

Food Additives and Effect of Thickness on Fish Crackers Quality

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Abstract

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

Introduction

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

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

Amylopectin is one of the starch components which has an important role in influencing cracker expansion (Yu *et al.*, 1981). A higher amylopectin content in the starch gives a better expansion than a higher amylose content (Cecil *et al.*, 1982). In addition, these two components also influence the texture and density of the cracker (Bredger, 1990 and

Smith, 1987 in Yu, 1993). Other factors affecting cracker expansion are thickness, moisture and protein content of the raw cracker. Chinnaswamy and Hanna 1990 (in Yu, 1993) and Yu (1991a) found that an increase of protein content tends to decrease the expansion. The ratio of fish to sago higher than 2:1 decreased the expansion which was related with the cracker crispiness (Yu, 1991a).

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

Materials and Methods

1. Raw Materials

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

2. Methods

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

a. Effect of Fish Species and Fish Flesh Percentage Studies

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

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

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

3. Processing of Fish Cracker

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

4. Observations and Measurements

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

the glass until it is filled and a flat surface was achieved. The volume of beads was then measured using a volumetric glass. The volume of cracker was determined as $V_1 - V_2$, and specific volume was defined as volume of cracker divided by cracker weight:

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

V_1 = beads volume without sample

V_2 = beads volume filled with sample

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

$$\text{Expansion Volume (\%)} = \frac{V_f - V_r}{V_r} \times 100\%$$

V_r = specific volume of raw cracker

V_f = specific volume of fried cracker

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

Results and Discussion

1. Effect of Fish Species and Fish Flesh Percentage

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

Proximate comparison of fresh fish

Moisture, protein and fat contents of fresh fish used are presented in Table 1. It shows that the highest fat content was indicated by featherback followed by snapper and yellow pike conger while the highest protein content was produced by snapper followed by featherback and yellow pike conger. Featherback had the softest texture compared to the

other two fish, resulting in a smooth minced meat. Conversely, the minced meat produced by snapper was coarser as the fish texture was the hardest. Fish texture is affected by the amount of connective tissue of each fish which commonly increases as the fish meat got darker (Suzuki, 1981) - the more connective tissues the harder the fish texture. Fish meat colour of snapper was the darkest among the fish used. Besides, fish meat texture also depends on the fat content. Higher fat content tends to decrease the softness of fish meat (Yeates *et al.*, 1975) and it is relatively higher in darker fish meat rather than lighter ones (Eskin, 1971).

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

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

Dough characteristics

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

Fish cracker properties

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

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

Table 2. Proximate analysis of fish crackers.

Fish species	Fish flesh percentage	Protein (%)	Fat (%)
Control	0	0.78	0.04
Yellow pike conger	25	5.08	0.24
	40	8.13	0.38
	50	9.38	0.47
Snapper	25	5.87	0.27
	40	9.38	0.46
	50	11.44	0.59
Featherback	25	5.48	0.48
	40	8.44	0.76
	50	10.49	0.94

Table 3. Physical characteristics of fried fish crackers.

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

Table 3 describes the physical characteristics of fried fish cracker. Fried fish cracker made from featherback was lighter in colour and had better expansion than that from snapper. It was due to the color and texture of raw material, where the featherback and yellow pike conger had better colour and texture than snapper.

Expansion volume of crackers

Cracker prepared by adding 25% fish flesh from yellow pike conger has higher expansion volume than snapper and featherback. Increasing the percentage of fish flesh resulted in a decrease in expansion volume (Table 4).

Table 4. Mean values of volume expansion of fried fish crackers.

Fish species	Fish Flesh percentage			
	0	25	40	50
Control	374	-	-	-
Yellow pike conger	-	308	281	252
Snapper	-	236	216	203
Featherblack	-	184	150	145

b. Effect of Fish Species on Fish Cracker Crispiness

Result of the rating test (Table 5) shows that increase of the expansion volume is not followed by increase of crispiness especially on the snapper (236) and featherback fish (184). Score of crispiness for the snapper cracker (4.0) is lower than featherback cracker (5.4). Statistical analysis shows that the score of crispiness for control and the addition of yellow pike conger is not different. Crispiness of the cracker with the ranking test shows the control is ranked 1 followed by yellow pike conger (2), snapper (3) and featherback (4). This showed that ranking test is more precise than the rating test. Crackers made from the addition of 25% fish flesh of yellow pike conger were

more accepted by panelists than that with snapper and featherback fish flesh.

Table 5. Mean values of the expansion volume and crispiness of fish cracker added with 25% different fish flesh with rating and ranking tests.

Fish species	Volumetric expansion (%)	Crispiness	
		Rating test	Ranking test
Control	374 ^a	7.0 ^a	1
Yellow pike conger	308 ^b	6.9 ^a	2
Snapper	236 ^c	4.0 ^b	3
Featherback	184 ^d	5.4 ^c	4

Note: The same notation indicates statistically not different (P>0.05).

c. Effect of Fish Flesh Percentage on Fish Cracker Crispiness

Table 6. Mean values of the expansion volume and crispiness of fish cracker added with different percentage of flesh of yellow pike conger with rating and ranking tests.

Fish Percentage	Volumetric expansion (%)	Crispiness	
		Rating	Ranking
0	374 ^a	6.85 ^a	1
25	308 ^b	6.65 ^b	2
40	281 ^{bc}	5.85 ^c	3
50	252 ^c	5.45 ^d	4

Note: The same notation indicates statistically not different (P>0.05).

Based on the crispiness rating test an increase of fish flesh percentage resulted in a decrease in cracker crispiness. The highest crispiness was obtained from control (6.85) followed by addition of 25, 40 and 50% fish flesh with score 6.65, 5.85 and 5.45 respectively (Table 6). Yu (1991b) reported that increase of protein content can decrease expansion volume and crispiness.

d. Effect of Fish Flesh Percentage on the Fish Cracker Taste

From single stimulus test by 20 judgements on the crackers without addition of fish flesh it was found that 5 judgements agreed that control has fish taste, but 15 judgements denied that it had fish taste. Fortified with 25% fish flesh, 19 judgements indicated that the crackers had fish taste. When 40% and 50% fish flesh was added, all judgements indicated that the crackers had fish taste (Table 7).

Table 7. Influence of percentage of yellow pike conger on the crackers taste using single stimulus test.

Judgment	Fish Percentage			
	0	25	40	50
1	0	1	1	1
2	0	1	1	1
3	0	1	1	1
4	0	1	1	1
5	0	1	1	1
6	1	1	1	1
7	1	1	1	1
8	0	1	1	1
9	0	1	1	1
10	1	1	1	1
11	1	0	1	1
12	0	1	1	1
13	0	1	1	1
14	0	1	1	1
15	0	1	1	1
16	0	1	1	1
17	1	1	1	1
18	0	1	1	1
19	0	1	1	1
20	0	1	1	1
Total	5	19**	20**	20**

Note : 0 = fish taste not detected
1 = fish taste detected

** 15-17 significantly different $P > 0.05$ and $P > 0.01$

Intensity of crackers taste added with 0, 25, 40 and 50% fish flesh are 0.6, 2.6, 3.5 and 3.9 respectively (Table 8). Fortification with 25% fish flesh gave fish taste an intensity of 2.6; it means a judgment agreement of between soft and slightly strong taste. Crackers containing 25% fish flesh has 5.08% protein content, which fulfills the crackers standard of 5% based on Indonesian Industrial Standard 0272-90 (SII, 1990).

Table 8. Influence of yellow pike conger percentage on crackers intensity taste from 20 judgements.

Judgment	Fish Percentage			
	0	25	40	50
1	0	2	4	3
2	0	3	3	4
3	0	3	3	4
4	0	3	2	5
5	0	3	2	3
6	1	2	3	4
7	1	3	3	4
8	0	3	4	3
9	0	4	3	4
10	2	3	4	3
11	4	0	4	4
12	0	3	4	5
13	0	3	5	4
14	0	1	3	5
15	0	1	4	3
16	0	3	3	3
17	3	3	4	4
18	0	2	3	4
19	0	3	4	5
20	0	3	4	4
Total	11	51	69	78
Mean	0.6	2.6	3.5	3.9

Note: 5 = very strong; 4 = strong; 3 = slightly strong;
2 = soft; 1 = very soft

Results from this research show that yellow conger pike can be used as a substitute for the featherback fish to prepare fish cracker, based on the expansion volume and crispiness. There are many beneficial factors in the use of yellow pike conger to make crackers compared to featherback fish with regards to price and resources. Price of yellow pike conger in September 1994 in Angso Duo Fishing Port,

Jambi (South Sumatera) was only Rp. 1,500/kg and price of featherback fish was Rp. 12,000/kg.

2. Effect of Food Additive as Leavening Agents and Thickness

Addition of sodium bicarbonate as food additive made the dough very compact and elastic, but use of ammonium bicarbonate, by comparison resulted in lower compactness and elasticity. Addition of sodium polyphosphate made the dough more soft, compact and elastic. Sodium bicarbonate increased the pH of the dough compared with ammonium bicarbonate and sodium polyphosphate. Low pH made the dough softer (Ockerman, 1983).

a. Cracker Characteristics

Results of the use of food additives and thickness on the colour of the cracker is shown in Fig.1. Kinds of food additives and the thickness influence the cracker's colour. Thicker product results in a darker colour. Sodium bicarbonate also made the crackers more dark in colour and less transparent compared to use of ammonium bicarbonate. The best colour resulted from use of sodium polyphosphate where the colour was close to the control.

b. Fried Cracker Characteristics

Adding of sodium bicarbonate made the crackers more porous, have bigger pore size, darker, coarser surface than crackers with ammonium bicarbonate and sodium polyphosphate. Treatment with sodium polyphosphate resulted in fried crackers with softer texture, containing smaller bubbles and whiter appearance; these are close to the characteristics of the control crackers (Fig.2).

The effects produced as a result of CO₂ released by the food additives are different. Sodium bicarbonate produced bigger hollow spaces than ammonium bicarbonate and sodium polyphosphate. This made the crackers with sodium bicarbonate more porous, big pored and dark. Since sodium polyphosphate was able to bond strongly with water during kneading, on its release during cooking, the excess water vapor pressure creates the hole spaces and make the crackers more porous (Soekarto and Muliawan, 1990).

c. Expansion Volume of the Fish Crackers

The influence of food additives and thickness on the expansion volume are shown in Table 9.

Table 9. Mean values of fish crackers expansion volume as influenced by food additives and thickness.

Food Additives	Thickness		
	2 (mm)	3 (mm)	4 (mm)
Control	309	132	95
Sodium bicarbonate	674	279	170
Ammonium bicarbonate	328	165	127
Sodium polyphosphate	445	243	103

Treatment with sodium bicarbonate resulted in the largest volume increase followed by sodium polyphosphate and ammonium bicarbonate for crackers of 2 and 3 mm thickness, except for the 4 mm thickness. The biggest volume increase was from sodium bicarbonate treatment on the 2 mm crackers. It was observed that an increase in cracker thickness resulted in lower volumetric expansion, this is probably because the oil penetrates more slowly into the insides of the crackers than the thin ones. This case hardening occurs before the oil has penetrated into the deeper parts (Matz, 1984). It has been reported that the value of absorbed oil at the core of sago crackers with the thickness 1, 2 and 3 mm are 34.1, 19.0 and 11.2 % respectively (Yustica, 1994).

d. Cracker Crispiness

The results of sensory evaluation with rating and ranking tests for acceptability are presented in Table 10. The rating test showed that higher crispiness resulted from use of sodium bicarbonate followed by ammonium bicarbonate, sodium polyphosphate and control. Based on ranking test the use of ammonium

bicarbonate and control received a lower score and were also unacceptable.

Table 10. Mean values of expansion volume and crispiness as influenced by different food additives and 2mm thickness of the crackers.

Food Additives	Volumetric expansion (%)	Crispiness	
		Rating	Ranking
Control	309 ^c	7.1 ^d	4
Sodium bicarbonate	674 ^a	7.6 ^a	1
Ammonium bicarbonate	328 ^b	7.4 ^b	3
Sodium polyphosphate	445 ^{bc}	7.2 ^c	2

Note: The same notation indicates statistically not different ($P>0.05$).

From Table 11 it can be seen that cracker crispiness by ranking test is in the order of sodium bicarbonate, sodium polyphosphate, ammonium bicarbonate and control. Influence of thickness on the crispiness based on rating and ranking test on acceptability of the crackers showed that 2 mm thickness has high score and expansion volume.

Table 11. Influence of food additives on the crispiness of fried crackers with 2mm thickness for 20 judgments.

Ranking No.	Food Additives			
	Control	Sodium bicarbonate	Ammonium bicarbonate	Sodium poly-phosphate
1	3	8	2	7
2	4	6	5	5
3	5	4	7	4
4	8	2	6	4

Conclusion

This study has shown that increase of fish flesh percentage causes a decrease in the cracker expansion volume and crispiness is depressed by an increase in protein content. Yellow pike conger fish could be used as a substitute for featherback to produce cracker. The expansion volume was in the order of yellow pike conger (304%) snapper (257%) and featherback (213%). In terms of crispiness the order was yellow pike conger, featherback and snapper. Addition of 25% fish flesh imparts a distinct fish taste to the cracker, which also meets the standard of 5% protein content as required by Indonesia.

Addition of sodium bicarbonate resulted in the highest expansion volume (674%) followed by sodium polyphosphate (445%) and ammonium bicarbonate (328%) with the crispiness ranking 1, 2, and 3. Thickness of the cracker influences the cracker expansion volume. The best cracker was obtained from treatment with 25% yellow pike conger fish flesh with 2 mm thickness and addition of 0.2% sodium bicarbonate.

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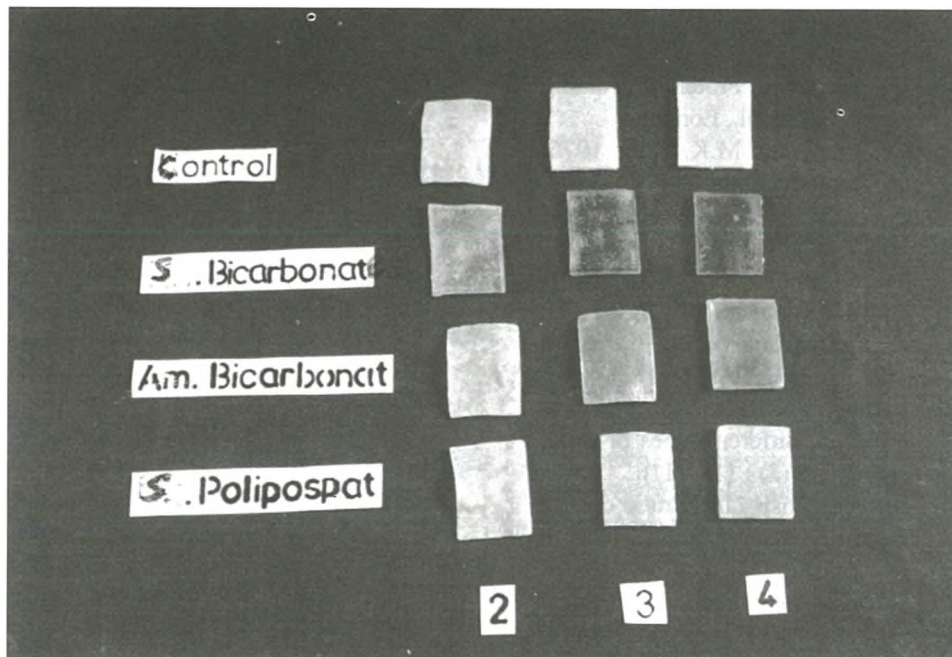


Fig. 1. Effect of food additives and thickness on the raw cracker characteristics.

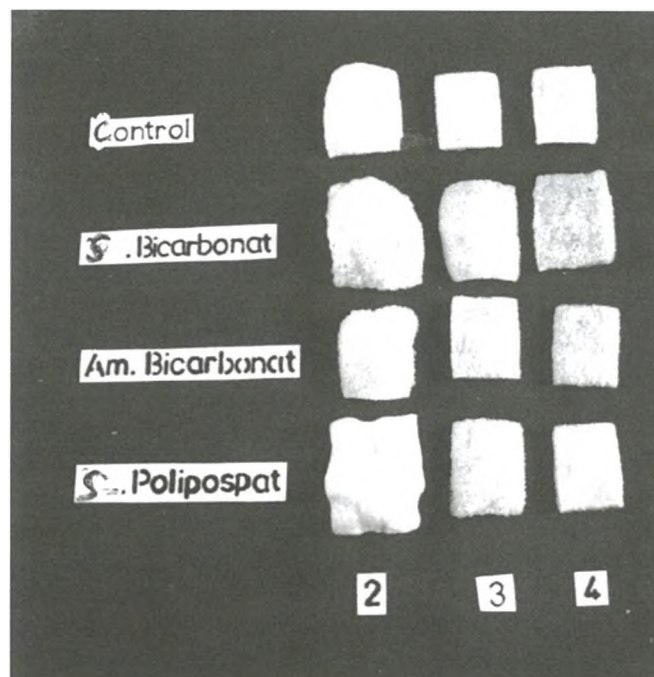


Fig. 2. Influence of food additives and thickness on the fried cracker characteristics.

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Discussion

During the discussion, Ms Rosmawaty clarified that during the conduct of sensory evaluation, the 20 sensory panelists were properly trained on sensory evaluation.