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Effect of Shrimp Shell Flour Substitution on *Croissant* Liking Level

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This research aims to determine the effect of different ratios of shrimp shell flour and wheat flour in making croissants on the level of panelist preference. This research was conducted at the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University in September 2022. The method used in the research is the experimental method with the treatment of four different ratios of the use of wheat flour and shrimp shell flour, namely 100% wheat flour, 2.5% shrimp shell flour: 97.5% wheat flour, 5%: 95% and 7.5%: 92.5% with 20 panelists as replicates. The parameters tested were appearance, aroma, texture, and taste. Data processing used Friedman test and Bayes test. Observations made were hedonic tests including appearance, aroma, texture, and taste as well as chemical tests in the form of proximate and calcium content tests. The results showed that croissants with a usage ratio of 5% shrimp shell flour: 95% wheat flour is the most preferred treatment by panelists with an average value of appearance 7.10; aroma 7.00; texture 6.70; and taste 7.40; calcium 289.591 mg/100g.

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1. INTRODUCTION

Croissant is a pastry product derived from folded dough that is similar to puff pastry with the characteristic layered and crescent-shaped (French), meaning crescent in Indonesian, but there are also horn-shaped [1]. According to a survey, 15 out of 20 bakeries, cafés, and minimarkets in Bandung City sell croissants. This shows that the delicious taste and thin texture of croissants make them popular as snacks, especially for tea and coffee.

Making *croissants* cannot be separated from the use of wheat flour. Products that have flour as the main raw material are a source of carbohydrates and tend to have low calcium levels [2]. *Croissants* themselves usually have calcium levels of around 40-80 mg/100 g depending on the ingredients used. Calcium is one of the macro minerals, which is a mineral needed by the body in amounts of more than 100mg/day [3]. The average calcium intake of Indonesian people ranges from 260-300 mg per day. The recommended calcium requirement for Indonesians based on age group is 500 mg per day for children under the age of ten, 1000 mg per day for adolescents, 1150 mg per day for pregnant women, and 800 mg per day for adults, both men and women [4]. To increase calcium levels in *croissant* products, it is necessary to add or substitute other ingredients that have high calcium levels, example shrimp skin.

The utilization of processed fishery waste is currently still not optimal, especially the utilization of head, tail, fin, bone, shell, and digestive organ waste. Along with the development of the fishing industry, the waste produced also increases [5]. One of the fishery products that produce large amounts of waste is shrimp. The proportion of shrimp waste generated from shrimp processing is 30%-75% which is wasted without being processed and even causes pollution. The amount is very large for the size of industrial waste [6]. This is unfortunate because shrimp waste contains high nutrition in the form of protein 42.23%, fiber 19.87%, fat 2.89%, calcium 13.23%, phosphorus 2.08%, and chitin 9.56%.

Food testing is not only seen from the chemical aspect, but also from the taste and aroma [7]. Therefore, it is important to test the level of liking to find out whether a new product can be accepted by the public or not. Research on the substitution of shrimp skin flour has been conducted in the form of *luchisan biscuit products* [8]. Based on this research, it can be concluded that *luchisan biscuit* products with a substitution of shrimp skin flour of more than 10% have an influence on color, while on aroma, taste, texture, and overall not much different from products without substitution. Based on the description above, a study will be conducted on the effect of substituting shrimp shell flour for wheat flour in making *croissants to* find the most preferred product.

2. MATERIALS AND METHODS

The tools used in this study consisted of analytical scales, cake scales, basin, rolling pin, mixer, electric oven, square pan, knife, zipper bag, refrigerator, and 500ml measuring cup. The ingredients used in this research are wheat flour, shrimp skin flour, butter, yeast, salt, water, and milk. The method used in this research is an experimental method with four treatments and 20 panelists as replicates:

1) Treatment A : 0% shrimp shell flour and 100% wheat flour
2) Treatment B : 2.5% shrimp shell flour and 97.5% wheat flour
3) Treatment C : 5% shrimp shell flour and 95% wheat flour
4) Treatment D : 7.5% shrimp shell flour and 92.5% wheat flour

This treatment was repeated 20 times according to the number of panelists used. The panelists were students of the Faculty of Fisheries and Marine Science, Padjadjaran University. Hedonic test data will be analyzed using *Friedman's* two-way variant, with *Chi-square* test. The best decision from a number of treatments will be made using the *Bayes* method.

2.1 Procedure

The formulation of ingredients in the manufacture is presented in Table 1.

Table 1. *Croissant* making formulation

Material				
	A	**B**	**C**	**D**
Wheat Flour	500g	487,5g	475g	462,5g
Butter	375g	375g	375g	375g
Yeast	7.5g	7.5g	7.5g	7.5g
Salt	7.5g	7.5g	7.5g	7.5g
Water	150ml	150ml	150ml	150ml
Milk Powder	15g	15g	15g	15g
Shrimp shell flour	0g	12.5g	25g	37.5g
Sugar	25g	25g	25g	25g

2.1.1 Preparation of shrimp shell meal

The preparation of shrimp skin flour starting with washing and cutting shrimp skin into small pieces, then shrimp skin is boiled for 12 hours then dried in an oven at 121^{o} C for 60 minutes, after drying it is then blended and mashed with a 100 mesh sieve so that shrimp skin flour is obtained [9].

2.1.2 Croissant making

The preparation of shrimp skin flour which was modified in this study, starting with mixing wheat flour, butter, yeast, salt, water, milk powder, shrimp skin flour with concentrations as much as control, 2.5%, 5%, 7.5%, and sugar using a mixer until mixed and smooth. After it is smooth, the dough is then stored in the refrigerator using a *ziplock* with a temperature of 1 -4^{oo} C for one hour, the dough that has been stored for one hour is then rolled out to form a circle and the butter is placed in the center of the dough and then folded towards the center, the dough is again rolled out to form a rectangle with a length of 35x10 cm, then 1/3 of the dough is folded to the center and the remaining 1/3 of the dough is folded back to the center so that they stack each other (single fold) and then stored in the refrigerator. The process is repeated up to three times. The dough that has been removed from the refrigerator is then rolled out until it is about 4-7mm thick, then cut into triangles using a knife (bottom 15cm wide), then the dough is rolled from the widest part then allowed to rise, smeared with egg then baked in the oven at 210 -220^{oo} C for about 15-17 minutes [10].

2.2 Hedonic Test

Hedonic test was conducted on the final croissant product using the consumer preference test. Hedonic test includes organoleptic testing which includes characteristics of appearance, aroma, texture and taste. This test aims to get the best concentration based on the choice (preference) of semi trained panelists conducted by 20 people. Panelists' assessment of the parameters is indicated by a numerical rating on a scale of one to seven, where 1 = very dislike, 3 = dislike, 5 = neutral, 7 = like, 9 = very like [11]. The requirements for hedonic test panelists are not hungry or full, not sick, not in a state of stress or intoxication. Before testing will be briefed, the rules of the test procedure, and a sample organoleptic form.

2.3 Data Analysis

Data obtained from hedonic tests on appearance, taste, aroma, and texture of croissants were analyzed by Friedman's two-way variant with Chi-squared test. The aim was to determine the effect of treatment on the level of liking of croissant products. The statistical formula used in the Friedman test is as follows:

$$X_r^2 = \left[\frac{12}{(nxk)(k+1)} x \sum_{j=1}^{k}(Rj)^2\right] - [(3n)(k+1)]$$

Description:

X = Friedman test statistics
N = replication
K = treatment
Rj^2 = total ranking of each treatment

If there is the same number, the correction factor (FK) is calculated using the following formula:

$$FK = 1 - \frac{T}{N^3 - N}$$

$$X_e^2 = \frac{X^2}{FK}$$

The significance value of the observation price X_e^2 can be found by using the Chi-Quadrat critical prices table with db = k-1; α = 0.05.

H_0 = treatments did not give significant differences at the α = 0,05
H_1 = treatments did not give significant differences at the α = 0,05

If the value of $X_n^2 < Xt_{(a,k-1)2,}$ then H0 is accepted and H1 is rejected, if $X_n^2 > Xt_{(a,k-1)2}$, then H0 is rejected and H1 is accepted. If H1 is accepted, then further analysis will be carried out using multiple compression. The goal is to find out the difference between treatments. The multiple comparison test has the following formula:

$$|\overline{Ri} - \overline{Rj}| \leq Z_{\left\{\frac{a}{k(k-1)}\right\}}^{\sqrt{bk(k+1)/6}}$$

| Ri-Rj | = Number of Ranks b = Number of replicates
Ri = Number of ranks of the i-th sample k = Number of treatments
Rj = Total rank of the jth sample
α = Experiment wise error

The best treatment decision maker based on appearance, taste, texture, and aroma uses the Bayes method. The Bayes method is used to determine the best treatment. The Bayes method is one of the techniques used to analyze in making the best decision from a number of alternatives or treatments by considering criteria [12]. Decision making with the Bayes method is quantifying the likelihood of an event occurring and is expressed by a number between 0 and 1. The Bayes equation used to calculate the value of each alternative is simplified as follows:

Total score I = Σ - score ij (criteria ij)

Description:

Total value I = total final value of the i-th alternative
Value ij = value of the 1st alternative on the jth criterion
i = number of alternatives.

The probability value obtained from initial information can be subjective or objective. The value of this probability can be improved with additional information obtained from several trials. The initial information about the probability value is called the prior distribution, the probability value being improved with additional information is called the posterior probability.

The Bayes method procedure is as follows:

1. Data obtained through experimental results can be used in the decision-making process.
2. The decision is sought by first calculating the posterior probability distribution of θ for each X = x
3. Choose the action that minimizes the expected loss $l_n(a)$ similar to the risk statement including the trial cost.
4. The θ discretized calculation of the expected loss is:

$$l_n(a) = E\ [\ (l\ (a,0)] = \ \Sigma\ l\ (a,k)\ h_{\theta\ |\ X=x}(k)$$

$h_{\theta\ |\ X\ =\ x}(k)$ is the discrete posterior probability distribution

5. For continuous θ, the posterior probability distribution is expressed as hθ | X = x (y), with the loss calculation being:

$$l_n(a) = E\ [\ (l\ (a,0)]$$
$$= \int_{\infty}^{\infty} l\ (a,y)\ h_{\theta\ |\ X=x}\ (y)dy$$

Data obtained from calcium tests were taken from croissant products with 0% shrimp shell flour concentration (as control) and also the most preferred one. The data obtained were analyzed descriptively.

3. RESULTS AND DISCUSSION

3.1 Hedonic Test Croissant

Organoleptic analysis is a sensory assessment using the human senses or five senses with the aim of measuring and observing product development such as appearance, aroma, taste, and texture.

3.1.1 Appearance

The results of observations on the appearance of *croissants* are presented in Table 2.

Table 2. Average croissant appearance based on treatment

Treatment	Median	Average
A	5	5,50[ab]
B	7	6,70[b]
C	8	7,10[b]
D	5	5,00[a]

Fig. 1. The appearance of *croissants* with various treatments

Based on the results of the study for the appearance aspect of 0% shrimp skin flour substitution *croissants, the* average value was 5.50, 2.5% substitution obtained an average value of 6.70, 5% substitution obtained an average value of 7.10, while 7.5% substitution obtained an average value of 5.00. The results of the assessment with the *Friedman* test showed that there was a significant effect on the *croissant* substitution of shrimp skin flour on the appearance aspect. *Croissant* treatment A was not significantly different from treatment B, C, and D. Treatment B was not significantly different from treatment C but significantly different from treatment D. Treatment C was significantly different from treatment D. The following *croissant appearance is* presented in Fig. 1.

The color of *croissants* with shrimp skin substitution is different from 0% treatment *croissants*. *Croissants* with shrimp shell meal substitution have a brownish yellow color while *croissants* without shrimp shell meal substitution have a yellowish white color. The more levels of shrimp shell flour used, the darker the color of the *croissants*. However, the substitution of shrimp shell flour up to a percentage of 10% is still preferred/accepted by panelists because the percentage of shrimp shell flour substitution used is relatively small. Color changes during baking are influenced by the *Maillard Browing* reaction, which is a brown discoloration reaction caused by the reaction between proteins and carbohydrates [13]. The *Maillard* reaction produces melanoid brown pigments that are influenced by ketones in sugar with amino acids that form glucosylamine. shrimp skin is brownish red because it contains carotenoid pigments. Carotenoids are a group of yellow, yellowish red or dark red pigments, are soluble in oil and are hydrocarbons with many unsaturated fish so that these pigments are easily oxidized.

3.1.2 Aroma

The observation results of the *croissant* aroma are presented in Table 3.

Table 3. Average *Croissant* aroma by treatment

Treatment	Median	Average
A	5	6,00[a]
B	7	7,00[a]
C	7	7,10[a]
D	5	5,80[a]

Based on the results of the study for the aroma aspect of 0% shrimp skin flour substitution *croissants, the* average value was 6.00, 2.5% substitution obtained an average value of 7.00, 5% substitution obtained an average value of 7.10, while 7.5% substitution obtained an average value of 5.80. The results of the assessment with the *Friedman* test found that there was no significant difference in the *croissant* substitution of shrimp skin flour in the aroma aspect. This is in line with research conducted [14] that there is no influence between the substitution of shrimp waste flour and sticks in the aspect of aroma. This is because the level of substitution given is not too high so it does not have a significant effect on the aroma of the stick. Based on the level of liking, all treatments are still preferred by panelists because the average value of the aroma of all treatments is still above the limit of product rejection value.

Croissants in each treatment have almost the same aroma, namely the typical aroma of butter and grill. The difference is in *croissants* with shrimp skin flour substitution, there is a faint smell of shrimp. The grill aroma is caused by heating which triggers the *Maillard* reaction on heterocyclic nitrogen compounds that produce grill aroma. The *butter* aroma is caused by the oxidation of fatty acids during roasting which is a process that occurs at the beta carbon atom producing acetyl CoA, NADH, and FADH2. The distinctive aroma of shrimp is due to biochemical breakdown caused by enzyme activity in the shrimp shell. These enzymes break down or disassemble macromolecular and volatile compounds so that with the substitution of shrimp shell flour in *croissants, the* distinctive aroma of shrimp is more pronounced than without the substitution of shrimp shell flour.

3.1.3 Texture

The observation results of the *croissant* texture are presented in Table 4.

Based on the results of the study for the texture aspect of *croissants with* 0% shrimp shell flour substitution, the average value was 6.90, 2.5% substitution obtained an average value of 7.10, 5% substitution obtained an average value of 6.70, while 7.5% substitution obtained an average value of 6.00. The results of the assessment with the *Friedman* test found that there was no significant difference in the *croissant* substitution of shrimp skin flour in the texture aspect. Based on the results of the *Friedman* test, it can be concluded that there is no influence in the texture aspect. The difference in texture is not significant because the texture results obtained in each treatment are not too far apart. Thus, it can be said that the substitution of shrimp skin flour does not affect the texture of *croissants*.

In general, *croissants* in each treatment have a *flaky* and crunchy texture on the outside and soft on the inside. The volume and type of additives given to wheat flour for the manufacture of a type of food product affect gelatinization and gel strength [15]. The higher the content of shrimp shell flour, the crispier the texture of the *croissant*. The addition of shrimp shell flour results in an anti-elastic reaction that reduces the elastic properties of gluten [16]. The decrease in gluten content will cause the level of crispness of biscuits to be higher [17].

3.1.4 Taste

The observation results of the *croissant* flavor are presented in Table 5.

Based on the results of the study for the flavor aspect of *croissants with* 0% shrimp shell flour substitution, the average value was 7.00, 2.5% substitution obtained an average value of 7.10, 5% substitution obtained an average value of 7.40, while 7.5% substitution obtained an average value of 5.70. The results of the assessment with the *Friedman* test showed that there was no significant difference in the *croissant* substitution of shrimp skin flour in the aspect of taste. The higher the fortification of shrimp shell meal up to 5% treatment, the higher the average value of *croissant* flavor. *Croissants* with shrimp shell meal substitution up to 7.5% were still accepted/liked by the panelists.

Table 4. Average *Croissant* Texture by Treatment

Treatment	Median	Average
A	7	6,90[a]
B	7	7,10[a]
C	7	6,70[a]
D	6	6,00[a]

Table 5. Average *Croissant* taste by treatment

Treatment	Median	Average
A	7	7,00[a]
B	7	7,10[a]
C	7	7,40[a]
D	5	5,70[a]

Generally, *croissants* have a savory taste caused by the concentration of proteins and electrolytes. In addition, *croissants* have a distinctive salty flavor resulting from butter roasting [18]. Amino acids contained in shrimp shell protein include the amino acids methionine (sulfur, *meaty,* slightly sweet*,* cysteine (sulfur), and tryptophan (bitter and sweet) so that the taste of *croissants* with shrimp shell flour substitution is different from *croissants in the* 0% treatment [19].

3.1.4 Decision making with bayes method

The completion of the results of pairwise comparisons carried out by matrix manipulation to determine the weight of appearance, aroma, taste, and texture of *croissants is* presented in Table 6.

Based on the calculation of the weight of the criteria for appearance, aroma, taste, and texture of *croissants, the* results show that the assessment of taste is a more important criterion compared to other criteria. Even though the assessment of other characteristics is good, if the *croissant* flavor is not liked by the panelists, the product will be rejected by the panelists. This shows that flavor criteria are the main consideration in choosing *croissant* products with the addition of shrimp skin flour. Determining the best treatment by considering the criteria of appearance, aroma, taste, and texture of *croissants* tested by the *bayes* method is presented in Table 7.

Based on the results of the Bayes calculation, it was found that Croissant treatment C with a ratio of 5% shrimp shell flour: 95% wheat flour had the highest alternative value and priority value, namely 7.1 and 0.28, followed by treatment B with 2.5% shrimp shell flour:97.5% wheat flour with an alternative value of 7.0 and a priority value of 0.27, then treatment A with 100% wheat flour with an alternative value of 6.3 and a priority value of 0.25. Finally, treatment D with a ratio of 7.5% shrimp shell flour: 92.5% wheat flour had the lowest alternative value and priority, namely 5.1 and 0.20. Finally, treatment D with a ratio of 7.5% shrimp shell meal: 92.5% wheat flour had the lowest alternative and priority values of 5.1 and 0.20. This shows that Croissants with treatment C or the ratio of 5% shrimp shell meal: 95% wheat flour is the most preferred treatment by panelists.

Table 6. *Croissant* criteria weight calculation results

Criteria	Priority
Appearance	0,10
Aroma	0,25
Texture	0,10
Taste	0,54

Table 7. Calculation Results of Criteria Weight for Each Treatment

Treatment	Criteria				Alternative Value	Priority Value
	Appearance	Aroma	Texture	Taste		
A (0%)	5	5	7	7	6,3	0,25
B (2,5%)	7	7	7	7	7,0	0,27
C (5%)	8	7	7	7	7,1	0,28
D (7,5%)	5	5	6	5	5,1	0,20
Criteria Value	0,10	0,25	0,10	0,54	25,5	1,00

3.1.5 Calcium Test

Calcium content test results are presented in Table 8.

Table 8. Calcium content test results

Treatment	Calcium Content
A (100% wheat flour)	157,341 mg/100g
C (5% shrimp shell flour: 95% wheat flour)	289,591 mg/100g

Based on the results of water content testing, the water content of croissants with a ratio of 5% shrimp shell flour: 95% wheat flour, which is 289.591 mg/100g, is higher than croissants using 100% wheat flour, which is 157.341 mg/100g. Based on the test results, calcium levels in croissants increased in products that substituted shrimp skin flour by 5%. This is in line with the research of [20] which states that the greater the amount of shrimp waste flour substituted in making cheese sticks, the calcium content will increase because shrimp skin flour has a high calcium content of 13.23%.

Human calcium needs per day are between 500 to 1000 mg/day. Calcium test results on croissants most favored by panelists with a 5% substitution of shrimp shell flour at 289.591 mg/100g do not meet the calcium needs of humans per day, but calcium deficiency can be added by consuming at least two croissants substituted with shrimp shell flour at 5% of other foods such as milk, cheese, cereals, vegetables (spinach, broccoli, and beans).

4. CONCLUSION

Based on the results of the most preferred croissant research, the test of favorability of croissants with different ratios of shrimp shell flour and wheat flour obtained the results that the croissants most favored by panelists were croissants with the use of 5% shrimp shell flour: 95% wheat flour. The average values of appearance, aroma, texture, and taste were 7.10; 7.00; 6.70; 7.40, respectively. The test results of calcium amounted to 289.591 mg/100g.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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