and equipment for filling	Clean at lunch breaks and end of work day.

4. Application of the HACCP plan for frozen surimi

The Hazard Analysis and Critical Control Point or HACCP has been broadly known as a system for control to ensure food safety and quality for consumers. The guidelines of HACCP plan for frozen surimi was based on the potential health hazards and risks to food quality which may arise throughout the processing steps. Information was gathered during plant inspections carried out by the Department (Keerativiriyaporn, *et al*, 1994-1996), and bilateral discussion between industry and the Department.

Hazard analysis and risk assessments were carried out for each processing step right from the time the raw materials come into the processing plant until the finished product was shipped out. The generic model was established by following the 7 principles of HACCP (Codex Alimentarius Committee on Food Hygiene, 1993) as follows :

- Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and provide the preventive measures.
- Identify the CCPs in the process by using a decision tree.
- Establish critical limits for preventive measures associated with each identified CCP.
- Establish CCP monitoring requirements, and procedures to follow up on the results of monitoring, adjust the process and maintain control.
- Establish corrective actions to be taken when monitoring indicates that there is deviation from an established critical limit.
- Establish procedures for verification that the HACCP system is working correctly.
- Establish effective record keeping procedures that document the HACCP system.

a. Hazard analysis and risk assessment

The hazard analysis and risk assessment for frozen surimi was conducted by reviewing the likelihood of occurrence of the various hazards at each activity point. Product description (Table 2), product ingredients and incoming materials list, and process flow diagram (Fig. 1) were the basic tools used in this assessment. Three major categories of hazards - biological, chemical and physical - were considered. The results are shown in Table 3.

Table 2. Product description for frozen surimi.

DESCRIPTION PRODUCT

PROCESS/PRODUCT TYPE NAME : Frozen minced fish

1. Product name(s)	Frozen surimi.
2. Important product characteristics (A_w, pH, preservatives....)	Raw, minced fish which pass through leaching process, mixed with sucrose, sorbitol (optional) and polyphosphate. Moisture content 76-78%.
3. How it is to be used?	Used as a semi-processed raw material for surimi-based products.
4. Packaging	Polyethylene bag.
5. Shelf life	1 year at -18°C or lower.
6. Where will it be sold?	Processing factory.
7. Labeling instructions	Keep frozen at -18°C or lower. No rough handling.
8. Special distribution control	Keep frozen at -18°C or lower at all times. No physical damage.

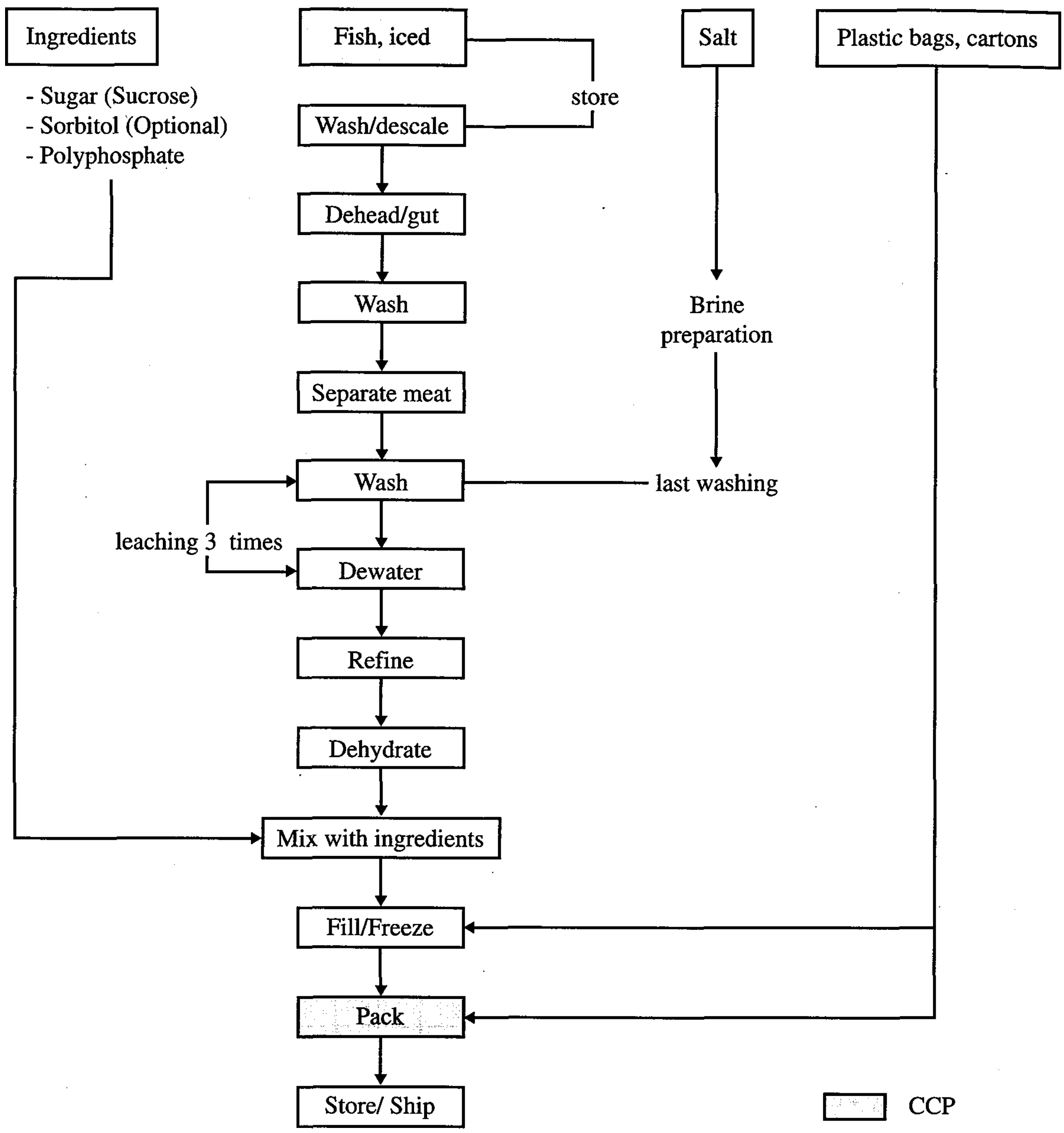

Fig. 1. Flow process diagram of frozen surimi.

Table 3. Results of a hazard analysis and risk assessment

Process step	Hazard concern	R	S	Preventive measures
A. Raw material				
1. Ingredients at arrival - Sugar - Sorbitol - Polyphosphate - Salt	1. Ingredients might contain chemical impurities. 2. Dust, foreign matters which contaminate ingredients. 3. Salt could be contaminated with halophilic bacteria.	L L L	L L L	1. Purchasing specification; certification of quality of incoming ingredients. 2. Purchasing from approved companies.
2. Fish at arrival	1. Bacteria contamination could occur from improper handling, eg. use of unclean containers, rough handling resulting in belly burst. 2. Temperature abuse during transportation from fish landing place to processing plant, eg. fish temp higher than 5°C could accelerate decomposition from enzymes, chemical or microbilogical reaction. 3. *Salmonella* and *E.coli* could contaminate fish from persons who handle fish. 4. Decomposed incoming fish.	M M M M	M H H M	1. Personnel training in GMP; sanitation control. 2. Sensory inspection of every lot at arrival. 3. Train persons who are involved in fish handling; thoroughly wash fish upon receiving. 4. Visual inspection; segregate off-quality fish.
3. Storing fish	1. Fish temperature during storage if higher than 5°C could cause decomposition. 2. Stored in a place without proper sanitation.	M M	M M	1. GMP; strict temp. control. 2. Sanitation control.
4. Polyethylene bags, cartons at arrival	Polyethylene bags could be contaminated with other chemical substances at the manufacturing plant.	L	M	1. Purchasing specification. 2. Visual inspection of every lot at arrival.
B. Process step				
1. Washing whole fish	1. Improper changes of washing water could cause ineffective reduction of microorganism, particularly when tap water temperature is used. 2. Microorganism contamination due to the use of unsanitary equipment eg. washer, fish containers, and low quality water.	M M	H M	1. Establish frequency of changing water; water overflowing at all times; management supervision. 2. Implement sanitation program; train persons involved.

Process step	Hazard concern	R	S	Preventive measures
2. Deheading & gutting	1. *Salmonella* and *E. coli* could contaminate fish due to poor personnel hygiene practices. 2. Micro-organism contamination due to improper cleaning of equipment used during operation eg. cutting boards, knives, tables. Deheading and gutting results in the spread of blood, fish juice, guts which are favorable media for bacterial growth. 3. Gut remnants in belly cavity resulting in reduction of product gel strength due to enzymatic action.	M M L	H L M	1. Improve personnel hygiene practices; management supervision. 2. Implement cleaning program. 3. Train personnel involved; random visual inspection.
3. Meat separating	Mince could be contaminated with bacteria from an unsanitary meat separator used. A pile-up of mince in the machine for many hours could result in high bacterial load.	M	M	Implement proper cleaning program.
4. Mince washing	1. Low water quality could result in microbiological contamination. 2. Insufficiently low temperature of wash water may result in microorganism growth. 3. Brine preparation in unsanitary condition (for last washing).	L L L	M M L	1. Implement proper water treatment system including chlorine injection; check chlorine residue in water twice a day. 2. Use chilled water at 5°C; chiller maintenance. 3. Train persons involved.
5. Dewatering	A pile-up of mince around the rotary sieve for many hours would allow micro-organism growth which subsequently contaminates product.	M	M	Implement cleaning program.
6. Refining	A pile-up of mince around refiner for many hours could lead to high bacterial load which subsequently contaminates product.	M	M	Implement cleaning program.
7. Dehydrating	A pile-up of mince around screw press for many hours could lead to high bacterial load which subsequently contaminates product.	M	M	Implement cleaning program.
8. Mixing	A pile-up of mince in silent cutter and other equipment for many hours could lead to micro-organism contamination in final product.	M	M	Implement cleaning program.
9. Freezing	Temperature control during freezing, eg. temperature is not low enough or not brought down fast enough.	L	M	1. Record temperature at each use; GMP. 2. Freezer maintenance.
10.Packing	Product could contain bits of metal from processing equipment.	M	H	1. Machine maintenance. 2. Metal detecting for every block.
11.Storing & shipping	Temperature during storing and distributing may fluctuate or rise above -18°C to cause microorganism growth and affect product gel strength.	L	M	1. Temperature recording; GMP. 2. Machine maintenance.

R = Risk S = Severity H = High M = Medium L = Low

b. Determination of critical control points

The selection of critical control points (CCPs) was based on the assessment of severity and likely occurrence of hazards and upon what could be done to eliminate, prevent or reduce the hazards at a processing step, as well as the final intended use of the product. Determination was done by using the HACCP decision tree developed by a Codex Alimentarius Working Group on HACCP in 1993. After selecting the CCP; critical limits were set; these are boundary posts by which to assess the safety of the product. Monitoring procedures to assess whether a CCP was under control are also set up, together with a corrective action plan which is activated when a deviation occurs. The final step was the establishment of a verification procedure to determine if the HACCP plan was operating properly.

The CCPs in frozen surimi production were identified from the hazards in the fish receiving and product packing steps. The generic models were as follows:

<u>Fish at arrival</u>

Hazard: Decomposition could be accelerated by enzymatic, chemical or microbilogical reactions due to temperature abuse (>5°C) during transportation from fish landing place to processing plant, particularly when these places are far from each other; or due to poor handling from the boats.

Critical limits: Fish should be received with adequate ice. Its internal temperature on arrival should be $\leq$5°C.

No decomposed fish is allowed to enter processing line.

A lot of fish sampled for freshness must pass the acceptable level.

Monitoring: Sufficient ice around fish is observed visually. Each lot of incoming fish is checked for internal temperature by sampling from at least 5 different spots.

5 kg of fish is sampled from each lot in sensory examination for freshness.

Corrective action: If any of the fish examined is found to have a temperature above 5°C, the lot will be accepted or rejected on the basis of the sensory evaluation. If fish is acceptable, special handling of fish must be performed, eg., bring down the temperature as fast as possible, and process it without delay.

If the acceptance number for decomposition is exceeded, the lot will be set aside for further attention. An individual check may be done depending on the defect level, eg., a defect level of >40% will result in outright rejection, while a <40% defect level will be individually checked.

Verification: 5 kg of whole round fish is sampled from deheading table twice a day for decomposition examination.

Record keeping: A fish-at-arrival record is filed.

<u>Packing</u>

Hazard: Metal contamination in product.

Critical limits: No metal is detected in blocks of product.

Monitoring: Metal detectors are calibrated daily with the standard metal chips before start-up.

Every block of frozen product is passed through metal detector before packing.

Every 2 hr, the metal detectors must be recalibrated for accuracy, and the standard metal chips are used to test that the equipment is in working order.

Corrective action: If metal chip is detected, discard the product.

If the metal detector is found to be faulty, any product which passed through since the previous metal detector check will be brought out and retested.

Verification: The metal detector is tested with the test samples twice a day.

Record keeping: Metal-check records are filed.

Conclusion

In conclusion, when a quality assurance program provides preventive measures against hazards likely to occur in a processing plant, the overall quality of product will also be much improved. There will also be less waste either from the processing lines or of finished products.

In the case of frozen surimi, hazards which could result in rejection of the product are considered to be more concerned with food quality rather than safety. For example, the hazards from decomposition of raw material impact on product gel strength. As mentioned earlier, frozen surimi is not categorized as a high risk product; however, this does not mean that good manufacturing controls could be neglected. On the other hand, its production still needs to comply with food hygiene requirements, since once it is out of control, other complications will emerge.

An effective quality assurance program for frozen surimi is not just a single control program, but acts in combination with other relevant sub-control programs. Processing GMP and plant sanitation controls are designed to work together with HACCP plans. The application of the latter plans is not aimed to replace GMP, but to help ensure food safety. GMP and plant sanitation are prerequisite requirements which should be met and be the foundation of the HACCP plans. If the prerequisite program is not adequate and effective, then the HACCP plans will be composed of more CCPs and be more difficult to implement.

Acknowledgment

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Discussion

The Seminar took note of the information that Japan is in the process of preparing the code of practice for surimi production. Once finalized, this code should be disseminated to all countries in the region.

Development and Implementation of a National HACCP Training Program: The Experience of Vietnam

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Abstract

The first HACCP training course in Vietnam organized by FAO and INFOFISH took place in Ho Chi Minh City in May 1991 with the participation of the managers from both industry and government. Following the principle of "training other trainers", other training courses (where all leading lecturers were Vietnamese) were organized all over the country. Under the Government Project KN 04-15 "Upgrading the Quality of Frozen Fish Products" five fish processing plants from all important fishing areas were selected for the Trial HACCP Implementation Program. The trial gave us reasons to conclude that instead of immediate implementation of HACCP or ISO 9000 programs, the best way is to choose GMPs as the first step to lead into the implementation of HACCP in Vietnam. This paper lists the main reasons, presents the working steps and the experiences gained from various plants' GMP implementation. Attention is paid to the role that NAFIQACEN (National Fishery Inspection & Quality Assurance Center) played in the implementation of the HACCP-Based Quality Management Program in Vietnam. The present obstacles are pointed out and activities planned to achieve the strategic objectives of the fisheries sector in the coming period are described.

Introduction

During the last 15 years (1980-1995) the development of the fisheries sector of Vietnam has achieved significant results. The annual fisheries production from catching and aquaculture has increased from approx. 600,000 tonnes in 1980 to around 1.344 million tonnes in 1995, while exports for the corresponding years - from approx. 19 million to 550 million USD -increased by about 29 times. In comparison with the other economic sectors in Vietnam the fisheries sector is among those with highest development rate, its export turnover is only exceeded by those of oil and rice. In the global fisheries economy the annual fisheries production of Vietnam is ranked number 19, the fisheries export value as number 30 and the aquaculture shrimp production as number 5. Today, Vietnamese fishery products are exported to more than 25 countries and some of these products have gained considerable prestige in several major seafood markets.

Before 1975 fish processing in Vietnam was mainly carried out by a number of household industries turning out traditional salted and dried products. In the period 1975-1980 more than 40 industrial fish processing plants, with a total daily freezing capacity of around 70 tonnes for the production of seafood were established. Today, the total number of fish processing plants in the country exceeds 180 and the total freezing capacity installed in these plants corresponds to a daily output of more than 800 tonnes of frozen finished products; about 150,000 tonnes of frozen products are produced a year. The total cold storage capacity in these plants exceeds 23,000 tonnes, and their ice-making facilities provide for a daily production output of around 3,300 tonnes. For the delivery of finished products to shipping ports and domestic markets adequate means of transportation in the form of 1,000 refrigerated trucks with a total capacity of 4,000 tonnes are used.

One of the overall development objectives for the fisheries sector is to reach an annual fisheries production of 1.6 million tonnes in the year 2000 with a corresponding export value of 1.1 billion USD. To achieve this goal the following development scenario is envisaged by the Government :

- Improve offshore fishing and increase its production,
- Increase aquaculture production, and
- Improve the present quality of products by suitable measures at each step along the fish production chain, from catching/harvesting through landing, receiving and transportation to processing, storage and dispatch of finished products.

The last point is one of the most important measures to reduce post-harvest losses and to preserve the natural nutritional value of fish. Our target is to increase the percentage of first grade raw-materials from today's approx. 15% of the total production to around 50% in the year 2000.

In order to realize the above-mentioned aims our attention is concentrated on the maintenance of high hygienic and sanitary conditions, the optimization of temperature-time history, the minimization of mechanical damage risk all along the fish production chain, from raw materials to semi-processed and finished products. The strategy adopted by the Ministry of Fisheries is to apply GMP practices as the first step in implementing HACCP all along the fish production chain, from catching/harvesting to processing, transportation and marketing of fish products.

Development of the National HACCP Training Program - Preparation, Familiarization and Training Courses on HACCP

In order to protect their consumers, all leading fisheries products importing countries require a quality assurance program for the imported products, in particular :

- Japan (the most important fish products importer of Vietnam) with a program to inspect and license the export companies on the basis of voluntary quality registration;
- European Union with Directives 91/493/EEC and 91/492/EEC laying down the health conditions for the production and the placing on the EU market of fishery products from other countries;
- United States (the world's second fishery products importing market) with the voluntary control program organized by FDA/NOAA to approve the import of products into the US the market;
- Canada with the Quality Management Program.

What is the way for a poor developing country like Vietnam to follow to meet the strict requirements of the international markets? We can see the resolution of the problem in the Hazard Analysis & Critical Control Points concept.

The Vietnamese fish quality management experts were first acquainted with the concept from the HACCP International Training Workshop organized in Cochin (India) in October 1990. Following that, 65 quality managers from the fisheries industry got their initial knowledge on the first HACCP training course in Vietnam organized by FAO and INFOFISH in Ho Chi Minh City on May, 1991 led by Dr. Carlos Alberto Lima Dos Santos, Senior Expert of UNDP/FAO Training Program in Fish Quality Assurance. Many Vietnamese fisheries managers and quality control experts also participated in international training courses and workshops on HACCP held in Thailand in 1991, Malaysia in 1992, Indonesia in 1992, and Denmark in 1995.

In order to apply the HACCP concept to the fisheries sector, the Ministry of Fisheries developed a national HACCP training program. To start off the program, the Ministry of Fisheries, in cooperation with the Quality Control Center of Seaprodex (the largest fishery company in Vietnam) organized HACCP training courses in the most important fishery centers of Vietnam, viz Ho Chi Minh City and Minh Hai Province in the South, Danang in the Central and Haiphong in the North. All lecturers of the training courses were Vietnamese experts, who had attended international or local training courses and workshops. The 230 participants of the training courses were members of factory directorates and their quality managers, and government quality management experts. Moreover, the other training courses on "Seafood Inspection and Laboratory Techniques" and "The Instruction to Establish GMPs in Fish Processing Factories" organized on April and December, 1995 by UNIDO/DANIDA Project US/VIE/93/058 in cooperation with the NAFIQACEN had improved the HACCP understanding in Vietnam. The most important result from the National HACCP Training Program is the positive change in thinking manner of many fish processing factory quality managers, and more importantly, the minds of many company and factory directors, who are responsible for all activities of the establishments.

Implementation of the HACCP-Based Quality Management Program - The Trial HACCP Implementation Program

In parallel with the HACCP training activities, the Ministry of Fisheries carried out a comprehensive investigation on the production technology for frozen fish products (period 1991-1992), the industrial capacity for value-added products (1992-1993) and the inspection for production conditions at 92 factories registered to export fish products to the EU (1993-1994).

The Ministry of Fisheries used the results from the investigations to classify all fish processing factories according to their investment input, export value, types of products and quality management status. Furthermore, 5 representative factories from the North, Central and South of the country were chosen for the trial program for HACCP implementation under the Government Project KN 04-15 "Upgrading the Quality of Frozen Fish Products". The selected factories were :

- Frozen seafood factory No 49, Quang Ninh Province (North)

- Frozen seafood factory No 10, Danang City (Central)
- Frozen seafood factory No 1, Ho Chi Minh City (South)
- Frozen seafood factory No 3, Ho Chi Minh City (South)
- Frozen seafood factory No 29, Minh Hai province (South)

The methodology used for the trial HACCP implementation program was as follows:

1. Factory's registration was made on a voluntary basis.
2. Evaluation of present conditions of the factories followed a system of checklists, score scale and grading based on NOAA/FDA documents.
3. Documents prepared:
   - Regulation on Health Conditions for the Production of Fishery Products (based on Directives 91/493/EEC and 91/492/EEC and the regulations on Good Manufacturing Practices of Canada and FDA).
   - Setting up of Good Manufacturing Practices (GMP) in shrimp, fish, cuttlefish or squid processing plants (based on Codex criteria).
   - Formulate guidelines for expanding the Quality Management program according to the HACCP method (based on NOAA/FDA documents).
4. In-house HACCP training for QC staff and workers.
   The training has to be in accordance with suitable programs for each relevant subject. It is conducted for directors, managers, workers and quality control staff who have direct responsibility for its implementation.
5. Setting up a HACCP based Quality Management Program.
   The program has to concentrate on raw materials, production conditions, final products and staff and consisted of 7 steps as follows :
   - Identify potential hazards associated with all stages in the production line. Analyze the risks related to those hazards.
   - Determine the Critical Control Points in the production line.
   - Establish critical limits for every CCP which must be met.
   - Set up monitoring procedures for each CCP (using scheduled testing and/or observations).
   - Establish a plan and implement it to ensure that corrective action is taken whenever procedures indicate that a particular CCP is not under control.
   - Set up verification and review procedures including supplementary tests to ensure that the monitoring system is working effectively.
   - Establish an effective record-keeping system to document how every aspect of the system is working and to ensure that every failure in the system is traceable.
6. Submission of the HACCP-Based Quality Management Program to the Ministry of Fisheries for approval.
7. Implementation of the approved program.

Table 1 is a summary of the trial HACCP implementation program in the 5 factories.

Evaluation

In spite of some positive results of the trial HACCP program, we came to the conclusion that immediate implementation of HACCP or ISO 9000 programs at Vietnamese fish processing factories will face some restrictions and difficulties because:

- We still don't have enough suitable government standards, legislation and facilities to satisfy all the conditions and activities influencing the quality of raw materials, especially offshore fishing and inland distribution. As a consequence, raw material quality is a very big problem for our factories to resolve before embarking on the HACCP or ISO 9000 programs.
- The mechanical sophistication is rather low at most Vietnamese fish processing factories. The fact that one factory produces many kinds of products in small quantities had sometimes created overlaps in the production lines. This creates remarkable difficulties for the reports documentation, records updating and storage as required by HACCP and ISO 9000 schemes. Although the overlapping is undesirable, it takes time to get rid of the present situation at our factories.
- The ISO 9000 programs, as illustrated in Fig. 1, are too complicated (in "paper work" terms) and require very high investment not only for the "hard-ware part" (upgrading facilities, cost for inviting advisers and assessors etc.) but also for the "soft-ware part" (effective training for staff, setting up a suitable quality management system etc.)

And that is why we have chosen GMPs as the first step for the implementation of HACCP in specific conditions in Vietnam.

Using the experience received from the trial HACCP implementation program, and in accordance with the requirements of EU, the NAFIQACEN and its 5 branches located all over the country organized the GMP implementation at all factories which have registered to export their fish products into EU markets. This exercise was carried out at the beginning of 1996.

The implementation of the GMP program at a factory was organized through the following steps :

1. Investigation of present production conditions (technology, products list, hygiene conditions, quality of products etc.) to establish GMP objectives.
2. Setting up GMP documentation for the factory, including :
   - Final products standards.

     It may be Vietnamese standards, Seaprodex standards or standards based on the requirement of customers (but they should be equivalent to Vietnamese standards).
   - Raw material standards.

     To be set up according to the final products standards.
   - Hazard Analysis Tables (for every step in production line of each product) as a basis to set up related GMPs. Each table has five points :

     Production operations: List all steps in the production flow chart at the factory for every product; for example, PUD shrimp production flow : Raw Material - RM Receiving - RM Storage - Preparation - Sizing and Grading - Washing - Weighing - Moulding - Interim Storage - Freezing - Glazing - Packaging - Storage.

     Hazards: Analyze every step to identify which hazard could reduce quality of product (for example, in RM Receiving step, there could be : bad quality of raw material, bacteriological and physical contamination, abundant growth of bacteria, and weight shortage, wrong size, wrong grade...) to identify the CCP location.

     Preventive actions: Identify the cause of the hazards (for example high storage temperature can cause abundant growth of bacteria) to set up suitable preventive actions.

     Documentation: Fill out the control forms at suitable frequency to be sure that all CCPs are under control.

     General requirements: List general hygiene requirements and corrective actions which should be taken when a CCP is out of control.
   - Listing of GMPs.
     - personnel hygiene;
     - cleaning and sterilization of utensils and working areas;
     - use and storage of chemicals (mainly chlorine, additives) and packaging materials;
     - use of water; water treatment, storage and use of ice;
     - storage and transportation of final products;
     - use of measuring equipment (balances, thermometers, etc.);
     - receiving and storage of raw materials;
     - freezing, icing, packaging; and
     - any other specific GMPs.
   - Monitoring and records keeping system.
3. GMP verification, approval and announcement by factory director.
4. GMP implementation.
   - GMP dissemination and learning (in QC staff and workers). Set up reward and punishment measures.
   - After GMP is implemented, carry out daily supervision and monitoring using record forms.
   - Records keeping.
5. Verification and approval of factory GMP implementation program by authorized agency (NAFIQACEN).
   - NAFIQACEN periodically inspects factory or make random unannounced visits to the factory to check on their GMP implementation (following approved program).
   - NAFIQACEN/factory discussions to set up corrective actions (if necessary).
6. Further implementation. Putting up documents for government approval.

General assessment

NAFIQACEN has issued authorization to 59 Vietnamese fish processing plants for export of their products to the EU. The names of these 59 factories have been submitted to the EU by the Ministry of Fisheries as a step towards the achievement of a general agreement between Vietnam and EU for the export of Vietnamese fish products to the EU.

In the individual agreements signed between the factories and NAFIQACEN as a part of the authorization procedures, it is stated that the factories will have to implement proper documentation as a part of their required upgrading activities.

Due to the above mentioned urgent requirements by major fish importers by the end of 1995, 75% of the fish processing factories have registered with the HACCP-based GMP program. The factories understand that instead of checking only the finish products they must shift to a preventive strategy. They also understand that in order to eliminate all non-safe and non-hygiene products, to improve the quality (and the price) of their own products, there isn't any other way.

The Trial HACCP Implementation Program gave us some of the following experiences:

First, it is obvious now that the most important thing we should change first is the mind-set of every factory director, who is responsible for all the problems concerning quality management.

Secondly, the defects in the "hard-ware part" of the factory during HACCP implementation on many occasions could be overcome by suitable actions from the "soft-ware part". It means that by re-orientating the thinking of concerned people, and by using some suitable preventive action without very big changes to the building structure, a factory could sometimes improve the quality of their products.

Third, in addition to knowing HACCP and GMP concepts only in theory, by the GMP implementation program the quality management staff (not only of NAFIQACEN but also of fish processing factories) have gained invaluable initial practical experiences essential for the development of HACCP-based quality management programs suited for specific production conditions in Vietnam.

The initial achievements in economic benefits and improved product prestige reached by the factories which have implemented the program was recognized by the Ministry of Fisheries. Having acknowledged the achievements, the Ministry of Fisheries has decided to implement HACCP-based quality management programs to all activities in the fish production chain from fishing/catching, aquaculture farming, handling to processing and marketing. This is also an important point in the development strategy of the fisheries sector for the years between 2000 and 2010.

Present obstacles

The infrastructure of the Vietnamese fish processing industry, especially raw material storage at catching and landing sites, as well as transportation conditions are at a low level and may not entirely meet the safety and hygiene requirements. To satisfy HACCP concepts all factories need to invest on a scale that their present accumulated profits cannot meet.

The number of factories whose quality management systems need to be upgraded in terms of HACCP concept is rather big, while the human resources for aiding them in HACCP implementation program is not sufficient and not experienced enough at the present.

The Vietnamese legislative papers concerning HACCP-based quality management programs in fish processing factories have not been drafted or promulgated yet. The necessary guidelines and inspection forms for the program are still under elaboration.

Implementation plan for the coming period

To achieve the objectives of the fisheries sector for the year 2000, the fisheries authorities should carry out the following activities :

- Elaborate and submit to the Government and the Ministry of Fisheries the Inspection Regulation on production conditions in fish processing factories, the Decision on application of HACCP and GMP in fish processing and trading establishments and other legislative papers on approval procedures for HACCP implementation and work towards their eventual promulgation.
- Establish policies concerning finance, technology and personnel to support factories which have implemented HACCP-based quality management programs.
- Reinforce information dissemination activities, prepare/publish suitable teaching documents and organize training courses to prepare the establishment's directorate members, factory quality management staff and workers for HACCP and GMP implementation.
- Classify all fish processing and trading establishments according to their production competence level, technological compliance level and staff capability as a basis to identifying establishments which follow HACCP-based GMP programs and which ones could start their HACCP plan.
- Set up action plans to reach the year 2000 when all fish processing factories will implement HACCP plan, and all fishing vessels, fishing ports, etc apply the HACCP-based GMP program.
- Perfect the infrastructure, organization work and activities of NAFIQACEN headquarters and its branches as the main instrument to implement the HACCP-based quality management program in Vietnam.

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Discussion

Mr Hung emphasized that one way of overcoming the obstacles in the development of quality assurance program is through cooperation among countries and agencies in the region. There should be a continuous training of staff from ASEAN on HACCP and GMP programs.

The Seminar suggested that SEAFDEC could conduct the training programs and continue the activities from where the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II has ended. Such training programs could be conducted directly at the industry level.

Table 1. The results of the Trial HACCP Implementation Program in 5 factories.

	Implementation activities	Factory 1	Factory 3	Factory 10	Factory 29	Factory 49
1	Voluntary registration to participate in the program	+	+	+	+	+
2	Preliminary investigation of production conditions	+	+	+	+	+
3	Estimated capability of HACCP program implementation	Medium	Medium	Medium	Good enough	Good enough
4	Registered products	IQF squid fillet	IQF squid fillet	Cuttlefish, squid,*sashimi* and frozen fish fillet	Block-frozen shrimp	Cooked shrimps
5	Personnel involved (HACCP team)	6	4	7	7	7
6	Investment for premise upgrading	Small repairs	Total upgrading	Partial repair	Partial repair	Partial repair
7	Evaluation of Trial HACCP Implementation Program established by factory:					
	- Documents submitted	Good	Good	Good	Good	Good
	- Definition of Production Flow Diagram	Good	Good	Good	Good	Good
	- Determination of Critical Control Points	Too many	Medium	Too many	Medium	Medium
	- Record papers for Critical Control Points	Many	Medium	No	Medium	Medium
	- Preventive actions	Not enough	Satisfied	Satisfied	Satisfied	Satisfied
	- Corrective actions	Satisfied	Some are not reasonable	Satisfied	Satisfied	Satisfied
	- Do they have necessary measures to overcome?	Yes	Yes	No	Yes	No
8	Efficiency					
	- Quality aspect	Good	Good	Good	Good	Good
	- Economic aspect	New purchase orders for value- added commodities exceed factory's capability	Reduced the percentage of block frozen shrimp to 15%. Start the production of value-added products	Became one of the first factories in the Central region which processed products that excluded microorganism contamination in *sashimi*	First-class shrimp products increased by 10%; the highest product price in comparison with the other factories in the South.	Joint venture with Japan to process value-added products.
9	Social aspect					
	- Worker's income	Improved	Improved	Improved	Improved	Improved

Legend: + completed

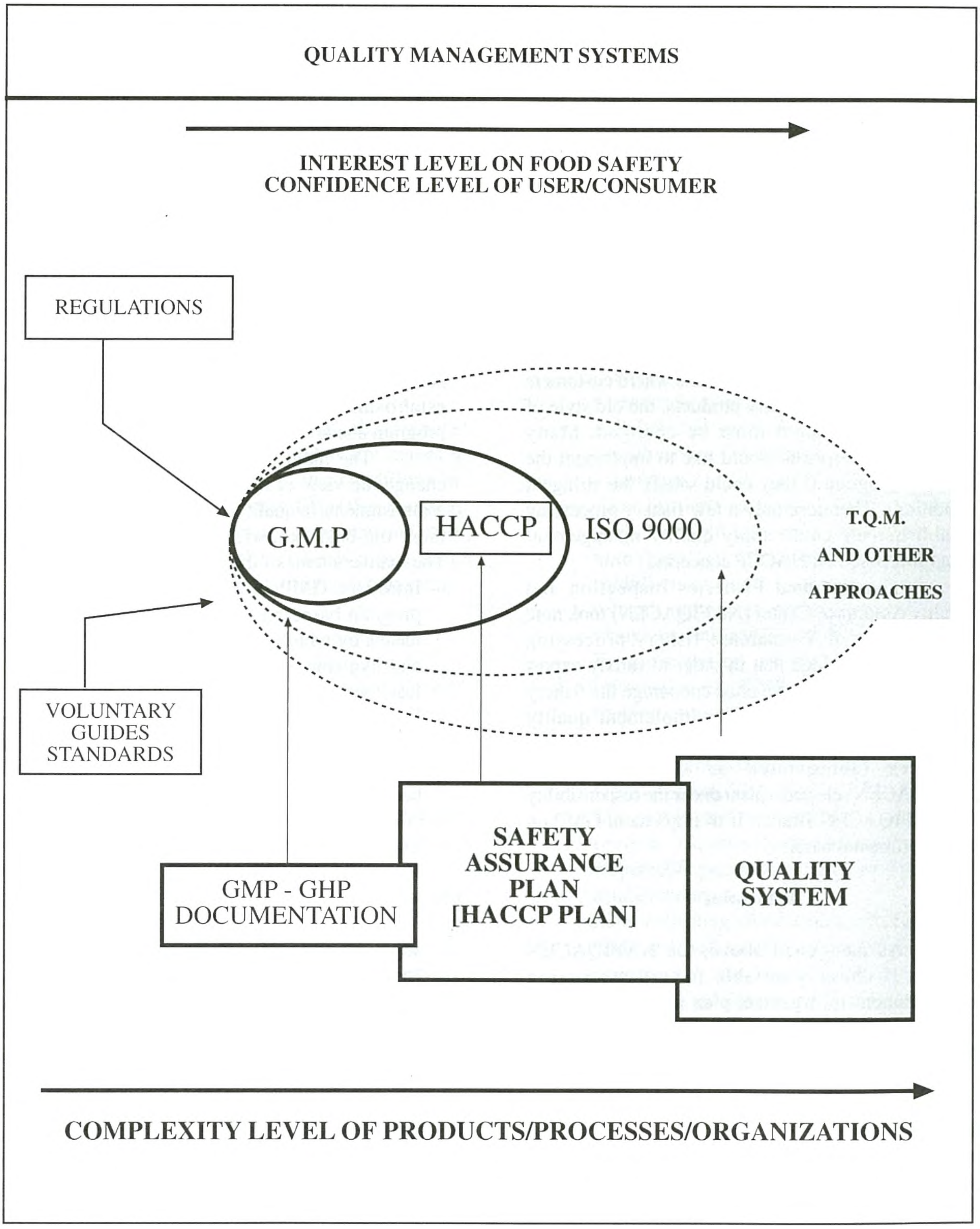

Fig. 1. Diagram of overlap of quality management system.

Some Experiences in Organizing, Planning and Applying the Quality Management Program Based on Good Manufacturing Practices (GMP) in Vietnam

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Background

Fishery products have been exported from Vietnam since 1970s. In the process of developing our exports, the quality of the products have been improving. Till 1995, however, quality management has been mainly performed through the control of final products.

In expanding into markets where customers require even better quality products, the old style of quality management must be changed. Many processing enterprises would like to implement the HACCP program if they could satisfy the stringent conditions. Therefore only a few fishery processing establishments could apply quality management programs based on HACCP concepts.

The National Fisheries Inspection and Quality Assurance Center (NAFIQACEN) took note of the status of Vietnamese fishery processing industry and decided that in order to satisfy export quality requirements, we must encourage the fishery processing establishments to implement quality management programs based on good manufacturing practices (abbreviated as GMP program). NAFIQACEN selected a plant under the responsibility of NAFIQACEN Branch II to implement GMP on an experimental basis.

Principles

As mentioned above, the NAFIQACEN Branch II chose a suitable fishery processing establishment to organize, plan and draft a GMP program together with experts of NAFIQACEN Branch.

After implementing the trial GMP program, experts of NAFIQACEN Branch II will continue to implement the GMP program in other fishery processing establishments, modifying some differences collected from real conditions in those fishery processing establishments. Whenever necessary, modifications can be made to suit the conditions of each establishment without sacrificing quality practices.

Preparations

1. Seminars.

NAFIQACEN Branch II organized seminars on GMP for fishery processing establishments in the locality to introduce this program ahead of time.

The main purpose of these seminars is to change the view of managers of fishery processing establishments in quality control activities and to give them the basic knowledge about GMP program. The main contents of these seminars are as follows :

- Introduce GMP as a total quality management program based on HACCP concepts. GMP is a means by which managers can ensure the safety and hygienic quality of their products with the least possible expenditure.
- By implementing the GMP program, managers can also reduce expenses for checking their final products; it also prevents defects to their products because the fishery processing establishments can control all important points in the processing lines.
- Introducing legal documents to establish GMP program. In accordance with the Governmental Ordinance on Commodities Quality, producers are responsible for the quality of their commodities. The competent authority for inspecting fishery products is NAFIQACEN, a center under the Ministry of Fisheries, and for setting Vietnamese standards of fishery products and conditions of fishery processing establishments, etc.
- Introducing some GMP programs practiced in the world, especially in the ASEAN countries. For example, in USA there are Quality Management Programs based on HACCP concepts. There is QMP in Canada. In European countries such as Denmark, there are enterprises practicing HACCP programs or "Own control system" which are

similar to GMP programs. In ASEAN countries, such as Thailand and Indonesia, there are also GMP programs.
- Introducing the participants to the basic conditions for implementing a GMP program in a fishery processing establishment.

2. Provision of guidelines to fishery processing establishments.

Sending guidelines to fishery processing establishments. The managers of these enterprises must personally check to ensure that their plants have the necessary conditions so that they can apply the GMP program. Only if they are sure that they have the basic conditions will they have the right to register for establishing a GMP program.

3. GMP program.

After a careful check of the fishery processing establishments, NAFIQACEN makes a list of those with good processing conditions or equivalent requirements for the EU, USA markets, etc. NAFIQACEN will then organize, plan and draft the GMP program for the fishery processing establishment to help them qualify for export status.

Operation

1. Drafting GMP program in a selected fishery processing establishment.
   - Experts of NAFIQACEN Branch II personally visit and assess all items submitted by the fishery processing establishment.
   - Legal documents to which the fishery processing establishment refers as authority for their processing activities are filed.
   - Assessment of items in the documents and problem areas of the plant which should be modified or rebuilt. The experts focus on technical procedures, regulations and files kept on quality control.
   - Choosing the staff who will directly work in drafting and operating the GMP program (abbreviated as "GMP staff"). This GMP staff consists of two experienced experts of NAFIQACEN Branch II, who are trained and qualified in establishing GMP program, and three persons from the fishery processing establishment who have experience and qualifications in managing, fishery processing and quality control activities.
   - Experts of NAFIQACEN Branch II preside over the GMP staff and plan the schedule for establishing the GMP program step by step as follows :
     a. Drafting regulations of the fishery processing establishment to satisfy legal requirements on the safety and hygiene of products.
     b. Drafting technical procedures and manufacturing standards based on Vietnamese standards and requirements. Attention is also paid to provide equivalence with target markets.
     c. Drafting GMPs for each kind of product of the fishery processing establishment.
     d. Drafting quality management files or forms to ensure that all critical points will be controlled. These files are also drafted to ensure that GMP programs are operating comprehensively.
     e. Submitting related reports to the related authorities for audit; verifying the GMP program.
   - After finishing each part of GMP program (a to e), the GMP staff send all drafts to quality managers in the fishery processing establishment and experienced experts in related authorities for their comments and recommendations.
     In anticipation of receiving feedback information, the GMP staff organizes the first training course for related managers and chiefs of sections in the fishery processing establishment to familiarise them with the draft GMP program.
     The GMP staff assesses the operation and records the feedback information from responsible persons in the fishery processing establishment.
   - After collecting all necessary information, the GMP staff submits the final draft of the GMP program to the Director of that fishery processing establishment for approval of the documents.
   - The final report is then submitted to the authorities (e) for auditing and verifying.
2. Routine operations of GMP program is as follows:
   - GMP staff organizes the second training course on approval of the GMP program.
   - In operation of GMP program, GMP staff continue to control the efficiency of the program through related documents and files.

- Periodically, the GMP staff will submit reports as required to NAFIQACEN on this program.

3. Authorities audit and verify the efficiency of the GMP program.
   The auditing and verifying activities are performed as follows :
   - NAFIQACEN staff who were not involved in establishing the GMP program will audit and verify the efficiency of this operation.
   - NAFIQACEN organizes a council of experienced experts for accrediting the GMP program in that fishery processing establishment and submits related reports to the Minister of Fisheries for certifying the program.

Extending of Activities to Other Establishments

1. Organize a seminar to announce the successful implementation of GMP program in the pilot fishery processing establishment.
2. Organize GMP staff from other fishery processing establishments.
3. Drafting GMP programs and related documents. GMP staff mainly use the pilot GMP program with modifications as necessary to suit other fishery processing establishments. One GMP staff of NAFIQACEN Branch II will preside over all GMP staff of registered enterprises to carry out the schedule as in the pilot program.

Results And Experiences

1. Time for establishing GMP program in experimental fishery processing establishment.

We saved a lot of down-time. In anticipation of receiving feedback information, we organized the first training course in the fishery processing establishment to further experiment with the draft GMP program. This activity helped us introduce the GMP program to persons in the establishment while we are waiting for approval. By this activity, we can assess the operation and record feedback information from responsible persons in the fishery processing establishment.

2. Time for establishing GMP program in other fishery processing establishments.

We also save time a lot. Due to experiences from pilot GMP program, we can establish other GMP program faster and in a more practical way. In this way, we established GMP program for many fishery processing establishments at the same time.

3. The GMP programs of fishery processing establishments was identified in all the country.

This program helped NAFIQACEN to audit, verify and manage the quality of fishery products more easily.

4. Economic efficiency.

By the above plan, fishery processing establishments reduced losses due to defects, contamination or unsafe products to a minimum.

By receiving many valuable opinions from experienced experts, GMP staff were very efficient in their use of resources in drafting documents.

The quality of products improved to the extent that the fishery processing establishments can negotiate with customers to get better prices for their products.

5. Social significance.

The prestige of Vietnamese fishery products has been enhanced in the international market.

The GMP staff of NAFIQACEN Branch II gained much experience in organizing, planning and applying quality management based on the GMP program. Subsequently, they are prepared to establish QMP based on HACCP concepts for other fishery processing establishments in the future.

The prestige of NAFIQACEN in consulting on quality management is enhanced.

The export of Vietnamese fishery products has been increasing. The exports to the EU and USA markets have also increased proportionately. In 1995, Vietnamese fishery products exported to these markets was 8% of the total quantity of exported fishery products. These exports have reached 11% of the total quantity of exported fishery products in the first 6 months of 1996.

Discussion

The representative from FAO, while noting the progress made by Vietnam in just a short period of time as far as fish processing is concerned, informed the Seminar that Vietnam could become the next tiger in Asia. He opined that the GMP used by Vietnam as indicated in Dr Phuong's paper might be misleading for this may have referred to quality management program as a pre-requisite to HACCP program, instead of GMP. In response, Dr Phuong said that Vietnam is now developing its GMP program. He added that NAFIQACEN staff assist the government in the development of a codex for safe products.

Quality Management of Fishery Products in Vietnam : Advancing Towards Integration With the Regional Countries and the World

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Introduction

Vietnamese economy is undergoing the process of *doi moi*; all over the country industrialisation and modernisation is taking place in order to achieve economic wealth, to build a society based on justice.

For more than 20 years Vietnam carried out post-war rehabilitation and rebuilding under the wise and capable guidance of the Vietnamese Communist Party and the intelligence, creativity and hard labour of the Vietnamese people, as well as with the aid of countries in the region and from other parts of the world. As a result of this accelerated rate of growth of the Vietnamese economy, Vietnam now enjoys harmony with countries in the region and around the World.

Fisheries has been identified as one of the important economic sectors for development and growth. Fish processing has contributed towards increasing the export of Vietnamese fisheries products and the income of fisheries workers. It is also the main animal protein source for most of our people. In order to develop further and to benefit the fishery sector and the national economy, the technology of fisheries processing must be upgraded and the quality management methods must be improved to meet the stringent requirements of customers from around the world as well as in the country.

Present status of fishery processing activities in Vietnam

Since 1977, when the first seafood products were exported, seafood processing in Vietnam has increased continuously in quantity as well as in value. Since then, the export value of fisheries products has risen 49 times. This sector is now ranked fourth in export value and is the fastest sector in the Vietnamese economy.

Seafood sold consist of shrimps, cephalopods, fish, oyster, crab and products of various mollusc and seaweed. Most of exported seafood products have undergone minimum processing. Because of the small value-added component, Vietnamese seafood products in the world's market are bringing in lower benefits to seafood processing companies.

Recently, although the processing establishments have made efforts to increase the diversity of seafood products and upgraded their production facilities and technology level, the product structure is still monotonous and cannot meet the demands of the world market. The major products are frozen, comprising 87-89% in quantity and 78-82% in value of total exports, of which frozen shrimp makes up 58-60% in quantity and 68-73% in value. The fish and mollusc products have increased in recent years, but their proportion is still low. The value-added products occupy only of 6-7% of export value.

The main customers of Vietnamese seafood are companies which reprocess and repackage with their trade label. These products are then re-exported. For example the products exported from Vietnam to Hongkong are usually re-exported to Japan.

Vietnam has yet to learn to deal with new and better clients. Although the processing plants may not completely meet the hygienic standards, seafood product quality is still accepted by clients who buy them for reprocessing.

However, it recognised that if the Vietnamese seafood industry wants to enlarge its market and raise the value of its products, it should step up the management and monitoring of seafood quality. It should invest in facilities and technology to upgrade production conditions and ensure high hygiene standards, in order to meet the requirements of the main clients in the world's market, where the products are sold directly to consumers.

At most processing plants, immediately after their establishment, there is a product quality control section consisting of 5-10 persons; most of them are trained in universities or colleges, or by the Quality Control Center (QCC), or in training courses on quality control organised by FAO.

There is a quality control laboratory in many plants, but most of them are not well-equipped and they only assess the quality of raw materials or products by sensory methods. When needed, they must ask accredited quality control institutions to inspect their products and issue the health certificate for export.

Faced with the practical requirement that there should be an office with jurisdiction to control and issue seafood products with health certificate, in 1983 the Export Aquatic Product Quality Control Center (QCC) was established. It belongs to the Ministry of Fisheries and is charged with the responsibility of sending cadres into plants to inspect their processing methodology, production technology and hygiene conditions and to take samples for the purpose of controlling product quality before issuing export seafood products with health certificate. The water samples from processing plants are also periodically tested in laboratories. But in practice its main office was in Seaprodex's building and its activities are related closely with this organisation. QCC has laboratories in Haiphong, Danang, Ho Chi Minh City, but most of their equipment are backward.

There are many laboratories providing seafood products with health certificates. These laboratories belong to different ministries; for example: Regional Centre for Standardisation Metrology and Quality (SMQ), Vinacontrol, Center of Hygiene & Epidemiology, Pasteur Institute, Seaspimex, Food Control Center, Animal Quarantine Center and others. The chaotic situation in the control and issue of such certificates has complicated the quality management program. This may have resulted in the erosion of the quality of Vietnamese seafood in recent years, leading to a drop in the average price of our exports.

In order to enhance the prestige of Vietnamese seafood products on the international market, the Ministry of Fisheries established the National Fishery Inspection Quality Assurance Center (NAFIQACEN). NAFIQACEN is responsible to the Minister of Fisheries to organise activities on inspection, to issue establishments with hygiene and assurance certificates, to control export of seafood products and to issue health certificates in accordance with state and international requirements. The NAFIQACEN headquarters is in Hanoi, with branches in Haiphong, Danang, Nhatrang, Ho Chi Minh City and Camau. Besides NAFIQACEN, the Fishery Resources Conservation Department and its branches, which are responsible for controlling diseases and quality of fishes, as well as inputs of aquaculture, also take part in the control and issue live fishes with health certificates.

Instead of quality management by control only of product quality and issue of certificate before exporting, nowadays quality management is extended and this consists of the quality management from culture, catch, handling and transport of raw material as well as processing, store and transport of export products.

Projects supported by international organisations such as UNIDO, DANIDA have helped Vietnamese fisheries train specialists in quality control of seafood products, educate the managers, processors and inspectors on new knowledge of quality management, equip NAFIQACEN branches with appropriate laboratories and train and guide processors in their application of GMP and HACCP in processing plants in the country.

Because of the pressure of market competition and quality requirements, processors are rushing to obtain aid from the project US/VIE/93/058 and NAFIQACEN to upgrade production facilities and upgrade technology in seafood processing. This is especially so in plants which want to export their products to the EU. Currently there are no Vietnamese plant that can meet completely the requirements of Directive 91/493/EEC dated July 22, 1991 of the Council of the European Communities. The number of plants permitted temporarily to export their products into the EU market is only 58%. That is why upgrading production facilities of seafood plants must be continued systematically in order to produce the products which can meet the hygiene assurance requirements of all markets in the near future.

Although NAFIQACEN was established only two years ago, it has contributed significantly to improvements in the quality of seafood exported. The average export price of Vietnamese seafood products was US$5.58/kg in the first 10 months of 1995, an increase of 30.1% over the annual average price of the year 1994.

Problems facing the seafood product processing industry

Although the quality management program of seafood products is a success, the Vietnamese seafood processing industry still faces the following problems :

- Fluctuations in the supply of raw materials, insufficient and unstable supplies resulting in excessive competition between fish processing establishments. Because they lack experience, some processors buy raw materials which do not meet quality requirements, therefore resulting in low quality products.
- In processing plants the technology must be upgraded, the lay-out of production lines must be rearranged, advanced methods of quality management must be implemented so that they respond to hygiene assurance requirements for seafood products.
- The fishing vessels, fishing ports, the

equipment for landing, transport and store of fish and fish products are not satisfactorily kept in good hygiene condition, resulting in deterioration and post-harvest losses.
- The aquaculture fisheries have not been developed sufficiently to supply enough raw materials to the processing industry.
- The fishermen in fishing vessels and workers in fish farms are not trained sufficiently for proper handling of raw materials to reduce post-harvest losses.
- Rules and regulations for quality management are lacking.

The fisheries quality management system is facing the following matters :

Because the fisheries quality management system has been established recently, we have yet to fine-tune the rules and regulations. These rules and regulations do not take sufficient note of the complicated situation of seafood product quality in the market. The Ministry of Fisheries is actively setting up new rules and regulations in order to manage thoroughly and closely the quality of fish products.

The government has passed the law of commodity No 86/CP on 8/12/1995. The enactment distributes responsibilities on commodity quality to the various ministries. Since July 1996, the Ministry of Fisheries, based on that enactment and on by-law rules and regulations, has been charged to carry out fishery quality management in the country. This will tidy up the control and issue of seafood products with health certificate. The Ministry of Fisheries will now manage closely and effectively the export of seafood products.

The fishery product quality inspection organisation is prepared to issue product hygiene and quality assurance for overseas customers. It is also providing proper training to cadres who are quality managers in state departments or establishments to upgrade their skills.

Future Developments in Relation to Quality Management

In order to improve the quality of Vietnamese fishery products and to keep up with fisheries development in the region the Ministry of Fisheries has set up the following measures on quality management to be implemented in the next few years:

1. Perfecting the fisheries product assurance and quality management system.

- Strengthen personnel, upgrade laboratories and train cadres from MOFI, NAFIQACEN, the Fishery Resources Conservation Department and branches of the last two organisations.
- Promulgate the rules and regulations for monitoring fishery product quality and hygiene assurance practised in the establishments from the production of raw material, post-harvest handling and preserving, collecting, transporting, processing and product storage and their import and export.
- Set up and promulgate the Vietnamese standards based on product quality. Stipulate the scope and objectives of these standards and supervise and monitor their implementation. In particular, attach importance to implementing good manufacturing practice (GMP) and advanced management methods based on the application of HACCP.
- Intensify training for quality inspectors, and quality managers of establishments; concentrate on training for total quality management.
- Establish relations with ASEAN fishery quality management systems. Cement the relationship with quality control institutions of EU, America and Canada in order to create conditions for the export of Vietnamese seafood products into those markets.

2. Set up the quality management program for raw materials.

- Promulgate the technical standards and procedures for producing, collecting, transporting and preserving raw materials. Only those establishments which meet those requirements in full will be issued with a permit to produce raw materials.
- Promulgate regulations which require processing plants to extend the scope of their quality management programs to the production of raw materials. Develop measures to help preserve raw materials, decrease post-harvest loss and promote hygiene and quality assurance. Organise seminars to disseminate technical guidance in preservation, transport and handling of raw material appropriate with hygiene and assurance conditions.
- Continue upgrading production facilities and improve preservation and processing technology, fine-tune investment policy, divert capital to increase production of raw materials, develop aquaculture in areas with commercial productivity into industrial-scale

concerns, rationalise exploitation of natural resources, and prevent the deterioration of the environment; also attach importance to off-shore capture fisheries.

- To meet the requirements of industrialisation and modernisation the fisheries processing sub-sector must re-organise itself to produce a large amount of products with added value, in order to meet the demands of different markets.

The issues concerning quality management must be confronted now so that the export value of fish products can be increased. Besides the Vietnamese economy can be subsequently strengthened and the country can keep in step with the rest of the region.

Recommendations for Seminar

After reviewing the draft recommendations, the summary of recommendations for the Seminar was adopted on 1 November 1996.

The winner of the two awards were announced. Ms Sirilak Suwanrangsi recieved the MFRD Award for the best country paper, while the Amano Award for the best research paper went to Ms Krissana Sophonphong for her paper on the Sensory Evaluation of Frozen Prawns.

Summary of recommendations :

1. To put emphasis on traditional fish products especially at improving quality, e.g. standardizing production methods, improving packaging, promoting utilization and upgrading the industry.
2. To use the ASEAN Network of Fisheries Post-Harvest Technology Centres (ASEAN Network) and its existing electronic information network to disseminate information and other aspects of technology development in the region.
3. To put more emphasis on handling and preservation of fish and raw materials.
4. To look into simple and rapid methods on quality assessment in the industry.

WORKSHOP ON COMPILATION OF FISH PRODUCTS IN SOUTHEAST ASIA

INVENTORY OF FISH PRODUCTS IN SOUTHEAST ASIA Third Edition, 1996

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Introduction

In 1984, the MFRD was requested to compile an inventory of fish products in Southeast Asia. The objective of the survey was to list the fish products available in countries in the region and the technical problems and constraints in meeting market requirements. That inventory, published in 1987, was the first of a series of compilations which is a comprehensive record of fish products in the region, and will be of interest to researchers, food scientists, fish technologists and administrators. It was also useful for fish traders, and may be used as a reference for further improvement of the quality of these products in the region.

In 1989, a similar survey resulting in the second inventory was undertaken. The challenge to conduct the second survey was raised at the 20th SEAFDEC Anniversary Seminar on Development of Fish Products in Southeast Asia in October, 1987, in Singapore.

Participants at the above seminar welcomed the publication and recommended periodic updating of information of the inventory. At that meeting, a workshop was held to deliberate on the second publication and suggestions for improvements were proposed for inclusion in the third edition.

This third edition was published in 1996 to coincide with the SEAFDEC Seminar on Advances In Fish Processing Technology In Relation to Quality Management In Southeast Asia, held on 28 October - 2 November 1996, in Singapore. At the same time, a workshop on the Compilation Of Fish Products In Southeast Asia was held to share the experiences of coordinators in the compilation of this inventory. This third inventory included the participation of a new member country, Vietnam for the first time. It also introduces readers to the various types of fish products consumed in the country.

Objectives Of Survey

The objectives of this survey are to :

1. update information on existing fish products,
2. to document new fish products,
3. to identify their quality level, and
4. to identify the constraints in their marketing and promotion.

The seven ASEAN countries that participated in this survey are :

1. Brunei Darussalam
2. Indonesia
3. Malaysia
4. Philippines
5. Singapore
6. Thailand
7. Vietnam

The ASEAN countries consumed a wide range of fish products. Based on critical responses received to the first edition of this inventory, the products were classified into the following categories (alphabetical) :

a. Boiled
b. Canned
c. Comminuted
d. Cured
e. Dried
f. Fermented
g. Fish Meal
h. Frozen
i. Powdered/Flaked
j. Smoked
k. Others

The questionnaire for this third inventory was sent in early 1995 to invite the participants to conduct the survey. Efforts were made to incorporate suggestions from users of the previous inventories; attempts were made to make the survey as comprehensive as possible, and to include all background information on fish products.

Achievements of the Three Inventories

The wide variety of fish products consumed in the Southeast Asian region are identified in the three inventories. The first inventory helped to identify the important fish products widely consumed in the region. This included traditional products such as those which are dried, fermented and smoked. It was stressed at that time some of the fish products have the potential to be upgraded to value-added products if more attention is paid to the final quality and improved packaging.

The second inventory saw new products emerging in the market which were not listed in the first inventory. These included fish products from canned, frozen and comminuted products such as sausage, burger, dumplings, fishcakes with various flavours and imitation crabmeat. The second publication also listed the problems faced in the production of fish products. The main problems are the short shelf-life and poor packaging of the final products and the poor hygiene and sanitation of processing areas.

One of the challenges in the second inventory was how to overcome difficulties in collecting data, as data on emerging products (e.g. surimi and surimi-based products) are not easily available. To ease this problem, SEAFDEC's Fishery Statistical Bulletin of the South China Sea Area (at the 6th Regional Workshop on Fishery Statistics in Southeast Asia, Bangkok, 1-4 Jul 86) adopted the same classification of fish products as used in the inventory. Therefore, the work of fish technologists and fish processors will be made easier in due course.

Achievements of the Third Inventory

One of the differences between the current (third inventory) and the previous inventories is the inclusion of the Vietnamese fish products. This results in a greater variety of fish products as compared to the previous editions. The survey indicated, however, that people in the ASEAN region consumed similar and a wide categories of products, as shown in Table 1. One of the problems indicated in this inventory is the lack of quality control during processing and the need to improve on packaging, which is also an indication of improved quality. The third inventory also provides readers with many photographs of fish products and their processing in order to give them a more complete understanding of the fishery products in this region.

Problems in the production and marketing of fish products recorded in previous inventories are again listed by the participating countries in the 1996 survey. This shows, unfortunately that improvements have not been made fast enough. The problems listed include short storage life and packaging of products, poor hygiene and sanitation of processing areas. In the case of the traditional products - dried, fermented and smoked products - the problems listed also included processing, poor handling of raw materials and processing methods resulting in inconsistent quality of the final products.

Problems Faced in Compiling the Third Inventory

1. Change of country coordinators.

Some of the country coordinators have been replaced; much time is spent by the compilers in explaining and familarising them to carry out this collaborative work.

2. Loss of information through the post.

Sometimes information was lost through the post and this caused concern and delay of work. This problem could be overcome with help of communication networking in the future.

3. Dateline not met.

Besides compiling and analysing information and data, one of the compiler's unrewarding jobs is to make sure that respondents adhere strictly to the dateline given to return the questionnaire. Deadlines overlooked by the respondents have resulted in a delay in the whole project.

Concluding Remarks

The first inventory was completed in 1987, followed by the second improved inventory in 1991. The third inventory was updated and published in 1996 as recommended by users of the second inventory. We hope that the inventory will be useful to all readers especially traders, processors, food researchers and scientists.

Table 1. Summary of fish products in the ASEAN Region.

Category	Brunei Darussalam	Indonesia	Malaysia	Philippines
Boiled	NA	Fish	Fish	NA
Canned	NA	Mackerel	Anchovy in sambal	Anchovy
		Tuna	Fish in tomato sauce	Mackerel in tomato sauce
		Sardine		Milkfish
				Milkfish in tomato sauce
				Milkfish, Salmon style
				Sardine in tomato sauce
				Tuna in oil
Comminuted	Fishball	Fishball	Cuttlefish ball, sausage	Fish burger
	Fishcake		Fish burger, fishcake, fishball	Fishball
			Prawn dumpling, wantan	Native sausage
			Otak-otak	
			Scallop flavour fish cake	
Cured	NA	NA	NA	*Kench* style cured fish
Dried	Chilled-sour salted fish	Anchovy	Anchovy	Abalone, anchovy
	Dried shrimp	Salted fish	Cockles	Barracuda, big-eye scad
	Fish		Cuttlefish	Crevalle, deep-bodied herring
	Salted fish		Jelly fish	Fimbriated herring
			Prawn	Hairtail, herring
			Salted fish	Indian sardines, lizard fish
			Shellfish	Long tailed nemipterid
				Mackerel, milkfish
				Roundscad, sea cucumber
				Shark fin, shrimp, slipmouth
				Squid, striped mackerel
Fermented	Cured shrimp	Fish	Anchovy	Fish, fish sauce
	Fish	Fish paste	Pickled prawn	Milkfish, salted fish patis
	Fish stomach	Fish sauce	Prawn paste	Shrimp paste
	Mussel		Shrimp paste	
	Shrimp paste			
Fish meal	NA	Fish powder	Fish manure	Animal feed
Frozen	NA	Fish, shrimp, squid.	Cuttlefish	Cuttlefish and squid
			Fish	Milkfish
			Prawn	Shrimps and Prawns
				Tuna
Powdered	NA	NA	Prawn dust	NA
Smoked	Dried fish	Fish	Tuna	Herring
				Milkfish
				Roundscad
				Sardine
Others	Fish cracker	Cracker	Prawn cracker	Shrimp *kropeck*
	Prawn cracker		Fish cracker	Seaweed
	Squid cracker		Fish satay	

Category	Singapore	Thailand	Vietnam
Boiled	Cooked fish	Steamed fish	Steamed fish
Canned	NA	Babyclam Crab meat Fish in tomato sauce Shrimp Squid, cuttlefish, octopus Tuna	Mackerel in tomato sauce Tuna in oil
Comminuted	Breaded fish finger Breaded squid ring Cuttlefish balls, fingers, paste Fishballs, fishcakes, *chikuwa* Imitation crabsticks Prawn balls, fingers	Fish ball Fish finger Fish noodle Imitation crabmeat Minced fish Surimi	Fish sausage Fish burger (dehead) Fish burger (boneless) Surimi
Cured	NA	Mantis shrimp Mussel	Jelly Salted moist fish
Dried	Sea cucumber Shark fin	Jelly fish Salted fish Salted freshwater fish Shellfish Shrimp Squid	Abalone, blue mussel clam Crimped squid, fish maw Jelly fish, oyster, peeled shrimp Salted fish (headed, split, whole) Scallop flesh, sea cucumber Sea horse, seasoned fish Shark fin, skinned cuttlefish Squid (whole), squid rings Urchin
Fermented	NA	Fish Fish sauce Shrimp paste	Acidified shrimp Fish sauce, fish meal Stiff shrimp paste
Fish meal	Animal feed	Animal feed	NA
Frozen	Cooked prawn Fish fillet Prawn Prawn meat Squids, cuttlefish Whole fish	Cooked shrimp Cuttlefish Fish Octopus Raw shrimp Shellfish Squid	Blue swimming crab block, cockle Comb-cuttlefish, cooked oyster Cooked shrimp IQF Cuttle fish block (edge, head, wing) Dipped shrimp, eel IQF Fancied swimming crab, cuttle fish Fillet cuttle fish, fish fillet Headed fish IQF, shrimp block Cuttlefish IQF, octopus block Peeled shrimp block, scallop block *Sai gon* rolled burger, seafood mix Shrimp *bisen*, skewered broiled shrimp Squid ring IQF, swimming crab roe Urchin blocks Whole cuttle fish block, IQF Whole fish degutted, IQF Whole shrimp block Whole skinned cuttle fish block
Powdered	NA	Fish powder, fish floss	Fish sauce concentrate
Smoked	NA	Dried fish	NA
Others	Prepared prawn cracker Prepared cuttlefish	Fish/shrimp cracker Fish satay	Agar, carrageenan, chitosan Fish cracker, fish liver oil, pearl Seaweed, shrimp cracker Sodium alginate

Problems Encountered in Data Compilation

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Status

The fish processing activities in Brunei Darussalam is presently on a cottage industry level. The number of processors in Brunei Darussalam is about 50, each with just one to five workers only. The production is inconsistent and generally follows market demand.

The products produced are crackers, fishballs, fishcakes, fermented products, dried-salted fish and dried smoked fish. In addition there are a few supermarkets which freeze products for their own outlets. The output of these fish processing establishments is between 5 to 100 kg per day of finished products.

Problems Faced

1. The processors are required to fill in forms provided by the Fisheries Department on a monthly basis. The data is either collected by our staff or returned by the processors. However problems arise when the processors were unable to return the data, or to return the forms on time.
2. There are processors who do not record their production. In this case the fisheries staff has to work with the processors to calculate the production figures. Therefore the figures are sometimes estimates.
3. Rapid changes in staff responsible for data handling in the supermarket also present a problem.
4. Limited manpower in the Fisheries Department for data collection.
5. Difficulties in getting previous production figures due to inconsistencies of operation or changes to data collection.

Suggestion

1. In order to get accurate data compilation I would like to suggest that all ASEAN countries have standard methods of collecting data.
2. Training of staff in statistics and data compilation to standardize procedures.

Problems on Compilation of Data on Fish and Fish Products

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Introduction

Indonesia is an archipelago which consists of more than 17,000 islands. Fish is one of our major sources of protein and non-oil revenue for the country.

During the last ten years (1985 to 1994), total fish production increased from 3,395,562 tonnes in 1985 to 4,013,831 tonnes in 1994, representing an increase of almost 20% over this period. About 56.1% of the fish captured from marine and inland open waters is consumed fresh and the remaining 43.9% goes to fish processing plants, including drying/salting, fermenting, smoking, freezing, canning and fish meal.

The latest statistics available on types and quantities of fish products is for 1994.

Technical Procedure of Compiling Data

The Directorate-General of Fisheries, Indonesia has established a standard operating procedure for compiling data on fish and fish products. The procedure is outlined below :

1. Institutions

The Directorate-General of Fisheries (DGF) determines the aims and methodology of the survey and instructs the Provincial Fisheries Services to compile the data, analyze the data and produce the national fisheries statistics.

The Provincial Fisheries Services produces a survey form with reference to the instructions of the DGF and in turn supervise the District Fisheries Services to collect the data, analyse it and produce the provincial fisheries statistics.

The District Fisheries Services in turn supervises field operators, processes the data collected by the operators and make a report of district fisheries statistics. One copy of their report is submitted to the Provincial Fisheries Services and another copy is sent to the DGF. The field operators obtain the data directly from processing plants and fill up the prescribed questionnaire forms.

2. Types of Fisheries Data

Types of data collected can originate from the following fields :
1. Marine fisheries,
2. Open inland water fisheries,
3. Brackishwater culture, and
4. Fresh water culture, both in ponds and in rice plants.

Figures from first two include fish production and utilization.

3. Method of Collecting Data

Data on fish production can be obtained from fisheries industries, landing places, and fisheries villages.

As stated above, during the survey, field operators are provided with forms which are approved by the DGF. Data from landing places is collected by field operators once a week, either on a Monday or Wednesday.

It is realised that not all fish captured is always landed at these landing places, since such facilities are not available in certain areas, particularly in remote areas. However, these villages are important with respect to compiling data on fish production. Collecting data from these fishing villages is therefore carried out quarterly. In addition, all fisheries industries are required to submit reports on their production to the government monthly.

Problems of Compiling Data

1. Geographical condition of the country

As Indonesia is an archipelago comprising 17,000 small and big islands, it is indeed time-consuming to collect data on fish and fish products.

2. Lack of manpower

All field operators are civil servants of the Fisheries Service. They not only collect fisheries data, but also give other necessary services such as training and exhibition to the public and fisheries sector. The number of field operators is insufficient for all the duties given to them. This situation can sometimes lead to delays in requests for data.

3. Bureaucracy

Indonesia is a big country consisting of 27 provinces, 243 districts, and 5,556 villages. Any information/data requested has to go through bureaucratic procedures, from the lowest level (village authority) to the highest hierarchy of authority (viz. the respective Departments). It is also time-consuming to obtain data/information.

4. Confidentiality

With respect to utilization of fisheries resources, it is comparatively easy to obtain data on fish species and fish products from the fisheries industries. However, it is not the case with obtaining accurate quantitative information from them. It is believed that such information is privileged reserved and sometimes even considered as confidential to the field operators.

5. Type of products

Indonesian fish processors are commonly considered as traditional fish processors and modern fish processors depending on their processing technology used and their scale of production. With regard to traditional products, any given type of product may be made from fish of very different origins, while the fish species used as raw material, and the processing techniques may also equally be different from place to place. As a result, the quality of the products may vary among the producers. For this reason, it is difficult to establish codes of practice for traditional products. For the purpose of compiling this inventory of fish products, it is not easy to choose a product that can represent its specifications. The alternative is to detail all variations of the product, which is an equally unacceptable exercise.

Fish Products Data Compilation in Malaysia

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Introduction

Fish is a major traditional source of animal protein for a large section of the population in Malaysia especially in the rural areas. In 1995, the total quantity of marine fish landed was 1,108,436 tonnes of which about 57% was consumed either fresh, dried, fermented or others, 29% was landed as trash fish and while rest was estimated to be lost due to spoilage.

In early 1996, the Marine Fisheries Research Department (MFRD) of the Southeast Asian Fisheries Development Center (SEAFDEC) requested the Department of Fisheries of Malaysia to conduct a survey on fish products in Malaysia. It was the third time SEAFDEC was compiling an inventory of fish products in Southeast Asia. The Southeast Asian Fish Products compilation provides comprehensive and convenient reference material for use by researchers, food scientists, fish technologists, administrators and fish traders and others in the private sector on the different fish products produced and consumed in Southeast Asia. The publication describes the different technologies and techniques involved in the production of fish products. Some information on prices of both raw and finished products are also documented, together with related packaging methods and materials, storage conditions, shelf life and ways of consumption. Information on production, export figures including countries of export destination and problems in marketing and quality control are also included.

Data Gathering

The collection and compilation of fish products data in Malaysia was done by the Fisheries Information System Section, Corporate Planning Division of the Department of Fisheries Malaysia. The Section sent questionnaires to the Marine Fisheries Extension Center in the country and to the Fish Handling Unit of the Malaysian Fisheries Training Institute in Terengganu. Still photographs and slides were also requested on the fish products. The questionnaire was designed to record the name and description of fish products, the main materials and additives used, cost per kg as well as outline of processing methods. Information on machines used to process the product, their packaging and storage conditions, shelf life, ways of consumption, retail prices and problems in marketing and quality control were also included in the questionnaire. Two months were given for the Center and Institute to collect the information.

The data for the production on the fish products for the years 1984 to 1993 was gathered from the Annual Fisheries Statistics, Volume I produced by the Department of Fisheries while data for export and countries of destination (export) for the years 1984 to 1993 were gathered from the Annual Fisheries Statistics Volume 2 produced by the Department of Fisheries (data was originally compiled by the Department of Statistics, Malaysia). Secondary data was gathered to supplement information for the questionnaire. These included data published in reports, manuals and results of other surveys.

Observations and Problems Encountered During the Survey

The questionnaires were returned to the Fisheries Information System Section as required. However, some data and information were not available. Production figures for products like smoked tuna, prawn dust and comminuted products were not available because the products are produced on a small scale and data was not recorded in the Annual Fisheries Statistics book. The export figures for the earlier years (1984-1987) for most products except dried prawn and fish meal were not available from the data given by the Department of Statistics in the Annual Fisheries Statistics Volume 2 for Import/ Export.

Recommendations and Conclusion

The fish products data is useful for researchers, food scientists, fish technologists, administrators, fish traders and others in the private sector who are interested in the fish processing and fish products field. As such, the periodic updating of the information as SEAFDEC is doing now is recommended further in the future. Malaysia will continue updating the current information and will send the information to SEAFDEC through electronic mail in the future. This is so because the current information gathered is not comprehensive yet especially for Sabah and Sarawak area. Furthermore Malaysia, under its 7th Malaysia Plan (1996-2000) is setting aside funds to increase its efforts in updating information in this area.

Reference

Department of Fisheries, Malaysia. 1996. Annual Fisheries Statistics, 1995.

Southeast Asian Fish Product, 2nd Edition SEAFDEC. 1991.

Compilation of Data on Processed Fishery Products

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Introduction

For several years now, the Bureau of Agricultural Statistics (BAS) has been catering to data requests on fishery statistics from international organizations such as the Food and Agriculture Organization (FAO). In such requests, the primary information required are fish catch production and value. In the case of Aquaculture, the hectarage utilized in the culture of different fish species, shells and seaweed is likewise requested. The Bureau did not have any difficulty in complying with their requests as the data items needed are included in the regular surveys being conducted nationwide.

In June last year, however, our host/organizer of this workshop the Marine Fisheries Research Department (MFRD), sent a questionnaire on processed fishery products categorized as frozen, dried, smoked, salted and canned. I suppose that the same set of questionnaires have been sent to the different countries for the purpose of compiling data on processed fishery products. Since the data requested are not being generated by the Bureau, our staff had to go to the different agencies and learning institutions to research.

This paper will present our experience in the compilation of processed fishery products. In particular, it will discuss the following :

- The BAS and its Mandate
- The MFRD Questionnaire on Processed Fishery Products
- Other Agencies Involved in Processed Fishery Products
- Learning and Research Institutions
- Problems Encountered in the Compilation
- Recommendations

The BAS and its Mandate

Under Executive Order No. 116 dated January 30, 1967, the BAS is responsible for the collection, compilation and official release of agricultural statistics. It exercises technical supervision over data collection centers and coordinates research activities pertaining to agricultural statistics of bureau, corporations and offices under the Department of Agriculture.

In carrying out its mandate, the bureau has three (3) technical divisions, two (2) support divisions, five (5) survey operations coordinating offices and provincial operation centers (POC) in all provinces of the country. The POCs undertakes the collection, monitoring and dissemination of agricultural statistics in the field in coordination with the technical divisions and survey operations coordinating offices at the Central Office.

At the Fishery Section of the BAS, regular activities include the conduct of every-other-day surveys of Commercial and Municipal fish catch unloaded at sample landing centers in 65 provinces and cities and semestral survey of aquaculture production in sample aquafarms in 77 provinces and cities.

For Commercial and Municipal surveys, the most important information obtained is the volume of fish catch production segregated by fishing ground, fishing gear and species. Other important data generated are price/kg and fishing effort. For aquaculture, the information on farm practices, stocking and farm inputs are likewise obtained. The Bureau's current fishery statistics, therefore, do not include information on processed fishery products.

However, recent developments in government priority programs recognize the importance of processed fishery products especially frozen and canned products because of their sizable contribution to the country's economy. Last year, President Fidel V. Ramos launched the 1993-1996 Medium Term Fisheries Management and Development Program in consonance with the government's continued effort to enhance the productivity of the country's fishery resources.

A major component of this project is the "Gintong-Ani for Fisheries" which is directed towards the development of aquaculture, management of lakes and the provisions of infrastructure and post-harvest facilities. The action plan on post-harvest facilities includes the establishment or improvement of ice plant and cold storage facilities in traditional fishing villages to attract private investors. The government also plans to expand post-harvest services and establish quality standards to ensure product acceptability in the world market.

With the vision of the government towards Philippines 2000, the need for a well established database on processed fishery products cannot be ignored.

The MFRD Questionnaire on Processed Fishery Products

The MFRD questionnaire categorized the different processed fishery products into frozen, dried, smoked, salted and canned. In each category, the following data items are included :

- Local Name (of product)
- Cost of Final Material
- Cost of Raw Material
- Description of Product
- References in Literature
- Main Materials
- Sub-Ingredients
- Processing Method
- Machine Used
- Packaging Conditions
- Storage Conditions
- Shelf Life
- Ways of Consumption
- Production Volume 1988 - 1993
- Export Volume 1988 - 1993
- Countries for Export
- Problems in Marketing and Quality Control

Other Agencies Involved in Processed Fishery Products

It was difficult to accomplish the MFRD questionnaire because the needed data are not covered by the generally accepted mandate of BAS. Our staff had to go to the different research institutions and government agencies to satisfy with the request.

1. National Statistics Office (NSO)

The NSO is the major agency mandated to generate general-purpose statistics. It is responsible for undertaking censuses and surveys of demographic and socio-economic aspects of national development such as population, health and education. It also undertakes censuses of agricultural holdings and establishments in coordination with the BAS.

The NSO has also field offices which take charge of the implementation and administration of the statistical programs and in the dissemination of statistics at the local level.

As for information on processed fishery products, the NSO provided the data on volume of export from 1988-1993 as well as the countries of destinations.

2. Bureau of Fishery and Aquatic Resources (BFAR)

The Bureau of Fishery and Aquatic Resources is responsible for the proper management and utilization of the country's fishery and aquatic resources. It also undertakes studies on the economics of the various phases of the fishing industry and provides technical assistance and advisory services.

The volume of production of processed fishery products for the whole country is not available. BFAR has an updated list of fish processing plant for 1995 but it identifies only a total of 176 fish processors. Small-scale fish processors are obviously not included in this listing.

3. Philippines Council for Agriculture and Resources Research and Development (PCARRD)

The Philippines Council for Agriculture and Resources Research and Development is one of the 19 councils under the Department of Science and Technology serving the National Research System. It publishes the Technology Series to highlight current advances in agriculture and natural resources for policy makers and research administrators. Among the published series which proved to be useful in the compilation are the following:

- Improved Icing of Milkfish
- Canning of Smoked Milkfish
- Cabinet-type Dehydrator for Drying

These publications were the primary sources of information in accomplishing the MFRD questionnaires, such as description of the processed fishery products, main materials and sub-ingredients used, the processing method, machines used, packaging and storage conditions, shelf life and problems in marketing and quality control.

Learning & Research Institutions

For these past years, people from the academic and government agencies have been actively involved in research studies for the improvement of fish processing methods and techniques, including cost and returns analysis. They also conduct verification projects to evaluate the efficiency of the developed methods.

Among the government agencies and learning institutions which contributed greatly to the advancement in the processing methods of fishery products are the following :

- Industrial Technology Development Institute,

Department of Science and Technology
- Bureau of Fisheries and Aquatic Resources
- Research Information Utilization Division, Philippine Council for Aquatic and Marine Research and Development (PCMARD)
- Food Terminal, Incorporated (FTI)
- National Institute of Science and Technology (NIST)
- College of Fisheries, University of the Philippines, Dillman, Quezon City
- University of the Philippines at Los Banos (UPLB)
- University of the Philippines in the Visayas (UP Visayas)
- Philippines Women's University (PWU)

Problems Encountered In The Compilation

As mentioned earlier, it was difficult for us to complete the MFRD questionnaires on processed fishery products primarily because of the following problems :

- Lack of a cohesive baseline information on processed fishery products. Baseline information is not complete. For instance, we really do not have an idea of the number of fish processors, including medium to small-scale processors and their volume of production.
- Lack of a centralized sources of information regarding the fish processing industry in the country. There is no single agency which is responsible, at least, for the dissemination of information pertaining to the country's fish processors and their processing activities. The researchers had to go from one agency to the next in gathering data on processed fishery products.

Recommendations

The fish processing industry is, no doubt, a thriving industry in the Philippines. Aside from local demand, the country has been exporting processed fishery products to different countries all over the world. However, its full potential in the world market has not been fully tapped because of problems besetting the industry.

The government is cognizant of these problems. It has already responded by formulating the action plan through the "Gintong Ani Program". With the absence, however, of cohesive baseline information on processed fishery products and a centralized source of information, implementation of the plan may not be as effective and efficient.

The Bureau of Agriculture Statistics, with its expertise and manpower, can very well function as the coordinating agency on matters pertaining to processed fishery product. The various agencies and learning institutions involved in research or improvement of fish processing methods and technologists can submit the results and findings of their studies to BAS for comparison and dissemination to policy makers, researchers, investors, foreign agencies such as the MFRD, students and other users of data on processed fishery products.

With appropriate funding, the Bureau can initially conduct a census of fish processors nationwide to generate the baseline information, to be followed by quarterly survey to monitor the production level of processed fishery products.

Conclusion

I have been telling you how difficult it was for us to accomplish the MFRD questionnaires on processed fishery products. Difficult as it was, we could not help but thank MFRD in giving us the opportunity to be of help in its endeavour to compile data on processed fishery products.

The experience has widened our vision on how the Bureau of Agriculture Statistics could better serve its clients especially the users of statistics on processed fishery products.

On behalf of the BAS, I would like to extend our sincere thanks and appreciation to MFRD for giving us the opportunity to be part of this important event.

Situation and Problems Faced by the Fishery Industry

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Introduction

Currently, the market for fish products manufactured in Singapore is mainly for local consumption. There are 104 fish processing plants (small and big scale) including 17 of them in the export business. Some of the processing factories also export fish products which are imported and processed from other countries.

The 2 main categories of fish products produced in Singapore is comminuted and frozen. The former comprises fish balls, fish cakes, *chikuwa*, breaded fish fingers and squid rings, cuttlefish balls, fingers and paste and prawn balls and fingers. The frozen products consist of cooked prawns, fish fillet, prawns, squid, cuttlefish and whole fish.

Comminuted Products

The production of breaded fish fingers has increased from 48 tonnes in 1988 to 653 tonnes in 1993, while the production of breaded squid ring has increased from 96 tonnes in 1988 to 699 tonnes in 1993 (Table 1). The production of fishball, fishcakes and *chikuwa* is the highest in 1989 at 950 tonnes whereas the product with the lowest production volume is prawn balls and fingers at 17 tonnes in 1988.

As compared to the production volume, the export figures are not substantial (Table 2). That the export figure in 1992 of prawn balls and fingers is higher than the production volume is explained by the fact that part of it was previously imported products. The highest export figure belongs to the breaded squid ring where their destinations are Australia and the European Union. From both Table Nos. 1 and 2, the main comminuted product produced in Singapore for local consumption is actually fishballs, fishcakes and *chikuwa*.

Frozen Products

The largest production is fish fillet with nearly 41,000 tonnes over the 6-year period from 1988 to 1993 (Table 3). The year of highest frozen products was 1990 with over 35,000 tonnes.

The highest export product is fish fillet with 31,184 tonnes over the 6 years and the year of highest export volume was in 1990 with a volume of 18,133 tonnes (Table 4). The destination countries are the EU, USA, Hong Kong, Taiwan, Saudi Arabia, Japan and the Middle-East countries.

Frozen products are mainly for export; and they are not so popular locally as consumers here prefer freshly caught seafood that can be bought in the local wet market or supermarkets.

Problems

Due to a shortage of land and high labour cost, many of the fish processing establishments in Singapore are unable to increase their scale of production. There is also a need for the fish processing factories to improve their manufacturing practices and implement programmes such as HACCP or GMP to increase the quality of their products and enable them to fully meet the requirements of the importing countries.

For the past few years, it is required for fish processing establishments to submit their annual production, export and local consumption figures according to the licensing requirements. However, submission of the price of raw materials and final products is not required. Thus, these data are generally not available in the survey. In order to fulfill the objectives of the survey, it is necessary to establish a close relationship with the fish processing industry so that we can obtain their cooperation in data collection for future surveys.

Conclusion

This survey has served its purpose in updating information on the current situation of the fish processing establishments in Singapore. The total production volume for comminuted products and frozen products from 1988 to 1993 is 10,002 tonnes and 112,860 tonnes respectively. Local consumption of comminuted products during this period is 66% of the total production volume. The export volume of frozen product is about 65% of its production.

Table 1. Production of comminuted products (tonnes), 1988-1993.

Types of Comminuted Products	Production Volume (tonnes)					
	1988	1989	1990	1991	1992	1993
Breaded fish finger	NA	NA	48	131	468	653
Breaded squid ring	96	125	NA	291	384	699
Cuttlefish balls, fingers, paste	44	95	328	207	606	52
Fishball, fishcakes, *chikuwa*	638	950	539	298	545	385
Prawn balls, fingers	17	18	49	49	103	78
Total	795	1188	964	976	2106	1867

Table 2. Export of the comminuted products (tonnes), 1988-1993.

Types of Comminuted Products	Export Volume (tonnes)					
	1988	1989	1990	1991	1992	1993
Breaded fish finger	NA	NA	47	131	384	643
Breaded squid ring	96	125	NA	291	17	699
Cuttlefish balls, fingers, paste	NA	NA	22	44	6	52
Fishball, fishcakes, *chikuwa*	38	48	NA	20	53	98
Prawn balls, fingers	5	3	2	19	468	47
Total	139	176	71	505	928	1539

Tables 3. Production of frozen products (tonnes), 1988-1993.

Types of Frozen Products	Production Volume (tonnes)					
	1988	1989	1990	1991	1992	1993
Cooked prawn	421	566	1549	1703	1038	394
Fish fillet	3985	4610	7054	7938	8464	8438
Prawn	2088	2049	2611	3844	3230	3956
Prawn meat	Nil	Nil	55	21	26	62
Whole fish	1929	6913	9875	5302	5331	5270
Total	8423	14,138	35,282	18,808	18,089	18,120

Table 4. Export of frozen products (tonnes), 1988-1993.

Types of Frozen Products	Export Volume (tonnes)					
	1988	1989	1990	1991	1992	1993
Cooked prawn	421	556	1547	1420	1038	394
Fish fillet	3696	3227	6745	6583	7578	7355
Prawn	1511	1537	2141	3735	2936	3394
Prawn meat	Nil	Nil	41	10	16	51
Whole fish	1584	2766	7659	3694	3254	3165
Total	3516	8086	18,133	15,442	14,822	14,359

Problems Encountered with Fisheries Product Statistics

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Introduction

In 1993, fish production was about 3.38 million tonnes of which about 90.0 % was marine and aquaculture fisheries and the rest was freshwater fisheries. Fish were processed into various types of products depending on market demand. Most of the traditional products were supplied to the local market.

To compile the data on fish products, the survey team collected 10 items with 42 fishery products altogether. Problems encountered in collecting data were as follows:

Location of Fishery Establishment

Most freezing, cold storage and canning plants were located along coastal areas. We have no problem collecting the data from the plants although we have a coastline of 2,600 km, stretching from the Central Region to South Thailand. For traditional products, the processing plants are scattered all over the country. Moreover, the size of the plants vary from big scale to household scale. Therefore, it is impossible to get the production figures of each traditional product.

Fishery Product Category

Fishery products have been grouped into main processing items depending on the requirement. For example, in the Foreign Trade of Fishery Commodity, Department of Custom, the item fish includes whole, fillet and minced in the fresh and frozen item. Therefore, the export figure of minced fish or surimi was not available separately. For Fisheries Statistics of Thailand, Department of Fisheries, the pattern of categorising disposition fish has remained the same as in the Foreign Trade of Fishery Commodity. As a result, the production figure of value-added products of some new products is not available.

Problems of Fish Products Statistics in Vietnam

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Vietnam fisheries has grown continuously since 1980. Its exploitation volume increased by 4-7% each year. The total production of 1,066,300 tonnes in 1991 rose to 1,344,140 tonnes in 1995. The value of exports of some items has also increased more than 12 times between 1988 and 1993 more rapidly between 1991 and 1995. In 1991 the export value was US$225 million, and rose to US$550 million in 1995. The details are described in Tables 1, 2 and 3.

Vietnamese factories with export capabilities have the following facilities :

- Frozen products, 780 tonnes per day
- Chill-storage capacity, more than 20,000 tonnes
- More than 150 storage vans with a total load of 800 tonnes
- More than 20 chill-storage vessels loading, more than 6,000 tonnes

Data on the export of fish products is as follows :

1981 - - US$ 11.2 million.
1991 - - US$252.0 million.
1995 - - US$550.0 million.

The absolute value for frozen shrimp is gradually increasing, but its average price tends to decrease; for example :

Year	Average Price
1982	US$ 6.5 / kg
1991	US$ 4.8 / kg
1993	US$ 4.6 / kg
1994	US$ 4.9 / kg

The products are mainly exported to Japan, Hong Kong and Singapore, and a small amount is exported to the EU and North America. For example, the export to the EU in 1994 was US$30 million.

Domestic fishery products are mainly fish sauce and fish meal for animal feed. In 1994, 150 million liters of fish sauce and 15,000 tonnes fish meal were produced.

An Industrial Consultant Committee for Development (ICD) found that only 30% of fishes caught are used in the processing industry in Vietnam; the remainder is consumed fresh. It is not yet possible to increase the volume processed because of a shortage of advanced and appropriate preservation equipment. The post-harvest losses of Vietnam fisheries are estimated by the ICD at up to 40% of the total volume.

Vietnamese fish products are produced in the form of semi-manufactured or in crude forms such as frozen, salted, dried and artisanal fermented products. Canned and value-added products occupy only a small percentage of processed products.

To enhance the value of fish caught, the Vietnamese fishery processing industry must focus on :

a) Minimizing post-harvest losses. This will be carried out by promoting preservation technology and mechanization to protect raw material from damage and spoilage and to quickly transport the raw materials in an optimal condition to the processing factories.
b) Upgrading export products quality to meet the standards of international markets.
c) Using low cost fishes and by-products from fish processing plants for making value-added products.
d) Diversifying fish products to meet consumers' demand in the domestic and foreign markets.

The Vietnam statistics for processed fish products needs improvement. The main reason is that fishery statistics have not been considered as important as it should be. Firstly, it is because fish processing in Vietnam is still a small scale industry and the products are of low value. Secondly, it is because of a lack of funds for running it.

Vietnam has not yet established a complete fishery statistics system. With the expected assistance from SEAFDEC for this sector in the coming year, we can hope to improve the situation and have a more effective statistics system.

Vietnam now, urgently needs assistance in :

- Fishery statistics methodology (data collection method),
- Organizing fishery statistics and budget for running fishery statistics.

The aim of Vietnam's fisheries for the year 2000 is to increase production to 1,600,000 tonnes with an export value of US$1 billion, from a sustainable fishery without affecting biodiversity.

Table 1. Total production of fisheries in Vietnam (tonnes) from 1988-1993.

Name of Product \ Year	1988	1989	1990	1991	1992	1993
Total Production	900,030	934,582	978,880	1,066,000	1,080,279	1,172,529
Processed Products:						
Fish meal	-	-	1,856	8,000	25,470	14,200
Fish sauce/10^3 L	-	-	105,076	136,200	143,552	150,000

Table 2.Production of capture fisheries of Vietnam during 1985 - 1995.

Year	Production (tonnes)	Number of boats	Power of boats (HP)	Fishermen	Output tonnes/fisherman/ year
1985	626,848	29,323	494,507	220,770	2.84
1986	597,718	31,680	537,503	269,279	2.20
1987	640,569	35,406	597,022	291,441	2.20
1988	662,816	35,744	609,317	299,300	2.21
1989	661,365	37,035	660,021	269,467	2.45
1990	672,130	41,866	787,685	753,287	2.65
1991	714,253	43,940	824,438	275,035	2.60
1992	746,570	54,612	986,420	338,927	2.20
1993	798,057	61,805	1,291,550	363,486	2.19
1994	889,998	NA	1,443,950	389,533	2.28
1995	928,860	NA	1,500,000	420,000	2.21

Table 3. Fisheries products exported (tonnes), 1988 - 1993.

Products \ Year	1988	1989	1990	1991	1992	1993
Frozen shrimp	25,192	23,624	94,000	40,058	38,795	55,680
Frozen cuttlefish	2,412	2,918	4,800	4,350	4,877	7,050
Frozen fishes	2,817	12,765	4,000	7,179	20,122	23,149
Dried product (mainly squid)/	4,213	3,171	4,279	5,814	9,500	20,135

Recommendations for Workshop

General :

1. MFRD should continue with the inventory and the publication. The compilation should be a regional activity with MFRD as the lead agency involving the national institutes in ASEAN.

2. MFRD should organize a workshop in order to discuss and define the activities to be undertaken during the compilation and to provide an opportunity for the exchange of updated information on fish products.

3. The compilation of information on the technical aspects of the fish products should be intensified. Such information should include the complete description of the products, the processing methods, raw materials used, source of raw materials, the end products, and usage and distribution of the products, whether these are used for local consumption or for export. In this respect, member countries of SEAFDEC were asked to provide more inputs for the compilation activity in terms of manpower and financial resources so as to reduce the number of "N.A." responses in the survey questionnaire.

4. MFRD should make use of the existing ASEAN information network to facilitate a regular exchange of information and comprehensive updating of the compilation.

5. The national standards of fish products that are already available may be quoted as a reference in the Fourth Edition of the Inventory.

National :

1. Country coordinators are encouraged to continuously collect and update as much information as possible and make the compilation an ongoing activity on a yearly basis so as to also reflect the seasonality of some products.

2. Country coordinators should work with their field officers to collect the information and data in addition to those gathered by their national customs/trade offices. Each country should negotiate with its customs/trade office to initiate the possible revision of the customs/trade codes of fish products so as to include information on new categories of fish products in the trade statistics of each country.

3. Information on small-scale and cottage industries should be included in the compilation.

4. Newly designated country coordinators should work closely with the former coordinators in order to have a smooth handover of responsibilities and for a better understanding of the activity.

APPENDICES

Appendix 1

SEMINAR PROGRAMME

29 October

8:30 - 9:00 am	Registration
9:00 - 9:30 am	Opening Ceremony Welcome Address by Dr Maitree Duangsawasdi, Secretary-General, SEAFDEC Opening Address by Dr Ngiam Tong Tau, Director PPD & SEAFDEC Council Director for Singapore
9:30 - 10:00 am	Keynote Address : Dr Keishi Amano *A Simple Way to Maintain the Fish Processing Industry*
10:00 - 10:30 am	Tea Break
10:30 - 12:00 pm	*Workshop on Compilation of Fish Products in Southeast Asia* Chairman : Mr Kazuo Inoue Coordinator : Ms Ng Mui Chng
12:00 - 1:30 pm	Lunch
1:30 - 4:30 pm	*Workshop on Compilation of Fish Products in Southeast Asia* (continued)
7:30 pm	Dinner hosted by SEAFDEC Council Director for Singapore

30 October

SPECIAL PAPERS

Chairman : Dr Maitree Duangsawasdi

9:00 - 9:45 am	*Some clever techniques in the processing of traditional fish products* - Dr Yutaka Shimizu
9:45 - 10:30 am	*World trend in surimi processing with respect to new technology and quality control* - Dr Minoru Okada
10:30 - 11:00 am	Tea
11:00 - 11:45 am	*Present status and perspective on the implementation of HACCP in Japanese fish processing industry* - Dr Toshiharu Kawabata
11:45 - 12:30 pm	*Regional HACCP and prerequisite requirement training to the year 2000* - Mr Leonard G. Limpus
12:30 - 1:30 pm	Lunch

COUNTRY PAPERS

Chairman : Mr Tan Sen Min

1:30 - 2:00 pm	BRUNEI DARUSSALAM : *Seafood processing industry in Brunei Darussalam* - Ms Mariani Hj. Sabtu, presented by Mrs Hajah Hamidah bte Haji Ladis
2:00 - 2:30 pm	INDONESIA : *Development of fish processing technology in relation to quality management in Indonesia* - Dr Josephine Wiryanti
2:30 - 3:00 pm	MALAYSIA : *Status and development in the fish processing industry in Malaysia* - Mr Hamdan Jaafar and Ms Wan Rahimah Wan Ismail
3:00 - 3:30 pm	Tea

Chairman : Mr Kazuo Inoue

3:30 - 4:00 pm	PHILIPPINES : *HACCP-based Philippines fish inspection program* - Ms Consurlo C. Baltazar, presented by Ms Muriel B. Camu
4:00 - 4:30 pm	SINGAPORE : *Control of fish processing establishments in Singapore* - Ms Chew Su Pei and Mr Chiew King-Tiong
4:30 - 5:00 pm	THAILAND : *Advances in fish processing technology in relation to quality management* *- Ms Sirilak Suwanrangsi*

31 October

Chairman : Dr Shiro Konagaya

9:00 - 9:30 am	VIETNAM : *NAFIQACEN - The Vietnamese Governmental Competent Authority on Inspection and Certification for Fishery Production Conditions and Product Quality* - Mr Nguyen Tu Cuong

RESEARCH PAPERS

9:30 - 10:00 am	*Evaluation on nutritional value of Javanese salted-boiled fish during processing with special reference to EPA and DHA content* - Kukuh S. Achmad, M. Fitriati and Sunarya
10:00 - 10:30 am	Tea
10:30 - 11:00 am	*Effect of food additives and thickness on the fish crackers quality* - Rosmawaty Peranginangin, Y.N. Fawzyam, Sugiyono and I. Muljanah
11:00 - 11:30 am	*Optimising quality retention in processing of salted-boiled fish based on kinetic organoleptic quality degradation* - Suparno and L. Daud
11:30 - 12:00 pm	*Chilled storage of Malaysian fishballs and hazards and CCP analysis* - Yu Swee Yean and C.C. Lee
12:00 - 1:00 pm	Lunch

Chairman : Mr Hooi Kok Kuang

1:00 - 1:30 pm	*Critical control points in the processing of fish snacks in Malaysia* - Wan Rahimah Wan Ismail
1:30 - 2:00 pm	*Effects of processing on the quality of salted, dried fish of different species* - Noryati Ismail
2:00 - 2:30 pm	*Development of value-added fishery products* - Emilia M. Santos-Yap
2:30 - 3:00 pm	*Sensory quality attributes of crab analogue and squid balls from Bighead carp (Aristichthys nobilis* Richardson*)* - Dalisay Fernandez
3:00 - 3:30 pm	Tea

Chairman : Prof.Yutaka Shimizu

3:30 - 4:00 pm	*Colour and quality assessment of tuna for sashimi* - Evelyn Chia Geok Hoon and L.K. Low
4:00 - 4:30 pm	*Utilization of lizardfish, Saurida tumbil, for surimi production* - Ng Mui Chng, H.K. Lee, K. Sophonphong, S. Rungjiratananon, O. Kongpun, W. Suwannarak and L.K. Low
4:30 - 5:00 pm	*Effect of citric acid on the quality and shelf life of dried shrimp* - Varatip Somboonyarithi, Y. Ruttanapornvareesakul, N. Rulsakulthai and M. Chaiwat.

1 November

Chairman : Mr Leonard G. Limpus

9:00 - 9:30 am	*Sensory assessment of frozen prawns* - Krissana Sophonphong
9:30 - 10:00 am	*Quality assurance program for frozen surimi in Thailand* - Suwimon Keerativiriyaporn
10:00 - 10:30 am	Tea
10:30 - 11:00 am	*Quality management of fishery products in Viet Nam advancing towards the* integration into the regional countries and the world *- Tran Thi Dung*
11:00 - 11:30 am	*Some experiences in organising, planning and applying the quality management* program based on good manufacturing practices in Viet Nam - Dinh Thanh Phuong
11:30 - 12:00 pm	*Development and implementation of a national HACCP training program, the* experience of Viet Nam - Le Dinh Hung
12:00 - 1:00 pm	Lunch
1:00 - 3:00 pm	General discussions and recommendations Chairman : Mr Tan Sen Min
3:00 - 3:30 pm	Tea
3:30 - 4:00 pm	Adoption of Report
4:00 - 4:30 pm	Presentation of Awards
4:30 - 5:00 pm	Closing session

Appendix 2

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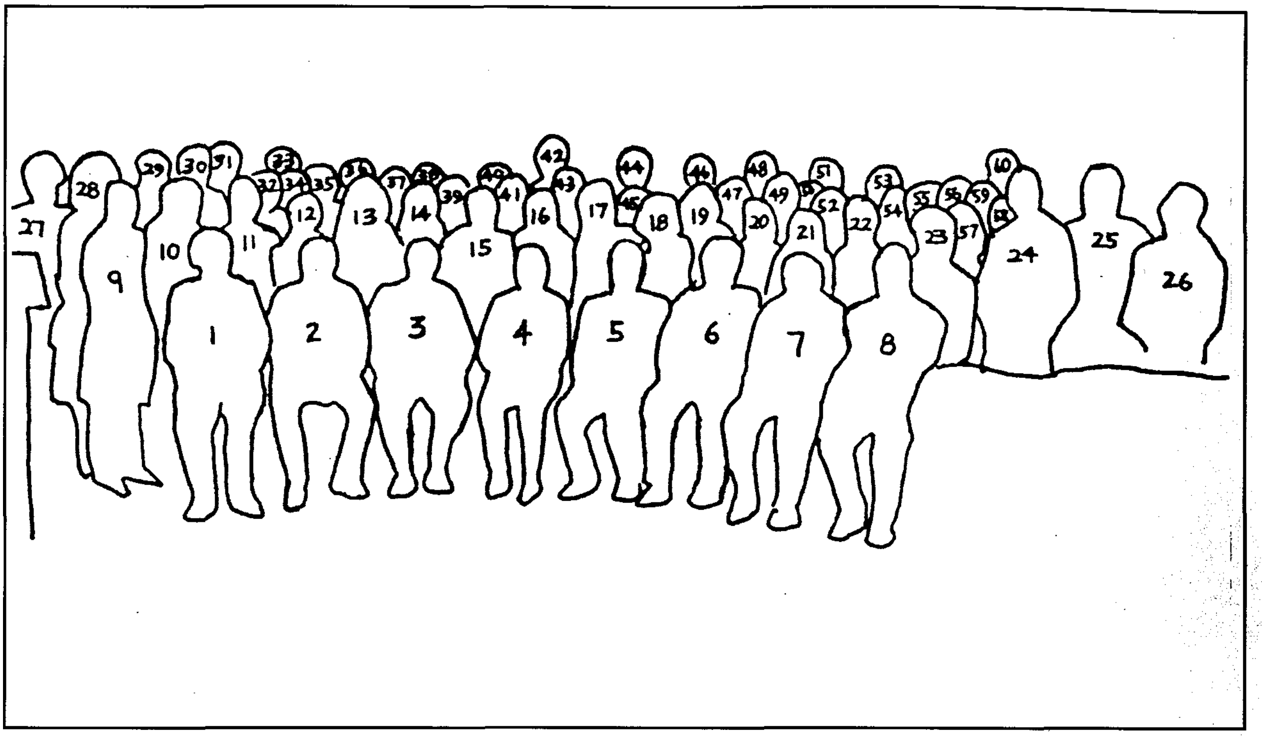
EXIT
MARINE FISHERIES RESEARCH DEPARTMENT
SEMINAR ON
ADVANCES IN FISH PROCESSING TECHNOLOGY
IN SOUTHEAST ASIA IN RELATION TO QUALITY MANAGEMENT
WORKSHOP ON



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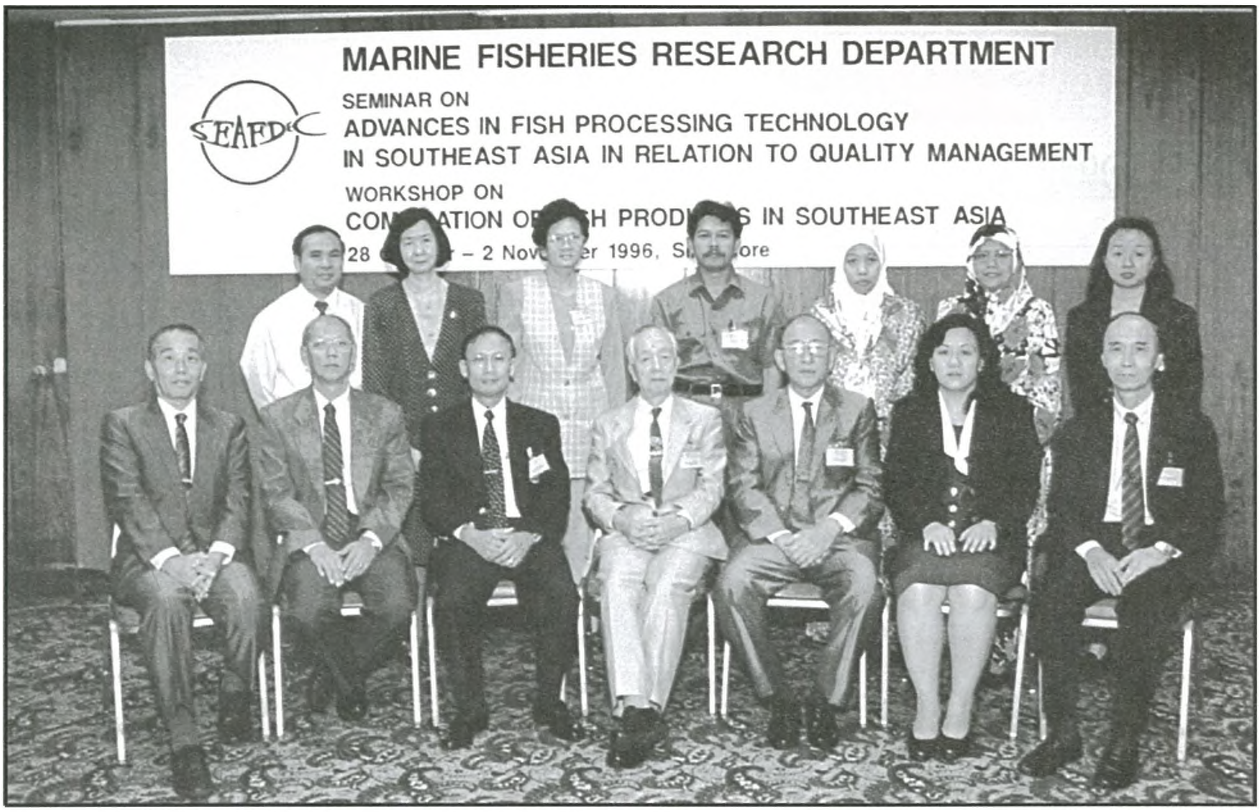
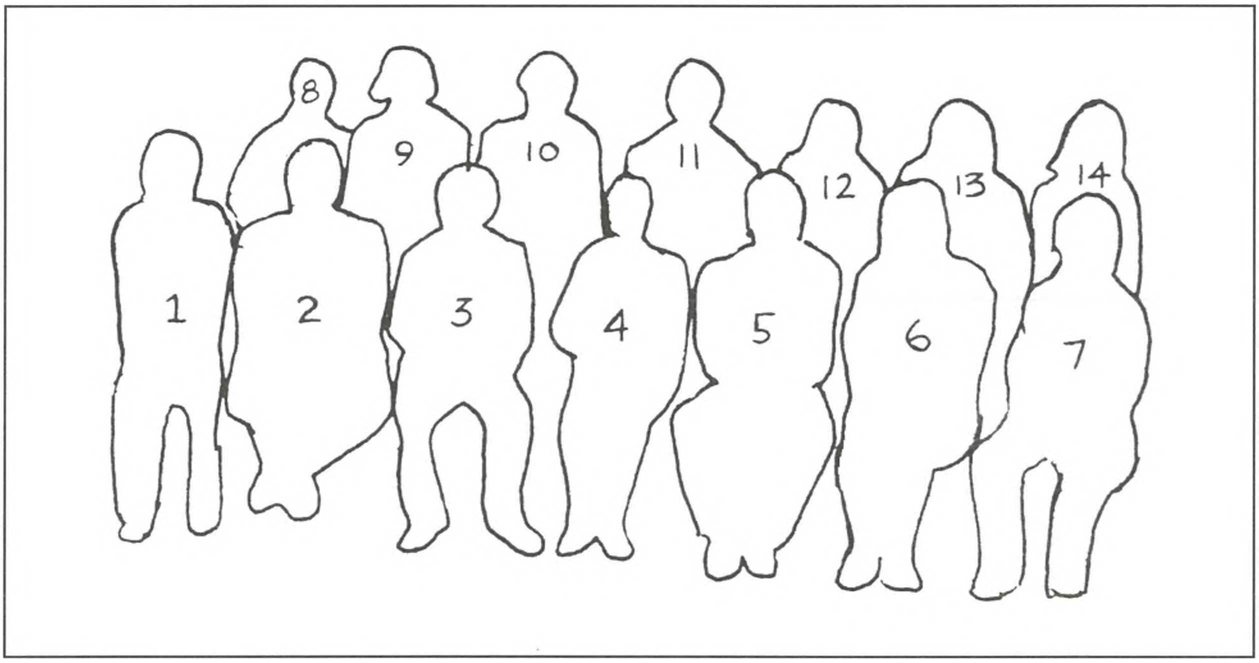


Workshop on Compilation of Fish Products in Southeast Asia



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This is the third Seminar organised by the Marine Fisheries Research Department of SEAFDEC to update information on the status of the fish processing industry in relation to quality management in the region with particular attention to developments that had occurred since the second Seminar in 1991. A workshop to discuss the SEAFDEC's 1996 compilation of fish products in Southeast Asia was also held in conjunction with the Seminar.

The meeting was attended by researchers from Brunei Darussalam, Indonesia, Japan, Malaysia, the Philippines, Singapore, Thailand and Vietnam, and by participants from the ASEAN-Canada Fisheries Post-Harvest Technology Project - Phase II, the Food and Agriculture Organisation and the Canadian High Commission, Singapore.

This volume reviews the advances made in the field of fishery post-harvest technology and presents edited papers, discussions and recommendations that emerged from the meeting.

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