Technology For Fish Cracker *(Keropok)* Production

YU SWEE YEAN

Faculty of Food Science & Biotechnology
University of Agriculture
Selangor, Malaysia

Abstract

The paper describes two levels of technology that can be used for *keropok* production.

Keropok are popular snack foods in Malaysia and the ASEAN countries, and are produced by gelatinization of starch with water, to form a dough which is shaped, cooked and then sliced. The slices are dried and expanded into a low-density porous product upon immersion in hot oil. However, production methods used are heavily dependent on manual labour, resulting in inferior quality products which have uneven expansion, dark objectionable colours and varying shapes, sizes and thicknesses. A mechanized method (modified method) has been developed to upgrade *keropok* technology. Products from this method were superior in terms of appearance, shape and linear expansion and were more acceptable to taste panellists.

Keropok was also successfully prepared by extrusion. The degree of expansion was measured as a function of extruder temperature and for products extruded at 100°C and above panelists found no significant difference between extruded samples and those prepared using the modified method.

Introduction

Crackers (in Malaysia known as *keropok*) are popular snack foods in Malaysia and the ASEAN countries. In the West, they would be classified as 'half-products' or 'intermediate' (Lachmann, 1969) and expanded snack products (Cumminford & Beck, 1972). Basically, they are produced by gelatinization of starch with water to form a dough which is shaped, cooked and then sliced. The slices are then dried and expanded into a low density porous product upon immersion in hot oil. Fish, prawns or other food ingredients are usually added.

Keropok production in Peninsular Malaysia is usually confined to the coastal fishing areas along the east coast states (Siaw & Yu, 1978). In the states of Trengganu and Kelantan, *keropok* production is a seasonal activity and is usually processed during the months of April to October. September and October are the peak production periods. A considerable proportion of the population is involved in *keropok* production in these two states (Maarof, 1976). Basically, production still follows traditional methods and remains a cottage industry.

The fish is deboned manually and mixed with flour. Generally, sago flour *(Metroxylon sagu)* and/or tapioca flour *(Manihot utilissima)* is used. Salt, monosodium glutamate, water and sometimes sugar are added. This mixture is then kneaded manually or pounded using long wooden poles in a wooden mortar, 30-50 cm in diameter and 20-25 cm in depth, placed on the ground.

After the appropriate consistency has been obtained, the dough is shaped manually by rolling into cylindrical rods, 25-30 cm long and 4-6 cm in diameter. To facilitate the rolling process, more flour is added to the dough during this procedure. The rolls are then boiled for about 1.5 hr until cooked. The cooked roll is then allowed to cool at room temperature. On the east coast of Peninsular Malaysia, the dough at this stage can be either fried or sliced. The fried product is known as *keropok lekur* and the sliced *keropok* is *keropok hiris*. The sliced variety is more popular.

Slicing is carried out manually using a knife and each slice has a thickness of 3-5 mm. The sliced pieces of dough are then dried in the sun. The drying period varies and can be as long as 2-3 days, depending on prevailing weather conditions.

It is hardly surprising then that *keropok* produced this way are of poor quality. Product compositions vary among processors and are largely dependent on the desired profit margin. If fish is expensive, less fish or less expensive species will be used. There is no form of control for consistency or quality. The mixing process does not ensure a homogeneous dough and the rolls subsequently produced are of varying diameters. The centres of the rolls very often remain uncooked after boiling. Manual slicing results in pieces of cooked dough with different thicknesses within and between slices, and the irregular diameter of the rolls causes different shapes and sizes to be produced. The process of sun drying is also uncontrollable and variable. This results in fluctuations in the moisture content of the dried slices. Usually, the moisture content is high as the product is sold by weight.

Preparation Of *Keropok* Using The Modified Method

The fish *(Clupea leiogaster)* was obtained fresh from the market. After deboning, the flesh and other ingredients were processed as outlined in Fig. 1.

The formulation used was 1:1 fish to flour, 2% salt, 1% sugar and 25-30% water. The fish : flour mixture and the other ingredients are mixed in a bowl mixer until a homogeneous mixture is obtained. The dough-like mixture is then stuffed into cellulose casings using a sausage stuffer (Dick, West Germany). The stuffed rolls are then steamed to gelatinize the starch granules for 60-90 min under ordinary pressure, when the temperature of the granules reaches 90-95°C. After steaming, the cooked roll is immersed in iced water in order to prevent shrinkage, reduce cook loss and to facilitate separation from the casing. It is then chilled overnight at 5-10°C before being sliced, using a gravity slicer. A thickness of about 3 mm was found to be more acceptable in terms of packing, drying and expansion properties. For oven drying, an initial lower temperature of 40-45°C was used to prevent case hardening which leads to poor expansion. A final temperature range not exceeding 65-70°C was used and the product dried to a final moisture content of 8-9%.

Examination Of Product

Chemical Analyses

Analyses for moisture, fat, crude protein, ash and salt contents were carried out according to Pearson (1970).

Linear Expansion

The linear expansion was obtained on deep frying the dried *keropok* in palm oil at 200°C. The unpuffed *keropok* were ruled with five lines across using a fine oil pen. Each line was measured before and after puffing. The percentage linear expansion was calculated as follows:

$$\text{Percentage linear expansion} = \frac{\text{Length after puffing} - \text{Length before puffing}}{\text{Length before puffing}} \times 100$$

Organoleptic Evaluation

The samples were evaluated after frying at 200°C by twenty-one experienced panellists who were asked to rate the colour, crispness, flavour and overall acceptability of the products using a rating test of 5 for excellent to 1 for poor. The results were analysed using the Duncan's multiple range test (DMRT).

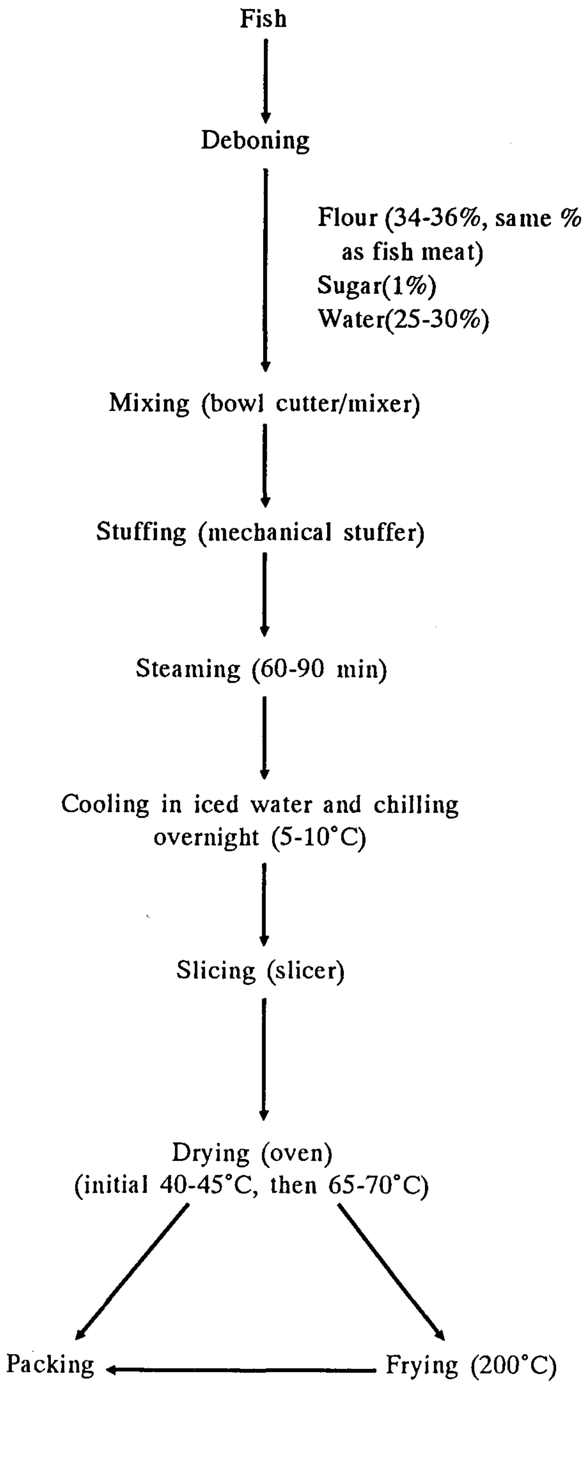

Fig. 1. The modified method of keropok *processing.*

Results

Chemical Composition And Expansion Characteristics

The chemical analyses and expansion properties of four samples of *keropok* processed traditonally, compared with those prepared using the modified method, are shown in Table 1.

There is slight variation in chemical composition whereas linear expansion varies considerably. Chemical composition depends on formulation whereas linear expansion depends on the physical properties of the fish-flour mixture. Traditional products (A-D) have much lower expansion and this is due to poor mixing, variation in the thicknesses of the sliced product and uneven drying. Basically this results from poor understanding of the functional properties of the ingredients utilized and processing technology involved. *Keropok* processing by the modified method begins with a homogeneous mixture of fish and flour that can only be achieved mechanically. A well-mixed structure will result in smooth texture and good expansion. Mixing that is not homogenous causes decreased gelatinization and therefore the expansion ratio is lowered. Processors should realize that only a well-mixed structure will gelatinize fully when cooked. Ungelatinized or semi-gelatinized starch granules will result in poor expansion characteristics. In the modified method, controlled cooking also ensures adequate gelatinization of the starch granules.

Organoleptic Evaluation

From Table 2, it can be seen that the appearance and shape score for *keropok* prepared by the modified method was rated higher and was more acceptable compared with those prepared traditionally. Samples were round and flat and obtained the highest mean score. In contrast, the shape of traditionally processed *keropok* varied considerably, from elongated and pointed to an oval shape. This inconsistency is due to the use of the hand rolling method as no casings or moulds are used to standardize shape. Hand slicing also causes variation in thickness. The main advantage of using a mechanical slicer is that thickness can be controlled.

Table 1. Chemical composition and linear expansion of fish *(Clupea leiogaster) keropok*. Samples A - D are traditional products.

		Samples				
		A	B	C	D	Modified Method
Chemical composition	Moisture	13.3	11.9	12.8	13.1	9.5
	Crude protein (N x 6.25)	20.3	20.6	20.0	21.7	21.6
	Fat	1.4	1.5	1.1	1.0	1.6
	Salt (Cl)	2.0	2.6	2.6	2.4	2.6
	Ash	2.9	2.4	2.8	2.7	2.8
Expansion property	Linear expansion	77.7	46.9	34.3	64.3	95.4
	S.D. (±)	7.2	9.2	9.8	8.1	6.7

Table 2. Mean score for appearance and shape of *keropok*. All samples showed significant difference at P ≤0.05.

	Samples				
	A	B	C	D	Modified Method
Mean score	3.4	2.4	2.9	3.9	4.5

The crispiness ratings for *keropok* prepared using the Modified Method were also much higher (Table 3) compared to most traditional samples. For the latter, poor cooking procedures and uneven drying in the sun causes the samples to crinkle upon frying. This is caused by the fact that some portions expand to a greater extent than others. The starch in the unexpanded portion has not been fully gelatinized. Starch granules that are fully gelatinized will result in better rupture of the starch cells during frying. A linear expansion greater than 77% was found to be the ideal level of crispiness. This was achieved in all samples prepared using the modified method. In comparison, less than 20% of the traditional samples had expansion ratios greater than 60%.

Preparation Of *Keropok* By Extrusion

The minced fish and flour were mixed at room temperature (~24°C) employing a Kenwood mixer equipped with a paddle beater. During the mixing stage 2% NaCl and 1% sugar were added to the formulation.

A Brabender (model 20DN) laboratory extruder was employed, fitted with a spiral screw with 1:1 compression ratio. A ribbon type die with a 23 mm x 0.5 mm discharge slit was used. A screw speed of 120 rev/min was employed. The material were fed through a feed hopper equipped with a continuous agitator. For all experiments no heating or cooling was applied to the first stage of the barrel and the die section was maintained at a temperature of 100°C. The temperatures for the second stage were varied from 60 to 140°C. After extrusion the product was dried in a forced-air cabinet drier (Apec, U.K.) at 70°C for 6 hr to give a final moisture content of 8-9%.

Results

Linear Expansion On Frying

Fig. 2 shows the percentages of linear expansion of *keropok* as a function of varying temperatures at the second stage of the extruder barrel. Expansion at 60°C was negligible (<5%) but increased with increasing temperature up to a

Table 3. Duncan's multiple range text (DMRT) for crispiness ratings of *keropok*. Samples joined by lines are not significantly different at 0.05 under the DMRT.

	Samples				
	A	B	C	D	Modified Method
Mean score	2.6	2.6	2.7	3.2	3.3
	———	———			
		———	———	———	———
	———	———	———		

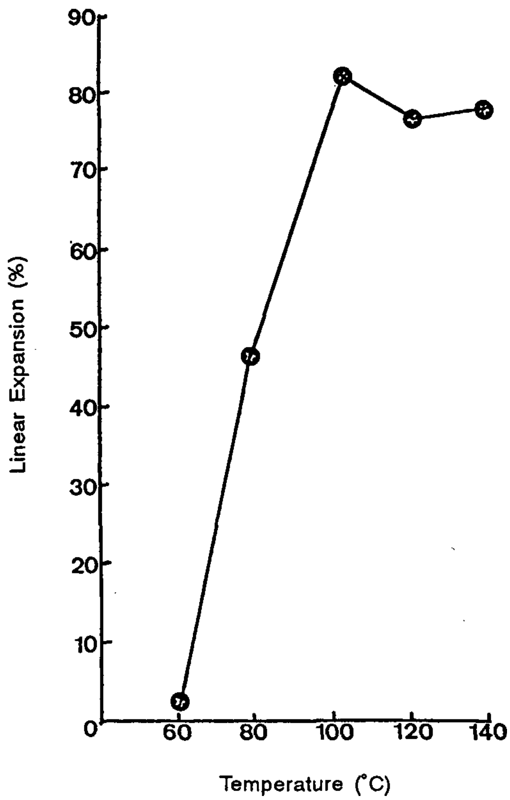

Fig. 2 Effect of extruder temperature on the linear expansion of keropok.

miximum at 100°C. Further increases of temperature did not affect expansion levels. The control sample prepared by modified method, however, showed an expansion of 101% which is some 20% greater than the maximum obtained with the extruded samples.

Organoleptic Evaluation

The results of the organoleptic evaluation are shown in Table 4. It can be seen that, provided the extruder temperature was 100°C or greater, the taste panellists detected no significant differences in colour, flavour, crispness or overall acceptability between the extruded product and *keropok* prepared by the modified method.

Chemical Analysis

Chemical analysis (Table 5) indicated that the extruded and the control samples had similar protein contents.

Extrusion appears to be a promising alternative method for preparing *keropok*. For the product extruded at temperatures of 100°C and above, panellists found no significant difference between the samples prepared using the modified method and the extruded samples. From the point of view of manufacture the extrusion method has several advantages. Since no extra water need be added to the original fish and flour mixture, the subsequent drying time is reduced. This variant of the process also cuts down labour requirements because extensive manual mixing of the dough, shaping and

Table 4. Effect of extruder temperature on colour, crispiness, flavour and overall acceptability of *keropok*. Figures with the same letter are not significantly different at the 0.05 level using the DMRT.

Temp.(°C) at 2nd stage of extruder	Colour	Crispiness	Flavour	Overall acceptability
60	1.76b	2.19b	2.24b	1.67b
80	2.10b	2.38b	2.24b	1.86b
100	3.05a	3.24a	2.95a	2.95a
120	2.76a	3.29a	3.10a	3.00a
140	2.90a	3.29a	2.85a	3.10a
Control (modified method)	2.86a	3.29a	2.76a	3.10a

Table 5. Protein and moisture contents of *keropok*.

Sample	Protein (%)	Moisture %
Extruded samples	20.86	8.6
Control (modified method)	21.60	8.4

subsequent boiling or steaming are no longer necessary. The process is faster and can be operated on a continuous basis as opposed to the traditional batch process. The product produced by extrusion is also more hygienic and homogenous.

Application Of The New Technologies For *Keropok* Production

There are 386 *keropok* factories in Peninsular Malaysia (Table 6). Total production in 1987 was 10,641 mt. (Din, 1988). The small-scale processors each produce 50-100 kg per month, medium-scale processors 150-200 kg per month and those that use machinery can produce 12,000 kg per month (Lembaga Kemajuan Ikan Malaysia, 1989).

The Fisheries Development Board of Malaysia (LKIM) trains *keropok* processors to upgrade their production capacity by teaching technical skills and introducing the use of machinery. Approximately five courses are held every year, with 15 participants per course. These courses are conducted in Mersing and Kuala Sedili in Johore, Malaysia. Up to 1988, 211 processors have been trained (Din, 1988) and 110 factories have purchased various types of equipment to boost production. The method most commonly

Table 6. Number of *keropok* factories in the states of Peninsular Malaysia.

State	No. of Factories
Perlis	-
Kedah	21
Pulau Pinang	1
Perak	4
Selangor	1
Negeri Sembilan	-
Melaka	3
Johor	82
Pahang	37
Trengganu	137
Kelantan	100
Total	386

used is the modified method as this is still cheaper than the extrusion method.

Table 7 shows the approximate cost for equipment outlay in a factory using the modified method. The production capacity is estimated to be 11,820 kg a month.

Table 7. Estimated cost for equipment outlay for *keropok* production using the modified method.

Unit : M$

1. Containers for fish (8)	4,000.00
2. Deboner (1)	8,000.00
3. Mixer (1)	3,000.00
4. Stuffer (1)	7,500.00
5. Steamer (1)	10,000.00
6. Slicer (2)	15,000.00
7. Packing machine (1)	500.00
8. Stainless steel tables (2)	1,000.00
9. Oven (1)	25,000.00
10. Racks & others	3,000.00
Total:	77,000.00

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Disscussion

In the discussion, a question was asked about the percentage of fish meat and type of flour used in fish crackers, and the amount of shrimp meat in the shrimp cracker, in the recommended modified method. Dr Yu replied that tapioca flour was used and in both cases 50 percent of either fish meat or shrimp meat was used. As regards the conditions of the first and second stages of oven drying, Dr Yu replied that in the first stage, the *keropok* was dried at 40-45°C for 1 to 1.5 hr. In the second stage the temperature was 65-70°C for up to 8 hours. The final product had a moisture content of 8-9%.

Regarding the critical factors during processing and important ingredients influencing crispness and linear expansion, Dr Yu said that a well-homogenized dough would result in good linear expansion and crispness. The addition of proteins actually decreases linear expansion as *keropok* made solely from starch has greater linear expansion.

Asked about criteria used for the organoleptic assessment of quality, Dr Yu said that hedonic scale of 1 to 5 was used with 2.5 to 3 as the cut-off point.

A participant commented that boiling has a more efficient heat transfer than steaming and asked whether there was a special reason why steaming was selected, Dr Yu said that in these studies, there appeared to be some migration of materials into the boiling water; steam was selected to reduce this effect.

Asked whether rancidity was a problem and if any antioxidant was used, Dr Yu said that rancidity was not a problem and that no antioxidant was required.

A participant wanted to know whether the linear expansion is dependent on the variety of starch used or on some other factor. Dr Yu replied that the starch granule is mainly responsible for this linear expansion and added that starches with low protein content such as tapioca and sago, would have good linear expansion results.