Training Manual On

Fish Quality Preservation

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The Southeast Asian Fisheries Development Center (SEAFDEC) is a technical organisation devoted to the accelerated development of fisheries in the region. The member countries of SEAFDEC are Japan, Malaysia, Philippines, Singapore and Thailand. SEAFDEC has three Departments namely, the Aquaculture Department in the Philippines, the Training Department in Thailand, and the Marine Fisheries Research Department in Singapore.

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FOREWORD

This **Training Manual on Fish Quality Preservation** is a continuation of the efforts of the Marine Fisheries Research Department (MFRD) to transfer fish quality preservation technology to the member countries of the Southeast Asian Fisheries Development Center (SEAFDEC).

The total production of seafood in South China Sea Area in 1988 amounted to 10.5 million tonnes, with a trade value of US$6.09 billion. Since seafood is a highly perishable item, the production and distribution of good quality seafood is a major challenge, especially in our hot tropical climate. It was for this reason that the MFRD began its fish-quality preservation programme in 1981, under the guidance of the late Dr. Masamichi Bito, who was formerly Head of the Fish Preservation Unit, Tokai Regional Fisheries Research Laboratories, Japan. Dr. Bito helped to define the direction of development for fish-quality preservation in the region. Under his leadership, the programme first concentrated on analytical methods to measure the chemical indices of fish quality. Simultaneously, research was initiated to investigate fish-handling and quality preservation methods that would be suitable for a hot tropical climate.

The analytical techniques and fish-quality preservation methods developed were actively extended to the commercial and government sectors through a series of regional training courses which started in 1981. The MFRD also published the **Laboratory Manual on Analytical Methods and Procedures for Fish and Fish Products** in 1987, to supplement the course.

The MFRD's Training Course on Fish Handling and Quality Preservation for Fish Retailers was introduced in 1986. The first course was attended by supervisors from several local super-market chains. Subsequent courses were modified to suit different levels of staff, ranging from shop-front personnel, supervisors and managers to in-house trainers. From 1988, the course was extended to public and private sector personnel from SEAFDEC member countries.

It was recognised that, if the technology was to benefit the industry, officials and semi-official organisations from SEAFDEC member countries would have to conduct training courses for industry personnel within their respective countries. This manual is produced to aid this training effort.

I would like to congratulate the authors and the MFRD on the production of this manual. I am confident that this manual will, in addition to being a compilation of technical matters relevant to tropical fish, also be a useful reference for the region's trainers when they conduct similar courses on fish handling and quality preservation in their own countries.

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PREFACE

The use of fish begins from the time the fish is harvested, moves through an often long distribution chain, before it is finally presented to the consumer for his eating pleasure. Along the way, some forms of handling and processing is essential in preserving the quality of the fish.

The quality preservation of fish also serves to ensure that its commercial value is not lost, and therefore is a key factor in making fish an internationally traded commodity.

Ultimately, fish is consumed by man for his well being and pleasure. It is this factor that dictates the true value of the fish. Hence, all the objectives of quality preservation and its practice throughout the industry should be geared towards this goal.

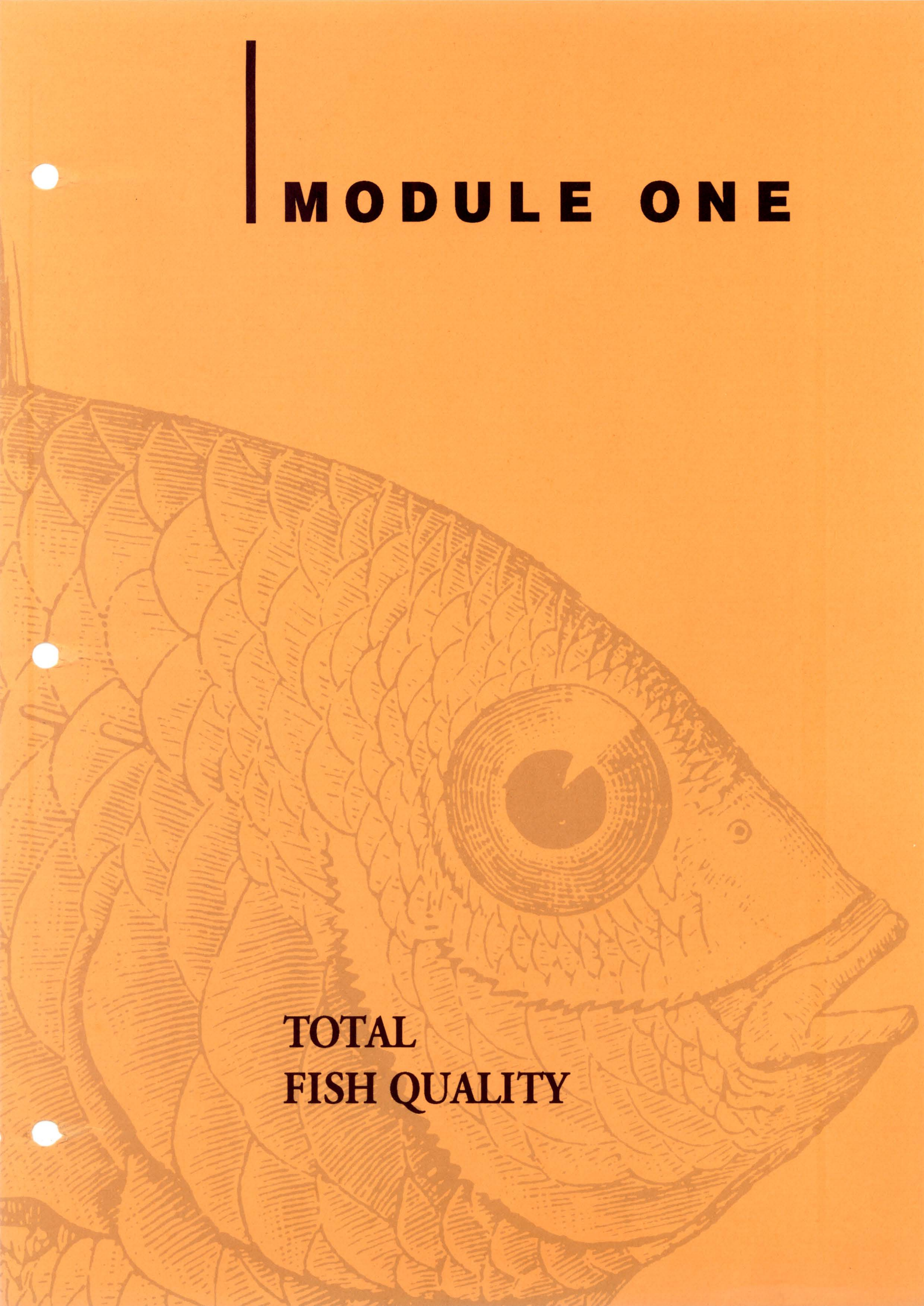
This manual represents a continuing effort by the Marine Fisheries Research Department to provide useful guides for technical personnel. The manual was prepared as a teaching tool for educators and trainers who need to conduct courses in fish quality preservation, primarily to fish retailers and seafood handlers.

The subject coverage in this manual is broad, touching on many concepts that have a bearing on fish quality preservation. On the other hand, the language used is deliberately kept as non-technical as possible, so that the manual user can effectively relate with his students.

The manual is divided into 2 Modules. Module I introduces the idea of Total Fish Quality. It covers the fundamental concepts of what constitutes fish quality, the changes occuring during fish spoilage and the value of fish as food. Module II introduces the two major forms of fish quality preservation, namely icing and freezing, identifies the role of hygiene and sanitation practices in fish quality preservation, and the practical requirements for quality preservation at retail outlets. The Module Objective, Lesson Objectives, and time allocations for each lesson and practical session are listed to aid the trainers in their programme planning. Trainee's notes and visual aids are provided in Annex 1 and Annex 2 respectively.

CONTENTS

MODULE ONE



TOTAL FISH QUALITY

MODULE OBJECTIVE

OVERALL AIM:

Trainees should be quality conscious and understand the concepts of freshness, quality, wholesomeness and nutritive value of fish and seafood.

LESSON	Trainees should be able to:	Time (h)
1	Identify the factors that affect fish quality at post mortem and thereby understand the concept of freshness.	1.50
2	State what fish quality is and identify the suitable procedures for assessing fish quality.	2.50
3	Point out the importance of producing wholesome food.	1.50
4	State the nutritive value of fish and seafood.	1.50
	Total time:	7.00

CONCEPT OF FRESHNESS

Time : 1.5 h

OVERALL OBJECTIVE:

Trainees should be able to identify the factors that influence fish quality at post mortem and understand the concept of freshness.

SPECIFIC OBJECTIVES:

Trainees should be able to :

1. State what is a fish and its commercial value.

2. State what is fish freshness.

3. Identify types of endogenous changes and how they affect fish quality.

   3.1 Rigor mortis
   - — what is it?
   - — how it occurs?
   - — how it affects quality of
     a) frozen whole fish
     b) frozen fillets
   - — how to control the effects of rigor?
   - — what is thaw rigor?
   - — how to prevent thaw rigor?

   3.2 Autolysis, protein denaturation and lipid deterioration

   3.3 Pigment changes in skin, meat and gills

4. Identify types of exogenous changes and how they affect fish quality.

   4.1 Physical changes
   4.2 Bacterial spoilage
   4.3 Temperature
   4.4 Atmosphere

VISUAL AID :

01-01-T1 : Fig.1. Diagram showing the different parts of a fish

01-01-T2 : What is freshness?

01-01-T3 : Post mortem changes in fish

01-01-T4 : What is rigor mortis?

01-01-T5 : How does rigor affect quality?

01-01-T6 : How to control the effects of rigor?

01-01-T7 : What is thaw rigor?

01-01-T8 : What is autolysis?

01-01-T9 : Effects of protein denaturation

01-01-T10 : Effects of lipid deterioration

01-01-T11 : Pigment changes in skin, meat and gills

01-01-T12 : Exogenous changes influencing fish quality

01-01-T13 : Effect of temperature on bacterial growth

01-01-T14 : Summary of lesson

CONCEPT OF FRESHNESS — LESSON PLAN

1. What is a fish, and its commercial value

01-01-T1

1.1 WHAT IS A FISH?

A fin-fish is a cold blooded animal that lives in water. It has a head, a body, a tail and fins. The head has the eyes, nostrils and mouth. Behind the head are the gills (for breathing) which are covered by the operculum. The body is covered by scales. Beneath the scales is the skin. This is followed by the W-shaped blocks of muscles which are attached to each other and to the backbone by connective tissues. A lateral line runs along the middle of both sides of the body from the head to the tail. It is a sense organ. The body narrows into the caudal peduncle and ends with the tail fin or caudal fin. Attached to the body are the pectoral fins (at the sides), the dorsal fins (at the top), the pelvic fins and the ventral fins (at the bottom). The fish uses the fins to move. Between the pelvic and ventral fins is an opening, the anus.

1.2 INTERNAL FEATURES OF A FIN-FISH

The internal features in the belly of the fish consist of organs belonging to the following systems:

— the circulatory system,
— the digestive system,
— the reproductive system, and
— the excretory system.

In opening the belly, one can find the heart at the anterior end near the head and the liver. Below the liver and further back are the stomach, pyloric caeca, gall bladder, spleen, gonads (ovary or testicles) and intestine. Lying beneath these is the swim bladder followed by the kidneys which lie just next to the backbone.

1.3 COMMERCIAL CATEGORIES OF FIN-FISH

Fishes can be classified as cartilaginous (elasmobranchs) and bony (teleosts) fishes. The cartilaginous fishes have soft, cartilaginous bones. Some examples are sharks, rays, dogfishes and skates. The bony fishes make up the majority of the commercial fishes. Some examples are sea bass, groupers, pomfrets, breams, cod, halibut, soles, herring, etc.

2. What is fish freshness?

01-01-T2

2.1 WHAT IS FISH FRESHNESS?

01-01-T3

Fish is usually dead before it can be used as food for man. When the fish dies, it has a store of "freshness" which decreases with the passing of time. Freshness of fish is influenced by many factors. In general we can group freshness as due to endogenous enzymes and due to exogenous bacterial enzymes.

3. Endogenous changes influencing fish quality at post mortem

3.1 RIGOR MORTIS

— *What is rigor mortis?*
It is the stiffening of the muscles of an animal shortly after death.

01-01-T4

— *How does it occur?*
Rigor in fish usually starts at the tail, and the muscles harden gradually along the body towards the head until the whole fish is quite stiff. The fish remains rigid for a period which may vary from an hour or so to three days or more, and then soften again.

— *Pre-rigor*
Immediately after death the muscles of an animal are soft and limp, and can be easily bent; the flesh is said to be in pre-rigor condition.

— *Full rigor*
Then the muscles begin to stiffen and harden, and the animal is said to be in rigor. At this point the muscles have already lost their ability to contract when stimulated.

— *Post-rigor*
After some hours or days the muscles begin to soften and become limp again. The muscles have now passed through rigor, and are in post-rigor condition.

— *Rigor in chilled fish*
Fish that are just killed and ice stored move from pre-rigor to full rigor within 1 hour to 3 or more days. Some well iced tropical fishes are known to stay in rigor for 6 to 8 days. Fish are considered to be very fresh when they are in the pre-rigor and full rigor stages even though freshness deterioration due to enzymatic action has commenced. When they enter into the post-rigor stage, spoilage is said to begin.

— *Factors affecting rigor mortis*
  — physical condition of fish at death
  — temperature
  — species
  — size
  — amount of handling

01-01-T5

— *How does rigor affect quality?*
— Rigor creates problems mainly for those sections of the industry concerned with freezing fish at sea, either as whole fish or
— fillets, or for those who handle very fresh inshore fish at the port for freezing very soon after landing.

— *Frozen whole fish*
Rigor can affect the quality of frozen whole fish in three main ways, *i.e.* by causing:
— gaping in wet & frozen fish
— toughness
— excessive drips on thawing in frozen fish

— *Frozen fillets*
Pre-rigor fillets will shrink, leading to distorted fillets & corrugated surface. Rigor also affects the toughness of and drip loss from frozen fillets in the same way as with whole fish.

01-01-T6

— *How to control the effects of rigor?*
Keep fish chilled at every stage before freezing.

01-01-T7

— *What is thaw rigor?*
When a muscle is frozen pre-rigor and kept for a short time in cold storage, it is still able to contract and go into rigor after thawing. This is known as thaw rigor. It is rarely a problem with thawed whole fish, but mainly a problem with pre-rigor fillets.

— *How to prevent thaw rigor?*
Extend the cold storage time of the stock of pre-rigor fish (about 8 weeks at –10°C).

Thaw slowly at room temperature for fish which have to be taken out of store in less than 8 weeks cold storage.

3.2 AUTOLYSIS

01-01-T8

— *What is autolysis?*
It is the "self-breakdown" or "self-digestion" of the animal tissue after death. It describes a variety of processes controlled by enzymes native in the flesh and various organs of the fish at death.

— *Effects of autolysis*
— discolouration
— softening
— breakdown of tissues
— "liver-burn"
— "belly-burn"
The effects manifested are due to
— protein denaturation
— lipid deterioration

01-01-T9

— *Protein denaturation*
— Protein is a group of chemical substances that help build up the animal body and keep it healthy.

— Protein denaturation are reflected in
  — lowering of water holding capacity
  — toughness development in muscle tissue
  — high free and expressible drips
  — poor quality fish meat i.e. tough, fibrous, dry and has poor taste.

01-01-T10

— *Lipid deterioration*
  — Lipid deterioration is the breakdown of lipids. The main process of lipid deterioration is lipid oxidation.

  — Lipid oxidation is the process where the lipid of the fish combines with the oxygen from the air to form a by-product called peroxides. It is a major cause of spoilage in fish muscle.

  — Effects of lipid oxidation are manifested as:
    — rancidity of fish meat
    — yellow discolouration of fish meat.

01-01-T11

3.3 PIGMENT CHANGES IN SKIN, MEAT AND GILLS

Colour plays a major role in whether a food is acceptable or not and often serves to identify that particular food. If a product is to be accepted in the market place, it must meet the consumer's expectation for colour as well as other attributes.

Fish and seafood contain the following groups of pigments:
— carotenoids
— melanins
— astaxanthine

The degradation of carotenoids can range from slight shifts of colour, to loss of colour in the presence of strong light, enzymes (lipoxygenases) or drying conditions.

4. Exogenous change influencing fish quality

Exogenous changes refer to those occurring outside the body of the fish. They are as follows:

01-01-T12

4.1 PHYSICAL CHANGES

— include changes due to the environment and handling by people

— result from mishandling of fish on board such as the use of sharp forks to poke the fish, stepping on and crushing fish as well as rough handling of frozen fish which are brittle and break easily.

4.2 BACTERIAL SPOILAGE

Bacteria are microscopic unicellular organisms which exist in nature. Fish carries a large number of bacteria on their body surface and in their gut. In live fish, their flesh is sterile. When the fish dies, the

bacteria will begin to attack the flesh. The bacteria secrete enzymes which break down complex substances in the fish muscle into simpler substances that contribute to the spoilt odour and causes spoilage. For example bacteria secrete enzymes which break down histidine to histamine, arginine to agmatine and lysine to cadaverine. Some bacteria such as *Achromobacter* causes development of brown colour in the meat of halibut. The number of bacteria will continue to increase until the fish is cooked.

Bacterial spoilage is affected by the following:

— careless handling which will further increase bacteria numbers

— cross-contamination which may occur along the line from the deck after catching to the retailer and this too will further increase bacteria numbers.

Spoilage due to bacteria putrefaction (spoilage) is easily detected by the development of off-odours.

01-01-T13

4.3 TEMPERATURE

Fish bacteria are very sensitive to temperature. Temperature affects the speed at which bacteria multiplies. In frozen fish stored at low temperature the bacteria can be kept in a state of suspended animation. The living processes of bacterial growth, enzymatic activities and other biochemical reactions are all temperature dependent. The lower the temperature, the slower the spoilage processes. Therefore, critical control of temperature is necessary for the quality preservation of fish.

4.4 ATMOSPHERE

A combination of the atmospheric oxygen, humidity and the presence and intensity of sunlight causes the fish quality to deteriorate. The fish loses its moisture gradually to the drier atmosphere leading to body surface dehydration. The other effects of these factors are colour bleaching and discolouration, and fat oxidation.

01-01-T14

Summary of lesson

CONCEPT OF FRESHNESS — PRACTICAL PLAN (45 min)

OVERALL AIM:

Trainees should be familiar with the features of freshness deterioration in fish.

SPECIFIC OBJECTIVES :

1. To enable trainees to observe the various stages of rigor.
2. To enable trainees to observe the effects of "liver burn", "belly burn" and autolysis.

MATERIALS:

1. Fish at pre-rigor.
2. Fish at full rigor.
3. Fish at post-rigor.
4. Indian mackerel with "liver burn".
5. Indian mackerel with "belly burn".
6. Indian mackerel with digested gut to demonstrate autolysis.

INSTRUCTIONS :

1. To observe the different stages of rigor, hold the fish up at the operculum in the position as if it was lying at its side. Your thumb should be positioned at the lower operculum and the other fingers resting on the upper operculum. The fish head should be held horizontal. This will be demonstrated by the trainer.
2. Observe the effects of "liver burn", "belly burn" and autolysis in the Indian mackerel and note the odour, the characteristics of the gut contents and the belly wall.

2 CONCEPT OF QUALITY

Time : 2.5 h

OVERALL OBJECTIVE :

Trainees should be able to state what fish quality is and identify the suitable procedures for assessing fish quality.

SPECIFIC OBJECTIVES :

Trainees should be able to :

1. Define quality and explain what is intrinsic quality and how external factors influence this quality.

2. Explain the methods of assessing quality and quality changes such as:

   2.1 sensory evaluation of fish

   2.2 chemical and biochemical methods
   - — Nucleotide degradation
   - — Amine compounds
   - — Lipid deterioration
   - — Protein denaturation

3. Understand time-temperature-tolerance concept and how it affects the quality of chilled seafood.

VISUAL AID :

01-02-T1 : What is quality?

01-02-T2 : What is intrinsic quality?

01-02-T3 : Defects caused by external factors

01-02-T4 : Sensory evaluation of fish

01-02-T5 : Guide on various attributes to be examined for sensory evaluation of fish

01-02-T6 : Grading of sea bass, *Lates calcarifer* (wholefish) during ice storage

01-02-T7 : Fig. 1. Changes in the physical characteristics of iced stored *L. calcarifer*

01-02-T8 : Fig. 2. Changes in texture of iced sea bass fillets

01-02-T9 : Evaluation of cooked fish

01-02-T10 : Simple hedonic scale for sensory evaluation of cooked fish

01-02-T11 : Fig. 3. Sensory evaluation of steamed sea bass fillets

01-02-T12 : Fig. 4. Sensory evaluation of the taste of steamed mangrove snapper using simple hedonic scale

01-02-T13 : Assessment of freshness of cooked frozen food

01-02-T14 : Chemical indicators of spoilage

01-02-T15 : The K-value index

01-02-T16 : Shelflife of ice stored fish

01-02-T17 : Amine compounds

01-02-T18 : Lipid deterioration

01-02-T19 : Time-temperature-tolerance

CONCEPT OF QUALITY — LESSON PLAN

1. Definition
01-02-T1

1.1 WHAT IS QUALITY?

Quality is defined as the "degree of goodness" according to the Longman Dictionary of Contemporary English.

In the context of seafood, the meaning of quality adopted is deliberately wide, including all attributes which consciously or unconsciously the fish eater or buyer considers should be present.

When one considers the quality of seafood, or any kind of food for that matter, one has to take into account the following:

— intrinsic composition of the seafood
— degree of contamination with undesirable materials
— nutritive value
— degree of spoilage
— damage
— deterioration during processing
— storage conditions
— distribution
— sale and presentation to the consumer
— hazards to health
— satisfaction on buying and eating
— aesthetic considerations
— yield and profitability to producer and middlemen.

01-02-T2

1.2 INTRINSIC QUALITY

Intrinsic quality is the total attributes that occur naturally in the harvested raw material. It is influenced by:

— *Species*
The rate of spoilage or deterioration is species dependent e.g. oily fish and lean fish.

— *Size*
The bigger the size the higher the price.

— *Sex*
Female capelins are of higher value because of their roe.

— *Condition, composition and season*
Fish captured when they are not feeding, or during spawning and post-spawning yield poor quality products. "Belly-burst" is observed in fish that were caught during heavy feeding because of the high activity of the digestive enzymes.

— *Parasites and other organisms*
They are the protozoans, flatworms, roundworms, crustaceans,

fungi and bacteria. The parasites are killed during freezing or thorough cooking.

— *Naturally toxic fishes*
Ciguatera poisoning, puffer fish or tetradotoxin poisoning, paralytic shellfish poisoning are some examples.

— *Contamination with pollutants*
  — metal contamination such as mercury, cadmium, lead and selenium.
  — elements such as zinc and copper gives an unpleasant metallic flavour in shellfish and a greenish colour.
  — organic chemicals such as DDT, PCBs, aldrin and dieldrin from agricultural source.
  — radioactive isotopes such as caesium from nuclear reactor fall out.
  — microorganisms.

— *Habitats*
Fish pick up contaminants from habitat and sometimes the muscle becomes tainted in flavour.

— *Eating habits*
Shellfish which are filter feeders tend to accumulate the contaminants in their gut and muscle tissues e.g. hepatitis.

01-02-T3

1.3 DEFECTS CAUSED BY EXTERNAL FACTORS

Defects such as discolouration, tainting, bruised surface, gaping, broken fish pieces, freezer burn, etc. are caused by poor workmanship and handling procedures, eg. methods of harvesting, storage, etc. These defects result in low fish quality.

1.4 WHAT IS QUALITY ASSURANCE?

Quality assurance is the application of quality measures that ensure the availability of only high quality seafood for consumption.

1.5 WHAT IS QUALITY CONTROL?

The main function of quality control is one of surveillance and education to assure that regulations and specifications which are well defined by the corporate office are implemented by the production plants.
(Elaborate on the role and functions of quality control).

2. Methods of measuring quality
01-02-T4

2.1 SENSORY EVALUATION OF FISH

— It uses the five senses namely sight, smell, taste, touch and hearing. By combining these senses, and by understanding the quality changes associated with fish, one can perform a measure of evaluation on the quality of the products.

— It is an important method, and is reliable with experience.

— It is simple and quick to use, but lacks objectivity.

01-02-T5

— *Evaluation of raw wholefish*

Raw fish are usually examined for its appearance and odour and texture. In examining the fish, the tester takes into account the following :

— *Eye*
Shape, clarity, colour and presence of blood

— *Gills*
Colour of gills, colour and amount of mucus and odour of gills

— *Body surface*
Odour of body surface and vent, quantity of slime on surface, colour and appearance of the body surface, presence of physical damage and firmness or resilience of body to touch. In the case of frozen wholefish observation is made on the amount of glaze, extent of frost formation on the body surface and presence and extent of dehydration.

— *Flesh*
Colour, odour, firmness or resilience of the flesh to touch, luminiscence of cut surface, and presence and size of blood spots.

— *Belly flap*
Odour, colour, shine, presence of bile stain and physical damage to wall e.g. "belly burn" and "belly burst".

— *Gut*
Odour, appearance and integrity.

01-02-T6
01-02-T7
01-02-T8

— *Drip*
Quantity and colour of drips or fluid exuding from the fish.

01-02-T9

— *Evaluation of cooked fish*

Numerous types of tests are available depending on requirements. It involves the use of the five human senses to gauge quality namely sight, smell, taste, touch and hearing. It is one of the better methods as consumers use the same to assess quality, and should be used to substantiate chemical data. Sensory tests involve a panel of judges called panelists. The samples are usually tested for appearance, taste, flavour and texture.

The basic sensory testing facilities required for sensory evaluation include a food preparation area, a panel discussion area and a panel booth area.

— *The food preparation area*

It is basically a kitchen located next to the panel booth area with enough sinks and working area to prepare the samples. Exhaust fans and fume hood should be fitted to channel odours emitted from the food out of the kitchen and away from the panel booth area. The kitchen should be equipped with the necessary utensils required such as glasses or disposal cups, appropriate cutlery, crockery, serviettes, kettles, oven or food warmers to keep food warm, microwave oven, fryers, steamers, refrigerator, disposal bins, and enough storage cabinets. There should also be a serving bench in the kitchen located next to the panel booths to facilitate serving panel members during the test.

— *Panel booth area*

This is a room fitted with 5 to 10 panel booths depending on the space available. The booths should be neutral grey in colour and fitted with daylight light. If necessary coloured lights should also be fitted to mask the colour of coloured food. Each booth should have a small sink for washing and disposal cup for waste. The booths should be completely separated from each other to prevent panel members from consulting with each other. The chairs should be comfortable and adjustable to meet the needs of different members. The room is air-conditioned to keep the place comfortable and cool; and the air-condition system should only allow cool air to flow in one direction i.e. into the room and out through the kitchen. This will help prevent air entering from the kitchen.

— *Panel discussion area*

This area and the panel booth area can be in the same room. The panel discussion area should have a whiteboard, a round table to sit 8 to 10 panel members and comfortable chairs. The room should also be fitted with daylight light and air-conditioned in the same manner as the panel booth area. This area is used for tests requiring round table discussion and for the test organizer to discuss results with the panel members. A notice board can be included to allow panel members to be informed of their results.

Panel members should be rewarded with some refreshments or momento after each test to encourage them to continue to be part of the panel. Panel members are to be brought on a familiarization tour of the facilities, be clearly briefed on the filling of forms, avoid eating, drinking or smoking at least 30 minutes prior to test. Drinking of plain water is permitted. Panelists can be screened to select those with the acumen for food testing to be included in a trained panel.

01-02-T10
01-02-T11
01-02-T12
01-02-T13

The results obtained are analysed statistically and can be presented in graphics form. Samples of test score sheet and graphical presentation of results for sensory evaluation of raw and cooked fish are shown in the attached tables and figures.

01-02-T14

2.2 CHEMICAL AND BIOCHEMICAL METHODS

The chemical and biochemical methods to be described are limited to measuring the extent of spoilage of fish in the chilled state. Details of the various tests are found in the "Laboratory Manual on Analytical Methods and Procedures for Fish and Fish Products" published by the Marine Fisheries Research Department, Southeast Asian Fisheries Development Center, Singapore.

In principle, these methods are applicable to frozen, dried, and canned fish. The biochemical indices are used to determine the following:

01-02-T15

— *Nucleotide degradation*

The K-value index is used to determine the extent of degradation of adenosine triphosphate (ATP) to hypoxanthine (Hx). It is expressed as the percentage ratio of the total amount of inosine and hypoxanthine produced over all nucleotides (from ATP to Hx) present. It is a measure of enzymatic freshness and is determined using anion exchange chromatography.

The higher the K-value the poorer the fish. For tropical iced marine fish, freshly killed fish has a K-value of less than 5%. In the initial stages of ATP breakdown, as IMP accumulates, the cooked fish tends to be more tasty. However as spoilage continues with an increasing concentration of hypoxanthine, a bitter taste may be detected in the meat.

01-02-T16

At their shelflife limit during ice storage, the sea bass (*Lates calcarifer*) had a K-value of 28%, the grouper *(Epinephelus tauvina)* 28%, the mangrove snapper (*Lutjanus argentimaculatus*) 30% and the golden snapper (*Lutjanus johnii*) 28%. These are aquacultured fishes purchased live from the farms and iced immediately after killing in iced water. For fishes purchased from the market, the iced Chinese pomfret (*Pampus chinensis*) had K-value of 24% and the iced white pomfret (*Pampus argenteus*) 39% when they are of reject quality.

01-02-T17

— *Amine compounds*

Marine fish species contain trimethylamine oxide (TMAO). The distribution of TMAO is uneven in the body of the fish. Usually white-meat fish (non-migrating and demersal) generally has higher TMAO levels, and the TMAO are found more in the ordinary muscle than the dark muscle portion. In red-meat fish

(migrating, pelagic) the TMAO content is generally lower and found in a greater extent in the dark muscle portion.

The TMAO are broken down by bacterial enzymes into trimethylamine (TMA) and its derivatives (volatile bases and formaldehyde) during spoilage. Hence one can test for trimethylamine-nitrogen (TMA-N) and total volatile basic nitrogen (VB-N) as parameters reflecting bacterial spoilage. Development of total volatile bases in fishes is usually accompanied with the detection of fishy odours.

01-02-T16

For temperate fishes, the extreme limits beyond which round, whole, chilled fish can be considered too spoilt for most uses, the TMA-N is 10 to 15 mgN/100g and the VB-N is from 35 to 40 mgN/100g. However iced tropical marine fish usually has a much lower level of TMA-N (about 1.5 mgN/100g) and often TMA-N is not detected at all (or less than 0.5 mgN/100g), when they are considered of reject quality. At their shelflife limit, iced tropical fish usually has VB-N levels of about 15 mgN/100g or more.

01-02-T18

— *Lipid deterioration*
Lipids or fat in fish are broken down by hydrolysis or oxidation. In hydrolysis, the lipids are broken down by enzymes (lipases) to glycerol and free fatty acids. The free fatty acids formed are analysed and gives the acid value of the sample. The higher the acid value the greater the extent of hydrolysis of the fish lipids.

Fish lipids combine physically with the oxygen in the air to form peroxides. This process is called lipid oxidation. Oxidative rancidity is the development of rancidity by the oxidation of fish lipids. Two tests are used to gauge the extent of oxidative rancidity viz. peroxide value (PV) and thiobarbituric acid number (TBA No.). In general for iced tropical marine fishes when the PV is between 10–20 meq/kg and/or the TBA number is about 1–2, rancid odour can be detected. Most tropical marine fishes are rather lean with less than 10% total lipid, usually less than 5% total lipid, and hence lipid oxidation do not pose a critical issue in iced fish.

— *Protein denaturation*
As fish spoils the protein in the muscle tissue denatures and is broken down. This results in the lowering of the water holding capacity of the meat, and in the poor texture. The changes in the protein can be observed by measuring the changes in the total protein nitrogen, the salt-soluble protein nitrogen, the water-soluble protein nitrogen and the stroma protein levels.

3. Time — temperature-tolerance

01-02-T19

3.1 HYPOTHESIS

Quality loss is proportional to the integrated accumulated effects of both time and temperature.

— The rate of quality loss will increase as storage temperature increases and decrease as temperature decreases.

— All quality losses are cumulative and irreversible.

— All temperature effects are cumulative i.e. they have the same result on the product quality, no matter when they occur during the life of the product.

3.2 RELATIONSHIP BETWEEN TIME AFTER DEATH AND FISH QUALITY

The quality of fish begins to decrease as soon as the fish dies. This quality degradation cannot be stopped. Hence the longer the fish has been dead (all other factors being equal), the less fresh the fish.

3.3 RELATIONSHIP BETWEEN EXPOSURE TEMPERATURE AND FISH QUALITY

The speed at which fish quality deteriorates is directly related to increased temperature. The higher the temperature, the faster the quality deteriorates. Fish quality deterioration can be slowed down tremendously by controlling the temperature i.e. keeping the temperature low.

3.4 COMBINED EFFECTS OF TIME AFTER DEATH, TEMPERATURE AND FISH QUALITY

Fish quality can only move in one direction i.e. it can only deteriorate. Quality deterioration is cumulative and irreversible. The combined influences of time after death and temperature history of the fish has an enhanced effect on the net quality deterioration.

3.5 PRACTICAL IMPLICATIONS

Chilling fish with ice is probably the most superior existing method to lengthen the quality life. In order to take full advantage of this preservation method, there are two basic prerequisites to consider, namely:

— The initial quality of the product subjected to chill preservation must be at an acceptable level.

— The temperature handling through the whole distribution chain must be properly taken care of, otherwise all good intentions in the first step will prove to be meaningless.

CONCEPT OF QUALITY — PRACTICAL PLAN (3 h)

Spoilage of fish during ice storage

OVERALL AIM:

Trainees should be able to examine the changes in the physical characteristics of fish, and understand the effect of time and temperature on fish quality.

SPECIFIC OBJECTIVES:

1. To enable trainees to assess the quality of ice stored fish by sensory evaluation of changes in physical characteristics.

2. Trainees should be able to describe changes in the eyes, gills, body and flesh of the sea bass *(Lates calcarifer).*

MATERIALS :

1. Ice stored sea bass (1 fish per 2 participants).

   Treatment:
   1. 0 day ice storage
   2. 3 days ice storage
   3. 8 days ice storage
   4. 17 days ice storage

2. Plastic chopping boards.

3. Filleting knives.

4. Towels and physical examinations score sheets.

INSTRUCTIONS :

1. Examine the fishes for rigor and changes in the external features of the eyes, gills, body and gut for their appearance, colour, odour and texture wherever relevant.

2. Record observations in the score sheet provided.

3. Cut a slit through the belly, avoiding damaging the viscera. Open it and observe the viscera for its odour, firmness, etc. Note if there is any bile stain in the belly flaps. Record your observations in the score sheet.

4. Make skinless fillets and examine the colour, odour, iridescence and texture of the flesh. Record the observations in the score sheet provided.

PHYSICAL EXAMINATION SCORE SHEET FOR RAW SEA BASS (WHOLEFISH)

NAME: _____ DATE: _____

PHYSICAL CHARACTER-ISTICS	FEATURES	SCALE	DATE			
			0	3	8	17
1. EYES	Surface	Not sunken				
		Slightly sunken				
		Sunken				
		Badly sunken				
	Eyeball	Golden, clear				
		Slightly cloudy				
		Cloudy				
		Opaque				
	Eye	Bright, clear intact				
		Cloudy, intact				
		Bloody				
		Damaged, bloody				
2. BODY SURFACE	Colour	Bright golden-grey				
		Bright blue-grey				
		Blue-grey				
		Faded blue-grey				
		Bleached				
	Shine	Bright opalescent sheen				
		Opalescent sheen				
		Dull, no shine				
	Slime	Copious slime				
		Slimy				
		Slight watery slime				
		No slime				
		Dry surface				
	Scales	Intact				

PHYSICAL CHARACTER-ISTICS	FEATURES	SCALE	DATE			
			0	3	8	17
2. BODY SURFACE	Scales	Some loose scales				
		Many loose scales				
	Odour	Seaweedy				
		Neutral/slight odour				
		Slight fishy/fishy				
		Salted fish odour				
		Slight rancid				
		Strong fishy				
		Ammoniacal				
		Putrid/nauseating				
	Texture	Firm & resilient				
		Soft & resilient				
		Soft & non-resilient				
3. GILLS	Colour	Bright red				
		Liver red				
		Deep/dark red				
		Dull red				
		Brown				
		Pale brown/bleached				
	Odour	Seaweedy				
		Neutral				
		Slight fishy/fishy				
		Raw grass odour				
		Salted fish odour				
		Slight rancid				
		Rancid				
		Putrid/ammoniacal				
		Musty				
	Slime	None to slight slime				

PHYSICAL CHARACTER-ISTICS	FEATURES	SCALE	DATE			
			0	3	8	17
3. GILLS	Slime	Moderate slime				
		Copious slime				
		Bloody slime				
4. VISCERA	Texture	Firm and intact				
		Soft and intact				
		Soft and digested				
	Odour	Normal gut odour				
		Slight fishy/musty				
5. FLESH	Colour	Grey-white				
		Grey-pink				
		Yellow-brown				
		Brown				
		Blood spots present				
	Odour	Sweet				
		Neutral				
		Fishy				
	Texture	Firm & resilient				
		Soft & resilient				
		Soft & non-resilient				
		Gaping				
	Shine (Cut surface)	Iridescent				
		Non-iridescent				
6. BELLY FLAP	Colour	Shiny white				
		White				
		Pink				
		Yellow				
	Bile stain	Present				
		Absent				
7. RIGOR		Pre-rigor				

PHYSICAL CHARACTER-ISTICS	FEATURES	SCALE	DATE			
			0	3	8	17
7. RIGOR		Full-rigor				
		Post-rigor				

COMMENTS:

3 CONCEPT OF WHOLESOMENESS

Time : 1.5 h

OVERALL OBJECTIVE:

Trainees should be able to point out the importance of producing wholesome food.

SPECIFIC OBJECTIVES :

Trainees should be able to:

1. Understand what is meant by wholesomeness in food.
2. Identify food safety as one of the factors contributing to wholesome food by
   - 2.1 defining what is safe food
   - 2.2 identifying what makes a safe product
   - 2.3 understanding some aspects of seafood toxicity
   - 2.4 understanding what causes scombroid poisoning
   - 2.5 understanding that pathogenic bacteria can cause food poisoning
   - 2.6 knowing some common parasitic and viral infections
   - 2.7 understanding why a quality assurance programme is necessary
   - 2.8 explaining how to attain product safety by a good quality assurance program.
3. Explain what is food cleanliness, sources of contamination andsteps to minimise cross-contamination.
4. Understand the relationship between freshness of seafood and wholesomeness.
5. Apply knowledge learnt to retail outlets.

VISUAL AID :

01-03-T1 : What is wholesomeness?

01-03-T2 : What is safe food?
What makes a safe food product?

01-03-T3 : Seafood toxicity

01-03-T4 : Scombroid poisoning

01-03-T5 : Pathogenic bacteria poisoning

01-03-T6 : Parasitic infections
Viral infections

01-03-T7 : Quality assurance program

01-03-T8 : Product safety

01-03-T9 : What is food cleanliness?
Sources of contamination

01-03-T10 : Steps to minimise cross-contamination

01-03-T11 : What is fresh food?
Steps to keep fish fresh

CONCEPT OF WHOLESOMENESS — LESSON PLAN

1. Concept of wholesomeness
01-03-T1

1.1 WHAT IS WHOLESOMENESS?

— A food product is considered wholesome when it does not cause any detrimental effects on a person's health or body after it has been consumed. Most food are deemed unwholesome if they harbour or contain large populations of micro-organisms, even when those organisms are not pathogenic in nature, and even if they have not altered the food significantly or noticeably.

— The wholesomeness of a food involves food safety, cleanliness and freshness.

2. Food Safety
01-03-T2

2.1 WHAT IS SAFE FOOD?

Safe foods imply foods that do not allow danger or harm to the consumers. Product confidence should be reason enough to justify food safety programs.

2.2 WHAT MAKES A SAFE PRODUCT?

A product is considered safe when it is:

— non-toxic and non-poisonous
— free of antibiotics
— free of pesticide
— free of pathogenic micro-organisms
— free of foreign chemicals
— free of foreign substances (eg. hair, detritus, etc.)

01-03-T3

2.3 SEAFOOD TOXICITY

There are two types of seafood toxicity. The first is due to chemical poisons such as mercury, arsenic, cadmium, lead, zinc and antimony. Cadmium poisoning takes about 15 to 30 minutes to manifest with characteristic symptoms such as nausea, vomiting and cramps. It is often fatal. Mercury poisoning from seafood was a major event in Minamata Bay, Japan, where children of the fishing community came down with an illness which affected their locomotive coordination and nervous system. This was known as the Minamata disease. It was later traced to mercury which was discharged into the bay from the industries nearby. The mercury was accumulated in the fishes which were the source of food and livelihood of the fishing community.

The second type of seafood toxicity is due to toxins which naturally occur in the seafood. The common marine food poisoning caused by toxins are ciguatera poisoning, poisoning by tetrodotoxin or puffer fish poisoning, paralytic shellfish poisoning and diarrhoetic shellfish poisoning.

Ciguatera poisoning is a unique poisoning due to ingestion of coral fishes i.e. fishes living near coral reefs. However, not all coral fish species cause ciguatera poisoning. The main areas where coral fishes have been found to contain ciguatera toxin are the sea around Okinawa and Amami islands of Japan, Carribean sea, seas around Phoenix island, Johnston island, Taihiti island, Maldive island, Seychelles island and Fernandez island. The fatality due to ciguatera poisoning is less than 0.5%. The toxins isolated from fishes which caused ciguatera poisoning are ciguatoxin, ciguaterin, wax, palytoxin and grammistin. The main cause of ciguatera poisoning is due to ciguatoxin, which is thermostable. The characteristic symptoms are aches in joints, "dry-ice" sensation i.e. the inability to feel heat but instead a cold sensation is felt even when the affected person touches hot objects. This pose a serious problem of accidental burning. Affected persons also feel "electric shock" sensation when they touch water. The symptoms may last as long as a year though the effects on nervous disturbances are not permanent. Patients recover slowly.

Puffer fishes are known for their toxicity. The potent toxin, tetrodotoxin, is thermostable. The minimun lethal dose is estimated to be 10,000 mouse unit (MU). In extreme cases, 0.2g of liver is sufficient to be a lethal dose. The highest toxicity is mainly in the liver and ovary, followed by the skin and intestine and the least in the muscle. Studies showed if 1g of muscle has 500 — 600 MU, then only 20g of muscle is enough to kill a man. The best advice is to avoid eating self-prepared puffer fish. In Japan, restaurant dealers selling and serving this fish must get a licence certifying that they have successfully completed a course on handling, preparing and serving puffer fish. The toxin affects the nervous system and death results from respiratory failure.

Paralytic shellfish poisoning (PSP) is due to PSP toxin caused by marine plankton or dinoflagellates. In Japan *Protogonyaulax catenella* and *P. tamarensis* are the major causative planktons. *P. catenella* is widely spread across the Pacific ocean whereas *P. tamarensis* is found mainly in the Atlantic ocean. PSP is caused by 10 different toxins of which gonyautoxin and saxitoxin are most common. As bivalves are filter feeders, they tend to accumulate the plankton and hence the toxin in their body. The bivalves commonly infected are scallops, mussels, short-necked clams and oysters grown in toxic areas. The symptoms are respiratory paralysis, trembling lips to complete loss of power in muscles of extremities and neck, and take about 5 to 30 minutes to manifest. PSP toxin is thermolabile and hence destroyed by heating. The outbreak of a plankton bloom called "red tide" poses serious problems to mariculturists as harvesting and sale of infected shellfish are curtailed by health authorities.

Diarrhoetic shellfish poisoning (DSP) was discovered recently. The poisoning is due to *Dinophysis* toxin. *Dinophysis fortii* and *Dinophysis acuminata* are the two plankton mainly responsible for DSP. The main symptoms are diarrhoea, nausea, etc. The general symptoms are similar to those caused by *Vibrio* sp. poisoning. However in DSP few patients manifest fever. This toxin is located exclusively in the digestive glands of the shellfish. Therefore the chances of being poisoned by DSP toxin is reduced if the digestive glands are removed from the shellfish before serving.

Other less common cases of seafood poisoning are due to wax esters, dinogunellin and venerupin. Wax esters causes poisoning characterised by severe diarrhoea. Escolar and castor oil fish have a high wax content and are prohibited for sale in Japan. Dinogunellin is found in northern blenny roe and causes diarrhoea. Venerupin is found in short-necked clams and the poisoning is typified by jaundice and difficulty in blood clotting.

01-03-T4

2.4 SCOMBROID POISONING

This is caused by the accumulation of histamine in the fish. Histamine is formed as a result of bacterial and enzyme action, however the mechanism of production of the toxin is not yet understood. Its effects can be observed within 2 to 10 hours and is found mainly in scombroid fishes. The toxin is heat stable.

01-03-T5

2.5 PATHOGENIC BACTERIA POISONING

This occurs when there is negligence and improper handling. There are 2 means of bacteria poisoning. They are bacterial infections and bacterial intoxications.

— *Bacterial infections*

Some common cases are salmonellosis, paratyphoid fever, typhoid fever, *Vibrio parahaemolyticus* infection and shigellosis.

Salmonellosis is due to *Salmonella* sp. and it takes 7–72 hours to manifest. Characteristic symptoms are abdominal pains, diarrhoea, chills, fever, vomiting and prostration.

Paratyphoid fever is caused by *Salmonella paratyphi B. Salmonella typhi* causes typhoid fever. It takes 7–21 days interval between ingestion of food and onset of illness. The characteristic symptoms are malaise, headache, fever and diarrhoea.

Salmonella poisoning in seafood is due mainly to secondary contamination and can be prevented by taking the following measures:

— human cases and carriers should not be allowed to handle food and drinks
— food preparation area should be kept clean and be rodent-proof and fly-proof

— wherever possible food should be eaten immediately after cooking
— cooked food should be hygienically stored in refrigerators to prevent secondary contamination
— avoid eating raw food.

Vibrio parahaemolyticus poisoning has its source mainly in fresh marine fish and shellfish. Secondary contamination is found in processed food (e.g. salted food). The characteristic symptoms are diarrhoea, stomachache, nausea, vomiting and fever. It takes 8–24 hours for the onset of symptoms. This food poisoning can be prevented by keeping food at low temperatures after catch to time of consumption, by avoiding secondary contamination, heating food before consumption and washing all equipment well with potable water.

Shigellosis is caused by *Shigella* sp. and takes about 1–7 days to manifest. The characteristic symptoms are diarrhoea, bloody stools and fever in severe cases. Improved personal hygiene in food handlers will greatly reduce the spread of dysentery caused by Shigella.

— *Bacterial intoxications*

Botulism is a food intoxication from a preformed toxin. It takes 2 hours to 8 days for the illness to manifest. The peak of the illness is 12 to 24 hours. There is a high incidence of death from this intoxication. The toxin affects the central nervous system producing double vision, difficulty in swallowing, and finally death by respiratory paralysis. Botulism is caused by *Clostridium botulinum* and the foods usually incriminated are improperly processed low-acid canned foods.

Staphylococcus aureus is responsible for staphylococcal food poisoning. The poisoning is also due to preformed toxins. The illness takes 1–6 hours to manifest, with vomiting, diarrhoea, acute prostration and abdominal cramps.

Cholera is caused by *Vibrio cholerae*. Man is the only host and the carriers are the main source of the disease.The main method of contamination is by water. The main prevention method, therefore, is to use clean, uncontaminated water for washing fish and to used boiled water in food preparation. Symptoms include fever and profuse diarrhoea which may lead to severe dehydration.

Clostridium perfringens in incriminated foods kept under anaerobic condition produces enterotoxin. The toxin is strongly heat resistant. The illness takes 5–24 hours to manifest with acute abdominal pain, diarrhoea, nausea but rarely vomiting.

01-03-T6

2.6 PARASITIC AND VIRAL INFECTIONS

Common parasitic infections found in fish are anisakiasis (by the worm *Anisakis* sp.) and infection by *Porrocaecum* sp.

The common viral infection from consumption of shellfish such as oysters and blood clam is infectious hepatitis (Virus A).

01-03-T7

2.7 QUALITY ASSURANCE PROGRAM

Food safety is a full-time operation and cannot be handled by edict only. It requires a well defined program, continuous surveillance and teamwork by all engaged in the enterprise. Good communications are required and each individual should feel his or her work is important.

01-03-T8

2.8 PRODUCT SAFETY

Product safety can be attained by a good Quality Assurance Program based on :

- — good procurement specifications
- — careful selection of raw materials
- — approved methods of transport
- — approved methods of storage of raw materials
- — approved methods of processing
- — proper selection and application of packaging system
- — approved methods of sanitation and housekeeping throughout the whole operation, including personnel hygiene.

3. Food cleanliness
01-03-T9

3.1 DEFINITION OF FOOD CLEANLINESS

A food is considered clean when it is free of dirt or unwanted matter.

3.2 SOURCES OF CONTAMINATION

- — Bacteria in the gills and guts of fish and on the body.
- — Bacteria and dirt from the environment e.g. air, floor, processing table, utensils, towels, packaging materials, machinery, etc.
- — Contamination from personnel eg. hair, dirt, bacteria from hands, etc.

01-03-T10

3.3 STEPS TO MINIMISE CROSS-CONTAMINATION

- — Use clean potable water for washing fish.
- — Use clean ice for cooling fish.
- — Use clean containers for keeping fish.
- — Keep fish well iced and covered during distribution.
- — Do not put ice or fish on the floor.
- — Keep the floor, processing table, sinks, utensils etc. clean, wash with proper detergents and sanitise.
- — Promote personnel hygiene.

4. Freshness of seafood
01-03-T11

4.1 WHAT IS MEANT BY FRESH FOOD?

A food is considered fresh when it is in a good, natural condition.

4.2 STEPS TO TAKE TO KEEP FISH FRESH

— Wash fish with cool, clean, potable water.
— Keep fish cool in sufficient clean, potable ice.
— Keep iced fish in chiller or refrigerator.

4.3 ACTUAL CONSEQUENCES OF QUALITY LOSS:

— When fish becomes unfit for human consumption it represents a loss of resource, opportunity and human effort.
— For the exporters/traders, a loss of customer confidence and financial loss.
— For the final consumer, a loss of opportunity to consume the fish.

5. Application

5.1 FOOD FOR THOUGHT

Is there a food safety program at your establishment/outlet?
If yes, how can you improve it?
If no, how can you set one up?

5.2 ACTION:

Return to your establishment and draw up plans for a food safety program, the measures to implement and implement them as soon as possible.

CONCEPT OF WHOLESOMENESS — PRACTICAL PLAN (1.25 h)

Wholesomeness of Seafood

OVERALL AIM:

Trainees should be able to appreciate the effect of spoilage and pathogenic bacteria and seafood toxicity on wholesomeness of seafood.

SPECIFIC OBJECTIVES:

1. To show trainees what some spoilage and pathogenic bacteria look like and that some are motile, living organisms.

2. To show trainees some types of poisonous and toxic fish.

MATERIALS:

1. Demonstration set of the following bacteria as colonies on agar plates; and as individual cells in gram stained slides and motility slides :

   a) Spoilage bacteria
      — *Bacillus.*
   b) Organisms of public health significance
      — *Escherichia coli*
      — *Staphylococcus aureus*
      — *Vibrio parahaemolyticus.*

3. Poster of poisonous fishes.
4. Book on toxic fishes.

INSTRUCTIONS :

1. Go through the demonstration materials displayed and appreciate the different shapes and types of bacteria present.

2. Look through the poster and book on toxic fishes and note the various types of fishes incriminated for toxicity.

4 CONCEPT OF NUTRITIVE VALUE

Time : 1.5 h

OVERALL OBJECTIVE:

Trainees should be able to state the nutritive value of fish and seafood.

SPECIFIC OBJECTIVES:

Trainees should be able to:

1. State why composition of food is important.
2. Understand the structure of fish muscle.
3. Understand that fish is a high protein food.
4. Understand the importance of fish as a source of minerals and vitamins.
5. Appreciate the health food concept of fish.

VISUAL AID :

01-04-T1 : Why food composition?

01-04-T2 : Structure of fish muscle

01-04-T3 : High protein food

01-04-T4 : Essential amino acids in fish

01-04-T5 : Vitamins and minerals

01-04-T6 : Fish as health food

01-04-T7 : Prostaglandin

01-04-T8 : Merits of fish oil to human health

01-04-T9 : Taurine

CONCEPT OF NUTRITIVE VALUE — LESSON PLAN

1. Importance of food composition
01-04-T1

1.1 WHY FOOD COMPOSITION?
It is important for the food processor, the nutritionist, and the consumer to know the composition of a particular food so as to help each of them answer the questions that they may have.

The normal variations in the principal constituents in fish muscles are 16–21% protein, 0.2–25 % fat, less than 0.5% carbohydrates, 1.2–1.5% ash and 66–81% moisture.

2. Fish muscle tissue
01-04-T2

2.1 STRUCTURE OF FISH MUSCLES
The main nutritional value of fish is that it is an abundant and often cheap source of proteins. The fish muscle tissue are made up of proteins. Fish muscles are arranged in blocks roughly in a "W" pattern, called myotome. Each block is formed from individual flakes, separated by sheets of connective tissue, which accounts for a small percentage of the total muscle weight.

2.2 TYPES OF FISH MUSCLE
Fish are made up of two kinds of muscle, the light muscle and the dark muscle. In white meat fish, the light muscle constitute a greater portion, leaving the dark muscle present as thin strips. In red meat fish, there is a greater proportion of dark muscle, which has higher concentrations of fats and certain proteins.

3. Fish — a high protein food
01-04-T3

3.1 Fish muscle is made up of about 15–20% of protein but values lower than 15% or as high as 28% are occassionally met. Proteins are chains of chemical units called amino acids, joined together. They are body building food. Two essential amino acids, lysine and methionine, are generally found in high concentrations in fish.

3.2 Fish proteins can be grouped as **structural, sarcoplasmic** and **connective tissue** proteins. The structural proteins, comprising of actin, myosin, tropomyosin and actomyosin, constitutes 70–80% of the total protein content in fish, compared with 40% in mammals. Also called myofibrillar protein, they are soluble in neutral salt solution of fairly high ionic strength (greater or equal to 0.5M). The sarcoplasmic protein comprise of myoalbumin, globulin and enzymes, and are soluble in neutral salt solutions of low ionic strength (less than 0.15M). This fraction makes up 25–30% of the total protein. The connective tissue proteins are made up mainly of collagen and varies in composition in different types of fish. Bony fishes or teleosts contain about 3% of collagen and cartilaginous fishes or elasmobranchs contain about 10%. In comparison, the connective tissue protein constitute 17% of total protein in mammals.

01-04-T4

3.3 In eating fish, man is able to obtain most of the essential amino acids required for good health and normal growth. Fish in general contains about 8.8% lysine, 1.0% tryptophan, 2.0% histidine, 3.9% phenylalanine, 8.4% leucine, 6.0% isoleucine, 4.6% threonine, 4.0% methionine-cysteine and 6.0% valine.

4. Minerals and vitamins
01-04-T5

4.1 Minerals and vitamins are two groups of substances which must be present in human diet for the welfare and health of man. Fish provides a well balanced source of minerals in a readily usable form.

4.2 Vitamins can be divided into 2 groups — the water soluble vitamins (Vit. B & C) and the fat soluble vitamins (Vit. A, D, E & K). All vitamins are necessary for good health in humans. The amount of vitamins present in fish vary widely from species to species, and throughout the year. Fish meat is a good source of vitamin B whereas fatty fish contains lots of vitamins A and D especially in the liver. The roe is a good source of water soluble vitamins.

4.3 Fish is also a valuable source of calcium, phosphorous, iron and copper. Marine fish has a high level of iodine. Sodium however is low and hence as an asset for health conscious people and those requiring a low sodium diet. The mineral and vitamin content of fish is not markedly affected by careful processing or by preservation, provided that storage is not very prolonged.

5. Fish as health food

5.1 Fish fat content varies much more widely than the water, protein or mineral content. The fat is not always uniformly distributed throughout the flesh of fatty fish. Fish oil contains much polyunsaturated fatty acids(PUFA) and more of the fatty acids from long carbon chains. Fish contains one quarter to half the amount of fat as compared to beef or mutton.

01-04-T6

5.2 Fish is presently regarded as healthy food because fish oil fatty acids are different from those of animal fat. It has the following features: -

— contains a large percentage of highly unsaturated fatty acids
— contains a great deal of carbon number 20 and 22 fatty acids, and omega 3 fatty acids
— contains a greater variety of fatty acids.

01-04-T7

5.3 Physiologically active substances are made from unsaturated fatty acids of carbon 20. These fatty acids are converted to prostaglandin, which has the following effects:

— regulation of blood pressure
— anti-thrombosis
— anti-asthma
— anti-ulcer

— inducing delivery
— anti-inflammation
— protection against sterility
— anti-arteriosclerosis.

5.4 Two fatty acids are useful to our health. They are eicosapentaenoic acid (EPA, $C_{20:5}$) and docosahexaenoic acid ($C_{22:6}$). A variety of studies on the function of EPA within the blood stream has shown that it reduces the low density lipoprotein cholesterol and neutral fat levels. When there is more EPA than arachidonic acid in the blood, clottings within the blood stream are less likely to occur, thus contributing to the reduction of heart and brain diseases.

01-04-T8

5.5 In summary, fish oils have the following merits in terms of its effects on human health :
— decreases blood circulatory diseases
— decreases serum total cholesterol levels
— increases high density lipoprotein cholesterol which is useful to human health
— decreases low density lipoprotein cholesterol which is detrimental to human health.

01-04-T9

5.6 Another useful substance that can be extracted from fish is taurine. Taurine is important during foetal development of the brain in man. Work with animals such as rats and cats also seem to suggest that taurine has an important function and possibly a structural role in the visual system, and also in the olfactory bulbs which senses smell.

CONCEPT OF NUTRITIVE VALUE — PRACTICAL PLAN (2h)

Organoleptic assessment of steamed ice stored fish

OVERALL AIM:

Trainees should be able to use simple hedonic scale to examine the quality of cooked fish in terms of appearance, odour, taste and texture.

SPECIFIC OBJECTIVES:

1. To enable participants observe and experience how an organoleptic assessment using simple 9-point hedonic test is conducted.
2. To help participants compare physical characteristics of ice-stored fish with the organoleptic characteristics.

MATERIALS:

1. Steamed fillets prepared from sea bass which were stored for different periods in ice, kept warm in glass casseroles.
2. Tray with glass of boiled water for rinsing mouth between sample testing, cutlery, a mug for disposal of waste material, serviettes.
3. Sensory score sheet, pencil and eraser.

FACILITIES:

1. Preparatory room with steamer and oven or warmer, sinks and preparatory area for preparing and cooking samples.
2. Taste panel room with individual booths separated from each other. The booths should be neutral grey. Each booth should be equipped with a small sink, tap, daylight light and adjustable chair.

INSTRUCTIONS:

1. You are provided with four samples of steamed fish.
2. Check for the odour, taste, texture and general appearance of the samples and record your preference on the appropriate box in the score sheet.
3. Before tasting, rinse your mouth thoroughly with the boiled water provided.
4. Then roll the sample thoroughly within your mouth and spit it out. Then evaluate the taste.
5. Wash mouth thoroughly with the water provided ensuring that no residual taste is left behind by the previous sample before testing the next sample.

SENSORY SCORE SHEET FOR STEAMED FISH

ODOUR	POINTS	SAMPLE CODE			
		756	640	153	397
Excellent	9				
Very good	8				
Good	7				
Fair	6				
BORDERLINE	5				
Slightly poor	4				
Poor	3				
Very poor	2				
Inedible	1				

Comments on odour:

TASTE	POINTS	SAMPLE CODE			
		756	640	153	397
Excellent	9				
Very good	8				
Good	7				
Fair	6				
BORDERLINE	5				
Slightly poor	4				
Poor	3				
Very poor	2				
Inedible	1				

Comments on taste:

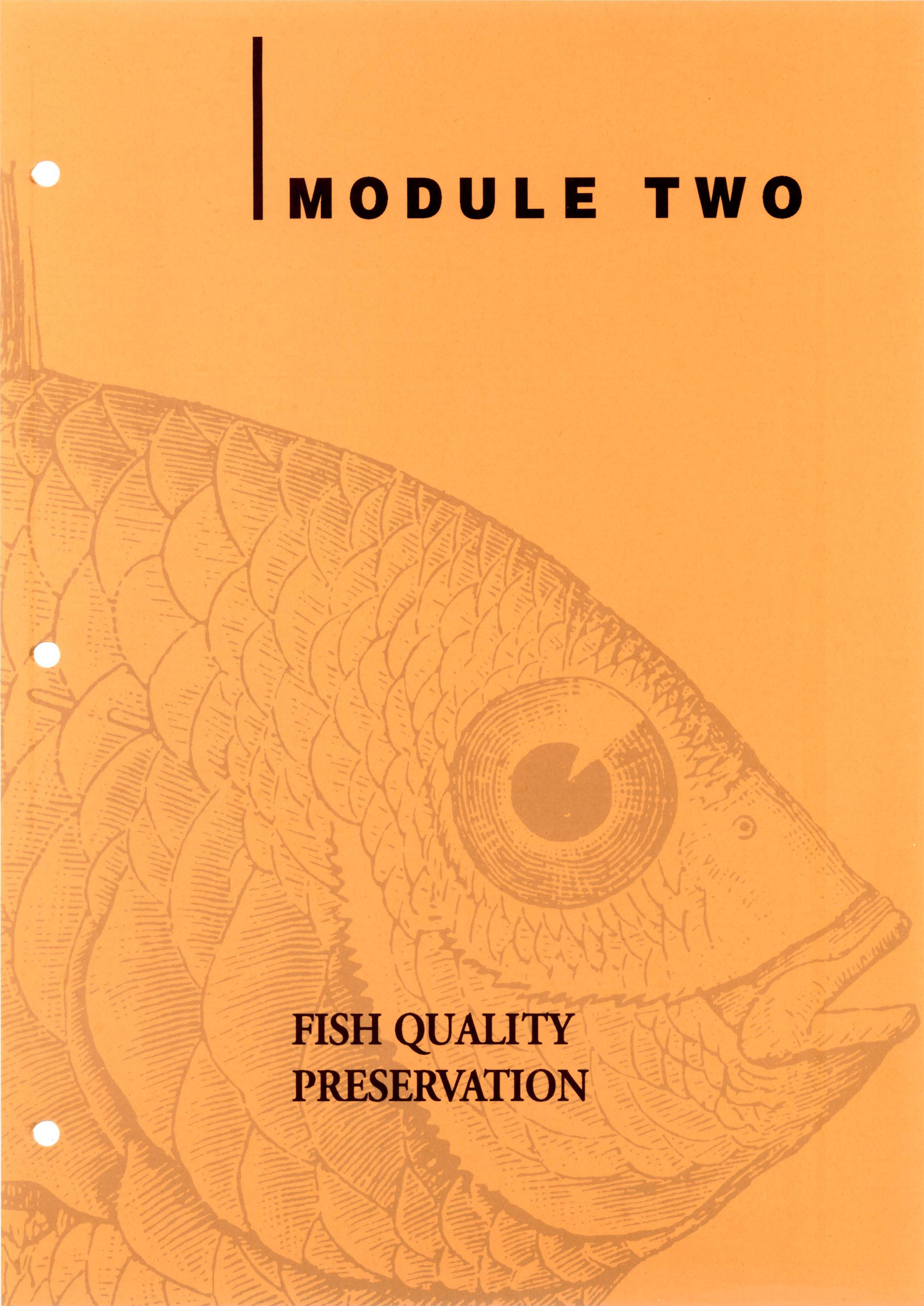
TEXTURE	POINTS	SAMPLE CODE			
		756	640	153	397
Excellent	9				
Very good	8				
Good	7				
Fair	6				
BORDERLINE	5				
Slightly poor	4				
Poor	3				
Very poor	2				
Inedible	1				

Comments on texture:

APPEARANCE	POINTS	SAMPLE CODE			
		756	640	153	397
Excellent	9				
Very good	8				
Good	7				
Fair	6				
BORDERLINE	5				
Slightly poor	4				
Poor	3				
Very poor	2				
Inedible	1				

Comments on appearance:

MODULE TWO



FISH QUALITY PRESERVATION

MODULE OBJECTIVE

OVERALL AIM:

Trainees should be aware of the principles and methods of fish quality preservation and how to apply them to retail outlets.

LESSON	Trainees should be able to:	Time (h)
1	State the importance of icing in fish quality preservation.	2.00
2	State the importance of freezing in fish quality preservation.	2.50
3	Identify the role of hygiene and sanitation in fish quality preservation.	3.00
4	Apply the concepts of fish quality control to retail store.	2.50
	Total time:	10.00

5 ICING

Time : 2.5 h

OVERALL OBJECTIVE:

Trainees should be able to state the importance of icing in fish quality preservation.

SPECIFIC OBJECTIVES:

Trainees should be able to:

1. Understand why icing is important and to understand the concept and principles of icing such as the importance of temperature.

2. State the advantages and disadvantages of various types of ice, such as:
   - 2.1 Flake ice
   - 2.2 Tube ice
   - 2.3 Crushed ice
   - 2.4 Block ice.

3. Understand fish spoilage patterns during ice storage:
   - 3.1 Eye
   - 3.2 Gills
   - 3.3 Muscle and connective tissue
   - 3.4 Body surface
   - 3.5 Belly burn
   - 3.6 Blood stain
   - 3.7 Drip loss
   - 3.8 Odour and rancidity
   - 3.9 Taste and flavour.

4. Know how to handle iced/chilled fish.

5. Explain the quality changes in relation to current practices at retail markets and supermarkets.

VISUAL AID:

02-01-T1 : Why icing?

02-01-T2 : Temperature of ice

02-01-T3 : Concept of icing

02-01-T4 : Types of ice

02-01-T5 : Fish spoilage pattern during ice storage:
- — eye
- — gills

02-01-T6 : Fish spoilage pattern during ice storage:
- — muscle and connective tissue
- — body surface
- — belly burn
- — blood stain
- — drip loss

02-01-T7 : Fish spoilage pattern during ice storage:
- — odour and rancidity
- — taste and flavour

02-01-T8 : How to handle chilled fish

02-01-T9 : Practical considerations

ICING — LESSON PLAN

1. Importance of icing
02-01-T1

1.1 WHY ICING?

Icing is the most practical and useful way to preserve the quality of fish over a relatively short period. Ice has a large cooling capacity for a given weight and volume.

Ice:
- is harmless, cheap and easy to handle
- is valuable for preserving fish as very rapid cooling is possible through close contact between fish and small pieces of ice
- keeps the chilled fish cold, moist and glossy
- prevents dehydration
- maintains fish at slightly above freezing point
- lowers the temperature of the fish and hence retards the growth of bacteria and also the endogenous degradation influenced by enzymes, air and other factors.

02-01-T2

1.2 TEMPERATURE OF ICE

The temperature and shape of ice will influence the efficiency of cooling. The maximum temperature of ice at normal pressure is 0°C, while the minimum is –273°C. In practice, the temperature of ice in the fish industry is seldom below –20°C. There are advantages and disadvantages of having ice below 0°C. The advantages of having ice below 0°C is that no liquid is present, making the melting slower and handling easier. However, the freezing point of fish muscle is generally between –1 and –5°C. If very cold ice is used, meat in direct contact with the ice may be partially frozen, a condition that is not desirable.

02-01-T3

1.3 CONCEPT OF ICING

- Heat is a fluid that flows from "a source" to a "sink".
- The heat source can be the box, fishes within, the air and others.
- The heat sink is the ice.
- The main purpose is to allow the heat from the fish to flow quickly to the ice, while preventing heat from the outside from flowing to the ice.
- Besides contributing to cooling, the flow of melt water also washes away the bacteria, slime, spoilage products and any residual blood. This helps to preserve the fresh appearance and smell.

2. Types of ice
01-01-T4

2.1 FLAKE ICE

- Made by the "free-flow" technique resulting in thin layers of ice at sub-zero temperature.
- Gives good ice-fish contact because of its large surface area.

— Tends to form clumps, making it impractical.
— Melts very rapidly.
— Useful for cooling a product down quickly.

2.2 TUBE ICE

— Cut from long, hollow tubes of ice formed inside refrigerated pipes of small diameter.
— The cylindrical shape is not practical for icing.
— Lasts longer and melts more evenly than other shaped ice.
— Useful for transporting fish in uninsulated containers.
— More likely to bruise fish because of its larger size.

2.3 CRUSHED ICE

— Has sharp edges and irregular sizes.
— Causes bad indentations on the fish body.
— Effects poor heat transfer due to air pockets.
— If used, individual piece should not be larger than 2.5 cm.

2.4 BLOCK ICE

— Usually are large and heavy.
— Must be crushed into smaller pieces.

3. Fish spoilage pattern during ice storage
02-01-T5

3.1 EYE

The appearance of the eye of bony fishes (not elasmobranchs) is a good guide to the degree of spoilage. Very fresh fish have bright, convex (bulging) eyes with clear pupil. As spoilage progresses, the eyes become duller and greyer, and pass from being flat to concave (sunken). The lens of a fish eye is a hard sphere made of special protein, and is brilliantly transparent. The cloudiness in the eye is a guide to the length of time the fish has been dead. If the fish is frozen, the lens will become an opaque ball due to denaturation of the protein, and is irreversible.

3.2 GILLS

The gills are the respiratory organ in live fish. They are normally filled with blood cells and are bright red in life or freshly dead fish. At death the blood cells become oxidised and turn deep red or liver red and later brown. In poor quality fish, leaching of pigments occurs and pale, white patches appear on the gills. Mucus may also be present with storage and is indicative of the extent of bacterial spoilage. The gill odour ranges from fresh blood or seaweedy odour for fresh fish to raw grass, ammoniacal and pungent and then putrid when the fish is of very poor quality.

02-01-T6

3.3 MUSCLE AND CONNECTIVE TISSUE

The edible part of the fish consists of the muscles and connective tissues. Fish connective tissue dissolve into a gelatin on being cooked hence they do not cause toughness in meat. However, they

play an important role in gaping, i.e. the separation of blocks of muscle tissue.

Endogenous enzymes will continue to act on the fish muscle (autolysis) during storage resulting in loss of elasticity of the muscle. The fresh fish flesh is translucent with the colour characteristic of that species. It is firm when pressed gently and resilient with iridescence on the cut surface. Stale fish flesh tends to be opaque, dull, soft and sticky. In extreme cases it tends to be mushy and gape easily. The cut surface loses its iridescence and becomes dull.

3.4 BODY SURFACE

The scales become loose and drops off with storage time and rough handling. The colour fades with storage time.

3.5 BELLY BURN

The viscera (guts) also contains enzymes, one group of which is responsible during life for digesting food. On death, these digestive, powerfully proteolytic enzymes attack the organs and the surrounding tissues. The rate of attack is particularly great in fish that have been feeding heavily ("feedy fish"). In such cases the organs become degraded to a soupy structureless mass and the belly walls are either digested away completely or weakened, that the slightest abrasion or pressure causes them to tear. This is called "belly burn" or "belly burst", and is seen most in pelagic fishes. Gut enzymes are also able to penetrate the flesh and cause additional damage there. In shellfish like crustacea and rock lobsters, the gut enzymes are especially active and are able to attack the flesh of even moribund individuals. For this reason these animals should be kept alive in as full vigour as possible until just before processing if the best quality is to be obtained.

3.6 BLOOD STAIN

During spoilage, the blood contained in the kidney and blood vessels, especially those along the backbone gradually diffuses into the adjacent flesh resulting in blood stains or blood spots in the meat. This reduces the quality of fillets rendering them unacceptable.

3.7 DRIP LOSS

During stowage all fish tissues slowly lose fluid, the amount of which varies with conditions but which may amount from 5 to 10% of body weight after 10 or so days in melting ice. This fluid, or drip, carries away some of the flavour compounds and so contributes to the general reduction in flavour. The effect is enhanced by leaching when the fish, as is normal, are constantly irrigated with ice melt water. Loss on the one hand of weight through drip and on the other of flavour through leaching are both examples of quality loss but in many circumstances, no effective means of controlling them

are available. Leaching however tends to reduce the concentration of undesirable flavours in poor quality fish.

02-01-T7

3.8 ODOUR AND RANCIDITY

Fresh fish from the sea are normally seaweedy in odour or have no smell (neutral). Soon they develop a characteristic fishy odour and when spoilage is allowed to progress, it enters into a series of off-odours and ending in a nauseating, musty and putrid odour for very bad fish.

Rancidity is caused by non-enzymatic changes. It occurs when the lipid of fish combines with the oxygen in the air to form breakdown products. The deterioration takes the form of the development of a linseed oil-like, or painty odour and flavour, generally reckoned to be unpleasant to consumers.

3.9 TASTE AND FLAVOUR

The most significant enzyme deterioration are those that affect flavour. The compounds that are responsible for the sweetish, meaty and characteristic fish flavours of different species are changed by the intrinsic flesh enzymes to more neutral tasting compounds with the result that the fish becomes relatively more insipid. If this is allowed to continue sufficiently far, the concentration of one particular breakdown product, hypoxanthine, becomes high enough to contribute to the bitterness characteristic of unfresh fish.

4. Handling chilled fish

02-01-T8

4.1 Keep the fish clean by washing with clean, potable water.

4.2 Cool and pack freshly caught fish in ice.

4.3 Keep the fish moist.

4.4 Use clean containers to store fish. For hygienic considerations plastic containers should be used.

4.5 Use clean ice made from potable water.

4.6 Ice (especially block ice) should not be in direct contact with floor.

4.7 Handle fish properly, do not throw them about or puncture or bruise the body surface.

4.8 Keep iced fish in shaded areas and not exposed to direct sunlight.

4.9 Keep fish in ice even when storing in chiller.

5. Practical considerations

02-01-T9

5.1 Maintaining chilled fish in ice at 0°C is important. Even a rise of 1-2°C in temperature can have serious consequences.

5.2 In retail markets, fish should be placed on ice slabs as this guarantees a temperature close to 0°C. However it is labour intensive and may not be practical.

5.3 In supermarkets, fish have been prepacked and displayed. The two disadvantages are:

— in the plastic wrap trays, modified atmosphere packing or vacuum packaging results in poorer cooling of the products.

— the use of mechanically operated display counters provide temperatures above 0°C for the fish.

Thus progress in chilled food handling and distribution has actually led to the products being distributed at a higher temperature than before.

ICING — PRACTICAL PLAN (2 h)

Spoilage of prawns and squids during storage

OVERALL AIM:

Trainees should be able to examine the changes in the physical characteristics of prawns and squids, and understand the effect of time and temperature on their quality.

SPECIFIC OBJECTIVE:

1. To enable participants to observe and describe changes in the prawns stored in ice slush and at −1° to +1°C with and without bisulphite treatment.

MATERIALS:

1. Demonstration set of prawns subjected to the various treatments.
   Treatments:
   I. Normal untreated prawns stored in ice slush for
      a) 1 day
      b) 3 days
      c) 5 days.

   II. Prawns treated with 1.25% $NaHSO_3$ solution (1 min soaking and 15 sec rinsing under running water) and stored in ice slush for
      a) 1 day
      b) 3 days
      c) 5 days.

   III. Normal untreated prawns stored at −1° to +1°C for
      a) 1 day
      b) 3 days
      c) 5 days.

   IV. Prawns treated with 1.25% $NaHSO_3$ solution (1 min soaking and 15 sec rinsing under running water) and stored at −1° to +1°C for
      a) 1 day
      b) 3 days
      c) 5 days.

2. Demonstration set of squids subjected to different treatments.
   Treatments:
   I. Squids stored in direct contact with ice for
      a) 0 day
      b) 3 days
      c) 6 days.

II. Squids stored in refrigerator (–1° to +1°C) for
   a) 0 day
   b) 3 days
   c) 6 days.

3. Physical examination score sheets for prawns and squids.

4. Towels.

5. Knives.

INSTRUCTION :

1. Observe the appearance, colour and odour of the prawns and squids, and record in the score sheets provided.

PHYSICAL EXAMINATION SCORE SHEET FOR PRAWNS

PHYSICAL CHARACTERISTICS	UNTREATED			1.25% $NaHSO_3$		
	ICE STORAGE (DAYS)					
	1	3	5	1	3	5
ODOUR						
APPEARANCE (Black spot)						
COLOUR						
TEXTURE						

COMMENTS:

PHYSICAL CHARACTERISTICS	UNTREATED			1.25% $NaHSO_3$		
	−1° to + 1°C					
	1	3	5	1	3	5
ODOUR						
APPEARANCE (Black spot)						
COLOUR						
TEXTURE						

COMMENTS:

PHYSICAL EXAMINATION SCORE SHEET FOR SQUID

PHYSICAL CHARACTERISTICS	Direct contact with ice (days)		
	0	3	6
ODOUR			
COLOUR			
TEXTURE			
PHYSICAL DAMAGE			
ACCEPTABILITY			

COMMENTS:

PHYSICAL CHARACTERISTICS	Refrigerated storage (−1° to +1°C, days)		
	0	3	6
ODOUR			
COLOUR			
TEXTURE			
PHYSICAL DAMAGE			
ACCEPTABILITY			

COMMENTS:

6 FREEZING

Time : 1.5 h

OVERALL OBJECTIVE:

Trainees should be able to state the importance of freezing in fish quality preservation.

SPECIFIC OBJECTIVES:

Trainees should be able to:

1. Understand the principles of freezing and the three stages in the freezing process.

2. Explain fish spoilage patterns during frozen storage.

3. Understand how to assess the quality of frozen fish, such as
   - 3.1 Dehydration
   - 3.2 Freezer burn
   - 3.3 Denaturation
   - 3.4 Lipid changes
   - 3.5 Cold store flavours
   - 3.6 Weight loss.

4. Understand the time-temperature-tolerance concept for frozen fish.

5. Know how to handle frozen fish.

6. Understand the principles of thawing frozen fish.

7. State the various thawing methods.

VISUAL AID:

02-02-T1 : Why freeze fish?

02-02-T2 : Stages in the freezing process

02-02-T3 : Freezing temperature and percentage of ice formation

02-02-T4 : What is slow freezing?

02-02-T5 : What is quick freezing?

02-02-T6 : What is freezing time?

02-02-T7 : Variables affecting freezing time

02-02-T8 : Characteristics of poorly frozen fish

02-02-T9 : Quality assessment of frozen fish

02-02-T10 : Freezer weight loss

02-02-T11 : Cold store weight loss

02-02-T12 : Time-temperature-tolerance concept

02-02-T13 : Glazing

02-02-T14 : Problems in glazing

02-02-T15 : Packaging

02-02-T16 : Cold store

02-02-T17 : Ways in which heat enters cold store

02-02-T18 : Good cold storage conditions

02-02-T19 : Factors in designing and operating cold store

02-02-T20 : Factors affecting cold store conditions

02-02-T21 : Product handling and storage

02-02-T22 : Handling on arrival of frozen products

02-02-T23 : Storage of frozen products

02-02-T24 : Display cabinets

02-02-T25 : Display cabinets — daily checks

02-02-T26 : Display cabinets — weekly cleaning schedule

02-02-T27 : Temperature fluctuation

02-02-T28 : Stock control

02-02-T29 : Restocking

02-02-T30 : Thawing frozen fish:
— heat required
— drip and weight loss

02-02-T31 : Thawing frozen fish:
— handling during thawing

02-02-T32 : Thawing methods

FREEZING - LESSON PLAN

1. The freezing process
02-02-T1

1.1 WHY FREEZE FISH?

The purpose of freezing is to lower the temperature of fish and thus slow down spoilage. Frozen fish can be kept much longer than iced fish.

02-02-T2

1.2 STAGES IN THE FREEZING PROCESS

The freezing process involves 3 stages:

— *Removal of heat*
The temperature of the fish flesh from which heat is removed falls rapidly to just below 0°C, the freezing point (cryostatic temperature) of water.

— *Conversion of water to ice (crystallisation of water)*
Temperature remains almost stationary until most of the water turns to ice (0 to –5°C).

— *Further cooling of frozen fish*
Temperature of fish flesh falls rapidly again as the frozen fish is further cooled till the ultimate temperature for storage (–30°C).

To obtain a high freezing rate, it is important that during the first stage, the air temperature is sufficiently low. During the second stage, the air velocity is the main factor in order to remove the latent heat which amounts to 60 — 70% of all heat to be removed. In the third stage, the difference between air temperature and product temperature is the most important factor.

02-02-T3

During freezing, about 12% of the water do not freeze out, even at very low temperatures. At a product temperature of

–5°C some **75%** of water are converted into ice,
–10°C some **82%** of water are converted into ice,
–20°C some **85%** of water are converted into ice,
–30°C some **87%** of water are converted into ice,
–65°C some **88%** of water are converted into ice.

02-02-T4

1.3 SLOW FREEZING

Slow freezing results in products of inferior quality because of protein denaturation. The longer the fish is allowed to be at –1° to –5°C, the greater the extent of denaturation due to maximum enzyme activity (–1° to –2°C) as well as maximum ice crystal formation. The temperature range between –1° to –5° is called the Zone of maximum ice crystal formation. When freezing extends to beyond 12 hours difference, or greater than 24 hours, it is likely to result in inferior products.

02-02-T5

1.4 QUICK FREEZING

In quick freezing, the conditions are set such that the product goes through the zone of maximum ice crystal formation in less than or about 2 hours. The warmest part of the fish should be at –20°C at the completion of freezing.

02-02-T6

1.5 FREEZING TIME

The freezing time is the time taken to lower the temperature of the product from its initial temperature to a given temperature at its thermal centre. The final temperature at the thermal centre is therefore selected to ensure that the average fish temperature has been reduced to this storage value. When the warmest part of the fish at the thermal centre is reduced to –20°C, the average temperature of the fish will be close to the required storage temperature of –30°C.

02-02-T7

1.6 VARIABLES AFFECTING FREEZING TIME

— freezer type
— freezer operating temperature
— refrigeration system and operating condition
— air speed in an air blast freezer
— product temperature
— product shape
— product contact area and density
— product packaging
— species of fish.

The above factors will determine the overall heat transfer coefficient and hence the freezing time.

2. Spoilage patterns of frozen fish

2.1 Below –10°C, bacterial action will be stopped by the freezing process. Chemical, biochemical and physical processes leading to irreversible changes will occur at a very slow rate. Deterioration during freezing in frozen storage is inevitable and in order to obtain satisfactory results emphasis must, among other things, be placed on the state of the raw material.

02-02-T8

2.2 Some of the characteristics of poorly frozen fish after thawing are:

— dull and spongy flesh
— lack of elasticity in the flesh *i.e.* the flesh is soft, sags and breaks easily
— the fluid is easily squeezed out leading to substantial loss of fluid
— the cooked flesh is usually fibrous and dry
— presence of off-odours such as rancid and cold store odours
— the body surface is often dry and dehydrated

3. Quality assessment of frozen fish
02-02-T9

The main deteriorative changes can be observed physically, such as:

3.1 DEHYDRATION

This is the undesirable migration of water from frozen fish during cold storage. It results in spongy flesh and freezer burn after prolonged storage.

3.2 FREEZER BURN

This is the damage in frozen fish as a result of excessive drying during cold storage, and not during the freezing process. It results in matt, white patches on the surface of frozen fish and consequent change in appearance of the thawed product.

3.3 DENATURATION

This is the undesirable, irreversible change in appearance, texture, water holding capacity and chemical properties of protein in frozen fish, and is accelerated by poor cold storage conditions.

3.4 LIPID CHANGES

— *Rusting*
It is the development of brown discolouration in fatty fish due to the combination of some products of fat oxidation with substances in the flesh that contain nitrogen.

— *Rancidity*
It is the disagreeable odour and flavour that develop when fats in fish have undergone oxidation during storage. It is characterized in the early stage by a marked fishy odour and flavour followed by an unpleasant taint, described as like linseed oil or paint.

3.5 COLD STORE FLAVOUR

It is the characteristic odour and flavour acquired by frozen fish as a result of incorrect and prolonged cold storage. It is found mainly in cold storage of lean fish.

3.6 WEIGHT LOSS

— *Freezer weight loss*
Freezer weight loss is by dehydration. It is due to physical damage during the freezing process. The physical damage results from agitation, e.g. when product is fluidized by the cooling air, from fish adhering to trays or conveyor belts and from small particles being trapped in mesh belts. The losses should be small and need not be greater than 1% if the correct freezer and freezing process is used.

02-02-T10

Freezer weight loss by dehydration depends on:
- type of freezer
- freezing time
- type of product
- shape and size of product
- air velocity
- freezer operating conditions.

It occurs mainly in air blast freezers and those which use a gas such as nitrogen and carbon dioxide which comes in direct contact with the product. Weight loss by cryogenic freezer is low because of short freezing time. Weight loss by air blast freezers is about 1.2% whereas that by carbon dioxide freezers is about 0.6%. The percentage of weight loss by small fish is greater than large fish. The rate of weight loss is proportional to exposed surface area of fish. Individually frozen fish losses more weight than those frozen in block. Fish kept in ice for a number of days is likely to lose more weight than fish kept in freezers.

02-02-T11

- *Cold store weight loss*
  It varies with the following:
  - temperature
  - temperature fluctuation
  - humidity
  - heat transfer
  - air flow over product
  - radiation effects of lighting
  - the product
  - shape and size of the product
  - type of wrapper.

4. Time-temperature-tolerance concept
02-02-T12

This is based on two assumptions:

4.1 For every frozen product, a relationship between storage temperature and the time it takes (at that temperature) for the product to undergo a certain amount of quality change exists.

4.2 Changes during storage and distribution at different temperatures are cumulative and irreversible over the entire storage period and sequence is without influence in the size of the accumulated total quality change.

5. Handling frozen fish

It is important to know the following:

- that commercially frozen fish are prepared in the factory under very good conditions. Good quality frozen fish are obtained by freezing fish quickly and individually.

— that display of frozen products is an essential part of retailing and it is necessary to avoid unnecessary loss of quality.

02-02-T13

5.1 GLAZING

Frozen fish should be glazed and wrapped, and immediately transferred to a low temperature store or cold store.

Glazing is the application of a layer of ice to the surface of a frozen product by spraying, brushing on water or by dipping. It is widely used to protect the product from effects of dehydration and oxidation.

In order to form a complete and uniform glaze, the glazing process must be controlled closely. The amount of glaze depends on:
— glazing time
— fish temperature
— water temperature
— product size
— product shape.

02-02-T14

— *Problems in glazing:*
  — if products are of very low temperature e.g. less than or equal to –70°C, the glaze will fracture and break easily due to stress during ice formation. This glaze is easily dislodged during subsequent handling.

  — if fish is immersed in glaze water for too long, it will result in a thick, soft glaze which is also easily dislodged because the equilibrium temperature between fish and ice is only slightly below 0°C.

02-02-T15

5.2 PACKAGING

— It is important in terms of preservation and aesthetic value.
— Wrapping material should have high resistance to water vapour and oxygen penetration, to prevent excessive drying and oxidation.
— Minimum air gaps (as air-tight as possible) should be present between the product and the package to prevent dehydration, frosting and oxidation.
— Glazing is a good method as it introduces an ice barrier between air and the fish itself.
— Proper sizes and shapes of packaging boxes or trays should be used as frozen fish is brittle and breaks easily.

02-02-T16

5.3 COLD STORAGE

After freezing, the time between unloading the products from the freezer and putting them in the cold store should be as short as possible.

In the cold store, dehydration of fish is dependent on drying effect of the air.

This in turn is affected by:

— *Temperature of air*
A higher temperature has greater drying effect. The surrounding air will dry the fish only if its relative humidity is less than 100%.

— *Relative humidity*
The lower the relative humidity, the higher the drying potential of the air.

High temperature and low humidity is more likely when heat is allowed to enter the store. Heat can enter the store in the following ways:

02-02-T17

— added by the product
— from other products
— heat leak through the insulation, lights and air ingress
— heat leak through a person working in the store.

02-02-T18

Good cold storage conditions are possible only if:
— heat leak is kept to minimum
— any heat entering store is quickly transferred to the refrigeration system.

02-02-T19

Factors to consider in designing and operating a cold store:
— low temperature
— uniform temperature
— steady temperature
— good air distribution
— minimum rate of air circulation
— minimum heat ingress
— type of cooler
— cooling arrangement
— method of operating the cooling system.

02-02-T20

Factors affecting cold store conditions:
— *Size and shape of store*
The ideal shape is a cube because it allows greatest storage space for the least surface area.

— *Vapour barriers*
This should be provided on the warm side of insulation and must cover all walls, roof and ceiling. The purpose of these barriers is to prevent ice build-up in the insulation layer.

— *Foundation and frost heave*
The ice formation below the cold store floor is called frost heave. It is affected by the type and texture of soil, availability of moisture, dimensions of store and seasonal climatic variations, etc. To prevent frost heave, heat the ground below store by low voltage electrical mat or circulation of heated liquid, or leave space below store for ventilation.

— *Air ingress*
Air entering gives heat and moisture. Some solutions are:
— air locks (not favoured)
— curtain of air blown downward or from side of doorway
— hatches
— curtains of overlapping strips of synthetic material.

02-02-T21

5.4 PRODUCT HANDLING AND STORAGE

— Unloading area
— use adjustable platforms, width 8 to 10m
— have a roof to prevent exposure to direct sunlight and rain
— in hot countries, there should be air-conditioned working area and unloading docks (10°C).

02-02-T22

Before the delivery trucks arrive, make sure that staff is ready to move stock to freezer by making sure:
— receiving area is clear
— cold stores are tidy and ready
— temperatures of cold stores checked
— the necessary gear e.g. jacks are at hand
— stock outside freezer should be stacked as closely as possible to minimise contact with warm air
— that personnel are alert.

All these are done with the purpose of minimising the exposure of frozen products to high ambient temperatures.

02-02-T23

— *Storage*
— pallets should be used for product storage
— check product temperature of consignment by placing a thermometer inside the product (should be lower than −12°C)
— work as fast as possible, and as much work as possible should be done in the cold store
— check "Use by" date and mark date received on every carton so that the "First in first out" (FIFO) principle can be applied effectively
— stack new merchandise behind others with labels facing door
— never overfill cold store

— allow 8 cm clearance space off floor
— allow 8 cm clearance space between stock and wall
— allow a clearance space of not less than 46 cm between stock and ceiling
— leave airways between rows of cartons
— stack "hot" products for maximum exposure to the cold air
— keep cold store door shut as much as possible
— allow a cool ante-room (10°C) leading to the cold store.

02-02-T24

5.5 DISPLAY CABINETS

Deep freezer display cabinets can be horizontal or vertical. Horizontal cabinets keep the products cold and are less subjected to temperature changes. Vertical freezer cabinets are self-contained and the occurence of fluctuation in temperature is the only clue to the presence of any fault. The cabinet temperature in all cases should not be above −18°C.

The efficiency of the freezer depends on electrical and mechanical operation, ambient heat and draughts and internal airflows.

Display freezers should be well maintained. The minimum check schedule includes:
— twice a day monitoring of temperature (start and close of shop)
— schedule should take into account the defrosting cycles
— maintenance of good records in order to detect any fluctuation of temperatures
— for "jumbo freezers" check defrost cycles 3 times a day : 8am, 12 noon and evening before security check.

02-02-T25

Display freezer cabinets should be checked daily:
— for proper operating of fans
— that internal airflows are not blocked by food displayed
— that load lines are not exceeded
— for the presence of ice build up
— for any spilled products or rubbish which must be cleaned or cleared
— for air leaks around doors for vertical freezers
— for any abnormal heat and draughts.

02-02-T26

A weekly cleaning schedule include:
— minimum check schedule
— clean cabinets and display area daily
— clean the outside of the cabinet with a mild detergent and then polish
— clean the glass doors with good window cleaners
— clear cabinets of any empty boxes, etc.
— make sure that freezer is switched on again after cleaning, and that the fans are operating.

02-02-T27

5.6 TEMPERATURE FLUCTUATION

— It is the most damaging factor on the final quality of the frozen product.
— Maintenance of a stable storage temperature will extend the shelflife of frozen fish considerably.
— The quality of fish continues to deteriorate even at –30°C, hence it is necessary to maintain low temperature at the retail counter.
— Frozen fish should not be exposed to temperatures higher than –18°C.
— Exposure to fluctuating temperature results in protein denaturation in the frozen fish.

02-02-T28

5.7 STOCK CONTROL

— The display cabinet must not be used as a stocker.
— Products should not be kept in display cabinets for any prolonged periods of time.
— It is recommended that frozen products be kept in a frozen cold store (–30°C) and small amount of stock be transferred out to display cabinets (–18°C).
— Do not overfill display cabinet above load line.
— Do not underfill. It is good to use a false bottom so that cabinet appears full.

02-02-T29

— Restocking
  — should be fast
  — proper stock rotation *i.e.* old stock to be placed on top (for horizontal cabinets) or in front (for vertical ones) and new stock beneath or behind old ones
  — the average turn over time should be about 5 days
  — worker must ensure good air circulation by not allowing the products to cover the air vent
  — stock check should be done before restocking
  — restock list should be in the same order as stocks in the cold store to ensure effective implementation of FIFO
  — do it at a quiet time *i.e.* when the shop is not that crowded
  — prior preparation and arrangement should be done to ensure that restocking does not take more than 20 minutes
  — remove and dispose of bad food according to company policy
  — keep aisle clear
  — use trolley for removal of unwanted things
  — for vertical cabinets the clearance space between stock and fan should be at least 12 cm
  — avoid putting "hot" stack into display cabinets.

6. Thawing frozen fish

Frozen fish must be thawed to be used. The extent of thawing depends very much on what the fish is eventually used for. The

types of equipment and methods used depend on the practical considerations.

02-02-T30

6.1 HEAT REQUIRED

To thaw a given weight of frozen fish, a specific quantity of heat must be supplied eg. 1 kg of white meat fish at –30°C will require about 300kJ of heat to thaw completely. Fish with high fat content require less heat to thaw than less fatty fish.

6.2 DRIP AND WEIGHT LOSS

Fish normally lose weight on thawing, this drip loss may account to about 5% for properly frozen and cold stored white meat fish.

02-02-T31

6.3 HANDLING FISH DURING THAWING

Frozen fish are brittle and easily damaged.

— Do not pry fish apart during thawing.
— Do not use ice picks or other sharp objects to poke the fish.
— Do not put blocks of frozen fish on the floor as cross-contamination with floor bacteria results.
— Use clean containers to thaw fish.
— Partially thaw larger blocks before removing the required portion for thawing and freeze the remaining lot immediately. This prevents exposing the remaining fish to unnecessary repeated freezing and thawing.
— Do not subject frozen fish to repeated freezing and thawing conditions.
— Thawing fish should be done in batches depending on the turnover.
— Overnight thawing of fish should be done close to 0°C. It is not advisable to thaw at too high temperatures, e.g. in hot water.

7. Thawing methods *02-02-T32*

The following thawing methods are available:

7.1 Thawing in air

7.2 Thawing in water

7.3 Simple immersion thawing

7.4 Air blast thawing

7.5 Contact plate thawing

7.6 Electrical resistance thawing

7.7 Dielectric thawing

7.8 Microwave thawing.

FREEZING — PRACTICAL PLAN (1 h)

Spoilage of frozen fish and fish products

OVERALL AIM:

Trainees should be able to appreciate the effect of poor frozen storage on seafood quality.

SPECIFIC OBJECTIVE:

1. Trainees should be able to identify the various types of deterioration characteristics in frozen fish and fish products and understand their causes.

MATERIALS:

1. Dehydrated fish.
2. Fish with freezer burn marks.
3. Fish showing rusting.
4. Rancid fish.
5. Frost formation in poorly packaged fish.
6. Fish with cold store flavour.

INSTRUCTION:

1. Go through the samples displayed and make your observations with the notes provided.

NOTES:

1. **DEHYDRATION**
   It is the undesirable migration of water from frozen fish during cold storage. It results in the flesh becoming spongy after prolonged storage.
   Synonyms: desiccation, drying.

2. **DENATURATION**
   This is the undesirable and irreversible change in appearance, texture and chemical properties of protein in frozen fish, accelerated by poor cold storage.

3. **FREEZER BURN**
   This is the damage to frozen fish caused by excessive drying during cold stor-

age, not during freezing; usually indicated by matt white patches on the surface of frozen fish and consequent change in appearance of the thawed product.

matt: dull, without gloss, as of the surface appearance of thawed frozen fish that have been badly stored.

4. **RUSTING**
   This is the development of brown discolouration of fatty fish. It is believed to be due to the combination of some products of fat oxidation with substances in the flesh that contain nitrogen.

5. **RANCIDITY**
   It is the disagreeable odour and flavour that develop when fats in fish have suffered oxidation during storage. Rancidity is characterized in its early stages by a marked fishy odour and flavour followed by an unpleasant taint, described as like linseed oil or paint.

6. **FROST FORMATION**
   This is the formation of frozen water vapour on a cold surface.

7. **COLD STORE FLAVOUR AND ODOUR**
   It is the characteristic undesirable flavour and odour acquired by frozen fish as a result of incorrect cold storage. This is found mainly in the cold storage of lean fish which have only small amounts of fat. Lean fish do not become markedly rancid during frozen storage but developed a recognizable cold store odour and flavour.

7 HYGIENE AND SANITATION

Time : 1.5 h

OVERALL OBJECTIVE:

Trainees should be able to identify the role of hygiene and sanitation in fish quality preservation.

SPECIFIC OBJECTIVES:

Trainees should be able to:

1. Understand what is cleanliness.
2. State the fundamentals of cleaning.
3. Understand the properties and purpose of detergents.
4. State the factors affecting cleaning efficiency.
5. State the various cleaning methods.
6. Explain what is sanitation.
7. State the properties and purpose of sanitising agents.
8. Understand the necessary conditions for sanitation.
9. Define hygiene and understand the role of management in hygiene and sanitation.
10. Understand the role of personal hygiene of the food handler in the food industry.
11. Understand the effect of environmental cleanliness on the quality of seafood:
    - 11.1 Understand the need for proper infrastructure and sanitation of retail premises.
    - 11.2 Know how to keep the working premises clean.
    - 11.3 Understand the need to control pests.
12. Explain the relationship between sanitation, product quality and sales.

VISUAL AID:

02-03-T1 : What is cleanliness, cleaning and soil?

02-03-T2 : Fundamentals of cleaning

02-03-T3 : Properties of detergents

02-03-T4 : Purpose of detergents

02-03-T5 : Factors affecting cleaning efficiency

02-03-T6 : Cleaning methods

02-03-T7 : What is sanitation?

02-03-T8 : Properties and purpose of sanitising agents

02-03-T9 : Necessary conditions for sanitation

02-03-T10 : What is hygiene?

02-03-T11 : Role of management in personnel hygiene

02-03-T12 : Role of the food handler

02-03-T13 : Steps to good personal hygiene

02-03-T14 : Good work habits and personal hygiene

02-03-T15 : When to wash hands

02-03-T16 : Protocol for food handlers

02-03-T17 : Environmental cleanliness — infrastructure and sanitation of retail premises

02-03-T18 : Environmental cleanliness — keeping work premises clean and control of pests

02-03-T19 : Relationship between sanitation, product quality and sales

HYGIENE AND SANITATION — LESSON PLAN

1. Cleanliness
02-03-T1

1.1 WHAT IS MEANT BY "CLEAN"?
The word clean implies absence of dirt or unwanted matter. Effective cleaning of equipment reduces chances for contamination of food during preparation/processing, storage and serving.

1.2 WHAT IS MEANT BY "CLEANING"?
Cleaning is the removal of unwanted soil from equipment and other areas of food preparation/processing premises.

1.3 WHAT IS MEANT BY "SOIL"?
Soil is 'matter-out-of-place'. There are two kinds of soil, namely water-soluble and water insoluble.

2. Fundamentals of cleaning
02-03-T2

2.1 To bring a cleaning agent into close contact with the soil.

2.2 To displace the soil from the surface to be cleaned.

2.3 To disperse the soil in the solvent.

2.4 To prevent redepositing of the dispersed soil back onto the clean surface.

3. Properties and purpose of detergents
02-03-T3

3.1 PROPERTIES OF DETERGENTS
- capacity to wet surfaces
- ability to penetrate deposits of dirt
- power to emulsify
- capacity to hold material in suspension
- quick and complete solubility
- dissolving action on food solids
- germicidal action
- easily rinsed away
- complete water softening power
- reduce water tendency to corrode on metal surfaces
- non-toxic
- economy in use.

02-03-T4

3.2 PURPOSE OF DETERGENTS
- deflocculation or dispersion
- dissolving
- emulsification
- penetration
- peptization
- saponification
- suspension
- rinsability
- water softening.

4. Factors affecting cleaning efficiency

4.1 THE CLEANER
- — knowledge
- — attitude
- — physical capability.

02-03-T5

4.2 TEMPERATURE

Increasing temperature
- — decreases the strength of bond between soil and surface
- — decreases viscosity
- — increases solubility of soluble materials
- — increases chemical reaction rate.

4.3 VELOCITY OF FORCE

This is applicable especially in the case of "Clean-in-place" situations. However efficiency is less affected by turbulence as the physical-chemical effectiveness of the detergent increases.

4.4 TIME

All other factors remaining constant, cleaning efficiency can be increased by increasing the cleaning time.

5. Cleaning methods
02-03-T6

5.1 REMOVAL OF CROSS FOOD PARTICLES

Loose material should be removed before the application of cleaning solutions. This may be accomplished by flushing the equipment surface with cold or warm water under moderate pressure. Very hot water or steam should not be used because it may make cleaning more difficult.

5.2 APPLICATION OF CLEANING COMPOUNDS

— *Soaking*

Small equipment of fittings or valves may be soaked in cleaning solutions in a sink while larger vessels such as tanks and vats may be partially filled with a pre-dissolved cleaning solution. The cleaning solution should be hot and the soaking be for 15-30 minutes before mechanically or manually scrubbing.

— *Clean-in-place systems*

This involves cleaning of fixed pipes and ducts or parts of equipment that cannot be dismantled and cleaned. The cleaning solutions may be flushed through the pipes followed by clean water for rinsing. The velocity of force of the cleaning solution is crucial for effective cleaning.

— *Spray methods*

Cleaning solutions may be sprayed on equipment surfaces by use of either fixed or potable spraying units of water or steam.

— *Abrasive cleaning*
Abrasive type powders and pastes are still available and used for removing difficult soil. Complete rinsing is necessary and care should be taken to avoid scratching stainless steel surfaces. Scouring pads should not be used on food-contact surfaces because small metal pieces from pads may serve as focal points for corrosion or may be picked up in the food.

5.3 RINSING
All equipment surfaces should be thoroughly rinsed with clean, potable water immediately after being cleaned in order to remove all traces of the cleaning solution. Very hot water may be desirable to decrease drying times.

6. Sanitation
02-03-T7

6.1 WHAT IS MEANT BY SANITATION?
It is the reduction of vegetative cells on items such as food processing equipment to levels judged safe by public health authorities.

7. Properties and purposes of sanitising agents
02-03-T8

7.1 PROPERTIES OF SANITISING AGENTS
Sanitising agents must:
— be an effective germicide
— be readily soluble in water
— have low toxicity
— be stable in concentrated form
— not significantly corrode metal or plastic
— be effective at low concentrations
— be unaffected by water conditions
— be safe to handle in both concentrated form and in solution
— deodourise
— be compatible with cleaning compounds previously used
— be of low persistence.

7.2 PURPOSE OF SANITISING AGENTS
The purpose of sanitation is to keep the populations of both pathogenic and non-pathogenic bacteria under control.

8. Necessary conditions for sanitation
02-03-T9

There are at least 4 physical/chemical factors affecting the use of sanitizers. They are as follows:

8.1 TIME OF EXPOSURE
The death of microorganisms follow a logarithmic relationship, so that if 90% of a population were killed in a unit time, the next 90% of the remaining would be killed in the next unit time, leaving only 1% of the original number.

8.2 TEMPERATURE
The temperature dependency of the antimicrobial activity of a

chemical agent represents a complex situation. Up to a point the growth and death rate of bacteria due to application of the chemical will both increase with increasing temperature. In general, however, the rate of sanitation greatly exceeds the rate of growth of the bacteria, so that the final effect of increasing temperature is to increase the rate of destruction of bacteria.

8.3 CONCENTRATION

Increasing the concentration of the sanitizer increases the rate of destruction of the bacteria.

8.4 pH

The activity of antimicrobials which occur as different species within a pH range may be profoundly influenced by relatively small changes in the pH of the medium.

9. Hygiene
02-03-T10

9.1 WHAT IS HYGIENE?

Hygiene is the study and practice of how to keep good health, especially by paying attention to cleanliness. In normal use it means freedom from the risk of infectious diseases. When applied to food and food processing, it often indicates good quality as well as the absence of any food poisoning hazards.

9.2 PERSONAL HYGIENE

Personal hygiene can be said to represent a combination of the public's perception of an individual's appearance and the individual's own health and personal cleanliness. Improving the personal hygiene of the food handler requires effort at three levels — management, employee and regulatory authority.

02-03-T11

9.3 ROLE OF MANAGEMENT

The management should require :

- — a pre-employment physical examination to assure that the employee is in good mental, physical and emotional health
- — a clear understanding with the employee that he will not lose his employment if he reports that he has an illness or a communicable disease
- — a posted protocol for the employee which indicates what are good personal hygiene and health practices
- — an emphasis by management and by management's example on the maintenance of high level of cleanliness and good health
- — a regular surveillance of all food handlers by management for signs of illness, infection and unsanitary states
- — a properly positioned set of facilities to permit the employee to maintain cleanliness in the form of:
  - — properly cleaned and fitted dressing rooms
  - — laundry services

— strategically placed hand washing facilities throughout the food service area, with an insistence on their use for the purposes for which they are designed.

10. Role of the food handler

02-03-T12

The food handler should assure his personal hygiene by:

a) keeping in a good state of health by the use of proper rest, nutrition, exercise and physical cleanliness

b) being health conscious and conscientious in the protection of his health

c) reporting any illness (such as stomach aches, throats or septic lesions) to his supervisor before he undertakes work with food so that work adjustments can be made to protect the public from the food handler's illness or disease

02-03-T13

d) Practising good personal hygiene through
- — daily bathing
- — use of appropriate deodorants
- — washing hair at least weekly
- — keeping nails clean and trimmed
- — wearing clean uniforms and clean underclothing
- — using a hair net or cap and paper masks over nose and mouth when on duty
- — preparing for work in a systematic fashion so that the individual and his clothing are clean at the time he begins his work.

02-03-T14

e) Developing good work habits such as follows:
- — frequent washing with soap will remove surface skin bacteria and other bacteria picked up while handling fish and equipment
- — hands should be dried on disposable paper towels or a hot-air hand dryer. The use of cloth towels is not recommended
- — touching of hair, nose and mouth should be avoided while handling food
- — all cuts and grazes must be covered with waterproof dressing. Cuts and boils are potential sources of food poisoning bacteria and must be kept covered
- — coughing and sneezing must be done into a handkerchief, preferably a disposable type.

02-03-T15

f) Washing hands regularly after performing these activities:
- — coughing and sneezing
- — visiting the toilet
- — smoking
- — handling soiled articles, boxes and other items
- — handling raw meat, poultry, egg shells, fish and shellfish
- — handling garbage or soiled materials
- — handling money

02-03-T16

g) Keeping employees hands from touching food surfaces of equipment, utensils, crockery and glassware.

h) Observing the "no smoking" rules in food preparation service areas.

i) Using disposable gloves when manipulating food which cannot be decontaminated by heating, like salads.

j) Being ever watchful of conditions which might cause contamination of food in his work area.

11. Environmental cleanliness
02-03-T17

For sanitation to be achieved in any fish retail outlet, there must also be good building design, efficient sewage and refuse disposal, good storm drainage and the introduction of effective pesticides to control flies and pests.

11.1 INFRASTRUCTURE AND SANITATION

Design of the premises is up to the individual, but it should conform to the requirements for the maintenance of cleanliness, safety and personal hygiene.

The following facilities should be available.

— *Hot water*
  — for washing hands and equipment.

— *Cold water*
  — for washing fish.

— *Washing facilities*
  — for washing the premises at the end of the day.

— *Toilet*
  — should be sufficient for staff and preferably not open directly into the food preparation area
  — should be kept clean and dry at all times
  — washing soap, disinfectant, disposable tissue dispensers or hot air hand dryers should be available.

— *Changing room*
  — should be available if possible for staff to change into clean working attire and to wash their hands and boots before entering food preparation area.

— *Air curtain*
  — air curtain or plastic flaps at the entrance of the food preparation area to prevent the entry of flies.

02-03-T18

11.2 KEEPING WORK PREMISES CLEAN

Flies present the most trouble in fish shops. Their presence on fish displayed for sale is repulsive and potentially dangerous to health as they feed and breed in decaying materials including animal faeces.

The control of flies in fishmongers' shops requires preventive measures inside and outside the shop. Flies breed very rapidly in our hot, humid climate. Hygiene must be maintained at a high level to minimise fly breeding, especially outside building.

- *Indoors*
  - floors should be thoroughly washed down at least once a day, and no fish waste should remain trapped in corners or on drain covers.
  - display units and containers should be kept covered and the contents kept chilled; this will reduce attractive odours and prevent flies getting on the fish.
  - fly screens of wire or nylon gauze of 2 mm mesh-hole size may be fitted over windows and other openings.
  - a large variety of methods and chemicals are available for killing the adults and larvae of flies. However, when using chemical insecticides, care should be taken to ensure that they do not come into contact with the food.
  - it is unwise to apply insecticides while foodstuffs are exposed. When insecticides are used, there is a risk of partially paralysed flies falling on unprotected fish on display. If insecticides are sprayed on surfaces, it must be ensured that the surfaces are thoroughly cleaned before putting food items on them.

- *Outdoors*
  - floors and yards should be liberally hosed and swept dry at least once a day.
  - drains should be kept clean.

- *Offal bins*
  - should have heavy, tight fitting lids with a deep lip, and always kept covered.
  - the area where the bin is stored in the open should be sprayed with insecticide.
  - all offal should be disposed off quickly; it should never remain on the premises for more than two days, and if possible collected daily.
  - the bins should be washed out after emptying.

11.3 CONTROL OF PESTS

Rodents and insects are the main pests in the food industries.

Constant vigilance is required as these pests are a constant source of contamination and potential danger to health.

The employment of a professional exterminator for your retail outlet is recommended.

12. Relationship between sanitation, product quality and sales. *02-03-T19*

In recent years consumers are growing increasingly aware of matters pertaining to food quality and safety. Hence, the fish and seafood industry (and for that matter the entire food industry) has to give increasing attention to cleanliness and sanitation of plant and premises, handling, microbiology of raw ingredients and finished products, and wholesomeness and safety of the processed food products.

Any company that sells fresh and processed fish and other seafood has the fundamental responsibility of assuring that the consumer gets a food product that is wholesome, safe and of good quality.

Fresh, attractive and wholesome fishery products produced as a result of proper handling procedures go a long way in establishing your company's reputation. Products with built-in quality are truly the road to company success. It is said that quality assurance and sanitation form a state of mind, and that everyone must have faith and believe in them if positive results are to be expected.

To ensure the practice of hygiene and sanitation, education in this field is unquestionably an essential factor in accomplishing lasting and gratifying results. Employees (especially those directly involved in food handling) must be educated on fundamental facts regarding handling practices and personal hygiene habits. Management must be constantly aware of the importance of a total sanitation program and the many advantages that will be accrued from its implementation.

Quality assurance is the application of measures that ensure the availability of only high quality seafood for consumption. It involves proper testing, inspection or analysis required to maintain a safe food product according to certain specifications, from the beginning to the end, or until the food reaches the customer.

Quality cannot be regarded as something you just dress up somewhere along the line, or something on which suppliers become involved in a battle of wits with buyers to tempt them into buying inferior products.

Quality is one of the most potent competitive weapon the retailer has in the battle for sales. A company with a reputation for quality and value has a much easier selling task than one which does not enjoy such a reputation.

Compared to earlier generations, today's customers are better educated, more discriminating, busier and more willing to experiment with food. More

homes are equipped with microwave ovens and freezers. Health food fads and diets also create more impact.

These presents more opportunities for the food retailer. However, today's customers are also more astute, and they demand quality. The product must look good, smell good and taste good. As retailers, you must give the customers what they want.

Some people are under the false impression that quality assurance is an expensive overhead. They see it as generating additional costs, and making it harder to get a return. But in reality, quality assurance is an investment, not an expenditure.

The old and obsolete philosophy "this is the way we have done for years and we are still in business" is no longer valid. Business is changing, attitudes are changing, consumer awareness is rapidly changing, government regulations and activities are changing, and as retailers, you must too, or perish in the process.

As you can see the subject is also related to profits. Every manager has to be concerned with profits. However, if you should be lax in sanitation and hygiene, and get involved in a regulatory action against your products, then not only will your profits be drained, but your business may never recover from the loss as a result of loss of customer confidence. Think about that and invest in quality assurance and sanitation. You will never regret it.

HYGIENE AND SANITATION — PRACTICAL PLAN (3h)

Hygiene and sanitation in the seafood industry

OVERALL AIM:

Trainees should be able to appreciate the channels of cross- contamination in the seafood industry.

PART 1: DEMONSTRATION OF PROPER HANDLING ON BACTERIAL LOAD IN ICE STORED FISH.

SPECIFIC OBJECTIVE:

1. To emphasize to participants the importance of washing in reducing the bacterial load on fish surface.

MATERIALS:

1. Fish purchased from market.
2. Two contact plates of MacConkey's agar for enteriobacteriaceae.
3. Two contact plates with nutrient agar for total plate count.

INSTRUCTIONS:

1. Label one of each set of the contact plates as WASHED and the other as UNWASHED.
2. Place the UNWASHED side on the fish surface, ensure complete contact. Lift it up and return to bottle.
3. Wash the fish with tap water and do likewise as in (2) using the WASHED side of the contact plates. Cover the contact plates and leave at room temperature for 24 hours.
4. After 24 hours, observe the number of bacterial colonies on the slides and make a rough comparison of the density of colonies among the various treatments.
5. Note the effectiveness in washing fish with water against not washing at all.

PART 2: CROSS INFECTION FROM FOOD

SPECIFIC OBJECTIVE:

1. To demonstrate how cross contamination from raw food to food handlers' hands can occur.

MATERIALS:

1. One fresh fish.
2. Two nutrient agar plates per person.

INSTRUCTIONS:

1. Label one agar plate as HAND and the other as HAND + FISH.
2. Place the unwashed fingers of one hand on the agar plate labelled HAND and move fingers around the plate.
3. Pass the unwashed fish from one person to another. Each person should hold the fish for 10 seconds in both hands.
4. Place your fingers on the second plate labelled HAND + FISH.
6. Incubate the plates and check for growth.

PART 3: CROSS CONTAMINATION USING A COMMON TOWEL

SPECIFIC OBJECTIVE:

1. To demonstrate how cross contamination from an apparently clean common towel can occur.

MATERIALS:

1. Broth culture of *Serratia marcescens.*
2. One clean towel.
3. One nutrient agar plate per person.
4. Basin of dettol solution.

INSTRUCTIONS:

1. The demonstrator will pour a culture of *Serratia marcescens* onto his hands, and will dry them on a towel.
2. Wash your hands with tap water and dry them on the same towel in succession.
3. Place your fingers on the agar plate and move them around the plate.
4. Incubate the plates and check for the presence of *Serratia marcescens* (bright red colonies).
5. Wash hands thoroughly with dettol solution provided.

PART 4: THE EFFECTIVENESS OF SOAP AND ANTISEPTICS AS ANTI-BACTERIAL AGENTS

SPECIFIC OBJECTIVES:

1. To demonstrate if ordinary soap is effective in removing microorganisms.
2. To demonstrate the effectiveness of various antiseptics in removing microorganisms.

MATERIALS:

1. One plate of MacConkey's agar per person.
2. One *Escherichia coli* culture plate per person.
3. Tissue paper.
4. Ordinary toilet soap.
5. Commercial disinfectant for food industry.
6. Antiseptic or germicidal solution.
7. Antiseptic soap.
8. 75% ethanol.

INSTRUCTIONS:

1. Mark the base of the MacConkey's agar plate as follows :

   BEFORE **AFTER**

2. Remove the lid from the petri dish, and place a sheet of tissue paper over the bacterial growth for one group and 3 sheets of tissue paper for the second group.

3. Press onto the paper with your fingers, then apply these fingers to the BEFORE side of the MacConkey's agar plate.

4. Each person should do one of the folowing:

   (a) wash fingers in tap water only. Label as "TW";

   (b) wash fingers in common toilet soap. Label as "TS";

   (c) wash fingers with antiseptic soap. Label as "AS";

   (d) wash fingers in antiseptic solution. Label as "DE";

   (e) wash hands in commercial disinfectant. Label as "DS";

   (f) wash with 75% ethanol. Label as "ET";

   (g) no washing. Label as "NW".

   Then apply the same fingers to the AFTER half of the MacConkey's agar plate.

5. Incubate at 37°C for 24 hours.

6. Examine incubated plates for the presence of colonies. Compare the relative amounts of growth on the control and test sections.

8 QUALITY CONTROL AT RETAIL STORE

Time : 2.5 h

OVERALL OBJECTIVE:

Trainees should be able to apply concepts of fish quality control to the retail outlets in their respective countries.

SPECIFIC OBJECTIVES:

Trainees should be able to:

1. State the responsibilities of seafood retailers.
2. Understand how much quality control is required.
3. Understand the use of the chiller room and cold store.
4. Understand the use of the chilled display cabinet.
5. Understand the use of the frozen display cabinet.
6. Explain the need of understanding their products.
7. Realise the need of understanding their customers.
8. Understand the principles underlying fish preservation and display.
9. Realise the usefulness of quality grading.

VISUAL AID:

02-04-T1 : Responsibilities of the seafood retailer

02-04-T2 : How much quality control?

02-04-T3 : Use of the chiller room and cold store — the DO'S

02-04-T4 : Use of the chiller room and cold store — the DON'TS

02-04-T5 : Use of the chilled display cabinet

02-04-T6 : Use of the frozen display cabinet

02-04-T7 : Understanding your product

02-04-T8 : Understanding your customer

02-04-T9 : Principles of fish preparation and display

02-04-T10 : Quality grading

QUALITY CONTROL AT RETAIL STORE — LESSON PLAN

1. Responsibilities of the seafood retailer
02-04-T1

1.1 Retailers should not only supply high quality seafood at time of sale, but must also ensure that there is sufficient quality to last to the point of consumption.

1.2 The retailer is the key to imparting information regarding methods of preparation, quality preservation and handling practices directly to the consumers because he has direct contact with them.

1.3 The retailer is also a key to a good image of the seafood industry.

2. How much quality control is required?
02-04-T2

2.1 The cost of quality control must be less than the benefits that accrues from the operation.

2.2 Some obvious benefits of implementing quality control are:
— establishing the store's reputation as a supplier of reliable and good quality seafood products
— reduction of direct and indirect monetary loss due to quality deterioration of delicate but expensive seafood products
— maximising profit potential through proper management.

3. Use of the chiller room and frozen store

3.1 Refrigerated stores could be classified as:
— chiller rooms (temperatures above 0°C)
— frozen stores (temperatures at or below –20°C).

3.2 These refrigerated stores function
— as an important link in the distribution of fresh and frozen food
— as a means of delaying food spoilage and allows more time to be available for distribution and sale
— as a bridge during seasonal fluctuations in certain products, thus ensuring a continuous supply.

02-04-T3

3.3 The Do's of using the chiller rooms and frozen stores:
— do use properly designed shelfing to store products. It allows easier stock check and stock movements. The maxim "first in, first out" can then be followed.
— do keep the chiller rooms and frozen stores clean.
— do place products requiring low temperature storage nearer the cold air outlet. Products that are less sensitive to temperature changes can be placed nearer the door.
— do put iced fish and raw materials in proper containers so that drips from the fish will not contaminate other food.
— do maintain good housekeeping.

02-04-T4

3.4 Don'ts of using the chiller room and frozen store.
- — don't put products directly on the floor.
- — don't put products in direct contact with the wall of the chiller room or frozen store.
- — don't stock products indiscriminately.
- — don't open the door of the chiller room or frozen store unnecessarily.
- — don't leave stains or spills uncleaned as this encourages bacteria and mould growth, and also causes off-odours which will taint other foods.

4. Use of chilled display cabinet
02-04-T5

4.1 The chilled display cabinet is a "productive" item as it serves as a direct link between the product and the customer. It influences the customer's decision to buy or not to buy the product.

4.2 Incorrect usage of the cabinet will reduce its efficiency. The following are some pointers for proper usage of the chilled display cabinet.
- — do not place warm food products directly into the cabinets as this would raise its temperature.
- — precool products for display in ice before putting them out in the cabinets.
- — do not overload your chilled display cabinet. Pre-packed fish, especially in styrofoam trays stacked several layers high, restricts cool air from coming into contact with your product. It is preferable to display products in styrofoam trays in a single layer.
- — do not leave products on the shelves of chilled display cabinets until they have exhausted their shelf-life.
- — the supply of mechandise should be placed in the chiller room and only sufficient amounts be placed in the display cabinet for sale.
- — maintain a good temperature to protect your product.
- — keep it clean, neat and attractive.

5. Use of the frozen display cabinet

5.1 The frozen display cabinet is also a "productive" item as it is a direct link between product and the potential customer.

02-04-T6

5.2 It is the responsibility of the retailers to ensure that the display cabinet is clean, tidy and attractive; bearing in mind the potential dangers of product spoilage if the frozen display is wrongly used.

5.3 The following are some precautionary measures in using a frozen display cabinet.
- — do not place food above the loading limit as the temperature is not low enough to keep the product frozen.
- — only products which are already frozen should be placed in the cabinet. The cabinet is not made to freeze the product.

— the frozen display cabinet is designed for short term frozen storage only. It should not be used as a cold store.
— maintain a low temperature and monitor the temperature regularly.
— take suitable precautions when stocking.
— stocks should not be removed from and returned to the cabinets except when absolutely necessary.
— defrost display cabinets at least once a week.

6. Understanding your product *02-04-T7*

6.1 The seafood products that you handle are high value products and the value can be jeopardised by improper handling and storage techniques. The basic principle of keeping it cold and clean applies throughout.

6.2 Generally there are two types of sales in the supermarkets. One is full service counters where the seafood are attractively displayed for the customers to touch, feel, smell and select. The other is the prepacked self-service counters which offer less scope for touching and smelling the products before deciding on a purchase.

6.3 The following are some suggestions for a full service counter:
— maintain a low temperature for the products, especially if it is not mechanically cooled.
— ice supplement is desirable in a mechanically cooled counter.
— generous icing reflects professionalism and can be decorative.

6.4 The following are some suggestions for a self-service counter:
— the quality of the fish for packing must be fresh to gain consumers' confidence and because the cooling conditions is less ideal than the full service counter.
— there should be a system in the organisation to remove and discard expired seafood off the shelves.
— it is good to downgrade products that are near the end of the shelflife for a specific purpose. These can be sold at a discount. however, the customers should be made aware of the quality and suggestions of cooking methods.

6.5 It is important for staff at the check-out counter to be educated to help maintain low temperature of the seafood. They should avoid putting cooked, ready-to-eat, chilled products with raw, chilled products. Chilled seafood should be packed together as much as is practical.

7. Understanding your cusotmer *02-04-T8*

7.1 The ultimate goal of the retailer is to sell his products *i.e.* to ensure customers return to his stall for more. Hence it is important to look into the customers' needs and to build a rapport with them through effective communication. [*Elaborate*]

8. Principles of fish preparation and display
02-04-T9

8.1 At the supermarket sales counter, the appeal and finish of the products are important to clinch the sale. Attractively arranged products will ensure that it is being displayed to the best advantage.

8.2 Supervisors should provide instructions to the staff to cut and trim neatly, and to arrange the products attractively.

8.3 To maintain quality, the following points should be remembered:
— time
— temperature
— contamination
— damage and deterioration.
[*Elaborate*]

9. Quality grading

02-04-T10

9.1 The retailer should be competent in maintaining good quality at:
— fish delivery
— fish storage and stock control
— fish preparation and display.
[*Elaborate*].

QUALITY CONTROL AT RETAIL STORE — PRACTICAL PLAN (2 days)

Field trips to fish wholesale, wet, dry and supermarkets

OVERALL AIM:

Trainees should get an overview of the current practices in fish retailing.

SPECIFIC OBJECTIVES:

1. To observe and compare the strengths and weaknesses in fish handling at the various types of fish wholesale and retail markets.
2. To emphasize to participants the feasibility of selling and maintaining good quality fish at supermarket level.
3. To observe and find out the areas for improvement at the different wholesale and retail markets.

MATERIALS:

1. Notebook and pen for recording observations.
2. Camera to take photographs where permitted.
3. Boots (for wholesale and wet markets).

INSTRUCTIONS:

1. **Wholesale, wet and dry markets**

   1.1 Record observations of the following:
   - — types of fish traded
   - — mode of transportation during distribution
   - — points where ice is used
   - — handling practises of wholesalers and retailers
   - — types of packaging of the seafood where relevant
   - — types of storage facilities available.

   1.2 Make recommendations on areas of improvement.

   1.3 Note the strengths in the handling, distribution and storage of seafood at these markets.

2. **Supermarket**

   2.1 Note the strengths and weaknesses in the facilities and handling practices at the various points listed below.

2.2 Note effort to provide good hygiene and sanitation at these facilities.

2.3 Make recommendations on areas for improvement where applicable.

Facilities

A. *Refrigerated display cabinet*
- — type/s used
- — temperature and temperature monitoring schedule
- — maintenance
- — lighting
- — overstocking
- — appearance of display and overall ambience
- — any instructions or promotional effort.

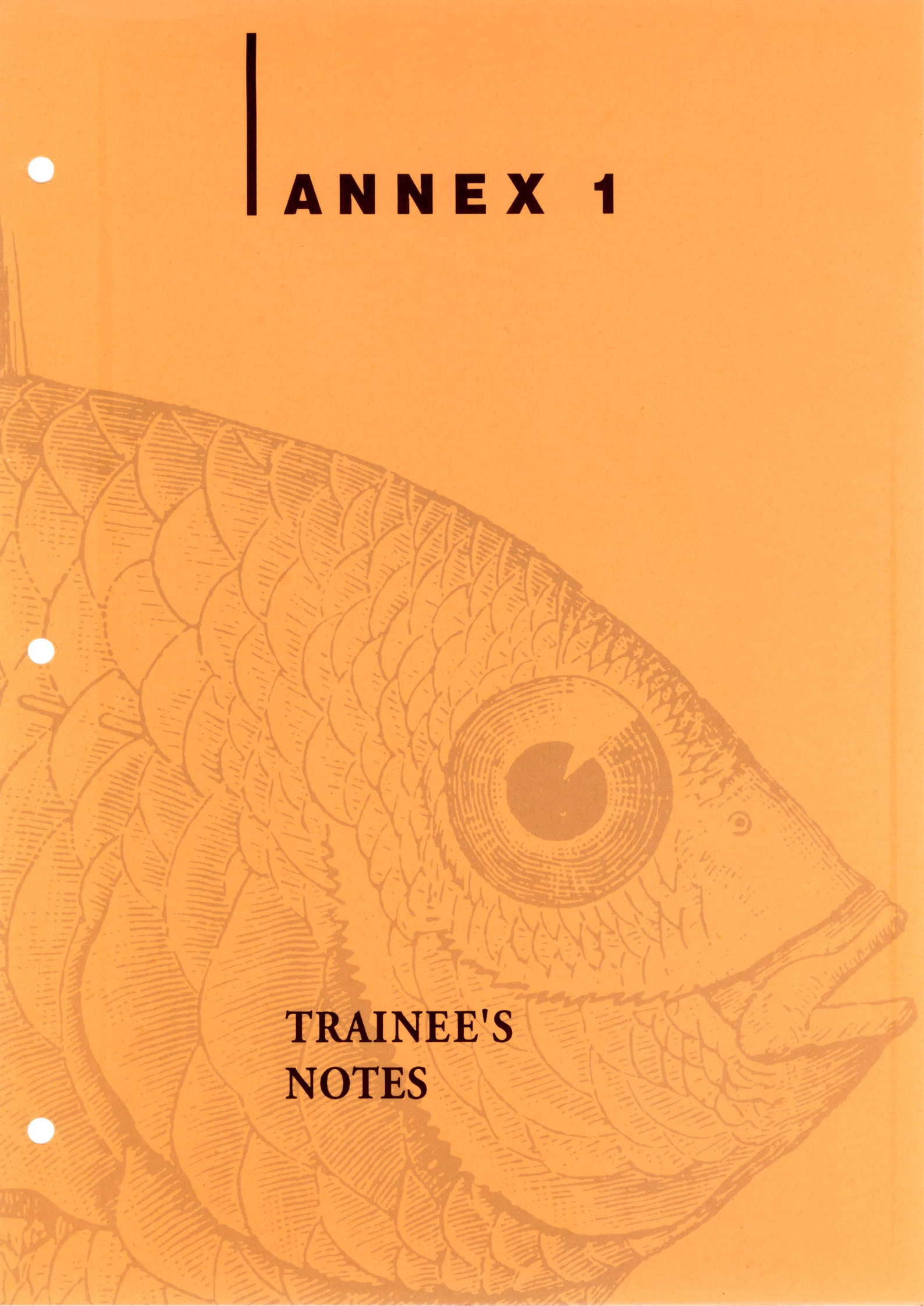
B. *Freezer display cabinet*
- — type/s used
- — temperature and temperature monitoring schedule
- — maintenance
- — lighting
- — presence of ice at sides of cabinet
- — overall ambience.

C. *Chilled fish*
- — method of display
- — method of packing
- — aesthetic value of packaged product
- — presence or absence of date marking.

D. *Frozen seafood*
- — overall appearance
- — method of packing
- — method of display
- — evidence of temperature fluctuation or abuse
- — evidence of physical damage
- — information of date of manufacture or consumption.

E. *Cooked products*
- — overall appearance
- — method of display
- — method of packaging
- — ambience of environment.

ANNEX 1



TRAINEE'S NOTES

CONCEPT OF FRESHNESS

1. **What is a fish and its commercial value?**

   1.1 *What is a fish?*

   _____

   _____

   _____

   _____

   1.2 *Internal features of a fin-fish*

   _____

   _____

   _____

   _____

   1.3 *Commercial categories of fin-fish*

   _____

   _____

   _____

   _____

2. **What is fish freshness?**

   _____

   _____

   _____

   _____

3. **Endogenous changes influencing fish quality at post mortem**

   3.1 *Rigor mortis (rigor)*
   What is rigor mortis?

   It is the _____ of the muscles of an animal shortly after _____.

   Pre-rigor: _____

   _____

   _____

Full rigor: _____

_____

_____

Post-rigor: _____

_____

_____

Rigor in chilled fish: _____

_____

_____

Factors affecting rigor mortis: _____

_____

_____

How does rigor affect quality?

_____

_____

_____

In the case of frozen whole fish:

a) Gaping: _____

_____

_____

b) Toughness and drip loss: _____

_____

_____

In case of frozen fillets: _____

_____

_____

Controlling the effects of rigor: _____

_____

_____

What is thaw rigor?

Can thaw rigor be prevented?

3.2 *Autolysis*
What is autolysis?

Effects due to protein changes:

Effects due to lipid deterioration:

3.3 *Pigment changes in skin, meat and gills:*

4. **Exogenous changes influencing fish quality at post mortem**

4.1 *Physical changes*

4.2 *Bacterial spoilage*

4.3 *Temperature*

4.4 *Atmosphere*

CONCEPT OF QUALITY

1. Definition of quality

1.1 *What is quality?*

_____

_____

_____

_____

When considering the quality of seafood, or any other food, one has to take into account the following:

1. intrinsic composition of the seafood
2. degree of contamination with undesirable materials
3. nutritive value
4. degree of spoilage
5. damage
6. deterioration during processing
7. storage conditions
8. distribution
9. sale and presentation at the counter
10. hazards to health
11. satisfaction on buying and selling
12. aesthetic considerations
13. yield and profitability to producer and middlemen.

The quality of seafood can be categorised into _____ quality and _____ caused by external factors.

1.2 *What is intrinsic quality?*

_____

_____

_____

_____

Factors affecting intrinsic quality are:

a. Species: _____

_____

_____

b. Size: _____

c. Sex: _____

d. "Condition", composition and season: _____

e. Parasites and other organisms: _____

f. Naturally toxic fishes: _____

g. Contamination with pollutants: _____

h. Habitats: _____

i. Eating habits: _____

1.3 *What are some defects caused by external factors?*

1.4 *What is quality assurance?*

1.5 *What is quality control?*

2. Methods of measuring quality

2.1 *What is sensory evaluation of fish?*

Evaluation of raw wholefish:

a) Eye:

b) Gills:

c) Body surface:

d) Flesh:

e) Belly flap:

f) Gut:

g) Drip: _____

_____

Evaluation of cooked fish:

a) The food preparation area: _____

_____

_____

b) Panel booth area: _____

_____

_____

c) Panel discussion area: _____

_____

_____

d) Panel members: _____

_____

_____

2.2 *Chemical and biochemical methods*

_____

_____

_____

_____

Nucleotide degradation:

_____

_____

_____

_____

Adenosine triphosphate (ATP) ⟶ denosine diphosphate (ADP) ⟶ adenosine monophosphate (AMP) ⟶ inosine monophosphate (IMP) ⟶ inosine (HxR) ⟶ hypoxanthine (Hx)

Amine compounds: _____

Lipid deterioration: _____

Protein denaturation: _____

3. **Time-temperature-tolerance concept**

3.1 *Hypothesis:* _____

3.2 *Relationship between time after death and fish quality:* _____

3.3 *Relationship between exposure temperature and fish quality:* _____

3.4 *Combined effects of time after death, temperature and fish quality:* _____

3.5 *Practical implications:* _____

CONCEPT OF WHOLESOMENESS

1. **What is wholesomeness of food?**

   A food product is considered wholesome when it does not cause any _____ effects on a person's _____ or body after it has been consumed.

   The wholesomeness of food involves _____ _____, _____ and _____.

2. **Food safety**

   2.1 *What is safe food?*
   Safe foods imply food that do not allow _____ or _____ to the consumers.

   Reasons to justify a food safety program are :

   a) _____

   b) _____

   2.2 *What makes a safe product?*

   A product is considered safe when it is :
   — non-toxic and non-poisonous
   — free from antibiotic
   — free from pesticide
   — free from pathogenic micro-organisms
   — free from foreign chemicals
   — free from foreign substances (e.g. _____, _____)

   2.3 *Seafood toxicity*

   _____

   _____

   _____

   _____

   _____

   2.4 *Scombroid poisoning*

   _____

   _____

   _____

2.5 *Pathogenic bacteria poisoning*

Bacterial infections:

Bacterial intoxications:

2.6 *Parasitic and viral infections*

2.7 *Quality assurance program*

2.8 *Product safety*

Product safety can be attained by a good Quality Assurance Program based on:
- — good procurement specifications
- — careful selection of raw materials
- — approved methods of transport and storage of raw materials
- — approved methods of processing
- — proper selection and application of packaging systems
- — approved methods of sanitation and housekeeping throughout the whole operation, including personnel hygiene.

3. Food cleanliness

3.1 *Definition*
A food is said to be clean when it is free from _____ or unwanted matter.

3.2 *Sources of contamination*

_____

_____

_____

_____

_____

3.3 *Steps to minimise cross-contamination*

_____

_____

_____

_____

_____

4. Freshness of seafood

4.1 *Definition*
A food is considered fresh when it is in _____, _____ condition.

4.2 *Steps to keep fish fresh*

_____

_____

_____

_____

4.3 *Actual consequences in quality loss*

CONCEPT OF NUTRITIVE VALUE

1. Importance of food composition

_____

_____

_____

2. Fish muscle

2.1 *Structure of fish muscles*

_____

_____

_____

2.2 *Types of fish muscle*

_____

_____

_____

White meat fish: _____

_____

Red meat fish: _____

_____

Light muscle:_____

_____

Dark muscle: _____

_____

3. Fish — a high protein food

Fish usually contains about _____% protein.

Two essential amino acids called _____ and _____ are found in high concentrations in fish.

Fish protein provides a good combination of _____ _____ which is highly suited to man's nutritional requirements and compares favourably with that provided by meat, milk and eggs.

3.2 *Types of fish protein*

Structural proteins or _____ protein:

_____

_____

_____

_____

_____

_____

Sarcoplasmic protein: _____

Connective tissue protein: _____

4. **Minerals and vitamins**

_____

_____

_____

_____

_____

_____

5. **Low saturated fat in fish**

The term fat includes _____, _____ and _____ as well as more complex, naturally occurring compounds of fatty acids.

Fish oil contains much _____ fatty acids and more of the fatty acids from _____ carbon chains.

6. **Fish as health food**

Fish oils contains

— a large _____ of highly _____ fatty acids

— a great deal of carbon number _____ and _____ fatty acids, and _____ _____ fatty acids

— a greater _____ of fatty acids

Physiologically active substances are made from unsaturated fatty acids of carbon 20. These fatty acids can be converted to _____, a substance with the following effects:

1. regulation of blood pressure
2. anti-thrombosis
3. anti-asthma
4. anti-ulcer
5. inducing delivery
6. anti-inflammation
7. protection against sterility
8. anti-arteriosclerosis

The two fatty acids which are useful for our health in these aspects are _____ _____, EPA ($C_{20:5}$) and _____ _____ ($C_{22:6}$).

_____

_____

_____

In summary, fish oils have the following merits in terms of its effects on human health :

— decreases blood circulatory diseases

— decreases serum total cholesterol levels

— _____ high density lipoprotein cholesterol level. This type of cholesterol is useful for human health

— _____ low density lipoprotein cholesterol level. This type of cholesterol is bad for human health

Another useful substance that can be extracted from fish is _____

_____

_____

_____

ICING

1. Importance of icing

1.1 *Why icing?*

Ice is harmless, _____ and _____ to handle.

It is valuable for preserving fish since very _____ cooling is possible through _____ contact between fish and small pieces of ice.

It keeps the chilled fish cold, _____ and _____.

It prevents _____ that could accompany other methods of cooling such as refrigerated storage without ice.

It maintains fish at a temperature just slightly above the point at which the fish would begin to freeze.

It _____ the temperature of the fish, hence, delays the _____ enzymatic of the fish and delays growth.

1.2 *Temperature of ice*

_____

_____

_____

1.3 *Concept of icing*

_____

_____

_____

2. Types of ice

2.1 *Flake ice*

_____

_____

_____

2.2 *Tube ice*

_____

_____

_____

2.3 *Crushed ice*

2.4 *Block ice*

3. Fish spoilage pattern during ice storage

3.1 *The eye*

3.2 *The gills*

3.3 *Muscle and connective tissue*

3.4 *Body surface*

3.5 *Belly burn*

3.6 *Blood stain*

3.7 *Drip loss*

3.8 *Odour and rancidity*

3.9 *Taste and flavour*

4. Handling of chilled fish

5. Practical considerations

FREEZING

1. The freezing process

1.1 *Why freeze fish?*

To lower the _____ and thus slow down spoilage so much that when the product is thawed after cold storage it is virtually indistinguishable from fresh fish.

FREEZING IS THE MEANS OF PREPARING FISH FOR STORAGE AT LOW TEMPERATURE BUT IS **NOT** IN ITSELF A METHOD OF PRESERVATION.

1.2 *Stages in the freezing process*

Freezing converts most of the water _____ in the fish into ice.

Removal of heat

Temperature of fish flesh from which heat is steadily removed first falls to just below 0°C, the freezing point of water, _____ temperature.

Conversion of water into ice
Temperature remains almost _____ until most of the water turns into ice (0 to –5°C).

Further cooling of frozen fish

Temperature of the fish flesh again falls rapidly as the frozen fish is further cooled till _____ temperature for storage (–30°C).

At –5°C most of the water in flesh is frozen.

To obtain high freezing rate: _____

During freezing, _____ % of water do not freeze out. At a product temperature of:
–5°C some _____ % of water is converted into ice,
–10°C some _____ % of water is converted into ice,
–20°C some _____ % of water is converted into ice,
–30°C some _____ % of water is converted into ice,
–65°C some _____ % of water is converted into ice.

1.3 *Slow freezing*

_____

_____

_____

1.4 *Quick freezing*

_____

_____

_____

1.5 *Freezing time*

_____

_____

_____

1.6 *Variables affecting freezing time*

_____

_____

_____

2. **Spoilage patterns of frozen**

2.1 _____

_____

_____

_____

2.2 Some characteristics of poorly frozen fish:

— _____ and _____ flesh

— lack of _____ in the flesh

— substantial loss of _____

— cooked flesh is _____ and _____

— presence of _____-_____

— _____ and _____ body surface.

3. **Quality assessment of frozen fish**

3.1 *Dehydration changes:*

_____

_____

_____

3.2 *Freezer burn:*
It gives white, toughened, dry and wrinkled appearance on the surface of frozen fish.

Remedy : glazing, wrapping with moisture-proof material, restricting the amount of heat entering the cold store (e.g. use air curtain), putting only frozen, cold products in cold store.

DON'T FREEZE PRODUCTS IN COLD STORE!

3.3 *Denaturation*

_____

_____

_____

3.4 *Lipid changes:*
— **Rusting:**

_____

_____

_____

It is the development of _____, rusty colour.

— **Rancidity**:

It is the smell of bad oil, painty taste.

Remedy: glazing, vacuum packaging with moisture-proof and air-proof wrapping.

_____

_____

_____

3.5 *Cold store flavour*

_____

_____

_____

3.6 *Weight loss*

_____

_____

_____

Freezer weight loss

Freezer weight loss by dehydration depends on :
— type of freezer
— freezing time
— type of product
— shape and size of product
— air velocity
— freezer operating conditions.

Cold store weight loss

4. Time-temperature-tolerance concept in frozen seafood

4.1 For every frozen product, a relationship exists between storage temperature and the time it takes (at that temperature) for the product to undergo a certain amount of change in quality

4.2 Changes during storage and distribution at different temperatures are _____ and _____ over the entire storage period; and sequence is without influence in the size of the accumulated quality change.

5. Handling frozen fish

5.1 *Glazing*

5.2 *Packaging*

5.3 *Cold storage:*

Factors in designing and operating cold store:
— low temperature
— uniform temperature
— steady temperature
— good air distribution
— minimum rate of air circulation
— minimum heat ingress
— type of cooler
— cooling arrangement
— method of operating the cooling system.

Factors affecting cold store conditions:
— size and shape of store

— vapour barriers

— foundation and frost heave

— air ingress

5.4 *Product handling and storage:*

Unloading area

Storage

_____

_____

_____

5.5 *Display cabinets:*

Daily check
- for proper operating of fans
- that internal airflows are not blocked by food displayed
- that load lines are not exceeded
- for the presence of ice build up
- for any spilled products or rubbish which must be cleaned or cleared
- for air leaks around doors for vertical freezers
- for any abnormal heat and draughts.

Weekly cleaning schedule
- minimum check schedule
- daily cleaning of cabinets and display area
- cleaning the outside of the cabinet with a mild detergent and then polished
- cleaning of the glass doors with good window cleaners
- making sure that freezer is switched on again after cleaning, and that the fans are operating.

5.6 *Temperature fluctuation:*

_____

_____

_____

5.7 *Stock control:*

_____

_____

_____

6. Thawing of frozen fish

6.1 *Heat required:*

_____

_____

_____

6.2 *Drip and weight loss:*

6.3 *Handling fish during thawing:*

7. Thawing methods

7.1 Thawing in air
7.2 Thawing in water
7.3 Simple immersion thawing
7.4 Air blast thawing
7.5 Contact plate thawing
7.6 Electrical resistance thawing
7.7 Dielectric thawing
7.8 Microwave thawing.

HYGIENE AND SANITATION

1. Cleanliness

1.1 *What is meant by clean?*

1.2 *What is meant by cleaning?*

1.3 *What is meant by soil?*

2. Fundamentals of cleaning

3. Properties and purpose of detergents

3.1 *Properties of detergents*

3.2 *Purpose of detergents*

4. Factors affecting cleaning efficiency

4.1 *The cleaner*

4.2 *Temperature*

4.3 *Velocity of force*

4.4 *Time*

5. Cleaning methods

5.1 *Removal of cross food particles*

5.2 *Application of cleaning compounds*

Soaking:

Clean-in-place systems:

Spray methods: _____

_____

_____

Abrasive cleaning: _____

_____

_____

5.3 *Rinsing*

_____

_____

_____

6. Sanitation

_____

_____

_____

7. Properties and purposes of sanitising agents

7.1 *Properties of sanitising agents*

_____

_____

_____

7.2 *Purpose of sanitising agents*

_____

_____

_____

8. Necessary conditions for sanitation

8.1 *Time of exposure*

_____

_____

_____

8.2 *Temperature*

8.3 *Concentration*

8.4 *pH*

9. **Hygiene**

9.1 *What is hygiene?*

9.2 *Personal hygiene*

9.3 *Role of management*

10. **Role of the food handler**

11. **Environmental cleanliness**

11.1 *Infrastructure and sanitation*

11.2 *Keeping work premises clean*

Indoors:

Outdoors:

Offal bins:

11.3 *Control of pests*

12. Relationship between sanitation, product quality and sales

QUALITY CONTROL AT RETAIL STORE

1. Responsibilities of the seafood retailer

2. How much quality control is required?

3. Use of the chiller room and frozen store

4. Use of the chilled display cabinet

5. Use of the frozen display cabinet

6. Understanding your product

7. Understanding your customer

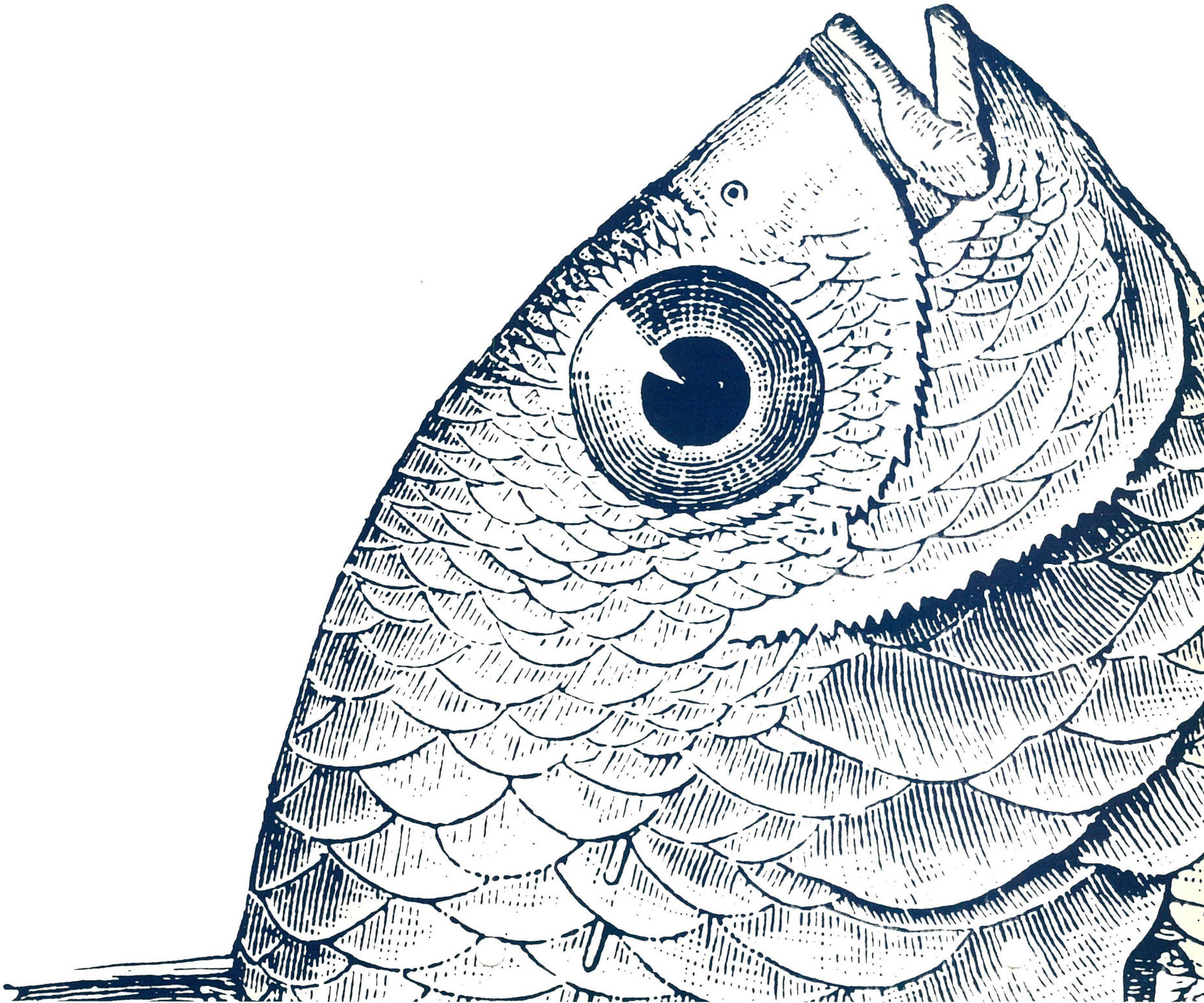
8. Principles of fish preparation and display

9. Quality grading

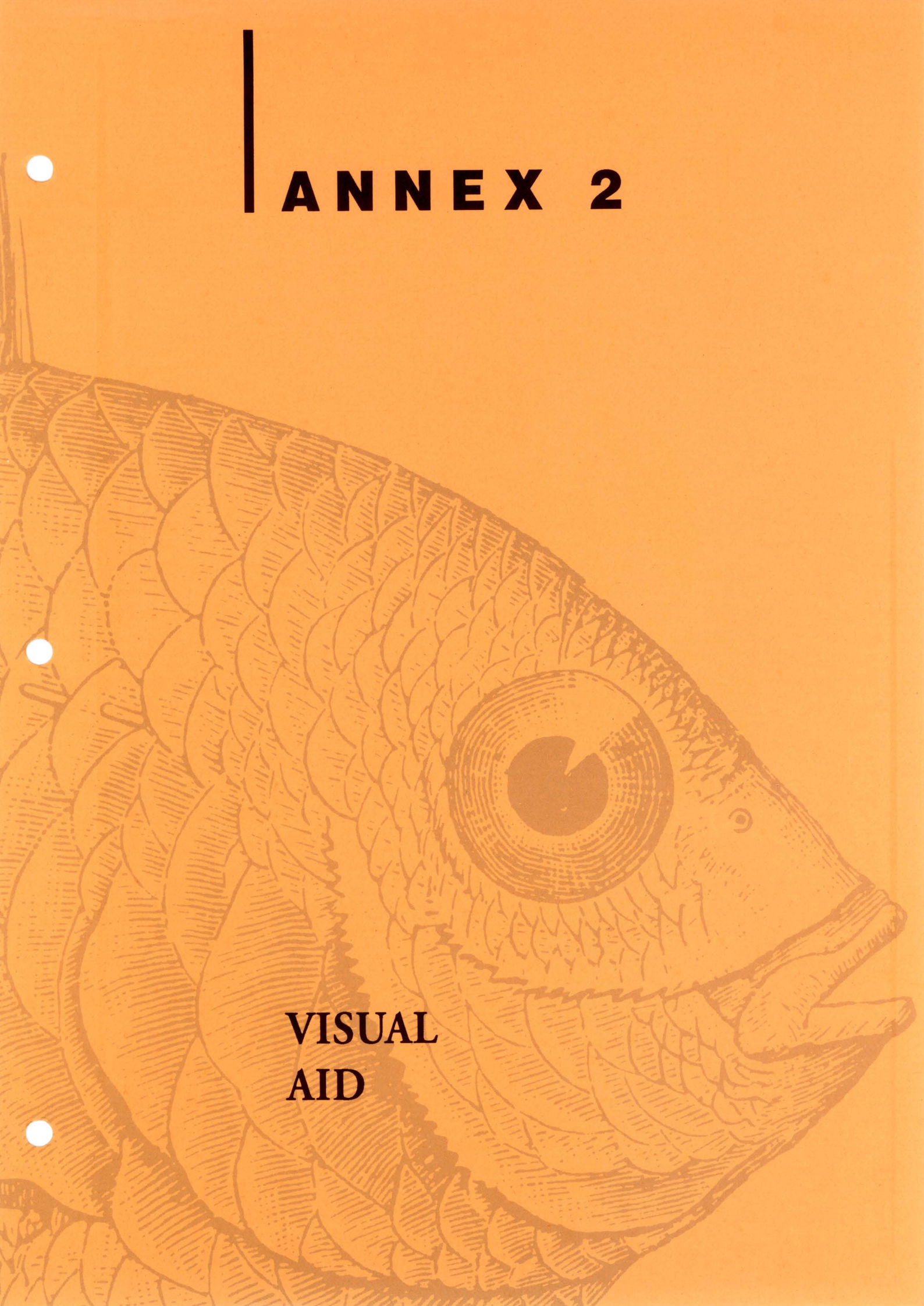
   9.1 *Fish delivery:*

   9.2 *Fish storage and stock control:*

   9.3 *Fish preparation and display:*



ANNEX 2



VISUAL AID

What is a fish?

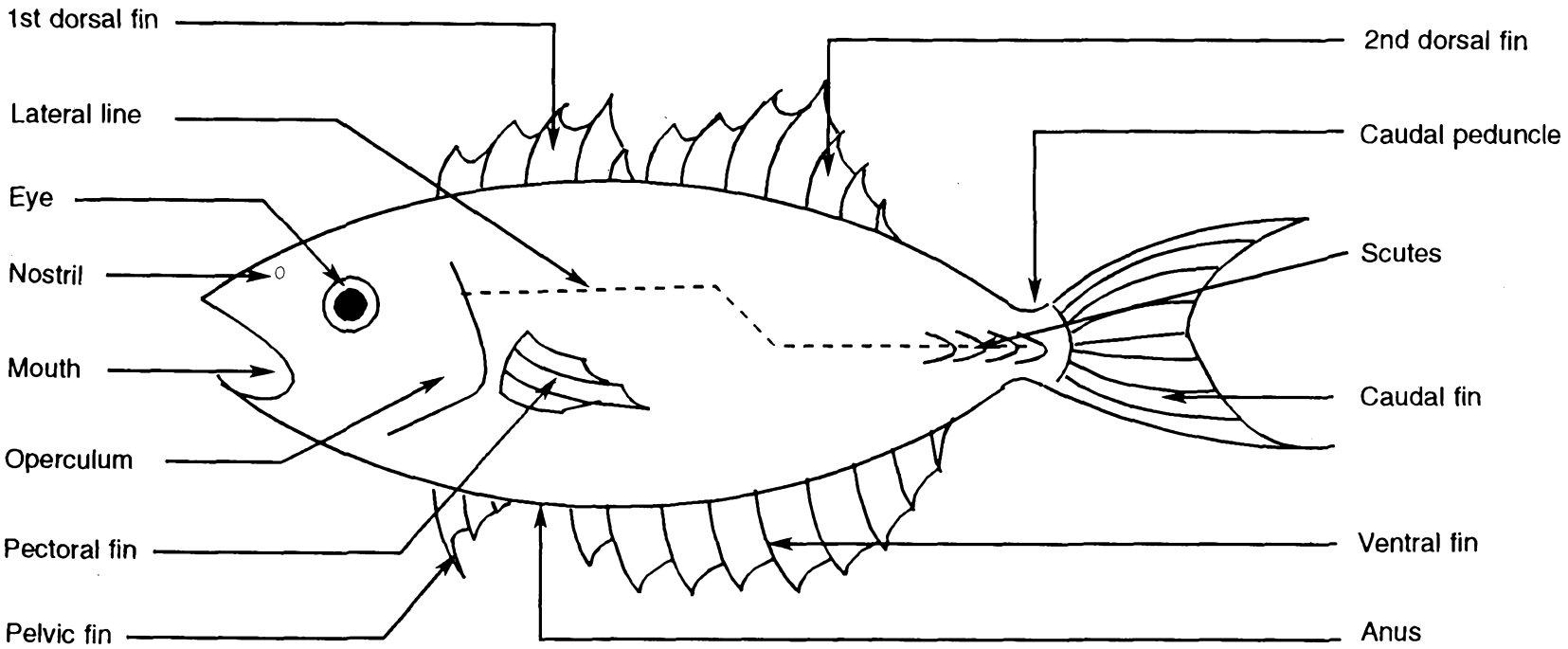


Fig. 1. Diagram showing different parts of a fish.

01-01-T1

What is freshness?

"Freshness of fish" includes:

(a) **ENZYMATIC FRESHNESS**

— lowering of freshness by autolytic action of fish tissue enzymes

(b) **BACTERIAL FRESHNESS**

— lowering of freshness by exogenous enzymes secreted by bacteria

01-01-T2

Post mortem changes in fish

Stage	
pre-rigor full rigor post-rigor	*occurs within 1 hour to 3 or more days after death.*
autolysis	*measure enzymatic freshness (K-value).*
putrefaction	*measure bacterial freshness (TMAO, FA, TMA, VB-N).*

01-01-T3

What is rigor mortis?

i) pre-rigor
ii) full rigor
iii) post-rigor

Factors affecting rigor mortis:

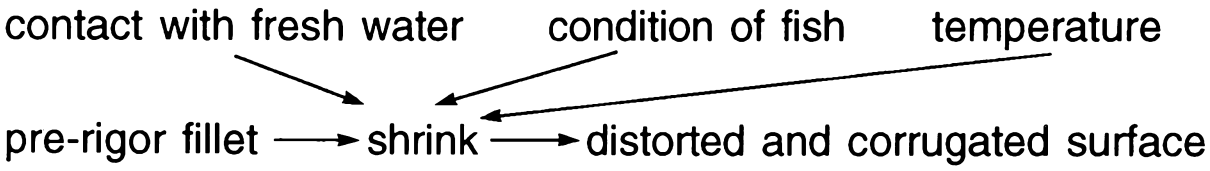
1. Physical condition at death
2. Temperature after death
3. Species
4. Size
5. Amount of handling

01-01-T4

How does rigor affect quality?

i) Frozen whole fish
   - — gaping
   - — toughness
   - — excessive drip loss

ii) Frozen fillets



Remedy: Immediate freezing after filleting pre-rigor fish

01-01-T5

How to control the effects of rigor:

Keep fish chilled at every stage

before freezing.

01-01-T6

What is thaw rigor?

The contraction observed in frozen pre-rigor fillets upon thawing.

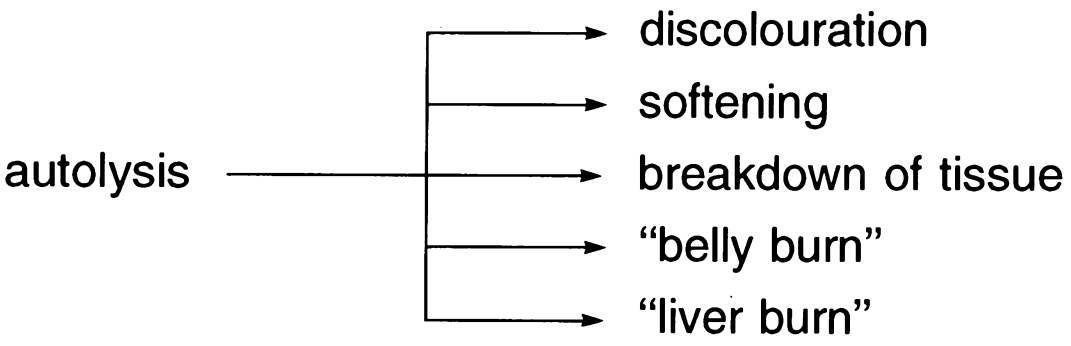
How to prevent thaw rigor?

1. Extend cold storage time of pre-rigor fish stock
2. Thaw slowly at room temperature

01-01-T7

What is autolysis?

— the "self-digestion" of animal tissue by enzymes from its own body



01-01-T8

Effects of protein denaturation

(a) lowering of water holding capacity

(b) development of toughness in muscle tissue

(c) high free and expressible drips

(d) poor quality fish meat i.e. tough, fibrous, dry with poor taste

01-01-T9

Effects of lipid deterioration

(a) rancidity in meat

(b) yellow discolouration of meat

01-01-T10

Pigment changes in skin, meat and gills

carotenoid ——————→ yellow, orange, red

melanin ——————→ brown to black

astaxanthine

myoglobin

01-01-T11

Exogenous changes influencing fish quality

1. Physical changes
   - — due to the environment
   - — due to handling by people

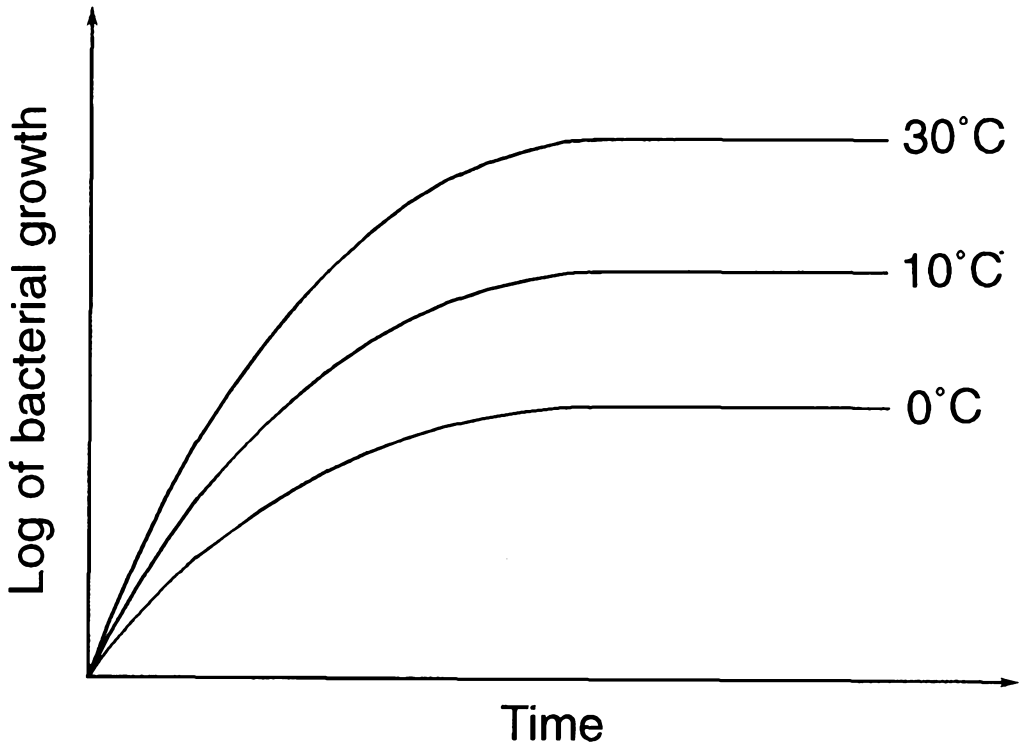
2. Bacterial spoilage

3. Temperature

4. Atmosphere

01-01-T12

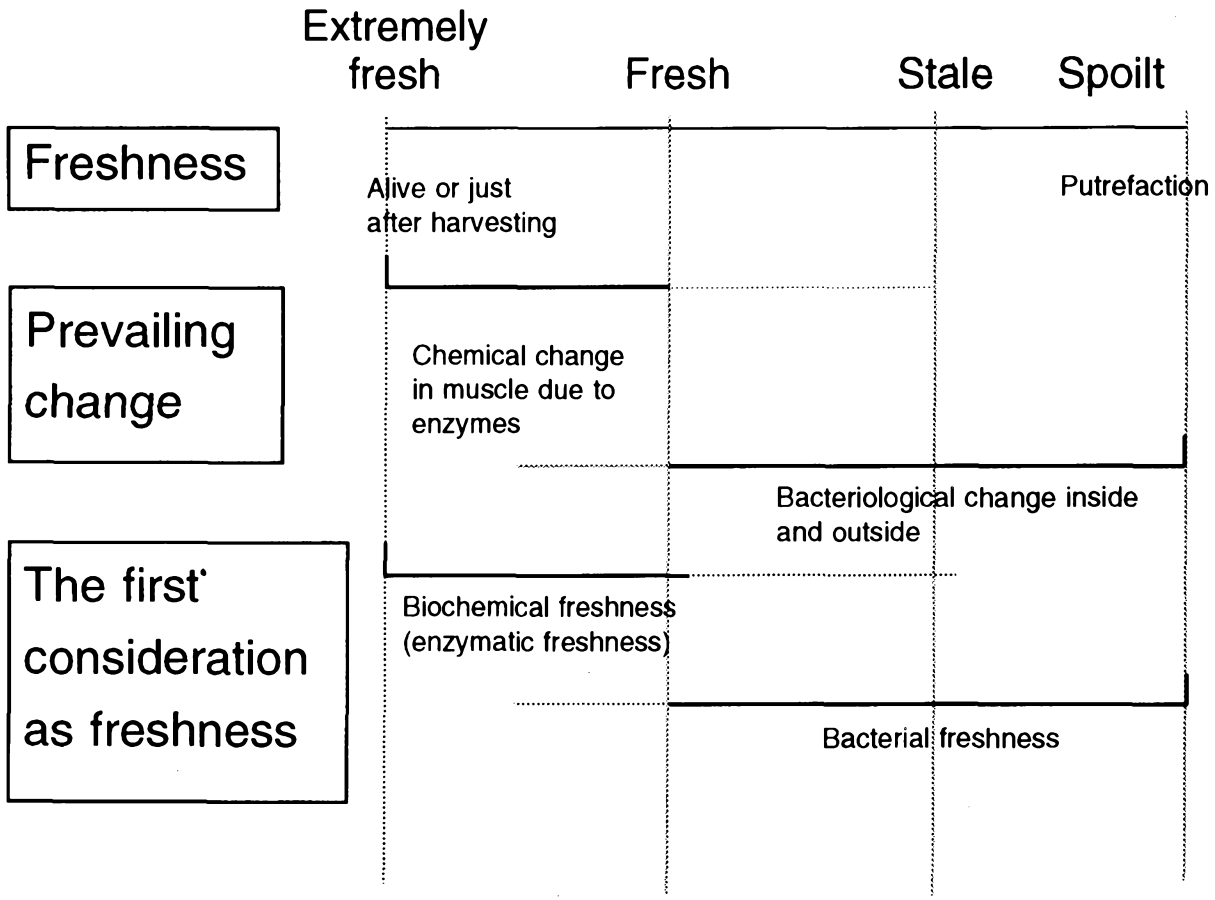
Effect of temperature on bacterial growth



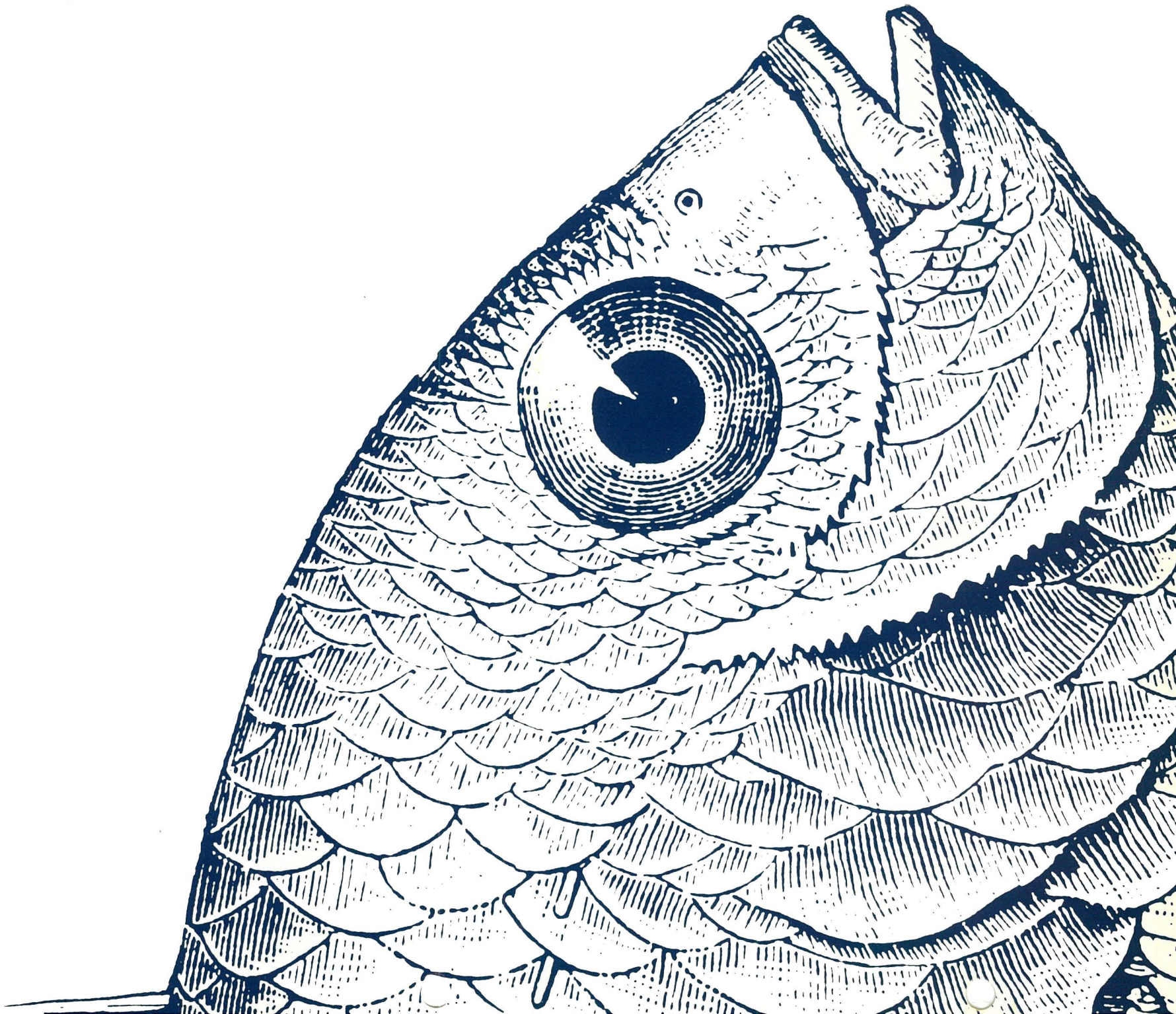
01-01-T13

Summary

Some stages of the freshness of fish after harvesting.



01-01-T14



What is quality?

— the degree of goodness

— includes all attributes which consciously or unconsciously the fish eater or buyer considers should be present

01-02-T1

What is intrinsic quality?

— the total attributes that occur naturally in the harvested raw material

— is influenced by:
  (a) species
  (b) size
  (c) sex
  (d) condition, composition and season
  (e) parasites and other organisms
  (f) naturally toxic fishes
  (g) contamination with pollutants
  (h) habitats
  (i) eating habits

01-02-T2

Defects caused by external factors:

eg. discolouration, tainting, bruised surface, gaping, broken fish pieces, freezer burn, etc.

What is quality assurance?

— the application of quality measures that ensure the availability of only high quality seafood for consumption

What is quality control?

— the implementation of surveillance and education to assure that regulations and specifications which were well defined by the corporate office are carried out by production plants

01-02-T3

Sensory evaluation of fish

— uses sight, smell, taste, touch and hearing to evaluate quality of product

— is reliable with experience

— is simple and quick to use

01-02-T4

Guide on various attributes to be examined for sensory evaluation of fish.

CHARACTERISTICS		WHOLE (round) ICED FISH	FROZEN, ROUND FISH		FROZEN FISH FILLETS	
			FROZEN	THAWED	FROZEN	THAWED
EYE SURFACE	Sunken / flat / not sunken (convex)	✓	N/A	✓	N/A	N/A
	Transparent / translucent/ opaque	✓	N/A	✓	N/A	N/A
	Presence of blood	✓	N/A	✓	N/A	N/A
	Dehydrated	✓	N/A	✓	N/A	N/A
EYE BALL	Transparent / cloudy / opaque	✓	N/A	✓	N/A	N/A
	Discoloured	✓	✓	✓	N/A	N/A
GILLS	Colour	✓	✓	✓	N/A	N/A
	Mucus / slime	✓	✓	✓	N/A	N/A
	Odour	✓	✓	✓	N/A	N/A
BODY SURFACE (Skin on)	Body surface	✓	✓	✓	N/A	N/A
	Vent odour	✓	✓	✓	N/A	N/A
	Colour	✓	✓	✓	N/A	N/A
	Slime / mucus	✓	✓	✓	N/A	N/A
	Physical damage	✓	✓	✓	✓	✓
	Glaze	N/A	✓	N/A	✓	N/A
	Frost	N/A	✓	N/A	✓	N/A
	Dehydration	N/A	✓	✓	✓	✓
	Firmness / resilience	✓	N/A	✓	N/A	✓
FLESH	Colour	✓	✓	✓	✓	✓
	Odour	✓	✓	✓	✓	✓
	Resilience	✓	N/A	✓	N/A	✓
TEX-TURE	Softness	✓	✓	✓	✓	✓
	Fibrousness	✓	✓	✓	✓	✓
	Toughness	✓	✓	✓	✓	✓
	Drips	✓	✓	✓	✓	✓
BELLY FLAPS	Bile stain	✓	✓	✓	✓	✓
	Physical damage	✓	✓	✓	✓	✓
	Odour	✓	✓	✓	✓	✓
GUT	Integrity	✓	N/A	✓	N/A	N/A
	Odour	✓	N/A	✓	N/A	N/A
	Presence of gut remnants	N/A	N/A	N/A	✓	✓

N/A = Not Applicable

01-02-T5

GRADING OF SEA BASS, *Lates calcarifer* (WHOLEFISH) DURING ICE STORAGE

Grade	Excellent	A	B	C (unfit)
Skin	bright, shining, iridescent or opalescent, no bleaching, golden-grey	slight loss of bloom, slight bleaching, blue-grey	dull, some bleaching, some loose scales, blue-grey	dull, marked bleaching, loose scales, blue-grey
Outer slime	transparent or water-white	watery, clear slime	no slime (washed by melt water)	no slime
Eyes	convex, clear cornea, golden pupil	plane, slightly translucent cornea, slightly opaque pupil	slightly concave, translucent cornea, opaque pupil	completely sunken, translucent, bloody cornea, opaque pupil
Gills	bright red, transparent mucus	liver red, slightly opaque mucus, no bleaching	dark red, slight opaque mucus, bleaching at edges	brown, bloody mucus, bleached
Gill odour	fresh, seaweedy	no odour, neutral, trace fishy, slight raw grass	fishy, raw grass, rancid, slight ammoniacal	sweet fruity, strong fishy, pungent ammoniacal, strong rancid, putrid, nauseating

01-02-T6

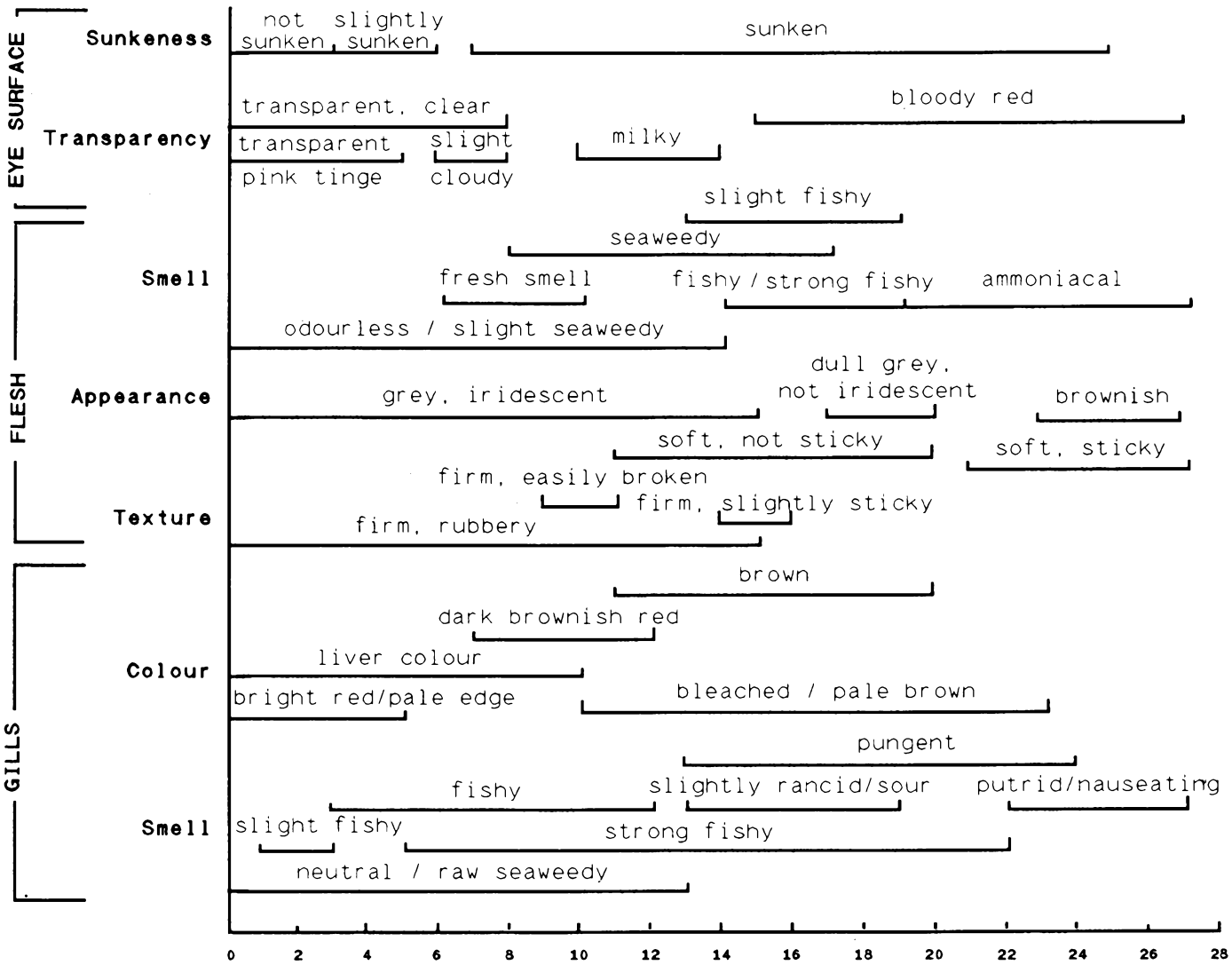


Fig. 2. Changes in the physical characteristics of ice stored L. calcarifer.

01-02-T7

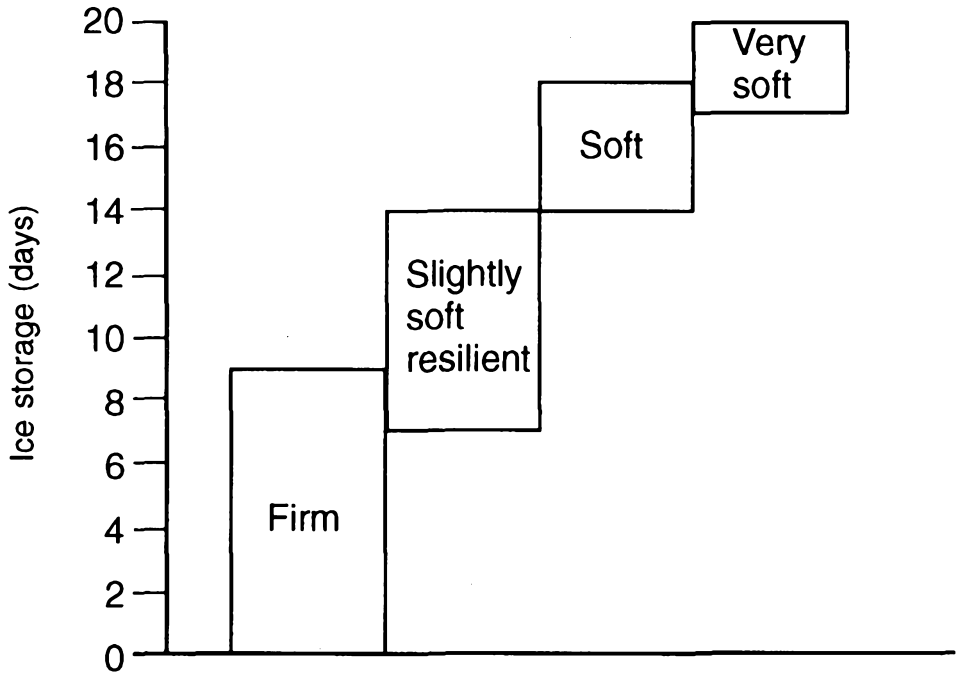


Fig. 3. Changes in texture of ice stored sea bass fillets.

01-02-T8

Evaluation of cooked fish

(a) Food preparation area

(b) Panel booth area

(c) Panel discussion area

(d) Panel members

01-02-T9

NAME : _____ SIMPLE HEDONIC SCALE DATE : _____

TASTE	Sample Code				
Excellent					
Very Good					
Good					
Fair					
BORDERLINE					
Slightly Poor					
Poor					
Very Poor					
Inedible					

TEXTURE	Sample Code				
Mushy					
Very Soft					
Soft-to-Tender					
Moderately tender					
OPTIMUM TEXTURE PREFERRED					
Moderately Firm					
Firm-to-Tough					
Very tough					
Extremely Tough, Rubbery					

Comments on taste : _____

_____

Comments on texture : _____

_____

01-02-T10

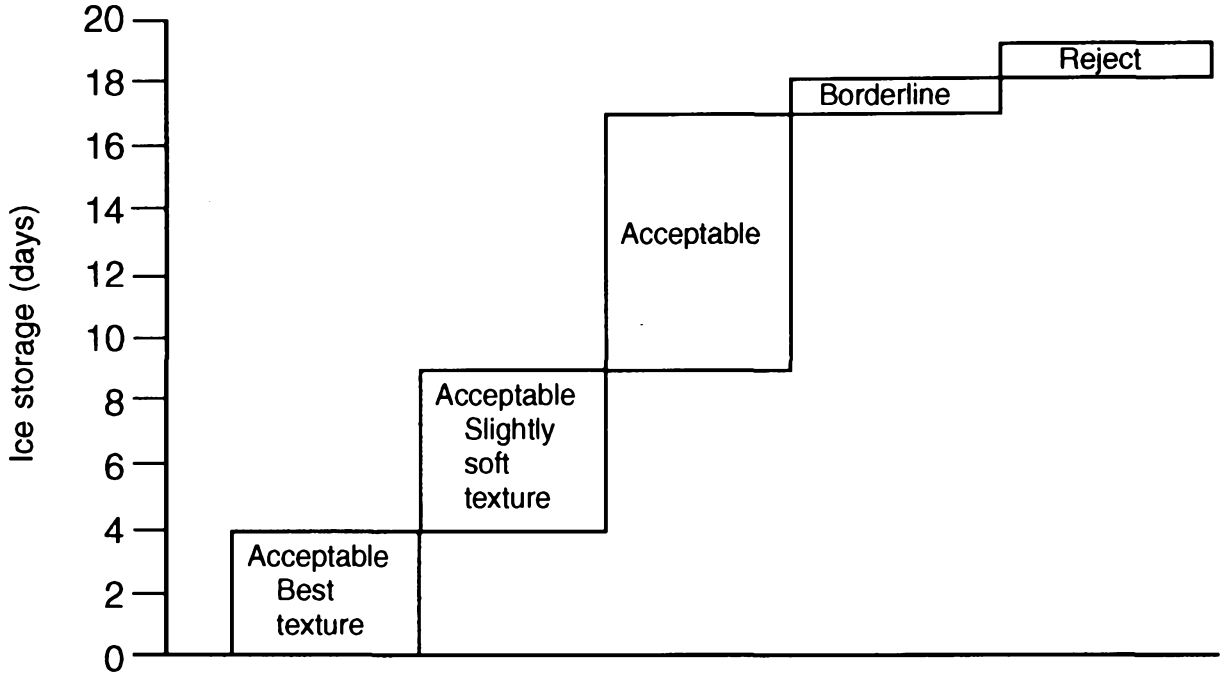


Fig. 4. Sensory evaluation of steamed sea bass fillets.

01-02-T11

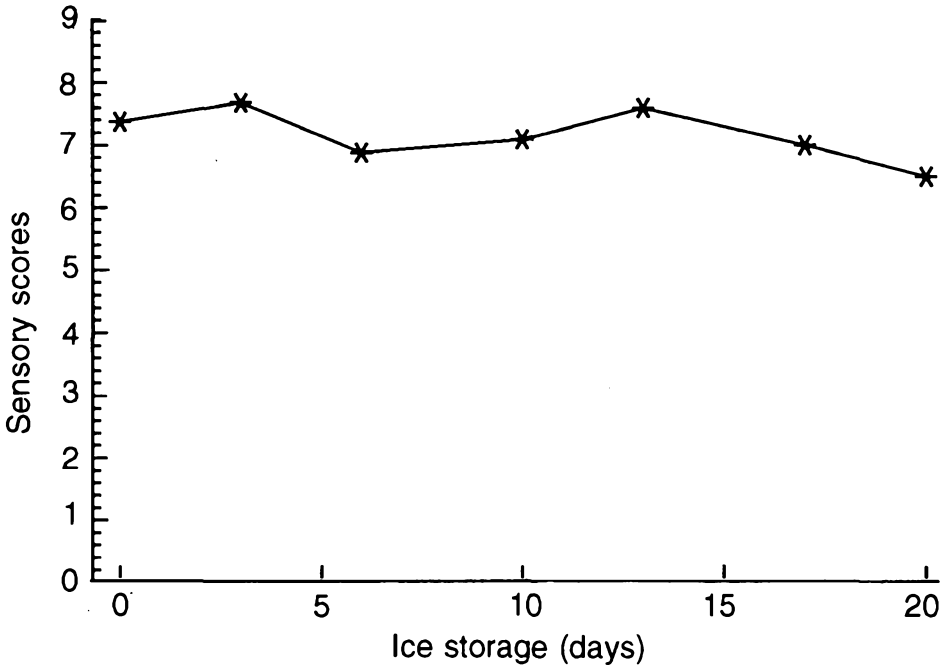


Fig. 5. Sensory evaluation of the taste of steamed mangrove snapper using the Simple Hedonic Scale.

01-02-T12

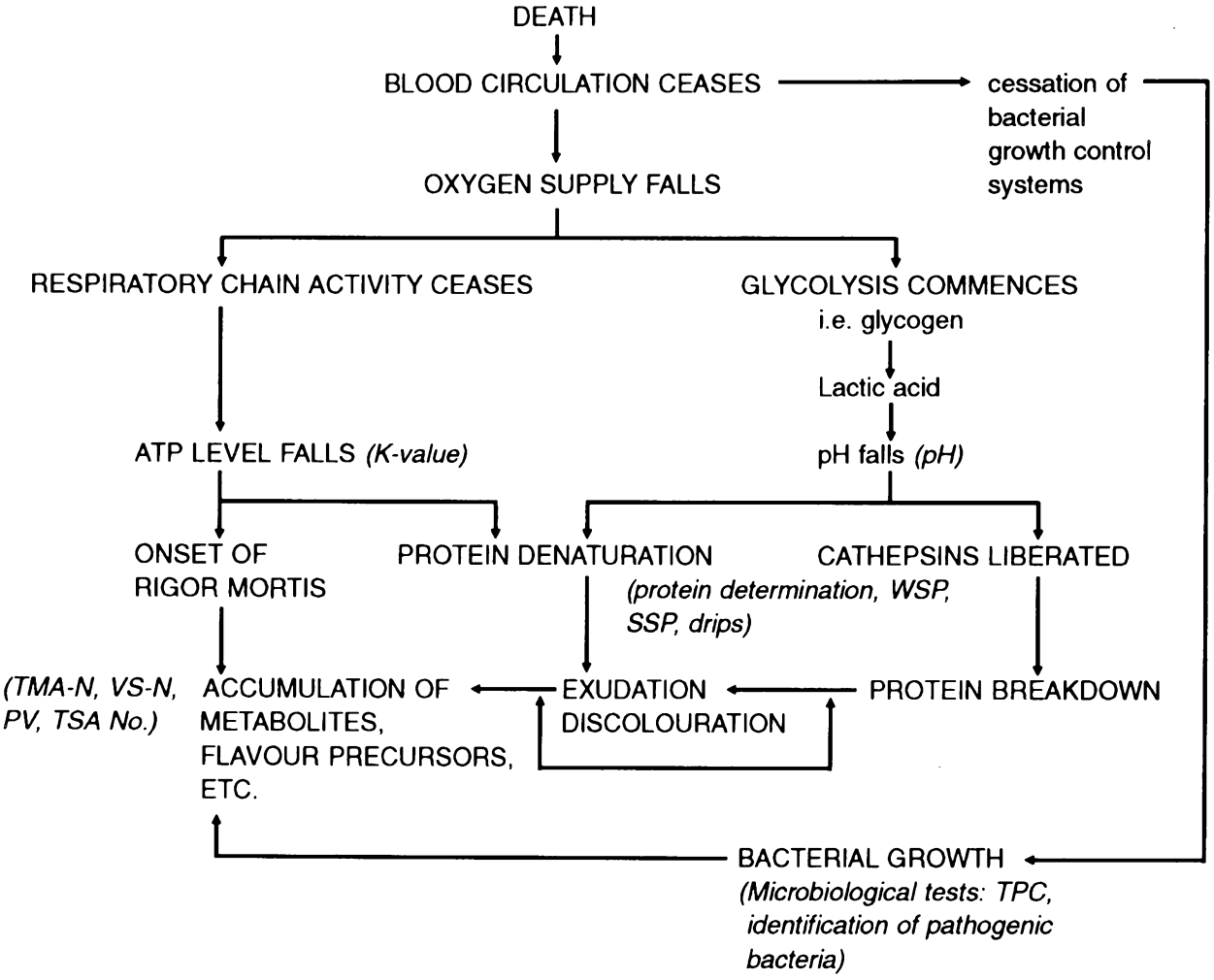
Assessment of freshness of cooked frozen food

Scoring system

Fresh, sweet flavours characteristics of species	10
Some loss of sweetness	9
Slight sweetness and loss of the flavour characteristic of the species	8
Neutral flavour, definite loss of flavour but no "off" flavours	7
Absolutely no flavour, as if chewing cotton wool	6
Trace of "off" flavours, some sourness but no bitterness	5
Some "off" flavours and some bitterness	4
Strong bitter flavours, rubber-like flavours, slight sulphide-like flavours	3
Strong bitterness but not nauseating	1
Strong "off" flavours of sulphides, putrid, tasted with difficulty	0

01-02-T13

Chemical indicators of spoilage



01-02-T14

The K-value Index

$$\text{K-value (\%)} = \frac{[\text{HxR} + \text{Hx}]}{[\text{ATP} + \text{ADP} + \text{AMP} + \text{IMP} + \text{HxR} + \text{Hx}]} \times 100$$

where ATP = adenosine triphosphate
ADP = adenosine diphosphate
AMP = adenosine monophosphate
IMP = inosine monophosphate
HxR = inosine
Hx = hypoxanthine

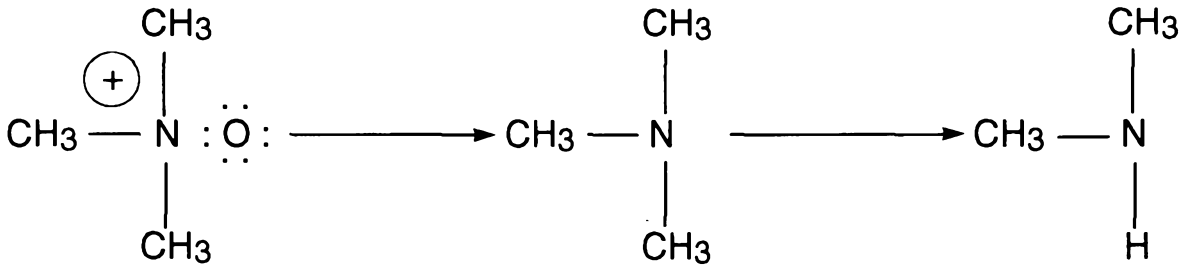
01-02-T15

Shelflife of ice stored fish

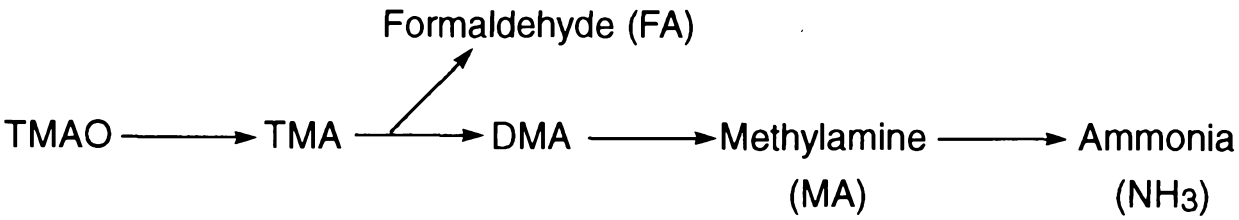
Common name	Scientific name	Acceptable (no. of days in ice)	K-value (%)	TMA-N (mg/g)
1. Sea Bass	*Lates calcarifer*	14	28	ND*
2. Grouper	*Epinephelus bleekeri*	24	37	ND
3. Grouper	*Epinephelus tauvina*	28	28	2.5
4. Chinese pomfret	*Pampus chinensis*	16	24	2.9
5. White pomfret	*Pampus argenteus*	12	39	3.4
6. Mangrove snapper	*Lutjanus argentimaculatus*	20	30	0.5
7. Golden snapper	*Lutjanus johnii*	14	28	0.5

01-02-T16

Amine compounds



Trimethylamine oxide (TMAO) → Trimethylamine (TMA) → Dimethylamine (DMA)

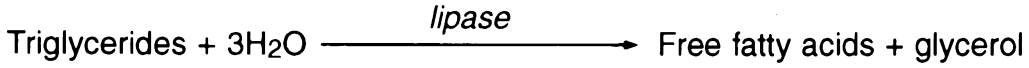


Total volatile basic nitrogen (VSN) = TMA-N + DMA-N + MA-N + NH_3

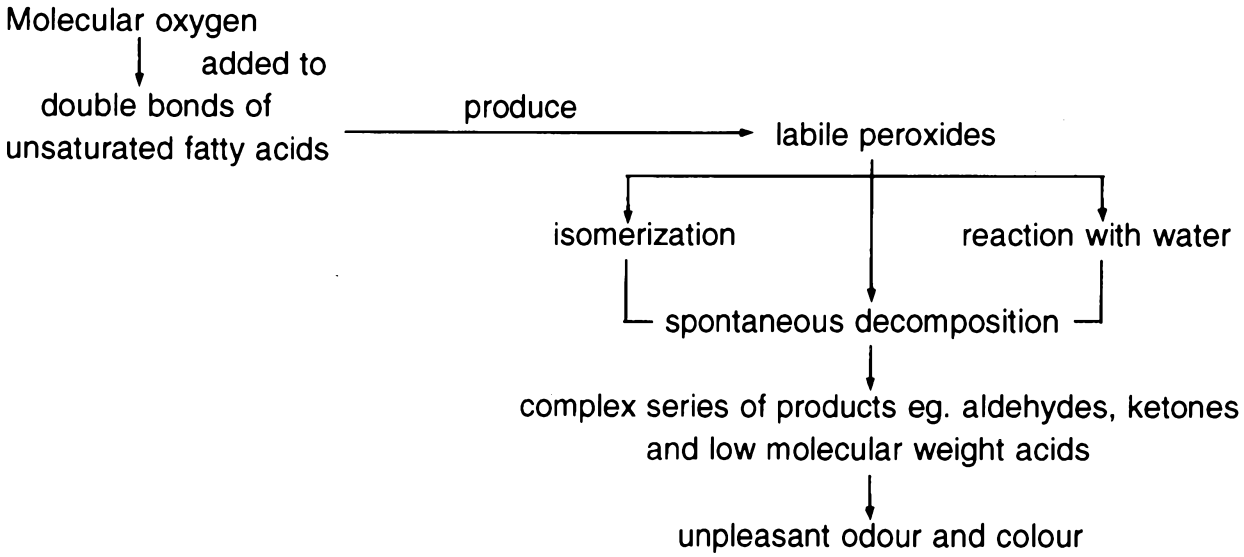
01-02-T17

Lipid deterioration

Hydrolysis of fish lipids:



Oxidation of fish lipids:



01-02-T18

Time-temperature-tolerance

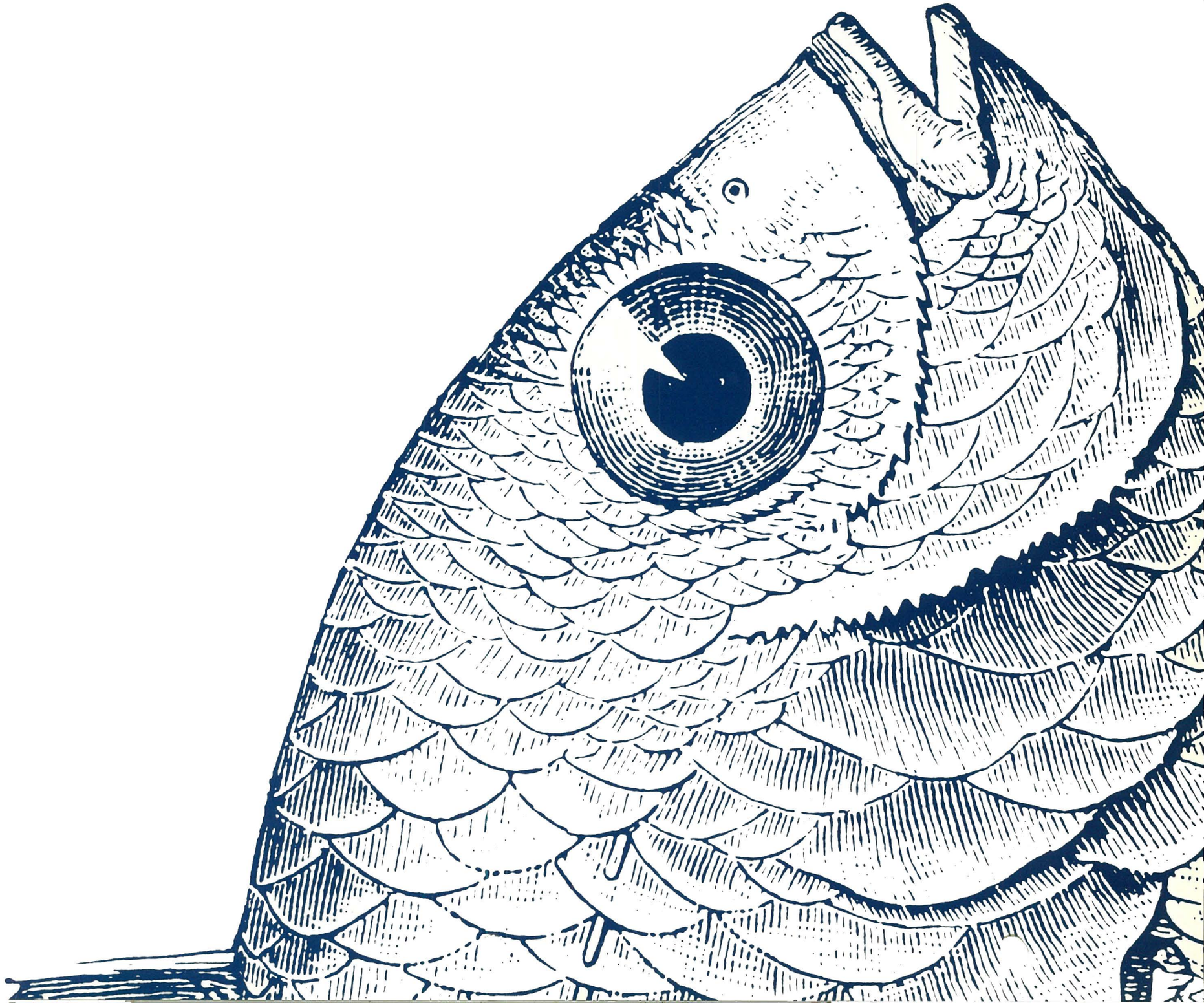
(a) Quality loss is proportional to the integrated accumulated effects of both time and temperature.

(b) The rate of quality loss will increase as storage temperature increases and decrease as the temperature decreases.

(c) All quality losses are cumulative and irreversible.

(d) All temperature effects are cumulative i.e. they have the same result on the product quality, no matter when they occur during the life of the product.

01-02-T19



What is wholesomeness?

A food product is wholesome when it does not cause any detrimental effects on a person's health after it is consumed.

01-03-T1

What is safe food?

— food that does not allow danger or harm to the consumers

What makes a safe food product?

A food product is considered safe when it is:

— non-toxic and non-poisonous
— free of antibiotics
— free of pesticide
— free of pathogenic micro-organisms
— free of foreign chemicals
— free of foreign substances

01-03-T2

Seafood toxicity

Intoxications due to chemical poisons:

1. Chronic mercury poisoning (Minamata disease)
2. Arsenic poisoning
3. Cadmium poisoning

Intoxications due to toxic seafood:

1. Ciguatera poisoning (ciguatoxin, ciguaterin)
2. Puffer fish poisoning (tetrodotoxin)
3. Paralytic shellfish poisoning (gonyautoxin, saxitoxin)
4. Diarrhoetic shellfish poisoning (Dinophysis toxin)
5. Other toxins (eg. wax esters, dinogunellin, venerupin)

01-03-T3

Scombroid poisoning

— histidine in fish is converted to histamine by bacterial enzymes

— causes allergic reactions in man
— its effects can be observed within 2 to 10 hours after ingestion

— found mainly in scombroid fishes (eg. tuna, mackerels, etc.)

01-03-T4

Pathogenic bacteria poisoning

1. Bacterial infections
   - — Salmonellosis (*Salmonella*)
   - — Paratyphoid fever (*Salmonella paratyphi B*)
   - — Typhoid fever (*Salmonella typhi*)
   - — *Vibrio parahaemolyticus* infection
   - — Shigellosis (*Shigella*)

2. Bacterial intoxications
   - — Botulism (*Clostridium botulinum*)
   - — Staphylococcal food poisoning (*Staphylococcus aureus*)
   - — Cholera (*Vibrio cholerae*)
   - — *Clostridium perfringens* food poisoning

01-03-T5

Parasitic infections

— Anisakiasis (*Anisakis* sp.)
— Porrocaecum infections (*Porrocaecum* sp.)

Viral infections

— Infectious hepatitis (Virus A)

01-03-T6

Quality assurance program

Food safety requires:

— a well defined program

— continuous surveillance

— teamwork

— good communications

01-03-T7

Product safety

— attained by a good quality assurance program based on:

  — good procurement specifications
  — careful selection of raw materials
  — approved methods of transport
  — approved methods of storage of raw materials
  — approved methods of processing
  — proper selection and application of packaging system
  — approved methods of sanitation and housekeeping throughout the operation, including personal hygiene

01-03-T8

What is food cleanliness?

A food is considered clean when it is free of dirt and unwanted matter.

Sources of contamination:

— bacteria in gills, gut and on body surface of fish

— bacteria and dirt from the environment

— contamination from personnel

01-03-T9

Steps to minimise cross-contamination:

1. Use clean, potable water for washing fish.
2. Use clean ice for cooling fish.
3. Use clean containers for keeping fish.
4. Keep fish well iced and covered during distribution.
5. Do not put ice or fish on floor.
6. Keep working premises clean.
7. Promote personal hygiene.

01-03-T10

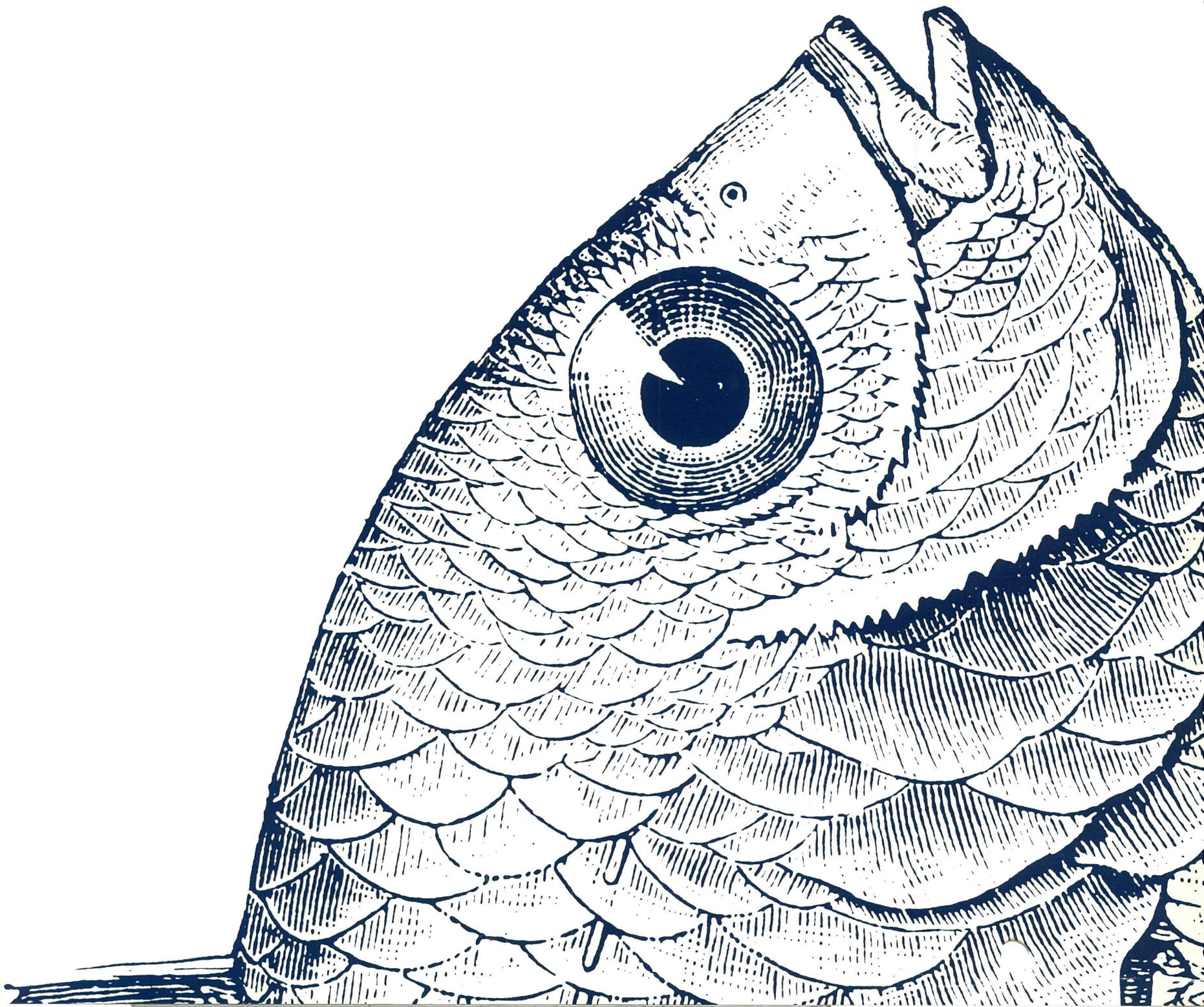
What is fresh food?

A food is considered fresh when it is in a good, natural condition.

Steps to keep fish fresh:

— Wash fish with cool, clean, potable water.
— Keep fish cool in sufficient clean, potable ice.
— Keep iced fish in chiller or refrigerator.

01-03-T11



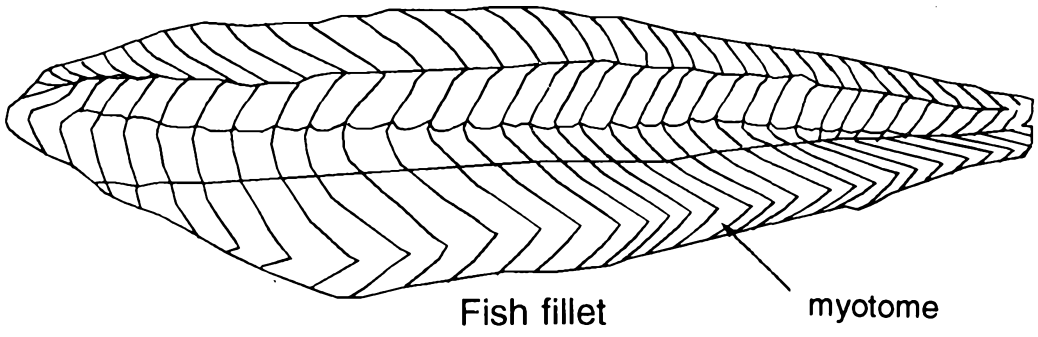
Why food composition?

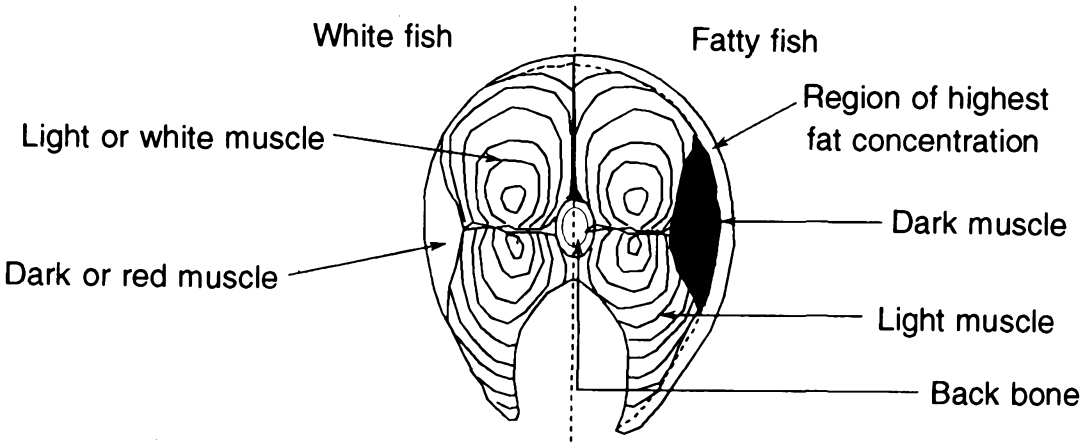
— the food processor, the nutritionist and the consumer require to know the composition of food.

Principal constituents in fish muscles:

protein	16 – 21%
fat	0.2 – 25%
carbohydrate	<0.5%
ash	1.2 – 1.5%
moisture	66 – 81%

01-04-T1


Fish fillet
myotome


White fish
Fatty fish
Light or white muscle
Region of highest fat concentration
Dark muscle
Dark or red muscle
Light muscle
Back bone

01-04-T2

High protein food

— rich in lysine and methionine

Types of fish protein:

— structural protein (myofibrillar)
— sarcoplasmic protein
— connective tissue protein (collagen)

01-04-T3

Essential amino acids in fish:

lysine	1.0%
tryptophan	8.8%
histidine	2.0%
phenylalanine	3.9%
leucine	8.4%
isoleucine	6.0%
threonine	4.6%
methionine-cysteine	4.0%
valine	6.0%

01-04-T4

Vitamins:

1. Water soluble e.g. Vitamins B and C
2 Fat soluble e.g. Vitamins A, D, E and K.

Fish meat	—	good source of vitamin B
Fatty fish	—	good source of vitamins A and D
Fish roe	—	good source of vitamins B and C

Minerals:

— good source of: calcium, phosphorous, iron, iodine, copper

— low in sodium

01-04-T5

Fish as health food

Fish contains:

— a large percentage of polyunsaturated fatty acids

— a great deal of long carbon chain fatty acids namely carbon number 20 and 22, and omega 3

— a greater variety of fatty acids

01-04-T6

Prostaglandin

Prostaglandin is made from unsaturated, carbon 20 fatty acids

Prostaglandin has the following effects:

— regulation of blood pressure
— anti-thrombosis
— anti-asthma
— anti-ulcer
— inducing delivery
— anti-inflammation
— protection against sterility
— anti-arteriosclerosis

01-04-T7

Merits of fish oil to human health:

— decreases blood circulatory diseases

— decreases serum total cholesterol levels

— increases useful high density lipoprotein cholesterol

— decreases harmful low density lipoprotein cholesterol

01-04-T8

Taurine

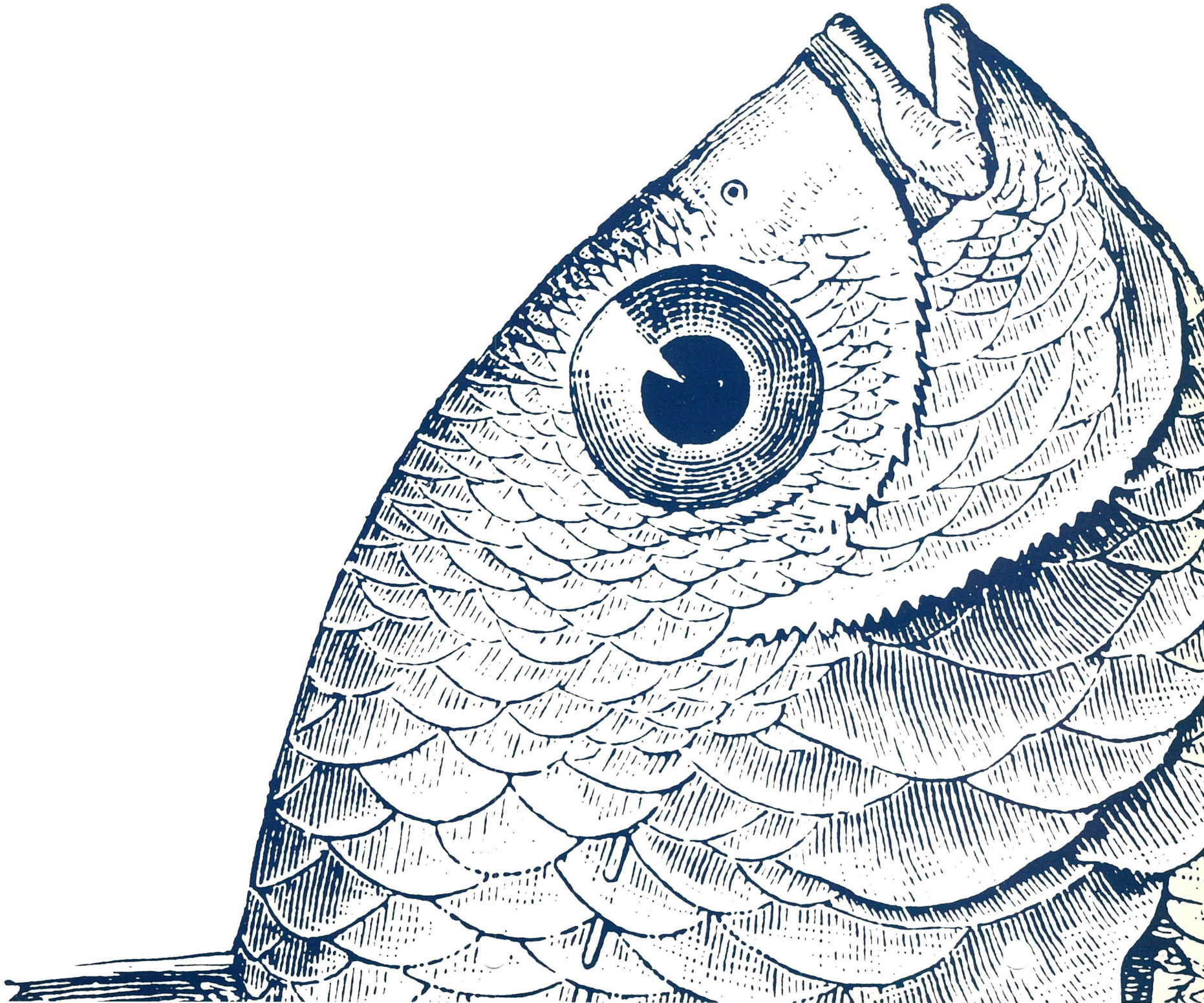
Important for:

— foetal development of brain

— development of visual system

— development of olfactory bulbs

01-04-T9



Why icing?

Because ice:

— has very large cooling capacity for a given weight
— is harmless, cheap and easy to handle
— allows very rapid cooling because of close contact between ice and fish
— keeps fish cold, moist and glossy
— prevents dehydration
— maintains fish at slightly above freezing point
— lowers temperature of fish and retards bacterial growth

02-01-T1

Temperature of ice

The efficiency of cooling depends on:

(a) the temperature of ice

(b) the shape of ice

At normal pressure, the

- maximum temperature of ice = 0°C
- minimum temperature of ice = –273°C

02-01-T2

Concept of icing

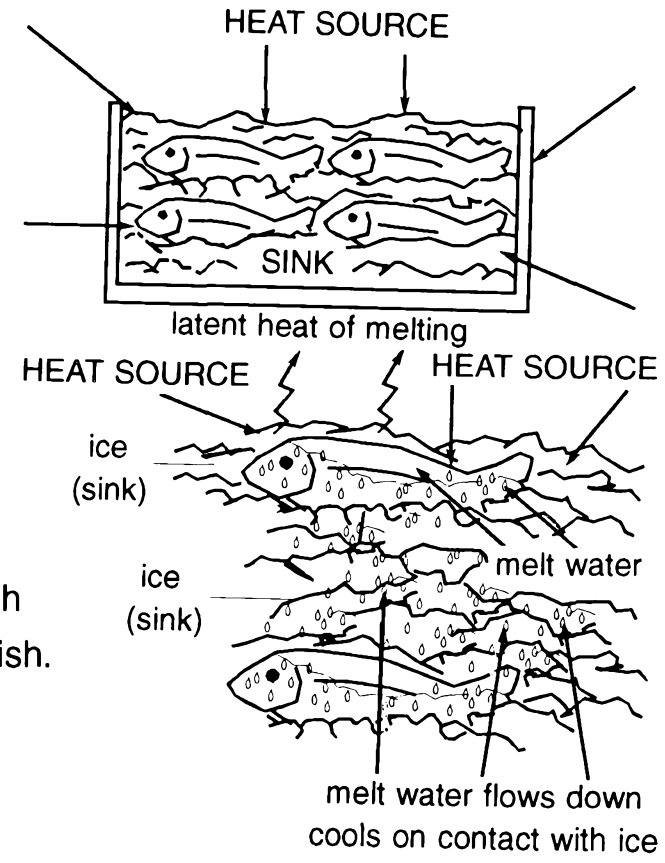
1. Heat from source flows to low temperature sink

2. Heat absorbed by sink. Latent heat of melting released. Ice melts to water.

3. Melt water splashes on fish. Melt water warms up as fish cools.

4. Warmed melt water cools in contact with ice.

5. Cooled melt water contacts fish deeper in box, and cools the fish.



02-01-T3

Types of ice

1. Flake ice

2. Tube ice

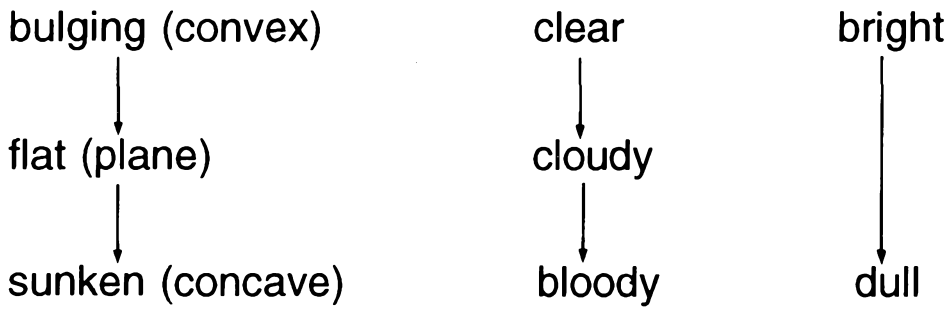
3. Crushed ice

4. Block ice

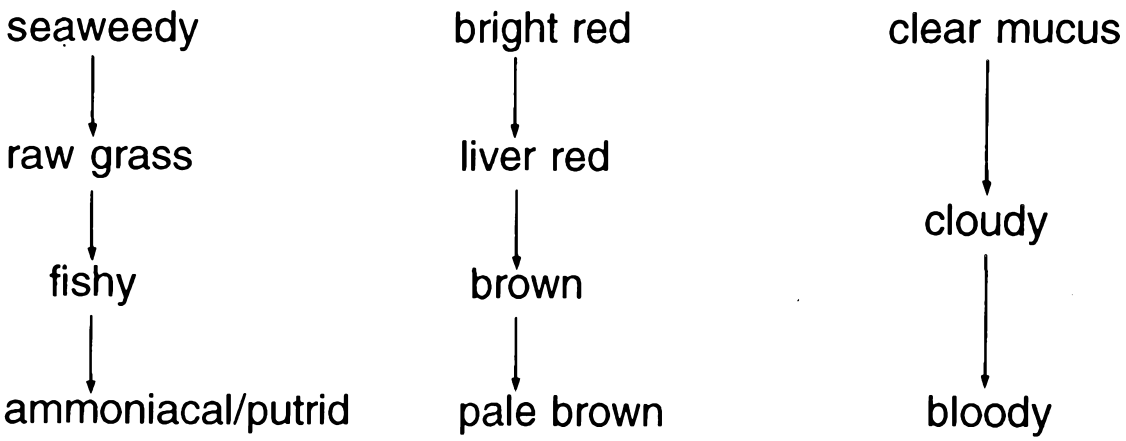
02-01-T4

Fish spoilage patterns during ice storage

1. EYE:



2. GILLS:



02-01-T5

Fish spoilage pattern during ice storage

3. MUSCLE AND CONNECTIVE TISSUE

4. BODY SURFACE

5. BELLY BURN

6. BLOOD STAIN

7. DRIP LOSS

02-01-T6

Fish spoilage pattern during ice storage

8. ODOUR AND RANCIDITY

Rancidity:

— caused by non-enzymatic reaction

— occurs when oxygen in air combines with fish lipids

— development of linseed oil-like, painty odour

9. TASTE AND FLAVOUR

sweet, meaty taste

↓

flat, insipid taste

↓

bitter taste

02-01-T7

How to handle chilled fish:

1. Wash fish with clean, potable water.
2. Cool and pack freshly caught fish in ice.
3. Keep fish moist at all times.
4. Use clean container to store fish.
5. Use clean ice made from potable water.
6. Do not allow ice to contact floor.
7. Do not puncture or bruise fish.
8. Keep iced fish in shaded areas. Do not expose to direct sunlight.
9. Keep fish in ice even when storing in chiller.

02-01-T8

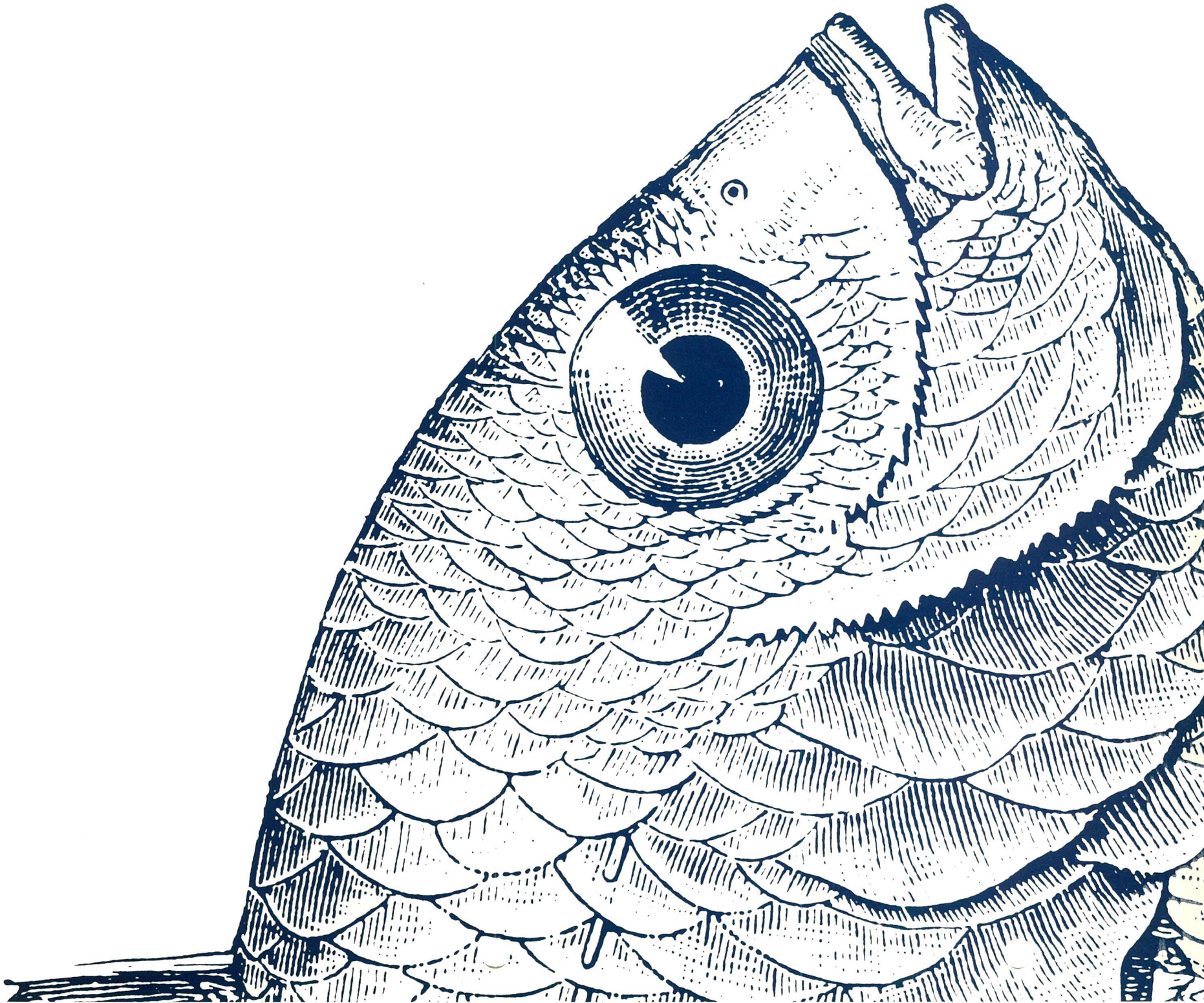
Practical considerations:

1. Always maintain chilled fish in ice at 0°C. Even at 1°C - 2°C rise can have serious consequences.

2. At retail markets, place fish on ice slabs to ensure a temperature close to 0°C.

3. At supermarkets, the styrofoam trays prevent quick cooling of fish. It is best to display fish in a single layer in the chill display cabinet.

02-01-T9



Why freeze fish?

PURPOSE:

1. To LOWER the TEMPERATURE of the fish.

   REASON:
   To SLOW DOWN spoilage due to enzymatic and bacterial action.

2. To EXTEND shelflife of the fish.
   Frozen fish can be kept much longer than iced fish.

02-02-T1

Stages in the freezing process:

1. RENEWAL OF HEAT:
   Temperature of fish falls rapidly to just below 0°C, the freezing point (*cryostatic temperature*) of water.

2. CONVERSION OF WATER TO ICE:
   Temperature remains almost unchanged until most of the water turns to ice (0° to –5°C). This is the stage of *crystallisation of water.*

3. FURTHER COOLING OF FROZEN FISH:
   Temperature of fish falls rapidly to the ultimate temperature for storage (–30°C).

02-02-T2

Freezing temperature and percentage of ice formation:

Product temperature	Percentage of water converted to ice
–5°C	75%
–10°C	82%
–20°C	85%
–30°C	87%
–65°C	88%

02-02-T3

What is slow freezing?

— occurs when freezing extends beyond 12 hours difference, or greater than 24 hours

— results in inferior products because of protein denaturation

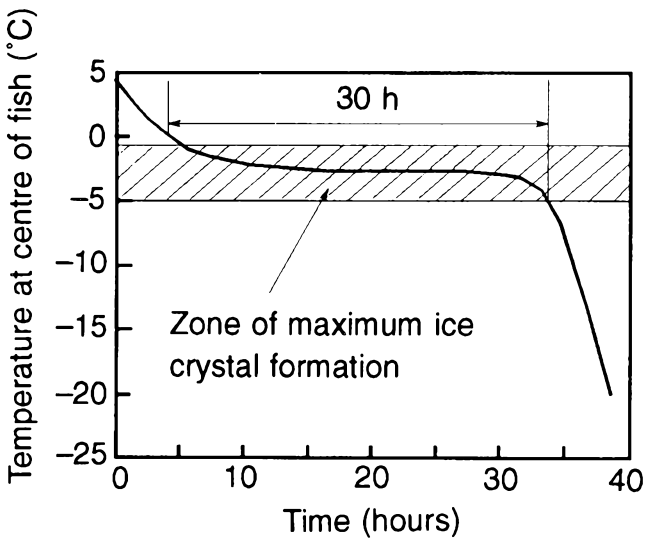


Fig. 6. Temperature change during slow freezing

— protein denaturation is greatest at zone of maximum enzyme activity (–1° to –2°C)

— temperature range of –1° to –5°C is the zone of maximum ice crystal formation because of protein denaturation

02-02-T4

What is quick freezing?

— occurs when the product goes through 0° to –5°C in less than 2 hours

— the warmest part of fish should be –20°C at the completion of freezing

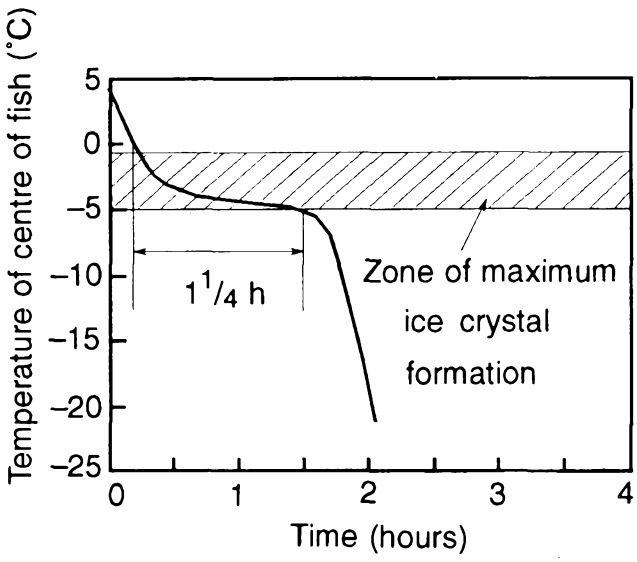


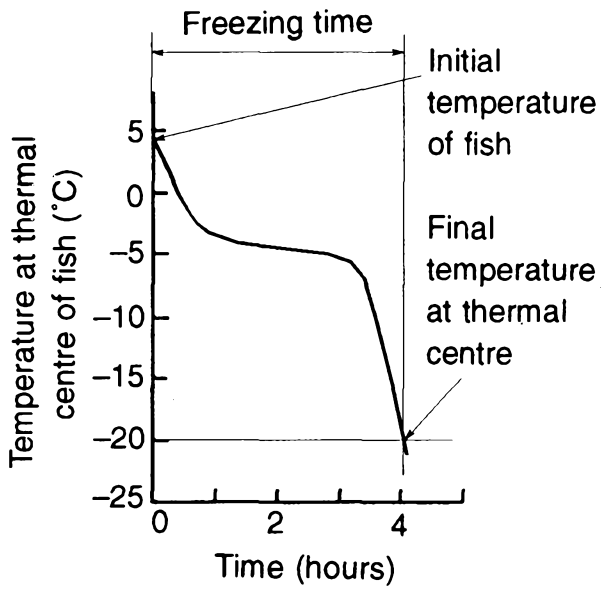
Fig. 7. Temperature change during quick freezing.

02-02-T5

What is freezing time?

— It is the time taken to lower the temperature of the product from its initial temperature to a given temperature at its thermal centre.

— The final temperature at the thermal centre must allow the average fish temperature to be at the same value as the storage temperature.



02-02-T6

Variables affecting freezing time:

- freezer type
- freezer operating temperature
- refrigeration system and operating conditions
- air speed in an air blast freezer
- product temperature
- product shape
- product contact area and density
- product packaging
- species of fish

02-02-T7

Characteristics of poorly frozen fish:

— dull, spongy flesh

— soft fleah, non-resilient, sags and breaks easily

— substantial drip loss because of poor water holding capacity

— fibrous and dry cooked flesh

— presence of rancid and cold-store odours

— dry and dehydrated body surface

02-02-T8

Quality assessment of frozen fish:

1. DEHYDRATION
2. FREEZER BURN
3. DENATURATION
4. LIPID CHANGES
   - — Rusting
   - — Rancidity
5. COLD STORE FLAVOUR
6. WEIGHT LOSS

02-03-T9

Freezer weight loss

Freezer weight loss by dehydration depends on:

— type of freezer

— freezing time

— type of product

— shape and size of product

— air velocity

— freezer operating conditions

02-02-T10

Cold store weight loss

It varies with:

— temperature

— temperature fluctuation

— humidity

— heat transfer

— air flow over product

— radiation effects of lighting

— the product

— shape and size of the product

— type of wrapper

02-02-T11

Time-temperature-tolerance Concept

1. A relationship exists between STORAGE TEMPERATURE and the TIME (at that temperature) for the frozen product to under go a certain amount of quality change.

2. Changes during storage and distribution at different temperatures are CUMULATIVE and IRREVERSIBLE over the entire storage period.

02-02-T12

GLAZING

It is the application of a layer of ice to the surface of a frozen product by spraying, brushing on water or by dipping.

The amount of glaze depends on:

- glazing time
- fish temperature
- water temperature
- product size
- product shape

02-02-T13

Problems in glazing:

1. FRACTURED GLAZE:
   The glaze will fracture and break easily if the products are of very low temperature (at or below –70°C).

   Fractured glaze is easily dislodged on handling.

2. THICK, SOFT GLAZE
   It occurs when the fish is immersed in glaze water for too long.

02-02-T14

Packaging

— important for preservation and aesthetic value

— wrapping material must have high resistance to water vapour and oxygen

— air-tight wrapping

— use of proper size and shape boxes or trays for different shaped products

02-02-T15

Cold storage

Dehydration of fish in the cold store depends on the drying effect of air in the cold store.

The drying effect of air is affected by:

— temperature of air

— relative humidity

02-02-T16

Ways in which heat enters cold store:

— added by product

— from other products

— heat leak through the insulation, lights and air ingress

— heat leak through a person working in the store

02-02-T17

Good cold storage conditions

Only possible when:

— heat leak is kept to a minimum

— any heat entering is quickly transferred to the refrigeration system

02-02-T18

Factors in designing and operating cold store

— low temperature
— uniform temperature
— steady temperature
— good air circulation
— minimum air circulation rate
— minimum heat ingress
— type of cooler
— cooling arrangement
— method of operating cooling system

02-02-T19

Factors affecting cold store conditions

— size and shape of store

— vapour barriers

— foundation and frost heave

— air ingress

02-02-T20

Product handling and storage

UNLOADING AREA:

— use adjustable platforms

— have a roof to prevent exposure to direct sunlight and rain

— in hot countries air-conditioned (10°C) working areas and unloading docks should be provided

02-02-T21

Handling on arrival of frozen products

Before arrival of delivery trucks, make sure:

— receiving area is clear

— cold storage are tidy and ready

— temperatures of cold stores are checked

— necessary gear (e.g. jacks) are at hand

— stock outside freezer are stacked closely together to minimise contact with warm air

— that personnel are alert

02-02-T22

Storage of frozen products:

— use pallets
— check product temperature on arrival
— check "use by" date and mark date received
— stack new merchandise behind others with labels facing the door
— never overfill cold store
— allow 8 cm clearance space off floor, between stock and wall, and 46 cm space between stock and ceiling
— leave airways between rows of cartons
— stack warmer products near cold air vent
— keep cold store door shut as much as possible

02-02-T23

Display cabinets

Minimum check schedule includes:

— twice a day temperature monitoring

— take into account defrosting cycles

— maintenance of good records

— for "jumbo freezers" check defrost cycles 3 times a day

02-02-T24

Display cabinets

Daily check

— for proper operating of fans
— that internal airflows are not blocked
— that loadlines are not exceeded
— for the presence of ice build up
— that spilled products and rubbish are cleaned and cleared
— for air leak around doors of vertical freezers
— for any abnormal heat and draughts

02-02-T25

Display cabinets

Weekly cleaning schedule include:.

— minimum check schedule
— clean cabinets and display area daily
— clean the outside of the cabinet with a mild detergent and polish
— clean glass doors with good window cleaners
— make sure the freezer is switched on again after cleaning

02-02-T26

Temperature fluctuation

— most damaging factor on final product quality
— maintenance of stable storage temperature will extend shelflife
— maintenace of low temperature at counter is essential
— frozen fish should not be exposed to temperatures above –18°C
— exposure to temperature fluctuation leads to protein denaturation

02-02-T27

Stock control

— do not use display cabinet as stocker
— do not keep products in cabinet for too long
— keep frozen products in frozen cold store (–30°C)
— transfer small amount of stock to display cabinets (–18°C) regularly
— do not overfill above load line
— do not underfill cabinet (use false bottom)

02-02-T28

Restocking

— should be fast
— proper stock rotation
— average turn over time = 5 days
— ensure good air circulation
— stock check before restocking
— restock list same order as stocks in cold store
— do at quiet time
— must not be more than 20 minutes
— dispose spoiled food, etc. Use trolley
— avoid "hot" stack

02-02-T29

Thawing frozen fish

1. HEAT REQUIRED

   To completely thaw 1 kg of white meat fish at –30°C, 300kJ of heat is required.

2. DRIP AND WEIGHT LOSS

   Drip loss on thawing may account to about 5% for properly frozen and cold stored white meat fish.

02-02-T30

Thawing frozen fish

3. HANDLING DURING THAWING

Frozen fish are brittle and easily damaged,

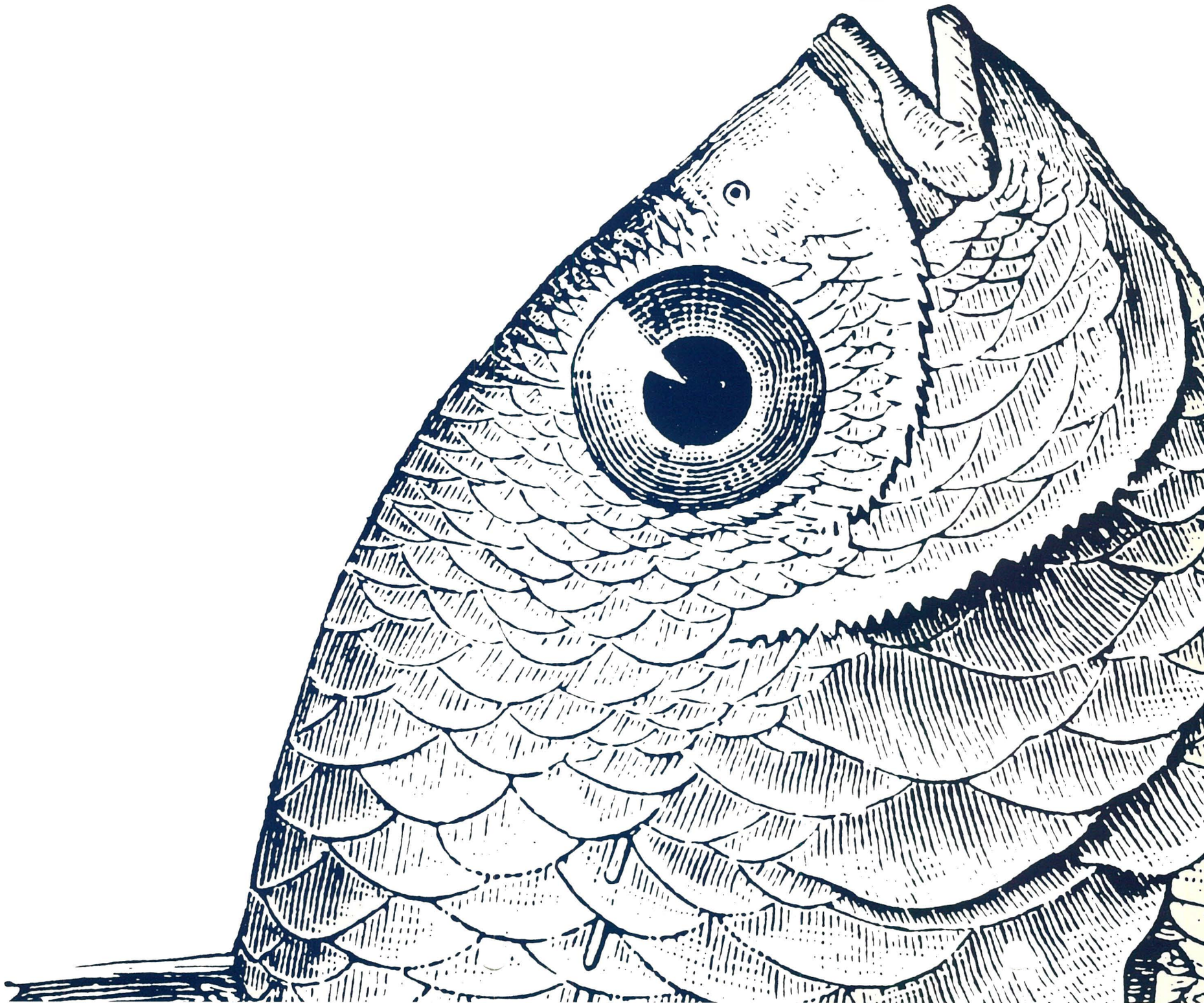
- do not pry fish apart
- do not poke fish with sharp objects
- do not put frozen fish blocks on floor
- do not subject the products to repeated freezing and thawing
- use clean containers for thawing
- partially thaw large blocks to remove the required portion for thawing, and refreeze the remainder
- thaw in batches
- overnight thawing must be close to 0°C

02-02-T31

Thawing methods

1. Thawing in air
2. Thawing in water
3. Simple immersion thawing
4. Air blast thawing
5. Contact plate thawing
6. Electrical resistance thawing
7. Dielectric thawing
8. Microwave thawing

02-02-T32



What is cleanliness?

Cleanliness refers to the absence of dirt or unwanted matter.

What is cleaning?

Cleaning is the removal of unwanted soil from equipment and other areas of food preparation/processing premises.

What is soil?

Soil is "matter-out-of-place". There are 2 kinds: water-soluble and water insoluble.

02-03-T1

Fundamentals of cleaning

1. To bring a cleaning agent into close contact with the soil.

2. To displace the soil from the surface to be cleaned.

3. To disperse the soil in the solvent.

4. To prevent redepositing of the dispersed soil back onto clean surface.

02-03-T2

Properties of detergents

— capacity to wet surfaces
— ability to penetrate deposits of dirt
— power to emulsify
— capacity to hold material in suspension
— quick and complete solubility
— dissolving action on food solids
— germicidal action
— easily rinsed away
— complete water softening power
— reduce water tendency to corrode on metal surfaces
— non-toxic
— economy in use

02-03-T3

Purposes of detergents

— deflocculation or dispersion
— dissolving
— emulsification
— penetration
— saponification
— suspension
— rinsability
— water softening

02-03-T4

Factors affecting cleaning efficiency

1. The cleaner
2. Temperature
3. Velocity of force
4. Time

02-03-T5

Cleaning methods

1. Removal of cross food particles

2. Application of cleaning compounds

   — Soaking
   — Clean-in-place systems
   — Spray methods
   — Abrasive cleaning

3. Rinsing

02-03-T6

What is sanitation?

It is the reduction of vegetative cells on items such as food processing equipment to levels judged safe by public health authorities.

02-03-T7

Properties of sanitising agents

— effective germicide
— readily soluble in water
— low toxicity
— stable in concentrated form
— not significantly corrode metal or plastic
— effective at low concentrations
— unaffected by water conditions
— safe to handle
— deodourise
— compatible with cleaning compounds
— of low persistence

Purpose of sanitising agents

To keep the populations of both pathogenic and non-pathogenic bacteria under control.

02-03-T8

Necessary conditions for sanitation

1. Time of exposure
2. Temperature
3. Concentration
4. pH

02-03-T9

What is hygiene?

— the study and practice of how to keep good health, especially by paying attention to cleanliness

— normally means freedom from the risk of infectious diseases

— in food processing, it often indicates good quality and absence of any food poisoning hazards

02-03-T10

Role of management

- pre-employment physical examination
- clear understanding with employee that they will not lose their employment if they report an illness or a communicable disease
- posted protocol for employees indicating good personal hygiene and health practices
- emphasis on the maintenance of high level of cleanliness and good health
- regular surveillance of all food handlers by management for signs of illness, infection and unsanitary states
- properly positioned set of facilities such as:
  - properly cleaned and fitted dressing room
  - laundry services
  - hand washing facilities

02-03-T11

Role of the food handler

— keep in good state of health by proper rest, nutrition, exercise and physical cleanliness

— be health conscious and conscientious in protecting his health

— report any illness to supervisor before commencing working with food

02-03-T12

Steps to good personal hygiene

— daily bathing
— use of appropriate deodorants
— washing hair at least weekly
— keeping nails clean and trimmed
— wearing clean uniforms and clean underclothing
— using a hair net or cap and paper masks over nose and mouth
— preparing for work in a systematic way

02-03-T13

Good work habits and personal hygiene

— wash hands frequently with soap
— dry hands on disposal towels or with a hot air dryer
— refrain from touching hair, nose and mouth while handling food
— cover all cuts and grazes with waterproof dressing
— cough and sneeze into handkerchief or disposal tissue

02-03-T14

When to wash hands?

After:

— coughing and sneezing
— visiting the toilet
— smoking
— handling soiled articles, boxes, etc.
— handling raw meat, poultry, egg shells, fish and shellfish
— handling garbage or soiled materials
— handling money

02-03-T15

Protocol for food handlers

Food handlers should:

— refrain from touching food surfaces of equipment, utensils, crockery and glassware
— observe the "NO SMOKING" rules in food preparation service areas
— use disposal gloves when handling food
— look out for conditions that may cause contamination of food

02-03-T16

Environmental cleanliness

INFRASTRUCTURE AND SANITATION AT RETAIL PREMISES

The following should be available:

— hot water
— cold water
— washing facilities
— toilet
— changing room
— air curtain

02-03-T17

Environmental cleanliness

KEEPING WORK PREMISES CLEAN

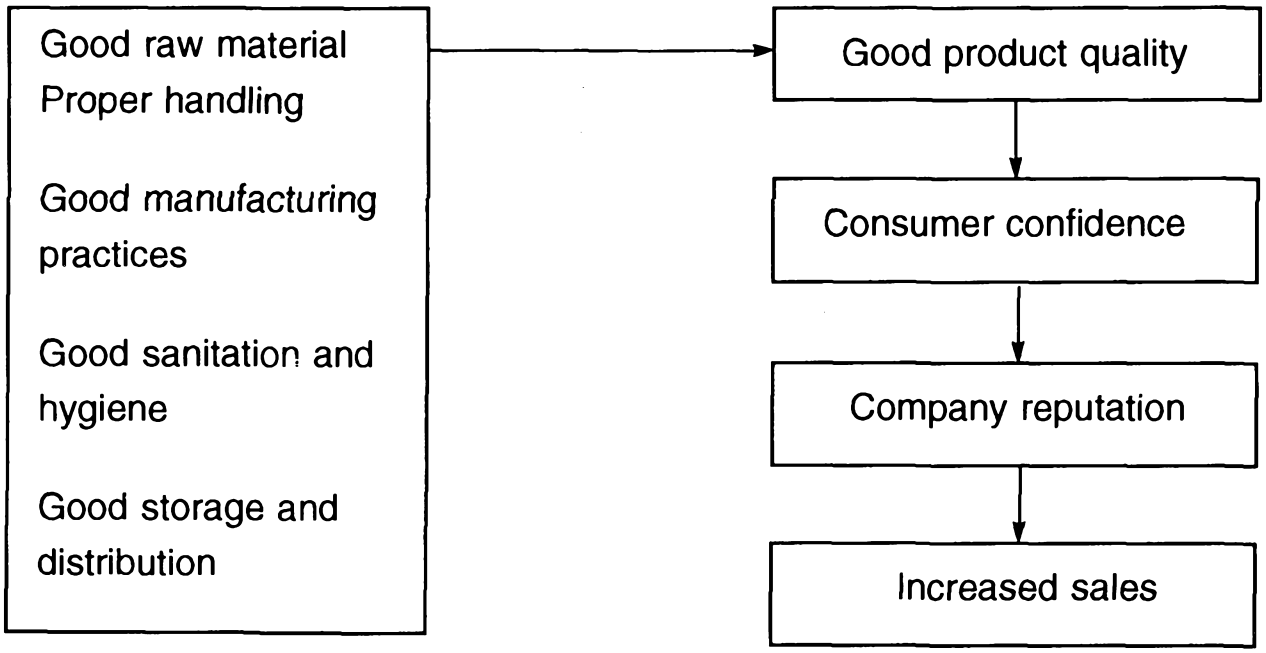
1. Indoors
2. Outdoors
3. Offal bins

CONTROL OF PESTS

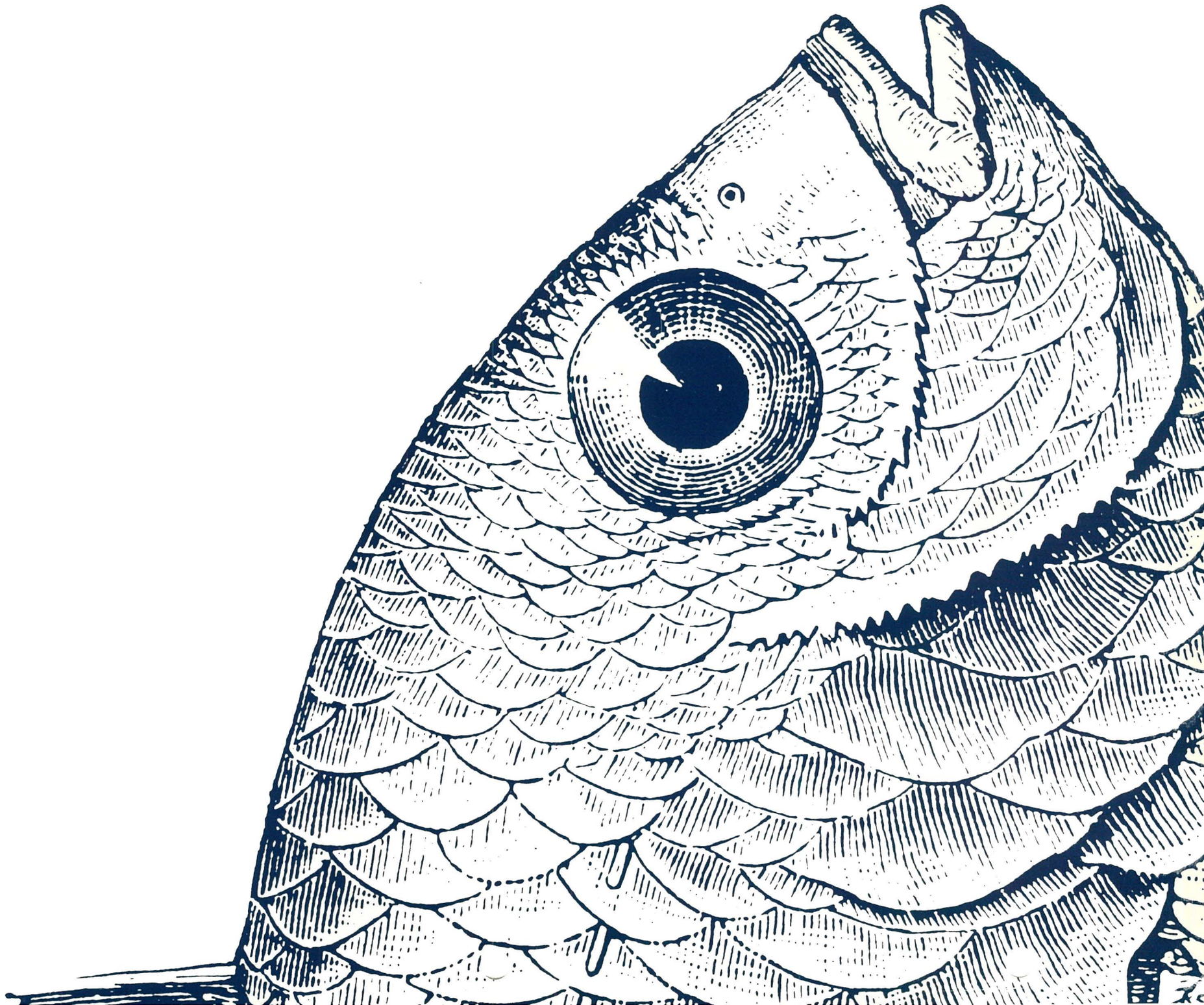
Employ a professional exterminator.

02-03-T18

Relationship between sanitation, product quality and sales



02-03-T19



Responsibilities of the seafood retailer

— supply good quality seafood

— impart information on method of preparation, quality preservation and handling practices to consumers

— key to good image of the seafood industry

02-04-T1

How much quality control?

— cost of quality control must be less than benefits

Benefits of implementing quality control:

— establishing store's reputation

— reduction of direct and indirect monetary loss

— maximising profit potential through proper management

02-04-T2

Use of chiller room and cold store

DO:

— use properly designed shelfing

— keep chiller rooms and cold stores clean

— place products requiring low temperature storage nearer the cold air outlet

— put iced fish and raw materials in proper containers

02-04-T3

Use of chiller room and cold store

DON'T:

— put products directly on floor

— put products in direct contact with the wall

— stock products indiscriminately

— open the door unnecessarily

— leave stains and spills uncleaned

02-04-T4

Use of chilled display cabinet

— do not place warm products directly into the cabinet
— precool products in ice before putting into cabinet
— do not overload
— do not leave products on shelves until they have exhausted their shelflife
— stock should be kept in chiller rooms and small amounts put in display cabinet
— maintain good temperature control
— keep it clean, neat and attractive

02-04-T5

Use of frozen display cabinet

— do not place food above loadlines
— place only products which are frozen
— do not use as freezer
— do not as cold store
— maintain low temperature and monitor regularly
— take suitable precautions when stocking
— products should not be removed from and then returned to cabinet
— defrost display cabinet at least once a week

02-04-T6

Understanding your product

FULL SERVICE COUNTER:

— maintain low temperature

— ice supplement is necessary

— ice generously to increase aesthetic appeal

SELF-SERVICE COUNTER:

— quality of fish must be fresh

— proper removal and disposal of expired seafood

— products near end of shelflife should be downgraded

02-04-T7

Understanding your customer

It is important for seafood retailers to understand and meet customers' needs and build a good rapport with them.

Personalized sales draw customer and helps promote customers' faithfulness.

02-04-T8

Principles of fish preparation and display

1. Arrange fish neatly and attractively.

2 Train workers to cut and trim neatly.

3. Maintain good quality by considering:
   — the time factor
   — the temperature
   — cross-contamination
   — damage and deterioration.

02-04-T9

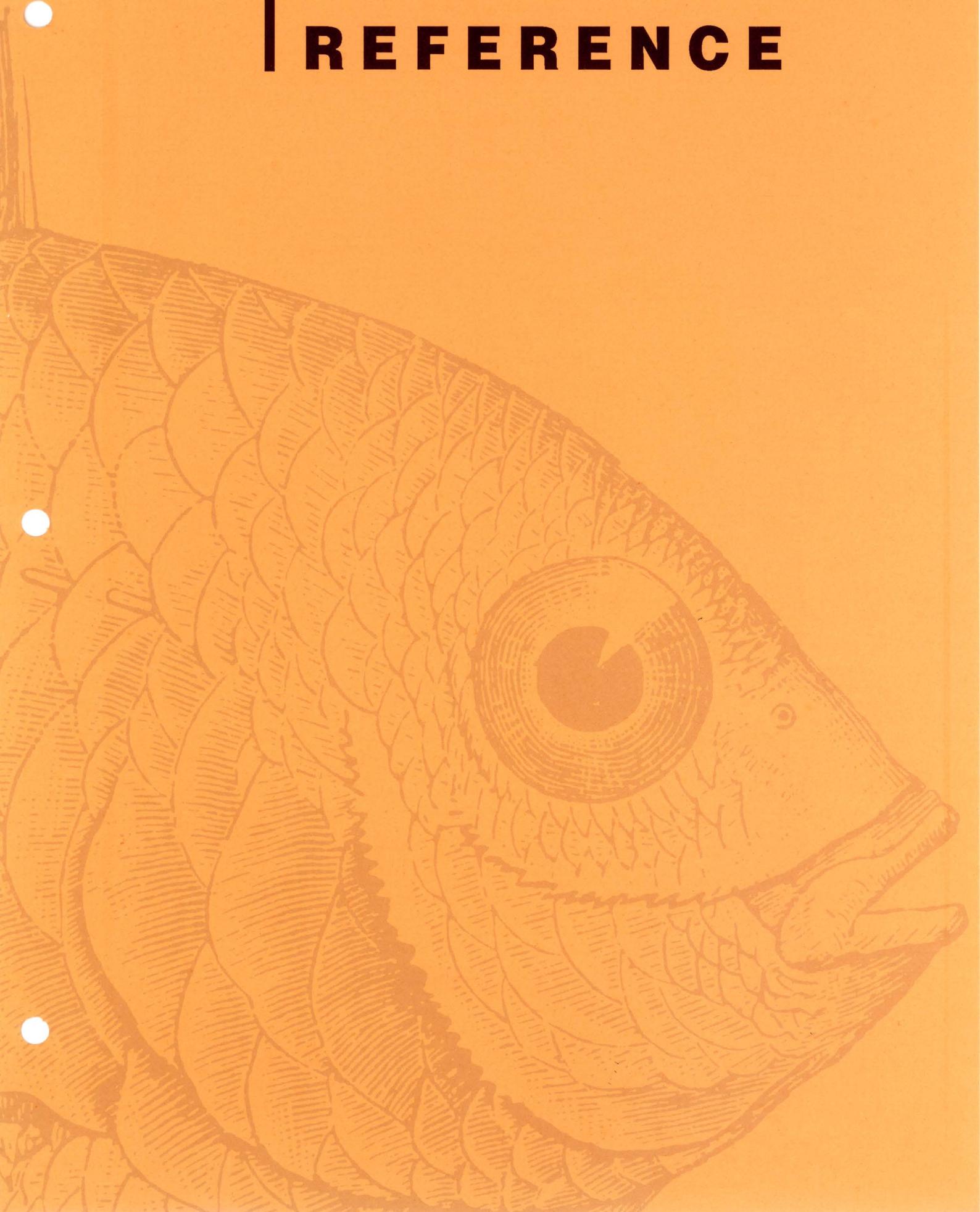
Quality grading

The retailer should be competent in maintaining good quality at:

1. Fish delivery
2. Fish storage and stock control
3. Fish preparation and display

02-04-T10

REFERENCE



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