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# THE EFFECT OF MILKFISH (*Chanos chanos*) BONE FLOUR FORTIFICATION ON THE PHYSICOCHEMICAL CHARACTERISTICS AND ACCEPTABILITY OF WHITE BREAD

Pengaruh Fortifikasi Tepung Tulang Ikan Bandeng (*Chanos chanos*) Terhadap Karakteristik Fisikokimia dan Daya Terima Roti Tawar

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## ABSTRACT

Milkfish bone waste is a by product of the fisheries industry that has not been fully utilized, despite its high calcium and protein content, making it a potential ingredient for food fortification. Meanwhile, white bread, a widely consumed food in the community, is known to have low calcium content. This study aims to evaluate the effect of adding milkfish bone flour on the physicochemical characteristics and consumer acceptability of white bread. The research was conducted using a Completely Randomized Design (CRD) with five levels of fortification concentration: 0%, 2.5%, 5%, 7.5%, and 10%, each with four replications. The parameters analyzed included moisture, protein, ash, and calcium content, as well as texture attributes such as hardness, cohesiveness, springiness, and chewiness, along with hedonic tests for color, taste, texture, and aroma. The results showed that fortification with milkfish bone flour had a significant effect ($p<0.05$) on most parameters, except for color. Increasing the fortification concentration resulted in higher protein, ash, and calcium levels, while moisture content and certain texture parameters decreased. The best treatment was found at 5% fortification (P2), based on Bayes analysis, with the highest scores across all parameters. The addition of 5% milkfish bone flour was proven to enhance the nutritional content of white bread without reducing consumer acceptance, while also promoting the functional and economic utilization of fishery waste.

**Keywords:** Acceptability, Calcium, Fortification, Milkfish Bone, White Bread

## ABSTRAK

Limbah tulang ikan bandeng ialah produk sampingan dari industri perikanan yang belum termanfaatkan secara maksimal. Produk tersebut terdapat kandungan kalsium dan protein tinggi sehingga potensial diolah sebagai bahan fortifikasi pangan. Roti tawar sebagai makanan yang populer di masyarakat diketahui rendah akan kandungan kalsium. Penelitian ini bertujuan guna mengkaji pengaruh penambahan tepung tulang ikan bandeng terhadap karakteristik fisikokimia dan tingkat kesukaan konsumen pada roti tawar. Penelitian menggunakan metode

Rancangan Acak Lengkap (RAL) dengan lima tingkat konsentrasi fortifikasi, yakni 0%, 2,5%, 5%, 7,5%, dan 10%, masing-masing dengan empat kali ulangan. Parameter ujinya meliputi kadar air, protein, abu, dan kalsium, serta atribut tekstur seperti *hardness*, *cohesiveness*, *springiness*, dan *chewiness*, disertai uji hedonik pada warna, rasa, tekstur, dan aroma. Hasil menunjukkan bahwa fortifikasi tepung tulang ikan bandeng berpengaruh signifikan ($p<0,05$) terhadap sebagian besar parameter, kecuali warna. Peningkatan konsentrasi fortifikasi menyebabkan naiknya kadar protein, abu, dan kalsium, namun menurunkan kadar air dan beberapa parameter tekstur. Perlakuan terbaik diperoleh pada fortifikasi 5% (P2) berdasarkan analisis Bayes, dengan skor tertinggi pada seluruh parameter. Fortifikasi tepung tulang ikan bandeng sebesar 5% terbukti mampu memperkaya kandungan gizi roti tawar tanpa mengurangi tingkat kesukaan konsumen, serta menjadi upaya pemanfaatan limbah perikanan yang fungsional dan bernilai ekonomi.

**Kata Kunci:** Roti Tawar, Fortifikasi, Tulang Ikan Bandeng, Kalsium, Daya Terima

## INTRODUCTION

Milkfish offers significant potential for use as a raw material in a variety of processed products (Fitri et al., 2016). Its role is not only as a source of consumption but also plays a crucial role in food security, particularly in diversifying local foods to meet the community's nutritional needs (Balubi et al., 2024). The milkfish processing industry produces approximately 15 kg of bone waste daily. This amount can reach 5.4 tons per year (Brilyan & Choirul, 2017). The food processing industry often neglects to utilize certain parts of the fish, such as the head, tail, fins, bones, and innards (Fitri et al., 2016). This waste can cause environmental pollution if not reprocessed (Bakhtiar et al., 2019).

The initial step in its utilization is to process the fish bones into flour through a grinding process. This flour product has the potential to be a source of calcium and phosphorus, which can be used to meet the human body's mineral needs. Its applications are quite broad, including in processed foods such as semi-finished products, biscuits, bread, and pastries (Bakhtiar et al., 2019). Imra et al. (2019) reported that milkfish bone meal contains 14.31% moisture, 13.55% ash, 4.1% fat, 5.63% protein, and 38.15% carbohydrate. Fish bone meal production in Indonesia adheres to the provisions stipulated in SNI 01-2715-1996 as a quality standard.

White bread is a type of food product frequently consumed by the public in a variety of types, flavors, and shapes. This bread is often used as an alternative to rice and is acceptable for all ages, from children to adults (Adam et al., 2020). The problem with white bread, which has long been popular with the public, is that it has limited health benefits. This condition occurs because the main ingredient, white flour, has undergone a processing process that results in the loss of some of its nutritional content. These products serve more as a snack than as a source of healthy nutrition (Rahmayani et al., 2017). Bread is generally high in fat and carbohydrates (Defira, 2019). The proportion of minerals, such as calcium, tends to be lower. Milkfish bones are known to contain high amounts of calcium, making them a key mineral source. This can be considered an alternative source to meet calcium needs (Mulyani et al., 2021). Calcium's function in the body is to help build strong bones and bones. Calcium deficiency can cause gradual tooth and bone decay, leading to osteoporosis in old age (Abidin et al., 2016).

According to Pusuma et al. (2018), Indonesia is currently still dependent on wheat imports due to increasing flour demand. According to data from the United States Department of Agriculture (USDA) (2024), wheat imports increased by more than 12 million tons in 2023/2024. To reduce wheat imports and improve public nutrition, it is necessary to reduce the consumption of wheat flour in bread making. One solution to this problem is to replace some of the wheat flour (fortification) with milkfish bone meal. This research is expected to provide

useful insights for the food industry in developing healthier and more sustainable bread products. This research not only contributes to improving public nutrition but also supports the sustainability of fishery resources.

## METHODS

### Research Time and Location

This research will take place from December 2024 to May 2025, at the Food and Chemistry Laboratory, Faculty of Fisheries and Marine Sciences, Airlangga University.

### Research Equipment

The equipment used includes a basin, oven, mixer, analytical balance, Soxhlet apparatus, UV-Vis spectrophotometer, and texture analyzer.

### Research Materials

The main ingredients used include wheat flour, milkfish bone meal, yeast, egg yolk, water, butter, sugar, milk powder, salt, and bread improver. Chemicals for analysis include $H_2SO_4$, $K_2SO_4$, $CuSO_4$, NaOH, HCl, $HNO_3$, chloroform, distilled water, and indicators such as bromocresol green and methyl red.

### Research Procedure

Based on modifications from the research by Afandi et al. (2024), the working procedure begins with the preparation of milkfish bones. Milkfish bone waste was cleaned, boiled at 80°C for 90 minutes, and then soaked in a lime solution for three days. After washing, the bones were steamed in a pressure cooker at 121°C for two hours, then oven-dried at 70°C for five hours. The next step was grinding and sifting through an 80-mesh sieve.

The bread product was made by mixing the ingredients according to the formulation. Yeast activation was performed first, followed by mixing the wet and dry ingredients. The next step was kneading for five minutes and fermentation for 75 minutes. Baking was carried out at 180°C for 25 minutes after the dough had risen and was then poured into the pan. The treatment varied the concentration of milkfish bone meal according to the research design.

### Research Design

This study used a quantitative method with a Completely Randomized Design (CRD), consisting of five milkfish bone meal fortification treatments (0%, 2.5%, 5%, 7.5%, and 10%), each with four replications. A similar study was conducted by Nugroho et al. (2016) using African catfish meat at concentrations of 15%, 12.5%, 10%, and 0%. The results of proximate and hedonic tests revealed that the best concentration of fish meat meal addition was 10%.

### Data Analysis

The collected data included measurements of the ratio scale for water content, ash content, protein content, calcium content, and texture. All data were statistically analyzed using Analysis of Variance (ANOVA) at a 95% confidence level in SPSS. If significant differences were found, the analysis was continued with Duncan's test. Hedonic test data were analyzed using the nonparametric Kruskal-Wallis method and continued with the Post Hoc Mann-Whitney test at the same confidence level.

## RESULTS

The research results consisted of proximate tests, texture tests, and hedonic tests. The proximate test was conducted to determine the moisture, protein, ash, and calcium content of the product. The texture test was used to determine the hardness, cohesiveness, springiness,

and chewiness of the white bread. The hedonic test was conducted to analyze panelist satisfaction with the white bread with the addition of milkfish bone meal.

**Analysis of White Bread Product Acceptability**

Table 1. Average Results of Hedonic Tests of White Bread Products

| Parameter | Treatment | Average Results ± SD (%) |
|---|---|---|
| Color | P0 | 4.13± 0.50[a] |
| | P1 | 3.80± 0.96[a] |
| | P2 | 4.17± 0.69[a] |
| | P3 | 3.93± 0.94[a] |
| | P4 | 3.73± 0.78[a] |
| Taste | P0 | 4.00± 0.69[a] |
| | P1 | 3.97± 0.76[a] |
| | P2 | 3.50± 0.90[b] |
| | P3 | 3.40± 1.00[b] |
| | P4 | 3.00± 1.01[b] |
| Texture | P0 | 3.60± 0.85[ac] |
| | P1 | 3.83± 0.83[ab] |
| | P2 | 4.23± 0.72[b] |
| | P3 | 3.67± 0.95[ac] |
| | P4 | 3.20± 0.96[c] |
| Aroma | P0 | 4.20± 0.66[a] |
| | P1 | 4.23± 0.62[a] |
| | P2 | 3.47± 0.90[b] |
| | P3 | 3.53± 0.90[b] |
| | P4 | 3.43± 1.07[b] |

Description: 1 = very dislike, 2 = dislike, 3 = quite like, 4 = like, 5 = very like. Different superscript letters indicate significant differences between treatments ($p<0.05$). Similar letters a, b indicates no significant difference at the 5% Mann-Whitney test level.

**Physical Analysis of White Bread Products**

Table 2. Physical Test Results of Milkfish Bone Flour White Bread

| Parameter | Treatment | | | | |
|---|---|---|---|---|---|
| | P0:0% | P1:2.5% | P2:5% | P3:7.5% | P4:10% |
| Hardness | 251.26±4.74[e] | 333.98±10.51[d] | 357.24±3.27[c] | 387.89±4.16[b] | 411.06±1.67[a] |
| Cohesiveness | 4.92±0.08[a] | 4.54±0.12[b] | 4.12±0.18[c] | 3.88±0.04[d] | 3.67±0.06[e] |
| Springiness | 1.85±0.11[a] | 1.72±0.13[ab] | 1.75±0.20[ab] | 1.59±0.11[b] | 1.36±0.10[c] |
| Chewiness | 2500.18±9.66[a] | 2320.05±12.13[b] | 2166.86±17.06[c] | 1978.95±12.55[d] | 1802.23±8.99[e] |

Note: Different superscript letters indicate a significant difference between treatments ($p<0.05$), while the same superscript letter indicates no significant difference ($p>0.05$).

**Chemical Analysis of White Bread Products**

Table 3. Proximate and Calcium Test Results for Milkfish Bone Flour White Bread

| Parameter | Treatment | | | | |
|---|---|---|---|---|---|
| | P0:0% | P1:2.5% | P2:5% | P3:7.5% | P4:10% |
| Water (%) | 35.19±0.15$^{a}$ | 34.13±0.33$^{b}$ | 33.00±0.23$^{c}$ | 31.82±0.25$^{d}$ | 30.92±0.12$^{e}$ |
| Protein (%) | 12.92±0.10$^{c}$ | 13.72±0.10$^{b}$ | 13.63±0.16$^{b}$ | 13.69±0.19$^{b}$ | 14.17±0.08$^{a}$ |
| Ash (%) | 1.00±0.06$^{e}$ | 1.36±0.04$^{d}$ | 1.80±0.06$^{c}$ | 2.25±0.06$^{b}$ | 2.80±0.03$^{a}$ |
| Calcium (%) | 5.98±0.11$^{e}$ | 6.40±0.03$^{d}$ | 6.83±0.07$^{c}$ | 8.01±0.93$^{b}$ | 10.30±0.41$^{a}$ |

Description: Different superscript letter notations indicate that there is a significant difference between the treatments ($p<0.05$), while the same superscript letter indicates that the treatments are not significantly different ($p>0.05$).

## DISCUSSION

Based on the acceptability analysis of the color parameters of white bread, the addition of milkfish bone flour did not show any significant differences between treatments ($p>0.05$). This is because the concentration of fish bone flour added to the product tends to be low. The final color appearance of the product tends to be determined by other additional components used during the processing process (Sulistiyati & Mawaddah, 2021). The Kruskal-Wallis test indicates that milkfish bone flour fortification significantly affects the taste of white bread ($p<0.05$), where increasing the flour concentration tends to decrease the taste preference by panelists (Andayani et al., 2022). According to Mukhaimin et al. (2022), the taste of white bread is highly dependent on the type and proportion of ingredients used in the formulation process. The taste of an ingredient is influenced by its texture and concentration (Mayangsari et al., 2018). The addition of high concentrations tends to reduce the textural quality of white bread (Yanti et al., 2024). Based on the Kruskal-Wallis test, the addition of milkfish bone meal also had a significant effect ($p<0.05$) on the aroma of white bread. Research conducted by Ratnaningtyas et al. (2024) showed that panelists' preference decreased with increasing amounts of catfish bone meal added due to differences in olfactory sensitivity.

The addition of milkfish bone meal (*Chanos chanos*) had a significant impact ($P<0.05$) on physical parameters tested using a texture analyzer, such as hardness, cohesiveness, springiness, and chewiness. This result indicates that increasing the fortification concentration causes gradual changes in the texture characteristics of white bread. Higher hardness values indicate a harder product texture (Sumartini et al., 2024). Bread cohesiveness also tended to decrease with the addition of composite flour to the formulation (Millar et al., 2019). A more compact bread is also more resistant to disintegration when chewed (Olojede et al., 2022). The reduced gluten content in the sample results in a decrease in the dough's gas-holding capacity. This can reduce elasticity and decrease springiness (Amelia et al., 2020). The chewiness parameter values ranged from 2500.18 to 1802.23 N. The chewiness results indicate a decrease in the chewability of white bread products. Widyaningrum et al. (2024) reported that the level of chewiness is significantly related to several other texture parameters, namely hardness, cohesiveness, and springiness. Chewiness is also significantly influenced by the elastic strength of the protein network in the product.

Fortification with milkfish bone meal significantly affected ($P<0.05$) the proximate test results, particularly moisture, ash, protein, and calcium content. Alisa et al. (2023) explained that the addition of fish bone meal to dough can reduce water content because the calcium content in it has the ability to bind water. The protein content in white bread also tends to increase with increasing fortification concentration, with values ranging from 12.92% to 14.17%. According to Sumartini et al. (2024), the protein content of the final product is influenced by several factors, including the initial protein content of the raw materials,

processing techniques, baking temperature and duration, additives, and chemical reactions during the production process.

The ash content found in this study ranged from 1.00 to 2.80%. This value is still within the maximum limit set by SNI (1995), which is 3% for white bread products. The average ash content increased in line with the increase in milkfish bone meal concentration, from P0 (0%) to P4 (10%). This increase was due to the high ash content in the milkfish bone meal itself (Kaswanto et al., 2019). The addition of fish bone meal also increased the calcium content in the product. The even distribution of bone meal in the dough also increased the calcium content because fish bones are rich in minerals and calcium. The product's calcium content increased with increasing flour addition (Sulistiyati & Mawaddah, 2021).

The Bayes test involved 30 panelists who were asked to provide their opinions (Yurian et al., 2025). The Bayesian method resulted in the best formula being the P2 treatment with 5% milkfish bone meal fortification. Chemical assessment of the P2 treatment showed a 13.63% increase in protein and 6.83% in calcium, significantly higher than the control. The texture of the bread in the P2 treatment showed high springiness, moderate cohesiveness, and moderate chewiness. Hedonic tests showed that P2 obtained the highest value for texture parameters and remained acceptable in terms of color, aroma, and taste. Good-quality white bread is characterized by a golden-brown crust, a bright interior, a distinctive bread aroma, a savory taste, and a soft texture (Shiddiq et al., 2023).

## CONCLUSION

Based on the research that has been done, it can be concluded that fortification of white bread with milkfish bone flour (*Chanos chanos*) significantly affects ($P<0.05$) the hedonic value of taste, texture, and aroma, but the color does not show a significant difference ($P>0.05$). The addition of milkfish bone flour shows a significant effect on the physicochemical testing of white bread. Based on the Bayes method, the best treatment was obtained at a concentration of 5% (P2).

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