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THE ADDITION OF SKIPJACK FISH FLOUR AS A SOURCE OF PROTEIN ON TORTILLA CHIPS PREFERENCE LEVEL

Penambahan Tepung Ikan Cakalang Sebagai Sumber Protein Pada Tingkat Kesukaan *Tortilla Chips*

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ABSTRACT

Innovations to increase protein content in tortilla chips can be achieved by adding skipjack tuna flour. This study aims to analyze the percentage of skipjack tuna flour addition in the production of tortilla chips that are most preferred by panelists and to analyze the proximate composition of the most preferred tortilla chips. This study was conducted at the Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, University of Padjadjaran, and the Laboratory of PT Saraswanti Indo Genetech in February 2025. The research method used was experimental with 4 treatments and 25 semi-trained panelists as replicates. The treatments involved adding skipjack tuna flour to tortilla chips at levels of 0%, 7.5%, 10%, and 12.5%. The parameters observed were organoleptic characteristics (appearance, aroma, texture, taste) and chemical characteristics (protein content, ash content, fat content, moisture content, and carbohydrate content). The data obtained will be analyzed using the Friedman test and Bayes' equation. The study concluded that the addition of 12.5% skipjack tuna flour was the most preferred treatment, with an average score of 6.28 for appearance, 7.64 for aroma, 8.04 for texture, and 8.84 for taste. The alternative value for the treatment with 12.5% skipjack tuna flour addition was 8.21. The proximate analysis results of the most preferred tortilla chip treatment showed a protein content of 7.56%, ash content of 1.82%, fat content of 20.67%, moisture content of 4.35%, and carbohydrate content of 65.60%.

Keywords: Fish Flour, Organoleptic, Skipjack, Tortilla Chips

ABSTRAK

Inovasi untuk meningkatkan protein pada makanan ringan *tortilla chips* dapat dilakukan dengan penambahan tepung ikan cakalang. Tujuan dari penelitian ini untuk menganalisis persentase tingkat penambahan tepung ikan cakalang pada pembuatan produk *tortilla chips* yang paling disukai panelis dan menganalisis komposisi proksimat produk *tortilla chips* yang paling disukai. Penelitian telah dilaksanakan di Laboratorium Pengolahan Hasil Perikanan, Fakultas Perikanan dan Ilmu Kelautan Universitas Padjadjaran serta Laboratorium PT

Saraswanti Indo Genetech pada bulan Februari 2025. Penelitian menggunakan metode eksperimental, digunakan 4 perlakuan dan 25 orang panelis semi terlatih sebagai ulangannya. Perlakuan yang digunakan yaitu penambahan tepung ikan cakalang pada *tortilla chips* 0%, 7,5%, 10% dan 12,5%. Pengamatan meliputi karakteristik organoleptik (kenampakan, aroma, tekstur, rasa) dan karakteristik kimiawi (kadar protein, kadar abu, kadar lemak, kadar air dan kadar karbohidrat). Data yang diperoleh akan dianalisis dengan uji friedman dan persamaan *bayes*. Hasil penelitian menyimpulkan penambahan tepung ikan cakalang sebanyak 12,5% merupakan perlakuan paling disukai panelis dengan nilai rata-rata kenampakan 6,28; aroma 7,64; tekstur; 8,04 dan rasa 8,84. Nilai alternatif pada perlakuan paling disukai (12,5%) adalah 8,21. Hasil uji proksimat dari perlakuan *tortilla chips* yang paling disukai mengandung kadar protein sebesar 7,56%, kadar abu 1,82%, kadar lemak 20,67%, kadar air 4,35% dan kadar karbohidrat 65,60%.

Kata Kunci: Ikan Cakalang, Organoleptik, Tepung Ikan, Tortilla Chips

INTRODUCTION

Fish is the second largest source of animal protein after beef, fish has a protein content of 20% and meat has a protein content of 23.20% (Rahma et al., 2024). According to FAO (2024), Indonesia's fish consumption in 2019 was still relatively low. The level of fish consumption of the Indonesian people was at 45.1 kg per capita/year, while Singapore had reached 46.1 kg per capita/year, Malaysia 54 kg per capita/year, South Korea 55.7 kg per capita/year and China reached 71.6 kg per capita/year. Based on production data in the fourth quarter of 2022, the fish commodity with the second highest production volume in the capture fisheries sector was skipjack tuna, with a total of 140,605 thousand tons, which showed a growth of 44.99 (KKP, 2022). According to USDA (2019) in 100 grams of skipjack tuna protein content is 28%. These figures indicate that skipjack tuna's nutritional content is higher than that of other saltwater fish, such as mackerel, mackerel, and salmon. According to Matondang (2022), per 100 grams, the protein content of skipjack tuna is 27%, tuna 26.3%, and salmon 19.9%. Skipjack tuna has a less attractive flesh color, being dark red, making it less attractive in the local market. Skipjack tuna utilization in Indonesia is still limited, such as for smoked skipjack tuna and cakalang floss, necessitating innovations in skipjack tuna processing (Widyastuti et al., 2023). The goal of fish processing is to extend shelf life, transform raw materials into consumer-pleasing products, and maximize raw material utilization (Irianto & Giyatmi, 2014).

Skipjack tuna meat can be processed into food fortifications, one of which is skipjack tuna flour. Skipjack tuna flour is a flour made from skipjack tuna meat through a drying and refining process, which is based on reducing the water content of the meat using high-temperature heating (Nurfitriyani et al., 2024). This process will cause weight loss from the fish meat to fish meal. Fish meal is used because it is easier to mix with other ingredients when compared to adding fish meat and has a longer shelf life than fresh fish, this is because the lower water content, so the spoilage process occurs more slowly (Nurfitriyani et al., 2024). The protein content in skipjack tuna meat is quite high, namely 32.27% (Maulidiah, 2020). Skipjack tuna flour can then be fortified in the manufacture of products such as tortilla chips.

Tortilla chips are a snack made from corn and have a savory taste (Wulandari et al., 2013). They are a popular snack among all age groups, including children, teenagers, and adults (Panjaitan et al., 2020). A 25g serving of commercial tortilla chips contains 16g of carbohydrates, 2g of protein, and 7g of fat. This indicates that the protein content of tortilla chips is quite low. One way to increase protein content is by adding other protein sources, such as fish meal.

Previous research on adding fishery products to tortilla chips has been conducted by

Okfrianti et al. (2013), who conducted a study on the addition of eel (*Anguilla* sp.) meal. Dinnaryanti (2019) conducted a study on the addition of patin fish meat. Based on previous research, the hypothesis was proposed that the most preferred addition of skipjack tuna meal at 10%. Ismanto (2023) stated that food product testing is carried out by considering several aspects such as taste, color, texture, and nutritional content, so a hedonic test is needed to determine the level of skipjack tuna flour addition to tortilla chips that is most preferred by panelists. There has been no further research on the addition of skipjack tuna flour to tortilla chips, therefore further research is needed to determine the percentage of skipjack tuna flour addition to tortilla chips that is most preferred by panelists.

METHODS

Time and Place of Research

The research was conducted from February to March 2025. The research was conducted at the Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University for the production of skipjack tuna flour and tortilla chips. Proximate testing was conducted at the PT. Saraswanti Indo Genetech Laboratory.

Tools and Materials

The tools used in this study were knives, cutting boards, dough containers, calico cloth, Joil digital scales (accuracy 0.01 grams), Kirim KBO-90M electric oven, Miyako BL-102 PL blender, rolling pin, baking paper, tray, steamer, kettle, stove and 100 mesh filter. The materials used were skipjack tuna (weight 1 kg/fish), MUGO instant corn flour, wheat flour, tapioca flour, margarine, salt, sugar, garlic powder, water and cooking oil.

Research Design

The study used an experimental method consisting of four treatments and 25 panelists as replicates. The panelists for the organoleptic test were semi-trained, students from the Faculty of Fisheries and Marine Sciences, Padjadjaran University, who had knowledge and experience conducting organoleptic assessments. The addition of skipjack tuna meal was calculated based on the corn flour used. The percentage additions were as follows:

Treatment A : 0% skipjack tuna meal addition
Treatment B : 7.5% skipjack tuna meal addition
Treatment C : 10% skipjack tuna meal addition
Treatment D : 12.5% skipjack tuna meal addition

Research Procedure

Procedure for Making Skipjack Tuna Meal

According to Yulianti (2018), the process of making skipjack tuna meal is carried out by washing and gutting the skipjack tuna thoroughly, then filleting the fish. The fillets are boiled at 70°C for 10 minutes. The fillets are pressed using calico cloth to remove the water content and shredded to facilitate the drying process. Drying is carried out in an oven at 60°C for approximately 6 hours. Flourization is carried out using a blender. The ground product is then sieved using a 100-mesh sieve.

Tortilla Chip Making Procedure

According to Wahyuni (2008), the procedure for making tortilla chips is to mix skipjack tuna flour, corn flour, tapioca flour, and all the spices in the appropriate proportions and stir until smooth. The dough is flattened using a rolling pin into sheets approximately 1-2 mm thick. The sheets are then formed into triangles using a triangle mold measuring 3.5 cm on each side. The dough pieces are arranged on a baking sheet and baked in an oven at 125°C for 5 minutes,

counting from when the oven reaches 125°C. The dough pieces were fried in hot oil at approximately 100°C for 30-60 seconds, measured when the oil reached approximately 100°C.

Data Analysis

Data analysis was performed using a non-parametric Friedman test to determine the effect of skipjack tuna flour addition on the level of preference for tortilla chips. A multiple comparison test was then conducted to determine the differences between the skipjack tuna flour addition treatments in tortilla chips. The best treatment was determined using Bayesian equations. The proximate test data for the control tortilla chips and the most preferred tortilla chips were analyzed descriptively using SNI 8646:2018 on fish crackers as a comparison.

RESULTS

Yield

Yield is the percentage of product yield from the ratio of the initial weight of raw materials to the final weight (Waluyo et al., 2022). According to Radityo et al. (2014), calculating fish meat yield aims to determine the amount of fish body parts that can be used as food ingredients. This research calculated the yield of skipjack tuna flour and tortilla chips with 0% and 10% skipjack tuna flour additions. The yield results are presented in Table 1.

Table 1. Average Yield of Tortilla Chips

Yield	Results (%)
Fish Meal	14.9
Tortilla chips with 0% skipjack tuna meal	75
Tortilla chips with 10% skipjack tuna meal	76

Appearance

The hedonic test on appearance aims to measure the extent to which panelists accept the product's appearance (Nupu et al., 2023). Appearance assessments of tortilla chips include uniformity, integrity, and color. The average appearance of tortilla chips with added skipjack tuna flour is presented in Table 2.

Table 2. Average Appearance of Tortilla Chips

Skipjack Tuna Flour (%)	Median Value	Average Appearance
0	9	8.04 a
7.5	9	7.88 ab
10	7	6.76 b
12.5	7	6.28 b

Note: Mean values marked with the same letter vertically indicate no significant difference at the 5% comparison level.

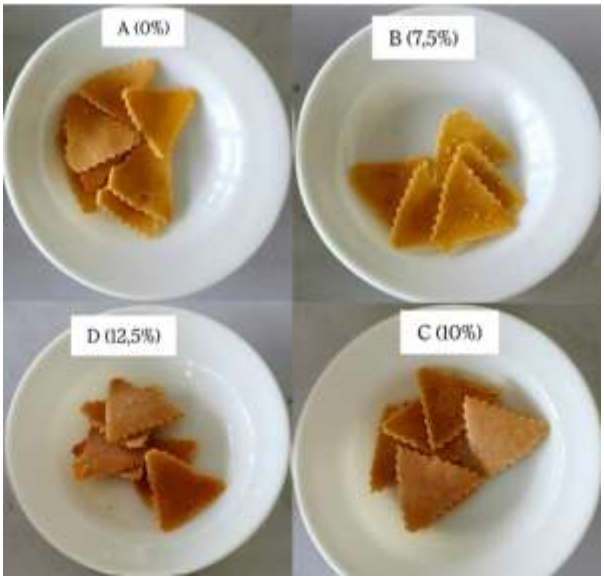

Figure 1. Tortilla Chips with Added Skipjack Tuna Flour

Aroma

Aroma is an important factor in assessing panelists' preference. Aroma plays a role in determining the deliciousness and flavor, which is derived from three main parameters: taste, odor, and mouthfeel (Mardesci & Imaryana, 2021). The average aroma of tortilla chips with added skipjack tuna flour is presented in Table 3.

Table 3. Average Aroma of Tortilla Chips

Skipjack Tuna Flour (%)	Median Value	Average Aroma
0	7	6.92 a
7.5	7	6.68 a
10	7	7.16 a
12.5	7	7.64 a

Note: Mean values marked with the same letter vertically indicate no significant difference at the 5% comparison level.

Texture

Consumers use texture in food products to assess their quality (Hariyadi, 2022). The texture perceived when tasting dry food products is primarily related to the product's level of crispiness. The average texture of tortilla chips with added skipjack tuna flour is presented in Table 4.

Table 4. Average Texture of Tortilla Chips

Skipjack Tuna Flour (%)	Median Value	Average Texture
0	7	7.40 a
7.5	7	6.92 a
10	7	7.64 a
12.5	9	8.04 b

Note: Mean values with the same letter vertically indicate no significant difference at the 5% comparison level.

Taste

Taste plays a crucial role in consumer acceptance of a product; even if other aspects are favorable, if the taste does not meet consumer preferences, the product will still be rejected

(Mardesci & Imaryana, 2021). Flavor arises from chemical stimuli received by the taste buds, namely the tongue (Mardesci & Imaryana, 2021). The average taste of tortilla chips with added skipjack tuna flour is presented in Table 5.

Table 5. Average Taste of Tortilla Chips

Skipjack Tuna Flour (%)	Median Value	Average Taste
0	9	8.04 a
7.5	7	7.72 a
10	7	7.40 a
12.5	9	8.82 a

Note: Mean values with the same letter vertically indicate no significant difference at the 5% comparison level.

Proximate Analysis of Tortilla Chips

Proximate analysis was conducted to identify the protein, ash, water, fat, and carbohydrate content of a sample. Proximate analysis was performed on tortilla chips that had undergone the frying process. The quality standards used for protein, water, and ash content refer to the BSN (2018) for fish crackers, namely SNI 8646:2018. The quality standard used for carbohydrates refers to the quality standards for commercial tortilla chips. The results of the proximate analysis for tortilla chips in the control treatment (0%) and the panelists' most preferred treatment (12.5%) are shown in Table 6.

Table 6. Proximate Analysis of Tortilla Chips

Chemical Content	Treatment	
	0%	12.5%
Protein (%)	3.27	7.56
Ash (%)	2.01	1.82
Fat (%)	18.37	20.67
Water (%)	4.76	4.35
Carbohydrate (%)		

Description: The average value with the same letter vertically shows no significant difference in the comparison test at the 5% level.

DISCUSSION

Yield

Based on research results, 5010 kg of whole skipjack tuna (skipjack tuna) was used to produce a yield of 2090 kg of skipjack tuna fillets. 312 g of fillets were processed into flour, resulting in a yield of 14.9%. The low yield of skipjack tuna meal is due to the reduced weight of the fish fillets due to the loss of water and fat content after the boiling and drying processes. The calculated yield of tortilla chips with 10% skipjack tuna meal was 76%, and the yield of tortilla chips without the addition of skipjack tuna meal was 75%.

The addition of fish meal increases tortilla chip yield because the high protein content in the flour acts as a calcium-binding agent and improves the dough structure. This protein forms complex bonds with calcium, thereby increasing the nutritional content and strengthening the product's texture (Lahagu et al., 2023). The addition of skipjack tuna flour can change the structure of tortilla chips and reduce the water content in the dough, resulting in more porous tortilla chips when fried, and more oil absorption (Lahagu et al., 2023). According to Krista (2017), the yield depends on the product's ability to absorb oil during processing. The product weight increases when the product absorbs more oil, thus increasing the yield.

Appearance

The highest average appearance score was found with 0% skipjack tuna flour, at 8.04, with a median score of 9 (very liked), with a uniform, intact, golden-yellow color. Tortilla chips with 10% skipjack tuna flour had an average appearance score of 6.76 and a median score of 7 (liked), with a uniform, intact, and yellowish-brown color. The lowest average appearance score was 6.28 with a 12.5% addition of skipjack tuna meal, and a median score of 7 (preferred), with a uniform, intact, and brown appearance. Friedman analysis results showed that the 0%, 7.5%, and 10% treatments were not significantly different. The 12.5% and 10% treatments were not significantly different, while the 0% and 7.5% treatments were significantly different from the 12.5% treatment.

One factor influencing the brown color of tortilla chips is the color of skipjack tuna meal. Skipjack tuna meal tends to be darker than other fishmeals, such as those from freshwater fish. Furthermore, the brown color change in tortilla chips containing skipjack tuna meal is also influenced by the Maillard reaction during processing. The Maillard reaction is a non-enzymatic browning process by which amino acid groups (-NH_2)—including amino acids, peptides, or proteins—are linked to the carbonyl group of reducing sugars such as glucose or fructose. This reaction occurs at high temperatures and produces brown pigments called melanoidins (Al-Abbasy et al., 2024). According to Al-Abbasy et al. (2024), the intensity of the brown color that occurs during the Maillard reaction is influenced by several factors, such as temperature >140°C, pH >7, and low water content. Tortilla chips in this study were fried at a temperature of ≥160°C, and according to Souza et al. (2021), snacks with added fish have a pH of 7-7.3. The color change that occurs due to the Maillard process makes tortilla chips brown and is a factor in reducing the dislike of tortilla chips (Febrianto et al., 2014).

Aroma

The highest average aroma value was found with the addition of 12.5% skipjack tuna meal (7.64), with a median value of 7, with a distinctive corn aroma and a savory fishy aroma. The lowest average aroma value was found with the addition of 7.5% skipjack tuna meal (6.68), with a median value of 7, with a distinctive corn aroma and no fishy aroma. Friedman analysis results showed that there was no significant difference between the 0%, 7.5%, 10%, and 12.5% treatments. This may be due to the lack of a strong fishy aroma in tortilla chips and the persistent corn aroma.

The distinctive fishy aroma in tortilla chips comes from the addition of skipjack tuna meal, which contains nitrogen compounds such as guanidine, trimethylamine oxide, and midazole derivatives, which produce a distinctive fishy aroma (Krista, 2017). The lipid and protein content in skipjack tuna meal contributes to the fish's distinctive aroma because lipids readily oxidize during processing, producing volatile compounds such as aldehydes, ketones, and free fatty acids, which contribute to the fish's distinctive aroma (Prasetyo, 2018). Volatile compounds found in skipjack tuna meal originate from the breakdown of protein and fat during storage and processing, including ammonia, trimethylamine (TMA), and dimethylamine (DMA). Furthermore, processing processes such as heating can trigger chemical reactions that enhance these aromas (Krista, 2017).

Texture

The highest average texture score was found with the addition of 12.5% skipjack tuna meal (8.04) and a median of 9, resulting in a crunchy texture. The lowest average texture score was found with the addition of 7.5% (6.92) and a median of 7, resulting in a crunchy and brittle texture. Tortilla chips without the addition of skipjack tuna meal had a crunchy texture. Panelists showed a higher preference for the texture of tortilla chips with the addition of 12.5% skipjack tuna meal, with a difference in average texture scores of 0.64. Based on Friedman's

analysis, the addition of skipjack tuna meal at 0%, 7.5%, and 10% was not significantly different from the 12.5% treatment, as seen in the resulting notation.

The texture of a food product can be determined by the water content and structural carbohydrates such as cellulose, starch, and protein contained in the product (Amalia & Kusharto, 2013). Water content can affect the crispiness of a product. A dry outer layer of the product produces a crunchy texture when bitten, while a water content of <5% can produce a crispy texture in tortilla chips (Chhabra et al., 2017). Starch can affect the texture of a product based on the percentage used. The gelatinization process during dough making can strengthen the product's bonds, and then during baking, the starch undergoes dextrinization, which can form a crispy structure (Chhabra et al., 2017). The protein contained in skipjack tuna meal has been denatured, allowing it to bind with the gelatinized starch from corn and wheat flour, forming a stiff and crispy matrix (Rofiqoh et al., 2024).

Taste

Tortilla chips with 12.5% skipjack tuna meal had the highest average score of 8.82 and a median of 9. They produced a distinctive corn flavor with a savory fish flavor. The lowest average score was found for tortilla chips with 10% skipjack tuna meal, at 7.40, with a median of 7 (preferred), with a distinctive corn flavor and a milder savory fish flavor. Tortilla chips without added skipjack tuna meal had a distinctive corn flavor. Friedman analysis results showed that there were no significant differences between the 0%, 5%, 7.5%, 10%, and 12.5% treatments. The addition of skipjack tuna meal had no significant effect on the taste of the tortilla chips.

Panelist acceptance increased with the increased use of skipjack tuna meal in tortilla chips. This is in line with Jacinda (2018) research, which stated that adding fish surimi flour up to 12.5% can increase panelists' preference levels and decrease with treatment of 15%. The taste of food is formed from a collection of flavors from the food ingredients used. Food products with the addition of fish can produce a distinctive taste because fish contains amino acids such as glutamic acid, lysine, glycine, and alanine (Nursholeh et al., 2022). These amino acids will interact with the reducing sugars contained in the flour during the frying process, thus creating a distinctive taste (Nursholeh et al., 2022). Okfrianti et al. (2013) stated that protein consists of various amino acids, one of which is glutamic acid, which can produce delicious flavors and enhance desired flavors, while reducing undesirable flavors.

Protein Content

Tortilla chips without added skipjack tuna meal have a protein content of 3.27%, while tortilla chips with 12.5% added skipjack tuna meal have a protein content of 7.56%. The increased protein content is due to the addition of protein from skipjack tuna meal. Skipjack tuna meal itself contains 32.27% protein (Maulidiah, 2020). Increasing protein content can affect the characteristics of tortilla chips. Increasing protein in tortilla chips strengthens the gluten network and structure, thereby reducing brittleness. However, adding too much protein can make tortilla chips hard or dry. Increasing protein content can also change the emulsion between water, flour, and oil, affecting oil absorption and texture (Tokarczyk et al., 2025). The results of this study meet the quality requirements for fish crackers according to SNI 8646:2018, which requires a minimum protein content of 2%.

Ash Content

The ash content of tortilla chips without added skipjack tuna meal was 2.01%, higher than the 1.82% ash content of tortilla chips with added skipjack tuna meal. The ash content of tortilla chips is influenced by several factors, such as the composition of the raw materials,

processing methods, and additives. Tortilla chips supplemented with skipjack tuna meal reduce the proportion of corn flour, resulting in a decrease in total ash.

Febrianto et al. (2014) stated that the increase in ash content was due to the high mineral content in the sample, while the decrease in ash content indicated an increase in organic matter content. The skipjack tuna meal used was derived from boneless fillets or heads, which are a source of minerals in fish, resulting in a lower ash content compared to corn flour. The ash content of skipjack tuna meal was 1.96% (Litaay & Santoso, 2013), and according to Lapu et al. (2021), the ash content of yellow corn flour was 4.21%. Processing methods such as frying and drying can affect the ash content of tortilla chips. Frying at high temperatures can trigger the Maillard reaction and the formation of volatile compounds, which then cause the mineral elements in fish to convert into gaseous forms, such as organic phosphate compounds, which undergo partial thermal decomposition due to evaporation (Tamanna & Mahmood, 2014). Based on the quality requirements for fish crackers (SNI 8646:2018), which requires a maximum ash content of 0.3%, this study found that skipjack tuna flour tortilla chips did not meet the quality requirements.

Water Content

The water content of tortilla chips without added skipjack tuna flour was 4.76%, while tortilla chips with 12.5% added skipjack tuna flour decreased to 4.35%. According to Azizah et al. (2021), commercial tortilla chips have a water content of 4.12%, a figure not significantly different from the water content found in the study. Based on the quality requirements for fish crackers (SNI 8646:2018), the maximum water content is 4%, meaning tortilla chips with added skipjack tuna flour do not meet the quality requirements. Raw materials and the processing process of food products can influence the water content. According to Litaay & Santoso (2013), the water content of skipjack tuna flour is 6.04%, and according to Aini et al. (2016), corn flour has a water content of 7.40%. The decrease in water content in tortilla chips containing skipjack tuna flour is caused by the drying process that the skipjack tuna flour has undergone, resulting in a lower water content. This is in line with the statement of Handoko et al. (2022) that the length of cooking time can affect water content, the longer the cooking time, the lower the water content.

Fat Content

The fat content of tortilla chips without skipjack tuna meal was 18.37%, according to proximate testing. This value is lower than that of tortilla chips with 12.5% skipjack tuna meal, which was 20.67%. This value is not significantly different from research by Azizah et al. (2021), which found that barracuda fortification of tortilla chips resulted in a fat content of 20.13%. These results align closely with SNI 8646:2018, which stipulates a maximum fat content of 30%. Based on these quality requirements, the fat content of tortilla chips with skipjack tuna meal can be considered to meet the requirements.

The increased fat content in tortilla chips is due to the addition of skipjack tuna meal, which has a higher fat content than corn flour. According to Aini et al. (2016), corn flour has a fat content of 1.6%, and according to Litaay & Santoso (2013), skipjack tuna meal has a fat content of 1.95%. The frying process of tortilla chips also contributes to increased fat content. The frying process reduces water content and absorbs oil into the tortilla chips (Azizah et al., 2021). This increase in fat content can also be attributed to the protein from skipjack tuna meal acting as a fat-binding agent, allowing fat to bind easily within the product matrix (Lahagu et al., 2023). Increasing fat content can affect the characteristics of tortilla chips. Increasing fat content tends to make tortilla chips crispier and tastier, as fat acts as a lubricant in the food matrix and influences the product's crispiness (Breemer et al., 2023).

Carbohydrate Content

Carbohydrate content was calculated using the by-difference method, subtracting the sum of protein, fat, and ash from the total of 100%. The resulting carbohydrate content represents a proportion of the overall proximate analysis results. The carbohydrate content of tortilla chips without the addition of skipjack tuna meal was 71.14%, but decreased to 65.60% with the addition of skipjack tuna meal. These results are not significantly different from Jacinda (2018) study, which found that the carbohydrate content of tortilla chips without fish meal and with 12.5% addition of swordfish meal was 74.82% and 69.82%, respectively. Commercial tortilla chips also had a similar carbohydrate content, at 62.11% (Azizah et al., 2021).

The decrease in carbohydrate content is due to the use of fish meal as a protein source, replacing corn meal. The addition of skipjack tuna meal to tortilla chips reduces the carbohydrate content while increasing the protein content. The decrease in carbohydrate content in tortilla chips, both without and with the addition of skipjack tuna meal, occurs because the carbohydrate calculation uses the by-difference method.

CONCLUSION

Based on the research results, it can be concluded that:

1) The panelists' most preferred treatment was tortilla chips with 12.5% skipjack tuna meal, based on a hedonic test with average values for appearance, aroma, texture, and taste of 6.28; 7.64; 8.04, and 8.84, respectively. The alternative value for the 12.5% skipjack tuna meal treatment was 8.21. The 12.5% skipjack tuna meal treatment was superior in aroma, texture, and taste characteristics.
2) The proximate test results for the most preferred tortilla chip treatment revealed a protein content of 7.56%, ash content of 1.82%, fat content of 20.67%, moisture content of 4.35%, and carbohydrate content of 65.60%.
3) The panelists' preference for the 12.5% skipjack tuna meal addition was not in line with the hypothesis of 10%. One influencing factor is the difference in the commodities used. In addition, the shorter interval of skipjack tuna meal addition allows for more specific information to be obtained.

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REFERENCES

Aini, N., Wijonarko, G., & Sustriawan, B. (2016). Sifat Fisik, Kimia, dan Fungsional Tepung Jagung yang Diproses Melalui Fermentasi. *Jurnal Agritech*, *36*(02), 160. https://doi.org/10.22146/agritech.12860

Azizah, A., Purwandhani, S. N., & Laswati, D. T. (2021). Fortifikasi Ikan Barakuda (Sphyraena jello) dalam Pembuatan *Tortilla Chips*. *Agrotech : Jurnal Ilmiah Teknologi Pertanian*, *3*(2), 18–26. https://doi.org/10.37631/agrotech.v3i2.280

BSN. (2018). *Kerupuk Ikan, Udang dan Moluska Siap Makan*. SNI. https://akses-sni.bsn.go.id/viewsni/baca/8613

FAO. (2024). Fishery and Aquaculture Statistics – Yearbook 2021. In *FAO*. FAO. 27 Agustus 2024. https://doi.org/10.4060/cc9523en

Febrianto, A., Basito, & Anam, C. (2014). Kajian Karakteristik Fisikokimia Dan Sensoris Tortilla Corn Chips Dengan Variasi Larutan Alkali Pada Proses Nikstamalisasi Jagung. *Jurnal Teknosains Pangan*, *3*(3), 22–34.

Handoko, Y. P., Sari, R. U., Mokhtar, M. K., & Atmaja, R. D. (2022). Pengolahan dan Karakteristik Mutu Rengginang dengan Penambahan Daging Ikan Cakalang (*Katsuwonus pelamis*). *Prosiding Simposium Nasional IX Kelautan dan Perikanan Fakultas Ilmu Kelautan dan Perikanan*, *2024*, hlm.153–160.

Hariyadi, P. (2022). *Tekstur : Tantangan Reformulasi Pangan Olahan*. Bogor: IPB University.

Irianto, H. E., & Giyatmi, S. (2015). *Teknologi Pengolahan Hasil Perikanan*. Tanggerang: Universitas Terbuka.

Ismanto, H. (2023). Uji Organoleptik Keripik Udang (L. vannamei) Hasil Penggorengan Vakum. *Jurnal AgroSainTa: Widyaiswara Mandiri Membangun Bangsa*, *6*(2), 53–58. https://doi.org/10.51589/ags.v6i2.3137

Jacinda, A. K. (2018). *Pengaruh Penambahan Tepung Surimi Ikan Cucut Terhadap Karakteristik Organoleptik dan Kimia Tortilla Chips*. Jatinangor:Universitas Padjadjaran.

Kementrian Kelautan dan Perikanan. (2022). Data Kelautan dan Perikanan Triwulan IV Tahun 2022. *Pusat Data, Statistik Dan Informasi. Sekretariat Jenderal Kementrian Kelautan dan Perikanan*, 15 *April* 2022, hlm. 1–4.

Krista, A. (2017). *Penambahan Tepung Ikan Kuniran (Upeneus. moluccensis) dan Nano Kalsium dari Tulang Ikan Bandeng (Chanos chanos) terhadap Mutu dan Kandungan Kalsium Tortilla Chips.* Malang:Universitas Brawijaya. http://repository.ub.ac.id/id/eprint/135756/

Lapu, A. R., Nopriani, U., & Mongi, H. (2021). Analisis kandungan nutrisi tepung jagung (Zea mays Lam) dari Desa Uedele Kecamatan Tojo Kabupaten Tojo Una-Una untuk pakan ternak. *Jurnal Agropet*, *18*(2), 42–46.

Litaay, C., & Santoso, J. (2013). Pengaruh Perbedaan Metode Perendaman dan Lama Perendaman terhadap Karakteristik Fisiko-Kimia Tepung Ikan Cakalang (Katsuwonus pelamis). *Jurnal Ilmu dan Teknologi Kelautan Tropis*, *5*(1), 85–92.

Mardesci, H., & Imaryana, I. (2021). Karakterisitik Organoleptik Bakso Ikan Gabus Dengan Penambahan Pati Jagung dan Tepung Tapioka. *Marinade*, *4*(01), 16–23. https://doi.org/10.31629/marinade.v4i01.3413

Matondang, S. E. (2022). Comparison of Protein Levels in Freshwater Fish and Saltwater Fish. *LAVOISER : Chemistry Education Journal*, *1*(1), 1–10.

Maulidiah, I. R. (2020). *Pemanfaatan Limbah Ikan Cakalang (Katsuwonus pelamis) Sebagai Alternatif Tepung Ikan Pada Pembuatan Pakan Ikan Lele Dumbo (Clarias gariepinus)*. Jember: Universitas Jember.

Nupu, A. K., Mile, L., & Yusuf, N. (2023). Analisis Organoleptik Hedonik Sambal Ikan Layang Asin Kering dengan Penambahan Rumput Laut. *Jurnal Ilmiah Perikanan Dan Kelautan*, *11*(3), 103–110.

Nurfitriyani, A., Triyastuti, M. S., Shitophyta, L. M., Wahidi, B. R., & Mukhaimin, I. (2024). Perhitungan Kadar Air, Rendemen dan Uji Organoleptik Pada Ikan Asin. *Media Teknologi Hasil Perikanan*, *12*(1), 45–55. https://doi.org/10.35800/mthp.12.1.2024.53300

Okfrianti, Y., Kamsiah, K., & Veli, D. G. (2013). Pengaruh Penambahan Tepung Ikan Sidat (Anguilla Spp) Pada Pembuatan *Tortilla Chip*s Terhadap Nilai Gizi, Kadar Air Dan Daya Terima Organoleptik. *Jurnal Sain Peternakan Indonesia*, *8*(2), 139–152. https://doi.org/10.31186/jspi.id.8.2.139-152

Panjaitan, P. S., Panjaitan, T. F., Siregar, A. N., & Sipahutar, Y. H. (2020). Karakteristik Mutu Tortila Dengan Penambahan Rumput Laut (*Eucheuma cottonii*). *Aurelia Journal*, *2*(1), 73–68. https://doi.org/10.15578/aj.v2i1.9406

Permadi, A., Salampessy, R. B. S., Waluyo, W., Gumilang, A. P., Sri Utami, D. A., & Dharmayanti, N. (2022). Optimalisasi Rendemen Ikan Tuna (*Thunnus* Sp.) Loin Beku

Dengan Metode Kaizen di PT. X-Jakarta Utara. *Barakuda 45: Jurnal Ilmu Perikanan Dan Kelautan*, *4*(1), 52–64. https://doi.org/10.47685/barakuda45.v4i1.222

Radityo, C. T., Darmanto, Y., & Romadhon. (2014). Pengaruh Penambahan Egg White Powder dengan Konsentrasi 3% Terhadap Kemampuan Pembentukan Gel Surimi dari Berbagai Jenis Ikan. *Jurnal Pengolahan dan Bioteknologi Hasil Perikanan*, *3*(4), 1–9.

Rahma, A. A., Nurlaela, R. S., Meilani, A., Saryono, Z. P., & Pajrin, A. D. (2024). Ikan Sebagai Sumber Protein dan Gizi Berkualitas Tinggi Bagi Kesehatan Tubuh Manusia. *Karimah Tauhid*, *3*(3), 3132–3142. https://doi.org/10.30997/karimahtauhid.v3i3.12341

USDA. (2019). *Food Data Central : Finfish and Shellfish Product*. Agricultural Research Service. 27 Agustus 2024. https://fdc.nal.usda.gov/fdc-app.html#/food-details/172005/nutrients

Widyastuti, A., Rumkorem, O. L. Y., & Pattipeilohy, A. (2023). Pengabdian Kepada Masyarakat Inovasi Pengembangan Produk Hasil Olahan Ikan Cakalang Kepada Masyarakat Kampung Sorido. *Jurnal Pengabdian Masyarakat Kauniah*, *1*(2), 188–195. https://doi.org/10.33096/jamka.v1i2.195

Wulandari, Z., Hidayar, R., & Polii, B. (2013). Karakteristik fisik dan organoleptik tortilla corn chips dengan penambahan tepung putih telur sebagai sumber protein. *Jurnal Ilmu Produksi dan Teknologi Hasil Perternakan*, *01*(1), 37–41. https://jadinti.uitm.edu.my/images/Volume21_2016/JurnalINTI16.pdf