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THE EFFECT OF ADDING MILKFISH FLOUR ON THE PREFERENCE LEVEL OF *CIRENG*

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ABSTRACT

The enhancement of the nutritional content in Cireng can be achieved by adding milkfish meat flour. This study aims to determine the appropriate amount of milkfish flour to add in the preparation of Cireng to produce the product most preferred by the panelists. The method used was experimental, with four treatments: 0%, 2.5%, 5%, and 7.5% addition of milkfish flour. The parameters observed included preference analysis using a hedonic test to assess appearance, aroma, texture, and taste, as well as proximate analysis and Texture Profile Analyzer (TPA) to evaluate chemical composition and texture characteristics. The results showed that the 5% milkfish flour treatment produced the most preferred Cireng, with the highest average hedonic scores across all sensory attributes: 7.13 for appearance, 7.07 for aroma, 7.80 for texture, and 7.07 for taste. Proximate analysis results showed protein content (3.11%), ash content (0.73%), fat content (0.83%), moisture content (45.36%), and carbohydrate content (48.79%). The TPA results indicated an increase in hardness (1,104.188 gForce) and recovery (0.996%), but a decrease in cohesiveness (0.430%), chewiness (455.576 gForce), gumminess (478.129 gForce), and resilience (0.631%).

Keywords: Belat fishing gear, Income, Kampung Laut Water's

INTRODUCTION

Milkfish is one of the main commodities in aquaculture that has experienced an increase in annual production. In 2022, the production of milkfish in Indonesia reached 785,719 tons, with a value of IDR 16.53 trillion, reflecting a 0.12% increase compared to the previous year (Central Statistics Agency, 2023). The protein content of milkfish ranges from 20–24%, which is higher compared to catfish (17.7%), goldfish (16%), and snakehead fish (20%). In addition, milkfish is also rich in Omega-3, which is essential for human health (Hafiludin, 2015; Syah et al., 2018).

However, milkfish has a disadvantage in the form of numerous bones scattered throughout its body, making it difficult to consume directly. One solution is to process milkfish into semi-finished products such as flour, which can be used to enhance the nutritional content of various food products.

Cireng, short for *"aci digoreng"*, is a popular snack made from tapioca flour in West Java. Cireng has a chewy texture and a savory taste that is favored by many people, particularly children (Solang et al., 2017). Its low nutritional content (50 grams of carbohydrates, 0.5 grams of protein, and 0.3 grams of fat per 100 grams

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of tapioca flour) makes Cireng a potential product for nutritional enhancement through added ingredients (Realita and Kristiastuti, 2014; Solang et al., 2017), such as milkfish meat flour.

The addition of milkfish flour to Cireng is expected to improve its nutritional content. A product with good nutrition is not always accepted by consumers, indicating that food testing should not only focus on its chemical aspects but also consider taste and aroma, as these are factors that affect consumer acceptance (Wardani et al., 2012; Rokhana and Bebilla, 2016). The acceptance of food can be influenced by preference levels. The higher the preference for the food served, the greater the acceptance of that food. On the other hand, if the preference is low, the acceptance will also decrease (Nuraeni and Ilmaknun, 2021).

Therefore, this study was conducted to identify the optimal concentration of milkfish flour that can be added to Cireng in order to enhance its nutritional value while maintaining high consumer acceptance based on hedonic testing.

MATERIAL AND METHOD

This research was conducted from September to November 2024. The process of making milkfish meat flour, preparing Cireng, and conducting the hedonic test were carried out at the Fishery Product Processing Laboratory, Universitas Padjadjaran. Proximate testing was conducted at the Food Technology Laboratory, Universitas Pasundan, Bandung, while the Texture Profile Analysis (TPA) test was performed at the Testing Laboratory, Faculty of Agricultural Industrial Technology (FTIP), Universitas Padjadjaran.

The materials used in this study included 2 kg of fresh milkfish, 2 kg of tapioca flour, 250 g of table salt, 250 g of green onions, 250 g of garlic, and 5 liters of drinking water. The tools used for making milkfish meat flour included a digital scale, oven, knife, cutting board, spoon, 80-mesh sieve, grinder, and airtight plastic bags. For the preparation of Cireng, the tools used included a pot, frying pan, spoon, basin, digital scale, and stove.

This study used an experimental method with four treatments of milkfish meat flour addition in Cireng: no addition of milkfish flour (0% as control), 2.5%, 5%, and 7.5% additions. Each treatment was tested on 30 semi-trained panelists, consisting of students from the Faculty of Fisheries and Marine Science, Universitas Padjadjaran. The panelists had basic knowledge of organoleptic testing.

The research procedure began with the preparation of milkfish meat flour, based on a modified method from Sari et al. (2020). Fresh milkfish was cleaned and steamed at 80°C for 10 minutes. Afterward, the fish meat was separated from the bones and dried using an oven at 50°C for five hours. The dried meat was then ground

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using a grinder for 10 minutes until it became flour, and then it was sifted through an 80-mesh sieve.

The preparation of Cireng followed the method by Imran et al. (2023), with modifications. Garlic was crushed using a chopper for 5 minutes, while green onions were chopped and then mixed in a 30 cm diameter container. Tapioca flour, milkfish meat flour, and salt were added and mixed thoroughly. A total of 250 ml of water was heated to 90°C and then gradually poured into the mixture while stirring until it became smooth. The dough was formed into flat round shapes (10 grams each) and then fried in hot oil (150°C, 2 minutes). After that, the temperature was lowered to 130°C until the Cireng turned golden white.

The base formulation used in the preparation of Cireng followed the method from Imran et al. (2023), as shown in Table 1. This formulation was modified by adding the predetermined amounts of milkfish meat flour: A (0%), B (2.5%), C (5%), and D (7.5%) based on the amount of tapioca flour.

Tabel 1. Ingredients for making Cireng

Ingredient	Quantity (g)
Tapioca Flour	250
Salt	5
Green Onion	10
Garlic	10
Drinking Water	250

Source: Imran *et al.* (2023)

Observations in this study include preference test, proximate analysis, and Texture Profile Analysis (TPA). The preference test was conducted by asking panelists to evaluate the appearance, aroma, texture, and taste of *cireng* using a hedonic scale ranging from 1 (very dislike) to 9 (very like). Proximate analysis was used to measure the water, ash, protein, fat, and carbohydrate content in *cireng* with the best treatment and the control. TPA was used to measure physical parameters such as hardness, springiness, cohesiveness, gumminess, chewiness, and resilience. The data from the preference test were analyzed using the Friedman test with multiple comparison tests to determine significant differences between samples. Meanwhile, the results of the proximate analysis and TPA were analyzed descriptively and comparatively.

RESULTS AND DISCUSSION

Preference Test

Appearance

The results of the appearance test showed that treatment A (0%) with a white color had the highest score (8.13), while treatment D (7.5%) with a yellowish color had the lowest score (6.87). Further analysis revealed that treatment A differed significantly from treatments C (5%) and D (7.5%), but not from treatment B (2.5%). The results of the appearance test on *cireng* with the addition of milkfish flour can be seen in Table 2.

Table 2. Average preference scores for the appearance attribute of *cireng* with various additions of milkfish meat flour

Treatment	Median	Average Appearance Score
A (0%)	9	8.13 b
B (2.5%)	7	7.27 ab
C (5%)	7	7.13 a
D (7.5%)	7	6.87 a

Note: Different letters in the group column indicate significant differences between treatments based on a multiple comparison test at a 5% confidence level.

The decrease in the scores for the treatments with added fish meat flour is likely due to a change in color, becoming more yellow due to the higher content of fish flour. This reduction may reduce the visual appeal. The appearance of the *cireng* with added milkfish meat flour can be seen in Figure 1.

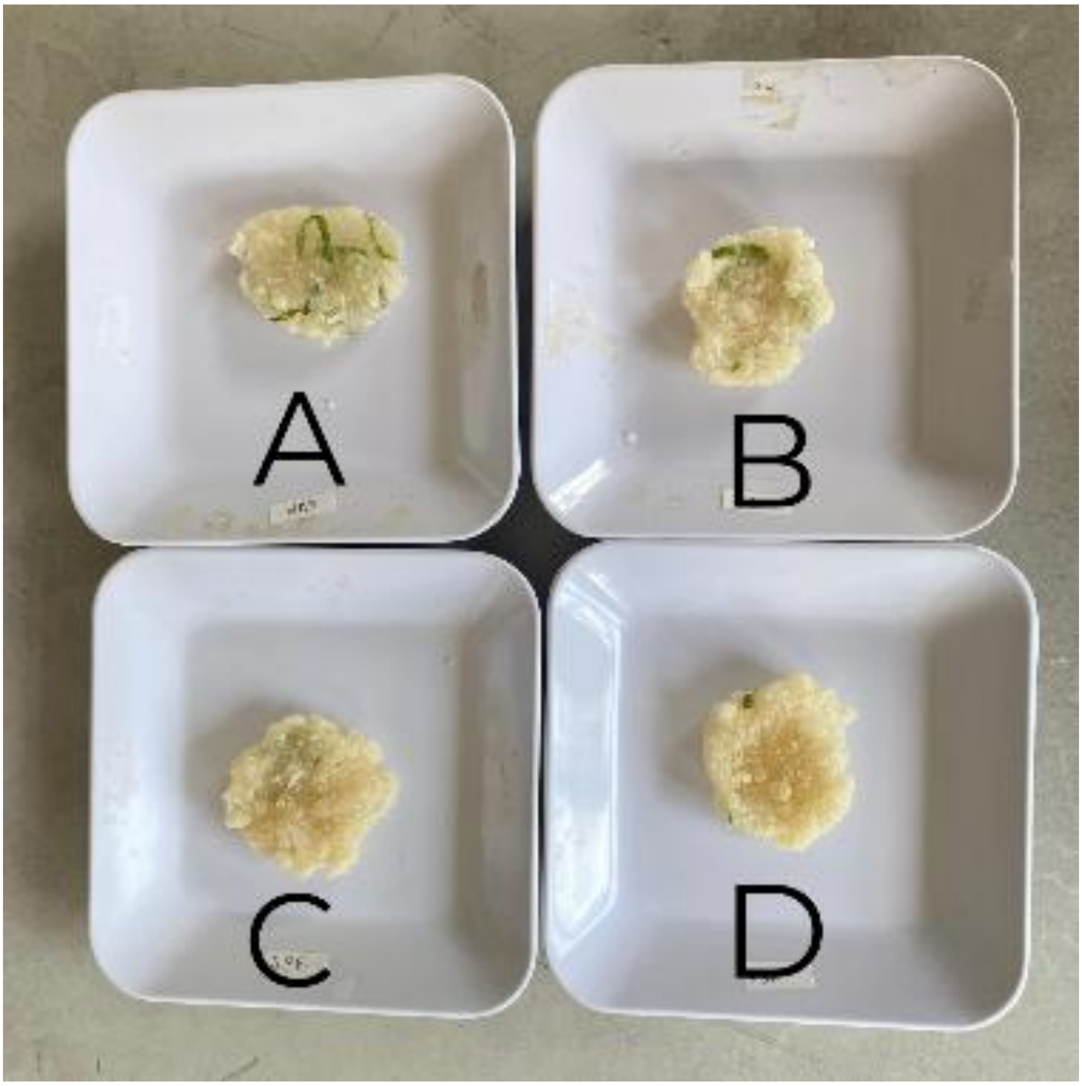

Figure 1. Appearance of *Cireng* after frying: A (0%) without milkfish meat flour, B (2.5%), C (5%), and D (7.5%) with the addition of milkfish meat flour according to the respective percentages

The color change in *cireng* is likely due to the Maillard reaction, which occurs as a result of the interaction between sugars in tapioca flour and proteins in the milkfish meat flour during

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frying (Törős et al., 2023; Al-Abbasy et al., 2024). A study by Karneta & Kartina (2023) demonstrated that the higher the protein content in tapioca flour-based products, the more intense the browning due to the Maillard reaction. This was also supported by Andhikawati & Akbarsyah (2022), who found that the combination of carbohydrates in tapioca flour and amino acids from fish influences the color of fish meatballs through the Maillard reaction.

Aroma

The preference scores for the aroma of *cireng* ranged from 6.67 to 7.27, indicating that the aroma was still acceptable to the panelists. The highest score (7.27) was found in the control (0%) and the treatment with a 7.5% addition of milkfish meat flour. The complete data on the average preference scores for the aroma attribute for each treatment are presented in Table 3.

Table 3. Average Preference Scores for the Aroma Attribute of *Cireng* with Various Additions of Milkfish Meat Flour.

Treatment	Median	Average Aroma Score
A (0%)	7	7.27 a
B (2.5%)	7	6.67 a
C (5%)	7	7.07 a
D (7.5%)	7	7.27 a

Note: Different letters in the group column indicate significant differences between treatments based on a multiple comparison test at a 5% confidence level.

Treatment A (0%) has a characteristic sulfuric aroma of garlic and scallions, while in Treatments B, C, and D, this aroma is likely overshadowed by the characteristic scent of milkfish. The interaction of volatile compounds from garlic and fish creates a unique combination of aromas (Kuncoro et al., 2019; Al-Abbasy et al., 2024).

In Treatment D (7.5%), the aroma is more pronounced due to the higher content of volatile fish compounds such as trimethylamine and dimethylamine (Liu et al., 2024). The phospholipid reaction produces trimethylamine (TMA), which can enhance the characteristic fish aroma but may potentially lead to an overly fishy smell if it continues (Dharma et al., 2014; Faroj, 2019). This finding is consistent with Faroj's (2019) research, which showed that the substitution of anchovy fish flour in pies increased the intensity of the aroma.

Hedonic testing indicates that the addition of milkfish meat flour did not significantly affect the aroma preference in the Friedman analysis at the 5% level. This result is consistent with Rochima et al. (2015), who reported that fish bone flour did not affect the aroma of *pempek*, as well as Faroj (2019), who found similar results in modified pie formulations.

Texture

Cireng generally has a crispy texture on the outside and chewy on the inside (Astuti et al., 2022; Imran et al., 2023). The results of the hedonic test show that the addition of milkfish meat flour (0–7.5%) did not significantly affect the texture preference of *cireng* (Friedman, p >

0.05). The average panelist preference scores for texture ranged from 6.40 to 7.80, indicating that the texture of *cireng* in all treatments was still liked by the panelists.

Table 4. Average Preference Scores for the Texture Attribute of *Cireng* with Various Additions of Milkfish Meat Flour

Treatment	Median	Average Texture
A (0%)	7	6.40 a
B (2.5%)	7	7.13 a
C (5%)	7	7.80 a
D (7.5%)	7	7.33 a

Note: Different letters in the group column indicate significant differences between treatments based on a multiple comparison test at a 5% confidence level.

The texture of *cireng* is crisper up to the 5% milkfish meat flour concentration due to the interaction between protein, starch, and water during cooking (Darmawansyah et al., 2018). Solang et al. (2017) also found that the protein in clam flour improves the texture of *cireng*. However, at 7.5%, the higher protein content increases water retention, reduces porosity, and makes the texture denser (Putra et al., 2015).

Taste

Taste is an important attribute in food quality, perceived by the tongue receptors (Nuraeni & Ilmaknun, 2021). Hedonic testing with a Friedman analysis ($p < 0.05$) showed that the addition of milkfish meat flour (0%, 2.5%, 5%, 7.5%) significantly affected the panelists' preference scores. The average scores ranged from 6.33 to 7.47, with the 2.5% concentration resulting in the highest score (7.47). However, at 5% and 7.5%, the preference scores decreased to 7.07. The results of the taste test for *cireng* with the addition of milkfish meat flour are shown in Table 5.

Table 5. Average Preference Scores for the Taste Attribute of *Cireng* with Various Additions of Milkfish Meat Flour

Treatment	Median	Average Taste
A (0%)	7	6.33 a
B (2.5%)	7	7.47 b
C (5%)	7	7.07 a
D (7.5%)	7	7.07 a

Note: Different letters in the group column indicate significant differences between treatments based on a multiple comparison test at a 5% confidence level.

The preference for taste increased at the 2.5% concentration but decreased at 5% and 7.5%, likely due to the stronger fish flavor. Volatile compounds such as trimethylamine and free fatty acids (Liu et al., 2024) are suspected to intensify the characteristic fish flavor, which is accepted by some panelists but too dominant for others. These findings align with Solang et al. (2017), who reported that the addition of clam flour also decreased the taste score due to an increase in its unique flavor intensity.

Proximate Analysis

Proximate analysis includes the measurement of moisture, protein, fat, ash, and carbohydrate content in *cireng* with a control treatment (0%) and a treatment with the addition of 5% milkfish meat flour. The treatments were tested on raw samples to avoid oil interference during frying. Detailed results of the proximate analysis for the control treatment

(0%) and the most preferred treatment (5%) are presented in Table 6.

Table 6. Proximate Test Results of *Cireng* Control and Most Preferred Treatment.

Parameter	Treatment	
	0%	5%
Protein	0.53	3.11
Water	48.14	45.36
Ash	0.42	0.73
Fat	0.56	0.83
Carbohydrate	49.36	48.79

Protein Content

Protein is an essential nutrient that plays a role in body development (Solang et al., 2017). Proximate analysis showed an increase in protein content in *cireng* with the addition of milkfish meat flour, from 0.53% (no flour) to 3.11% (5% treatment). This increase influences the organoleptic properties, including appearance, aroma, texture, and taste.

The appearance of *cireng* became more yellow, likely due to the Maillard reaction between protein and reducing sugars during frying, producing melanoidins (Nurhayati et al., 2019). The fish aroma became stronger due to volatile compounds such as trimethylamine and dimethylamine released during heating (Liu et al., 2024).

The texture of *cireng* changed likely due to the increase in protein, which is hydrophobic and forms a firmer network during cooking. Protein denaturation due to temperature and cooking time also affected the organoleptic characteristics (Natsir & Latifa, 2018; Sumandiarsa et al., 2020). The taste of *cireng* became more complex, similar to findings by Karneta & Kartina (2023) on *pempek*, where amino acids like glutamate, proline, and arginine contribute to the savory (umami) taste (Sood et al., 2024; Sahlan et al., 2018; Pratama et al., 2018).

Moisture Content

Moisture content affects the quality and shelf life of food, with lower moisture reducing the risk of microbiological spoilage (Musa & Lawal, 2013; Akhmadi et al., 2019). Proximate analysis showed a decrease in moisture content from 48.14% (control) to 45.36% (5% milkfish meat flour addition).

This decrease was due to the hydrophilic properties of the protein in the milkfish flour, which absorbs water and forms hydrogen bonds (Yuliani et al., 2018; Kaswanto et al., 2019). The interaction between the protein and starch granules in the tapioca flour creates a matrix that retains water, but competition with salts and other proteins reduces free water, resulting in lower moisture in the final product (Imanningsih, 2012).

Ash Content

Ash content indicates the mineral content in food (Permatasari et al., 2020; Husain et al., 2023). Proximate analysis showed an increase in ash content from 0.42% (control) to 0.73% (5% milkfish meat flour addition).

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Milkfish meat contains phosphorus, calcium, and magnesium, with 100 g of fresh fish containing around 150 mg of phosphorus and 120 mg of calcium (Hafiludin, 2015; Syifa et al., 2013). Processing the fish into flour increases the mineral concentration due to the reduced moisture content.

The increase in ash content contributes to the intake of important minerals (Syah et al., 2018), but it may also affect taste. Increased minerals can lead to a salty or metallic taste, as found by Rochima et al. (2015) in *pempek* with fish bone flour, which had a slightly chalky aftertaste.

Fat Content

Fat content plays a role in the absorption of fat-soluble vitamins, metabolism, and hormone formation, as well as influencing texture and flavor (Husain et al., 2023). Proximate analysis showed an increase in fat content from 0.56% (without milkfish meat flour) to 0.83% in the most preferred formulation.

This increase is due to the milkfish meat flour, which contains 4.8% fat per 100 g (Husain et al., 2023). However, the fat content remains low because the sample was not fried, so oil did not contribute to the final fat content. Additionally, the amount of fish flour used was limited. According to BPOM No. 1 of 2022, this *cireng* can be classified as a low-fat product.

Carbohydrate Content

Carbohydrates are the primary energy source that supports brain function (Husain et al., 2023). During cooking, starch hydrolysis due to high temperature and enzymes from fish produces dextrins, maltose, and glucose (Yong, 2019; Karneta & Kartina, 2023).

Proximate analysis showed a decrease in carbohydrate content from 49.38% (control) to 48.79% in *cireng* with milkfish meat flour. This decrease is due to the lower carbohydrate content in fish flour compared to tapioca flour (Kaswanto et al., 2019; Putra et al., 2015).

The difference in calculation methods also affected this result, as the increase in protein and fat automatically reduces the percentage of carbohydrates (Husain et al., 2023). The reduction in carbohydrates could make the texture crispier, consistent with Karneta and Kartina's (2023) findings, which showed that the dominance of protein in the dough increases hardness and chewiness due to the formation of a less elastic gel.

Texture Profile Analysis (TPA)

TPA includes the measurement of hardness, springiness, cohesiveness, gumminess, chewiness, and resilience in *cireng* with the control treatment (0%) and the treatment with 5% milkfish meat flour. Detailed results of the Texture Profile Analysis for the control treatment (0%) and the most preferred treatment (5%) are shown in Table 7.

Table 7. Results of the Texture Profile Analyzer Test for *Cireng* Control and Most Preferred Treatment

Parameter	Treatment	
	0%	5%
Hardness (gForce)	640.030	1.104.188
Springiness (%)	0.986	0.996
Cohesiveness (%)	0.766	0.430
Gumminess (gForce)	492.850	478.129
Chewiness (gForce)	485.774	455.576
Resilience (%)	0.765	0.631

Hardness

The Texture Profile Analysis (TPA) test shows that the hardness of cireng increased from 640.030 gForce (without fish meat flour) to 1,104.188 gForce in the most preferred formulation. This increase is attributed to the protein content in the fish flour, which interacts with the starch network, consistent with findings from Syadeto et al. (2017) in Kaswanto et al. (2019), which showed an increase in hardness values when fish meat flour was added to the product.

The gelatinization of starch results in a chewier texture due to strong bonds between protein, amylose, and water. The protein in fish flour also increases peak viscosity during heating, accelerates gel formation, but lowers viscosity at low temperatures, making the texture firmer and less elastic (Imanningsih, 2012).

This finding differs from research by Karneta and Kartina (2023), which showed that in pempek (a traditional fish cake), dextrin increased at low temperatures, making the fish dough softer. In contrast, the study by Putra et al. (2015) suggested that the high protein content in fish bone flour increased the hardness of crackers by inhibiting water release.

Springiness

Springiness measures the product's ability to return to its original form after pressure is released and is an important parameter in texture analysis. The TPA test shows that the springiness value of cireng increased slightly from 0.986% (control) to 0.996% (with 5% fish meat flour addition), a change that is very small and likely insignificant.

This difference is likely influenced by the interaction between tapioca starch and the protein in fish flour, which forms a gel structure during cooking, contributing to the elasticity of the product. This finding is in line with Bryant et al. (1995), who stated that protein content in the dough affects the product’s elasticity.

Cohesiveness

Cohesiveness measures the compactness of the dough and its resistance to being chewed. The TPA test shows that adding 5% fish meat flour decreased the cohesiveness of cireng from 0.766% (control) to 0.430%, making it less compact.

This decrease is likely due to changes in the dough composition, where the increased protein and fat content reduce the molecular interactions between starch and protein (Anindyajati et al., 2022; Kaswanto et al., 2019). As a result, cireng becomes more fragile when chewed, making it easier to swallow because its textural resistance decreases (Liu et al., 2017).

Gumminess

Gumminess is the combination of hardness and cohesiveness that indicates the effort required to chew food until it is ready to be swallowed (Indiarto et al., 2012). The TPA test shows that adding 5% fish meat flour decreased the gumminess of cireng from 492.850 gForce (control) to 478.129 gForce.

This decrease is related to the hydrophobic fat properties in fish flour (14.48%) that interfere with the interaction between starch and protein, making the dough less compact (Sari et al., 2020; Chen et al., 2023). In line with the decrease in cohesiveness, the cireng texture becomes more brittle and requires less effort to chew (Liu et al., 2017).

Chewiness

Chewiness measures the effort required to chew food until it is ready to be swallowed. The TPA test shows that adding 5% fish meat flour decreased the chewiness of cireng from 485.774 gForce (control) to 455.576 gForce.

This decrease appears to contradict the increase in hardness, but it can be explained by the reduced cohesiveness, making the cireng easier to break down during chewing (Liu et al., 2017). The protein in the fish flour, which has undergone denaturation due to drying, reduces gel formation (Dehnad et al., 2016), while the hydrophobic fat properties disrupt the interaction between starch and protein (Chen et al., 2023), making the texture less compact and easier to chew.

Resilience

Resilience measures the ability of the product to return to its original shape after pressure is released. The TPA test shows that adding 5% fish meat flour decreased the resilience of cireng from 0.765% (control) to 0.631%, making it more brittle.

Unlike springiness, which measures elasticity, resilience measures the rate of shape recovery (Bryant et al., 1995). This decrease is caused by the protein in fish flour, which has undergone denaturation during drying, reducing its elasticity, along with the fat content disrupting the interaction between starch and protein, weakening the dough structure (Chen et al., 2023; Schefer et al., 2021; Scott & Awika, 2023).

CONCLUSION

Based on the research results, adding 5% fish meat flour resulted in cireng with the highest preference score from the panelists. The texture attribute received the highest score of 7.80, followed by appearance (7.13), aroma (7.07), and taste (7.07). In addition to improving sensory appeal, the addition of fish meat flour also increased the nutritional content of cireng, with protein content reaching 3.11% and fat content 0.83%. In terms of physical characteristics, the addition of 5% fish meat flour increased hardness to 1,104.188 gForce and springiness to 0.996%, but caused a decrease in cohesiveness to 0.430%, chewiness to 455.576 gForce, gumminess to 478.129 gForce, and resilience to 0.631%.

These findings demonstrate that incorporating fish meat flour into traditional snacks can enhance both their nutritional value and consumer acceptability, making it a promising strategy for developing functional food products.

SUGGESTION

Based on the findings of this study, it is recommended to apply the formulation with the addition of 5% fish meat flour in the production of cireng to obtain a product with optimal sensory quality and nutritional value. Further studies can be conducted to explore the effects of various other ingredients to enhance organoleptic characteristics and nutritional content.

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