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Preparation and properties of fish cracker from different freshwater fish species

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Abstract

Fish crackers made from freshwater fishes is a new dimension in fish cracker industry. In this study, three species were chosen based on their general preference and acceptability by Malaysian. Together with other ingredients, these crackers were prepared using standard formulation and tested in laboratory for their proximate analysis and physical characteristic analysis includes linear expansion, oil absorption, color measurement and texture. Sensory analysis for overall acceptability was carried out among trained panelist in the school. The results for proximate composition and physical analysis showed that there were significant differences ($p<0.05$) between different species of fish crackers. There were also significant differences ($p<0.05$) between fish crackers of fried and un-fried crackers in terms of its proximate contents and physical appearance. It can be said that the high value of linear expansion increases the absorption of oil by crackers but decreasing their hardness properties. From the sensory evaluation results, the overall acceptability was the Bighead carp fish crackers.

Introduction

Fish crackers is one of the popular snack foods in Southeast Asian countries include Malaysia. They are made of fish flesh together with starch flour, water and seasoning which then shaped into round, oblique, stick or longitudinal forms and gelatinized by boiling or steaming (Huda *et al*., 2009; Latip *et al*., 2013). The cool dough is sliced and dried for certain times before being fried to be eaten as fresh and puffed crackers. In Malaysia, there are many producers from the cottage industry especially in these three major states, Terengganu, Kelantan and Pahang. There are more than 100 small scale producers along the streets in Terengganu that each of them producing different taste and look of the crackers. Other characteristics that differ among the fish cracker producers are an uneven expansion and shapes, different sizes and color. This is happen due to the different ratio of ingredients used by the producers. Therefore, it is important to ensure that the crackers suits the best characteristics of good quality crackers in terms of their sufficient expansion from puffing, crispiness, low moisture content and less oil absorption (Taewee, 2011).

Fish at large are divided into two main groups which are marine and freshwater fishes. In the fish cracker industry, marine fishes are usually been used by many producers since most of them live in the coastal area. As compared to the freshwater fishes, they are rarely used since the supply of these fishes to the producers is limited. However, as the aquaculture technology implemented in Malaysia, these freshwater fishes are easily supplied countrywide (Huda *et al*., 2009). Various freshwater fishes are being cultured through this method such as dory, carp, catfish (*Pangasius* spp.), tilapia, and many more. Bighead carp *(Hypophthalmichthys nobilis)*, Dory *(Pangasius hypothalamus)* and Rohu *(Labeo rohita)* are the freshwater fishes that is believed has the potential to be used in the fish cracker industry.

The ingredients to make the fish crackers play an important role in order to make the high quality crackers. Beside the fish flesh as the protein source, starch is an essential ingredients in making fish crackers. Starch is used to impart viscosity and texture of the crackers. Various sources of starch are used for this purpose such as tapioca, corn, potato, rice, wheat and many more. In general, starch consists of amylose and amylopectin. The amylopectin presence in the starch is correlated with linear expansion, oil absorption and crispiness (Mohamed *et al*., 1988). Highest linear expansion is achieved when the starch granules in the crackers are fully expand (Kyaw *et*

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al., 1999) where tapioca starch possess an excellent expansion properties (Mohamed *et al*., 1988; Yu,1991; Tongdang *et al.*, 2008). The ratio of the fish and starch flour determine its acceptability among consumers. Furthermore, it is also contributes in the linear expansion and the crispiness of the crackers. Seasonings used in fish cracker making are salt, sugar and flavor enhancer (monosodium glutamate). Salt is normally added around 2% of total fish cracker ingredients which serves as preservatives in restricting microbial growth and helps in protein stability. MSG is often added in fish crackers to enhance the meaty flavor of the fish and also its palatability (Taewee, 2011).

The objectives of this study were to prepare crackers from different species of freshwater fishes, and to analyse the physical, nutrition value and acceptability of the fish cracker.

Materials and Methods

Raw material

Frozen freshwater fishes of Bighead carp *(Hypophthalmichthys nobilis)*, Rohu *(Labeo rohita)* and Dory *(Pangasius hypothalamus)* were purchased from supermarkets and processed in laboratory in Food Technology Division, School of Industrial Technology, Universiti Sains Malaysia. The other ingredients were bought from a local shop.

Preparation of crackers

The crackers were made by following the method provided by King (2002) with slight modification. They were made by mixing 200 g fish meat, 180 g tapioca starch, 12 g sugar, 13.5 g salt, 30.5 g ice, 3 g MSG, and 2.1 g sodium bicarbonate. The dough was shaped into cylindrical with 4.3 cm diameter and steamed at 90°C followed by chilling in refrigerator. It was cut into 2 mm thickness and put into oven of 50°C for 10 to 12 hours until the moisture content reading was 10% ± 2% and fried in vegetable oil.

Proximate analysis

Proximate analysis was conducted to determine moisture, protein, fat, ash and carbohydrate of the fish crackers according to AOAC method (2000). Moisture content was determined after drying the samples in 105°C. The protein and lipid content was determined by Kjedahl and soxhlet method, respectively while the ash content was calculated after the sample is fully dried in the muffle furnace for 500-600°C. The carbohydrate was calculated by subtracting the percentage of moisture, protein, fat and ash.

Linear expansion

Linear expansion was determined by using Traceable Carbon Fiber Calipers 6 in for digital calipers 150Mm before and after frying. The lengths of individual lines were measured with a thread and measuring tape. The measurement was replicated 10 times. The percentage of the linear expansion was calculated using the equation provided by Yu *et al.* (1981).

Oil absorption

The percentage of oil absorption was calculated by weighing the sample before and after frying in palm oil at 180-200°C using the formula given below (Mohamed *et al*., 1988).

Color measurement

Colorimeter (Minolta Spectrophotometer CM3500d) was used to measure the color of the fish cracker before and after puffing. The measurement includes lightness (L^*), redness (a^*) and yellowness (b^*).

Texture

Texture measurement was conducted by using the Texture Analyzer (TA-XT2i Stable Micro System). The procedure to operate is stated in its Standard Operation Procedure. The conditions of the texture analyzer were carried out according to the method by Huda *et al.* (2009).

Sensory analysis

Hedonic test was performed to evaluate the degree of overall acceptance and satisfaction of the fish crackers. Laboratory panel consisting of 30 members were involved in evaluating the color, texture (crispiness), flavor, aroma, and overall acceptability of the crackers. Each member duplicated these tests.

Statistical analysis

The data obtained were presented as means ± standard deviation (SD) and all measurements were performed in triplicate and the data analysed by ANOVA using SPSS 17.0. The significant difference was considered at the level of $p < 0.05$.

Results and Discussion

Proximate composition

The proximate composition of three different species of fish crackers is shown in Table 1. It was significant differences ($p<0.05$) for all tests include moisture, fat, protein, ash and carbohydrate. Moisture content of fish crackers is one of the most important

Table 1. Proximate compositions of Bighead carp, Rohu, and Dory fish crackers

Sample	Moisture,%		Fat, %		Protein, %		Ash, %		Carbohydrate, %	
	unfried	fried	unfried	Fried	unfried	fried	Unfried	fried	unfried	fried
Bighead Carp	9.39± 0.34[a]	5.86± 0.07[b]	1.32± 0.06[a]	30.82± 2.00[a]	14.70± 0.17[b]	9.78± 0.13[b]	8.45± 0.03[c]	6.07± 0.04[c]	64.30± 0.36[b]	37.65± 5.28[a]
Rohu	12.73± 0.18[c]	7.58± 0.33[a]	3.06± 1.03[b]	29.87± 0.20[a]	16.19± 0.20[c]	12.2± 0.21[c]	8.17± 0.04[b]	5.77± 0.09[b]	59.85± 0.99[a]	44.50± 0.28[b]
Dory	11.49± 0.44[b]	5.34± 0.05[c]	3.16± 0.33[b]	40.65± 5.35[b]	13.79± 0.05[a]	8.82± 0.07[a]	7.28± 0.07[a]	4.74± 0.14[a]	66.11± 0.45[c]	50.27± 1.83[b]

*Each value is presented as mean ±standard deviation (n = 3).
[a–c] Means within each row with different letters differ significantly (P < 0.05).

Table 2. Sensory analysis for overall acceptance of Bighead carp, Rohu and Dory fish crackers

Sample	Colour	Crispness	Flavor	Adour	Overall acceptability
Bighead Carp	5.77±1.19[b]	5.17±1.39[a]	6.17±1.09[c]	5.90±0.99[b]	6.40±0.72[c]
Rohu	4.63±1.13[a]	5.30±1.09[a]	5.57±1.25[b]	5.47±1.22[b]	5.23±1.22[b]
Patin	5.00±1.11[a]	5.03±1.35[a]	4.13±0.97[a]	4.20±0.96[a]	3.93±0.83[a]

*Each value is presented as mean ±standard deviation (n = 3).
[a–c] Means within each row with different letters differ significantly (P < 0.05).

aspects that need to ensure to achieve its optimum level. Mohamed *et al.* (1988) explained that excess moisture content will reduce linear expansion and also difficult to handle but if insufficient, it causes incomplete gelatinization of the fish protein and starch.

The un-fried crackers of dory contained the highest fat content among these three types of un-fried crackers. The fat content in an un-fried crackers is strictly depends on the type of fish where Huda *et al.* (2009) reported that oily fish has more than 8% of fat while lean fish has less than 4%. The increase amount of fat reading from the un-fried to fried crackers was resulted from the oil absorption after frying.

The protein content in Rohu's fish crackers was the highest compared to others. In general, protein content of every fish crackers is strictly depends on the fish species and the ratio of the fish meat to the starch flour. King (2002) in his study reported that 10% of protein content is resulted from the 40% to 60% of fish to starch ratio. Thus, higher composition of fish meat in the crackers gives higher value of protein. According to Malaysian Food Regulation in agreement No. 168, the value of protein in fish cracker must contain at least 15% as reported by Muthia *et al.* (2010) at which from the result, Rohu's fish cracker meets this standard. Carbohydrate composition was contributed from the starch flour where Muthia *et al.* (2010) stated that 65-80% of carbohydrate content is the commercial range for fish crackers.

Sensory analysis

Sensory evaluation was performed to check overall acceptability of three different types of fish crackers reported in Table 2. The test includes panelists' acceptability in color, crispiness, flavor and aroma of the crackers rated from 1 (dislike very much) to 7 (like very much). From the result obtained, all characteristics were significantly difference except for crispiness that the panelists might had difficulties to differentiate between the crackers. The overall acceptance was the crackers made from Bighead carp. Many panelists prefer the bright color of the crackers and its tasty flavor. The high fishy off-flavor from the dory fish result in its least preference.

Linear expansion, oil absorption and hardness

The value of the linear expansion, oil absorption and hardness of the fish crackers are shown in Table 3. There were significant differences ($p>0.05$) in these criteria for these three types of crackers. The linear expansion and oil absorption value for Bighead carp fish crackers was 60.32% and 7.43%, respectively, the highest among all. From the result obtained, it can be said that the linear expansion is

Table 3. Linear expansion, oil absorption and hardness of Bighead carp, Rohu and Dory fish crackers

Sample	Linear expansion (%)	Oil absorption (%)	Hardness(N/cm^2)
Bighead carp	59.46±0.31^b	5.42±0.32^b	1212.02±120.05^a
Rohu	60.32±0.29^c	7.43±0.25^c	1249.73±140.88^a
Patin	57.46±0.13^a	3.70±0.16^a	1532.80±145.53^b

*Each value is presented as mean ±standard deviation (n = 3).
a–c Means within each row with different letters differ significantly (P < 0.05).

Table 4. Hunter color L*, a* and b* parameters of un-fried and fried of Bighead carp, Rohu and Dory fish crackers

Sample	L*	a*	b*
Un-fried Bighead carp	51.45±0.31^c	1.57±0.13^a	19.40±0.33^c
Rohu	50.60±0.29^b	8.47±0.21^c	14.48±0.35^a
Dory	40.40±0.13^a	3.52±0.20^b	16.33±0.30^b
Fried Bighead Carp	66.5±0.34^c	8.79±0.14^c	24.52±0.27^c
Rohu	51.68±0.31^a	-0.36±0.11^a	14.25±0.07^a
Dory	52.64±0.43^b	0.81±0.04^b	15.50±0.11^b

*Each value is presented as mean ±standard deviation (n = 3).
a–c Means within each row with different letters differ significantly (P < 0.05).

directly proportional to the oil absorption. Cheow *et al.* (1999) stated that this is happen when the starch gelatinize, it produces air bubbles that later absorb the oil when frying. In the other hand, the degree of hardness is increased with decreasing level of linear expansion. The percentage of hardness is related to the structure of fish protein that prevents the starch from expanding. Another method of analyzing hardness level is through sensory which described as crispiness. High crispiness that is preferable among consumer is explained by low hardness value (Huda *et al*., 2009).

Color measurement

The result for color measurement is shown in Table 4. There were significant differences for all type of fishes, un-fried and fried. The L* value for Bighead carp crackers was the highest as compared to the other type of fish which is depends on the composition of fish meat and the starch flour. Huda *et al*. (2009) said that the higher the content of the fish meat, the lower the L* value since the meat has its own color pigment. The color parameters of a* and b* increase in fried crackers were a result of the browning of protein and carbohydrate undergoing Maillard reaction. The increase value of lightness from un-fried to fried crackers may due to the distribution of color parameters when expanding during frying.

Conclusion

Fish crackers made from freshwater fishes are another dimension of typical fish crackers in food industry. The results for every analysis of the crackers vary significantly depends on the type of fish and the condition of the crackers whether un-fried or fried. In general, the results for all tests of proximate include moisture; protein, ash, and carbohydrate were decreased from un-fried to fried sample. However,

the values were increased significantly for fat analysis because of the oil absorption after frying. For physical analysis, the highest percentage for linear expansion and oil absorption was for Rohu's fish cracker while Dory's fish crackers had the highest percentage of hardness. In conclusion, the overall acceptability was higher for Bighead carp among these three species in terms of its proximate composition, linear expansion, oil absorption, hardness and color. In future, it is recommended to study on the nutritional and health benefits of these freshwater fish crackers.

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