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Study of Fishball Chips with the Use of Different Types of Fish and Frying Temperatures on Nutritional Content

Amilia Dwi Fatmawati[1], Dedin Finatsiyatul Rosida[1,2]*

[1] *Food Technology Department, Faculty of Engineering and Science, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya, Indonesia*
[2] *Innovation Center of Appropriate Food Technology for Lowland and Coastal Area, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya 60294, Indonesia*

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CORRESPONDING AUTHOR

*E-mail: dedin.tp@upnjatim.ac.id

A B S T R A C T

Fishball chips are snacks made from processed meatballs that are thinly sliced and then fried. This study used types of anchovies, mackerel and tongue, and frying temperatures of 70 ° C, 80 ° C, and 90 ° C with a vacuum frying method. Using this vacuum frying method in processing processed fish products such as fishball chips is an alternative to produce products that are crispier and lower in oil and can maintain the taste and color of the product. This study aimed to determine the effect of fish type and frying temperature on the quality of fishball chips. This study used a Completely Randomized Design (CRD) factorial pattern with two replications. Factor 1 is the type of fish (anchovy, Indian mackerel, tongue), factor 2 is the frying temperature with the vacuum frying method (70 °C, 80 °C, 90 °C). Data were analyzed using ANOVA and advanced DMRT tests at the 5% level. The best treatment was indian mackerel type with frying temperature of 80°C which produced fish meatball chips with moisture content of 4,07%, ash content of 6,19%, protein content of 32,79%, fat content of 26,80%, and carbohydrate content of 30,14%.

Contribution to Sustainable Development Goals (SDGs):
SDG 3: Good Health and Well-Being
SDG 9: Industry, Innovation, and Infrastructure
SDG 12: Responsible Consumption and Production
SDG 13: Climate Action

1. PENDAHULUAN

1.1. Research Background

Fish balls are one form of diversification of fishery products that have high economic value. Fish balls are processed products made from minced meat that is seasoned, flour, and food additives, and then the process of crushing meat, making dough, molding, and boiling is carried out [1]. Fish Ball Chips (Fried Meatballs), commonly abbreviated as basreng, is a food made from processed meatballs that are thinly sliced and then fried [2].

The high water content in fish balls makes them less durable and easily damaged or rotten [3]. Additionally, chips tend to absorb a lot of oil during the frying process, and the amount of oil absorbed can affect the chips' taste, texture, and final appearance [4]. Efforts to overcome these problems while extending the product's shelf life can be made through processing innovation by making fish ball chips. The technology that has the potential to be applied in this process is frying with the vacuum frying method. This technology uses a frying technique in a closed space with low pressure. The temperature and duration of frying are adjusted according to the amount of ingredients and the characteristics of the ingredients used [4].

Fish is a source of animal protein that is widely consumed by the public, is easy to obtain and cheap, but fish quickly undergo a rotting process [5]. The types of fish that will be used include anchovies, mackerel, and tonguefish, each of which has a unique nutritional content. Anchovy production was recorded at 31,754 tons, indian mackerel production at 20,748 tons, and tonguefish production at 46.77 tons [6].

Anchovies (*Stolephorus indicus*) are known to have high protein content and are rich in calcium. Anchovies have high protein content and are a good source of calcium because they are consumed whole with their bones. The nutritional content in 100 grams of fresh anchovies includes 77 kcal of energy, 16 grams of protein, 1.0 grams of fat, 500 mg of calcium, 500 mg of calcium, 1.0 mg of iron, 0.1 mg of vitamin A, and 0.1 mg of vitamin B [7].

Indian Mackerel (Rastrelliger kanagurta) is classified as a small pelagic fish. Indian Mackerel has a fairly high nutritional content with a protein content of 17-23% [8]. In addition, indian mackerel contains omega 3 and 6 [9]. Indian Mackerel has meat that has a strong taste, causing an umami or savory taste in processed food products, so it is very suitable for processing into fish meatball chips [10].

Tonguefish (Cynoglossus lingua) is a flat fish with a soft meat texture and is rich in nutrients. This fish contains protein, vitamin A, vitamin B6, and minerals such as magnesium and potassium. The nutritional content in 100 grams of tonguefish includes 104 kcal of energy, 15.6 grams of protein, 3.2 grams of fat, 2 grams of carbohydrates, 21% phosphorus and 19% iron [11].

Fish-based food product processing is still limited, so research on fish ball chips products is expected to increase fish consumption in the community. In addition to being easy to digest, the price of fish that will be used in making fish ball chips is also still affordable and easy to obtain in the community. By understanding the influence of fish types and frying temperatures on the characteristics of fish ball chips using vacuum frying technology, it is hoped that fish ball chips can be produced that are not only delicious but also highly nutritious and healthy.

1.2. Research Objective

This study aims to determine the effect of fish types (anchovies, indian mackerel, tonguefish) and frying temperatures (70°C, 80°C, 90°C) on the nutritional content of fish ball chips.

2. MATERIALS AND METHODS

2.1. Material

The ingredients used to make fish crackers are anchovies (*Stolephorus spp*.), Indian mackerel (*Rastrelliger kanagurta L*.), tonguefish (*Cynoglossus sp*.), tapioca flour (rose brand), salt (kapal brand), chicken egg white, STPP (Sodium Tripolyphosphate), ice water, cooking oil (tropical brand). The ingredients for chemical analysis are aquadest, K_2SO_4 (Merck), HgO (Sigma Aldrich), H_2SO_4 (Merck), H_2O_2 (Sigma Aldrich), boric acid (H_3BO_3) (Sigma Aldrich), NaOH (Merck), HCL (Merck), Na_2SO_4, (Sigma Aldrich) and CuSO4 (Sigma Aldrich), fat solvent (benzene) (Sigma Aldrich).

2.2. Research Procedures

This study used a Completely Randomized Design (CRD) factorial pattern with two replications. Factor 1 is the type of fish (anchovy, indian mackerel, tonguefish), factor 2 is the frying temperature using the vacuum frying method (70°C, 80°C, 90°C). The data obtained from the analysis results were processed using Analysis of Variance (ANOVA) so that there was a significant interaction and difference between each treatment. If there was a considerable difference, further testing was carried out using the Duncan's Multiple Range Test (DMRT) method at a level of 5%.

2.3. Making Fish Meatballs

Making fish balls begins with cleaning the fish by removing the stomach contents, bones, fins, tail, and head then the fish is filleted to separate the meat from the bones. The filleted fish meat is then ground with ice water until smooth. Next, 150 grams of mashed fish meat is mixed with 30 grams of tapioca flour, 4 grams of salt, 1 gram of STPP, 35 ml of ice water, and 30 grams of egg white, then stirred until homogeneous. The dough is formed into balls using hands with the help of a spoon, then boiled in boiling water for 10 minutes until they float. After boiling, the fish balls are cooled in ice water at a temperature of 4°C for 5 minutes to maintain their texture so that they remain chewy and do not shrink, then drained for 5 minutes.

2.4. Making Fishball Chips

The cooked meatballs were then sliced with a thickness of ±2 mm using a stainless steel knife that had been adjusted to produce uniform slices. The sliced meatballs were weighed as much as 250 grams, then frozen at -20°C for 24 hours. Furthermore, frying was carried out using the vacuum frying method with a pressure of 65–70 cmHg, at a temperature of 70°C, 80°C, and 90°C for 70 minutes, using 15 liters of cooking oil for every 250 grams of sliced fish meatballs. After that, the fish meatball chips were drained using a spinner for 5 minutes at 1140 rpm.

3. RESULT AND DISCUSSION

3.1. Moisture Content

The moisture content analysis results presented in **Table 1** show that for each type of fish, increasing the frying temperature leads to a decrease in the moisture content of the fishball chips. The highest moisture content, at 6.75%, was found in the tongue fishball chips fried at 70°C, while the lowest, at 2.86%, was observed in the anchovy fishball chips fried at 90°C. These results comply with SNI 8272, which states that the maximum moisture content for fish crackers is 12% [12]. Tongue fishball chips tended to have the highest moisture content, followed by Indian mackerel, and the lowest was found in anchovy. This pattern may be related to the raw fish's initial moisture content and the fishball product's moisture content before frying, which exhibited similar trends.

The reduction in moisture content indicates that the type of fish influences the final product's water content due to differences in initial moisture levels and tissue composition, such as fat content and muscle structure, which affect water-holding capacity during heating. Muscle structure and fat content influence water retention capacity during thermal processing [13]. The decrease in moisture content is also attributed to the frying temperature, where higher temperatures accelerate the rate of water evaporation from the material. This occurs because higher temperatures provide greater heat energy, increasing the moisture loss rate, resulting in lower moisture content in the fishball chips. The variation in temperature during the vacuum frying process significantly affects the reduction of product moisture content [14].

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Table 1. Analysis Results of Moisture Content, Ash Content, and Protein Content of Fishball Chips

Treatment		Moisture (%)	Ash (%)	Protein (%)
Types of Fish	Vacuum Frying Temperature			
Anchovy	70°C	4,73	6,14	26,71
	80°C	2,89	6,79	26,58
	90°C	2,86	8,22	24,88
Indian Mackerel	70°C	6,18	5,78	35,56
	80°C	4,07	6,19	32,79
	90°C	3,99	6,54	29,32
Tonguefish	70°C	6,75	5,29	30,55
	80°C	3,79	5,34	28,93
	90°C	2,97	7,63	23,29

3.2. Ash Content

The sample of anchovy fishball chips with a frying temperature of 90°C produced the highest ash content of 8.22%. Meanwhile, the sample of tongue fishball chips with a frying temperature of 70°C produced the lowest ash content of 5.29%. The results of the ash content analysis presented in **Table 1** show that for each type of fish, the higher the frying temperature, the higher the ash content of the fish ball chips. This can occur due to differences in the initial ash content of each fish's raw materials and meatballs, where anchovy fishball chips produced the highest ash content at all frying temperatures, followed by indian mackerel, and the lowest was tonguefish. This is in line with the initial ash content of the raw materials of fish and fish balls, where anchovy fish has the highest ash content, followed by indian mackerel and the lowest tonguefish.

The difference in ash content between fish species is also related to the natural mineral content of each fish. Anchovies are known to contain high levels of macro and micro minerals, such as calcium (500 mg), phosphorus (500 mg), and iron (1.0 mg) per 100 grams, most of which come from fine bones and spines that are ground into the dough [15]. Bones are the main source of inorganic compounds such as calcium and phosphorus that contribute to increased ash content [16]. The mineral content of anchovies is much higher than that of indian mackerel (calcium 136 mg, phosphorus 69 mg, iron 0.80 mg) and tonguefish (calcium 30 mg, phosphorus 143 mg, iron 2.0 mg). This high mineral content contributes directly to the high ash content, especially from the elements calcium and phosphorus which are the main components of ash in animal food ingredients [17].

3.3. Protein Content

The results of the analysis of the protein content of fishball chips in Table 1 show that for each type of fish, the higher the frying temperature, the lower the protein content of the fishball chips. The mackerel fishball chip sample with a frying temperature of 70°C produced the highest protein content, which was 35.56%. Meanwhile, the tongue fishball chip sample with a frying temperature of 90°C produced the lowest protein content, which was 23.29%. This can occur because of the relationship between the initial protein content of the raw materials and the fishball product. Indian mackerel showed the highest value among the three types of fish at almost all temperatures, with the protein content of the chips ranging from 35-29%, which is in line with the initial protein content and the highest indian mackerel fish balls. The high protein content in the product not only indicates a large initial protein content but also shows that high-temperature processing of certain types of fish can strengthen the concentration of solid components such as protein in the final product [18].

The analysis showed that the protein content of fishball chips from various types of fish still met the SNI 8272:2016 standard, which is a minimum of 5%. Using the vacuum frying method at low temperatures maintains high protein content. Vacuum frying can maintain nutritional content such as protein, fat, and vitamins [19].

Table 2. Analysis Results of Fat Content and Carbohydrate Content of Fishball Chips

Treatment		Fat (%)	Carbohydrate (%)
Types of Fish	Vacuum Frying Temperature		
Anchovy	70°C	27,43	34,99
	80°C	29,88	33,85
	90°C	33,31	30,73
Indian Mackerel	70°C	17,71	34,76
	80°C	26,80	30,14
	90°C	34,64	25,51
Tonguefish	70°C	17,33	40,08
	80°C	29,89	32,05
	90°C	32,11	34,01

3.4. Fat Content

The Indian mackerel fishball chips sample with a frying temperature of 90°C produced the highest fat content of 34.64%. Meanwhile, the tongue fishball chips sample with a frying temperature of 70°C produced the lowest fat content of 17.33%. The results of the fat content analysis of fishball chips in **Table 2** show that for each type of fish, the higher the frying temperature, the higher the fat content of the fishball chips. This can occur because of the relationship between the initial fat content of the raw materials and the fishball product. The increase in fat content in fishball chips is due to a significant decrease in water content during the frying process. In vacuum frying, low pressure lowers water's boiling point so that water can evaporate at a lower temperature. The higher the frying temperature, the higher the water evaporation rate, causing the product's water content to decrease drastically. As a result, the proportion of other components, such as fat appears to increase, although the absolute amount does not. Increasing the frying temperature in carrot chips with the vacuum frying method causes an increase in fat content due to faster water loss [20]. Increasing the frying temperature in the vacuum frying method on jackfruit causes an increase in fat content and a significant decrease in water content. This indicates that the observed increase in fat content is more related to the relative concentration due to water reduction than to the absorption of additional oil [21].

3.5. Carbohydrate Content

The results of the analysis of carbohydrate content of fishball chips in **Table 2**, show that in each type of fish with the increasing frying temperature, the carbohydrate content of fishball chips will decrease. The sample of tongue fishball chips with a frying temperature of 90°C produced the highest carbohydrate content of 40.08%. While the sample of indian mackerel fishball chips with a frying temperature of 90°C produced the lowest carbohydrate content of 25.51%. This can occur because of the relationship between the initial carbohydrate content of the raw materials and the fishball products. The decrease in the carbohydrate content of fishball chips in each type of fish with the increasing frying temperature can also be caused by a reduction in water content during frying, which can affect the measured carbohydrate content because the lower the water content, the proportion of carbohydrates in the product appears higher. The frying process using the vacuum frying method causes water evaporation in the chips, which impacts increasing other components [19]. The frying or drying process can increase the concentration of carbohydrates in the material. During this process, water is initially bound to molecules such as carbohydrates, which evaporate, increasing the concentration of carbohydrates in the material. This removal of water makes solid components such as carbohydrates appear relatively higher [22].

4. CONCLUSION

Chips tend to absorb a lot of oil during the frying process, and the amount of oil absorbed can affect the chips' taste, texture, and final appearance. Indian Mackerel fishball chips with a frying temperature of 80°C were the best treatment, with moisture content of 4,07%, ash content of 6,19%, protein content of 32,79%, fat content of 26,80%, and carbohydrate content of 30,14%.

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