Original Research Article

Fortification of Shrimp Shell Flour as a Source of Calcium on the Preference Level of Bread

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ABSTRACT

This research aim was to find the most preferred percentage of shrimp shell flour fortification on white bread. This research used an experimental method with 20 semi-trained panelists and 5 treatments of shrimp shell flour percentages which were 0%; 2,5%; 5%; 7,5%; and 10%. The parameters in this research were yield of shrimp shells, bread volume development, and calcium content which were analyzed with a comparative descriptive method; and preference level which was analyzed using the Friedman test. Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Science and Test Service Laboratory, Faculty of Agro-Industrial Technology, Padjadjaran University, between January and June 2023. Yield and volume development were tested by the ratio of the mass of shrimp shells flour and shrimp shells (yield test) and dough volume and white bread loaf (volume development test) times 100%. The Preference test used an organoleptic test with each panelist being given a test sheet to test 5 treatments of white bread fortified with shrimp shell flour and to test their preference level on 4 characteristics; which were color, aroma, texture, and taste. Calcium content was tested using the atomic absorption spectrophotometer method on the control treatment (0%) and the most preferred treatment. Yield result from shrimp shell flour was 27.8% (139 gr) from its initial mass (500 gr). Volume development of white bread showed decreases in volume with each treatment from 136.433% to 111.504%. The most preferred fortification of shrimp shell flour on white bread was treatment 2.5% with an alternative value of 7.22 and characteristic value of color 9, aroma 7, taste 7, and texture 7, which means overall still preferred. The calcium content within treatment 2.5% was 30.095 mg/100gr which is significantly higher than the calcium of treatment 0% (1.465 mg/100gr) and could assist humans meet their calcium needs.

Keywords: Shrimp Shell Flour; Preference Level; Calcium content; White Bread Loaf

1. INTRODUCTION

Shrimp is one of the fishery commodities exported by Indonesia and has a large role in the Indonesian fisheries industry, where the value of Indonesian shrimp exports reached 2.04 billion USD in 2020 [8]. Shrimp exported in the form of frozen shrimp are processed first by processing industries where the head, shells, and legs are separated; and become industrial waste that can damage the environment. Shrimp shells are mainly composed of calcium carbonate (20–50%), protein (20–40%), chitin (15–40%), and lipids (0–14%) [25]. The percentage of elemental calcium within calcium carbonate is 40% [14]. Calcium carbonate is classified as a calcium supplement used as a food additive dan dietary supplement, which can treat low calcium

conditions [4]. This shows that shrimp shells can be processed and used as a source of calcium.

Calcium is one of the macro-minerals needed by the human body, however, its recommended daily intake varies among age and sex, with its recommended daily calcium intake for 4 years old and over being ≥ 1000 mg [16]. Calcium is stored in bone and tooth tissue, which is around 99% and the rest helps other body functions such as blood vessels, muscles, nerve transmission, intracellular signaling, and hormone secretion [3]. The need for calcium is important for human life and calcium deficiency can cause various kinds of health problems or diseases within the human body.

Several health problems in the body; especially during the growth period; caused by calcium deficiency are weak bones, easy bending, and brittle bones. Calcium deficiency can disrupt the muscles, brain, and nervous system; where calcium has a role in the process of muscle contraction, heart electrical conduction, and brain function. If calcium deficiency is not addressed, it can cause muscle spasms and impaired brain and nervous system function [18].
The need for humans to consume adequate amounts of calcium is necessary to prevent diseases caused by calcium deficiency. One way to meet the calcium needs for human life is by fortifying food with the calcium contained in shrimp shells. Shrimp shell flour is flour made from the shells of shrimp heads and bodies, and can be added to various solid foods. Another food that can be fortified by calcium is white bread.

White bread is a type of bread that is popular because people can determine the taste of white bread [13]. This bread is made from high-protein wheat flour, water, yeast, fat, and salt which goes through a fermentation process by yeast and is baked [15]. White bread contains 9.97% protein, 0.09% fat, 0.19% fiber, 55.67% carbohydrate, and 1.67% ash (which contains minerals, such as calcium) [17]. The proximate indicates that white bread contains high carbohydrates and relatively low calcium, so calcium from shrimp shell flour can be added to the white bread to increase its calcium content.

White bread is generally not fortified with shrimp shell flour. Fortification of shrimp shell flour in white bread can increase the calcium content of the bread and can also help meet the human body's calcium needs, but it is uncertain whether the public accepts it or not. Based on this background, it is necessary to conduct research on the preference level of white bread fortified with shrimp shell flour as a source of calcium to determine the most preferred treatment, so that we can produce delicious white bread with high calcium content and high consumer acceptance rates.

2. methodology

2.1 Research Time

This research was conducted in January-June 2023 at the Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Sciences and Test Service Laboratory, Faculty of Agricultural Industrial Technology, Padjadjaran University. The research method was experimental, using 5 treatments of shrimp shell flour percentage based on the weight of wheat flour. The treatment percentages of shrimp shell flour were 0%, 2.5% (12.5 gr), 5% (25 gr), 7.5% (37.5 gr), and 10% (50 gr). The number of semi-trained panelists used during the research was 20, consisting of students from the Faculty of Fisheries and Marine Sciences, who had basic knowledge of organoleptic tests to determine the panelists' level of preference (hedonic level) for white bread.

2.2 Shrimp Shells Flour

Whiteleg shrimp (*Litopenaeus vanname*) was the shrimp species that was used in this research. The procedure for making shrimp shell flour is that shrimp shells were weighed up to 500 grams, the shrimp shells were washed with running water, the shrimp shells were cut to 1 cm, the shrimp shells were boiled in boiling water for 12 hours (the first 4 hours the water was changed every 30 minutes, the rest every 1 hour), the shrimp shells were removed and drained, the shrimp shells were dried in an oven at 121°C for 60 minutes, the shrimp shells were then ground with a blender, then the shrimp shells were sieved using a 100 mesh sieve [19]

2.3 White Bread

The procedure for making white bread is based on the procedure that all raw materials are weighed first, and the raw materials (wheat flour, shrimp shell flour, yeast, bread improver, sugar, and powdered milk) are mixed in a mixer. while adding water slowly, other raw materials (butter, egg yolk, salt) were then added to the mixer and mixed until the dough was smooth, the dough was then shaped into a ball and fermented for 15 minutes in a bowl covered with plastic wrap, the dough was flattened with a rolling pin and weighed until 500 grams, the dough was then fermented again for 20 minutes, the dough was flattened and shaped into a cylinder that fits into a 24x12x12 baking pan which was previously greased with butter, the dough was fermented for another 60 minutes, the dough was then baked in the oven (200°C) for 20 minutes until bread was baked enough, the bread was then removed from the oven and cooled down to remove hot steam [6].

2.4 Observed Parameter

2.4.1 Shrimp Shells Yield

Yield is an important value in the processing of a product. Yield is the comparison of the dry weight of the product produced with the weight of the raw material [35]. The yield value is useful for knowing how much weight the final product material can be used, from the weight of the initial raw material. Yield is calculated using the formula presented in Eq 1. [23].

(1)

2.4.2 Volume Development Percentage

Testing the volume of white bread was carried out to determine the percentage of development of white bread after adding shrimp shell flour. This is because consumer assesses the quality of the product by what they see first. Volume development is calculated using the following steps and formula [13]:

- The volume of the container used to measure the volume of white bread is calculated using the formula length (L) x width (W) x height (h) if the container's shape is block
- Bread dough that has been formed into a cylinder, its volume is measured by calculating the length (p) and diameter (D) of the dough and using the cylinder volume calculation formula ($P \times (D/2)^2$).

- The volume of baked bread is measured by placing it into the container and then adding green beans until full. The bread is then taken out from the baking pan and then calculate the volume of green beans in the container using the block volume formula (Length x Width x height). The bread volume is calculated by the reduction result between container volume and green beans volume.
- The bread development volume is then calculated using the presented formula in Eq 2. [13]

(2)

Description:

BDV = Bread Development Volume
Bv = Bread Volume
Dv = Dough Volume

2.4.3 Preference Level

The preference level was tested using a preference test, which is an organoleptic test used to test the final results of a product, where panelists are asked for personal responses about their likes or dislikes for the product and its level [26]. The preference test was carried out by testing each treatment on a group of semi-trained panelists consisting of 20 students from the Faculty of Fisheries and Marine Sciences, Padjadjaran University. Each panelist assesses each treatment by observing each characteristic of the bread (color, aroma, texture, and taste) on a preference scale ranging from 1-9, namely very dislike (1), dislike (3), normal/neutral (5), like (7), and very like (9). The preference level result data is then calculated using the Friedman test formula presented in Eq 3. [28]

(3)

Description:

x^2 = Friedman test statistic
N = number of repetitions
K = number of treatments
Rj = total of ranks of each treatment

The correction factor (CF) formula is then used presented in Eq 4.[28]:

(4)

Description:

T = N (t^3-t)
t = number of observation values that are the same for a ranking
K = number of treatments
N = The number of observations values that are the same for a ranking with the same t values

The significance value of the observation price Hc can be determined using the Chi-Square critical prices table with db = k-1; α = 0.05. The decision rule for testing a hypothesis is as follows:

H_0 = Treatment does not make a real difference in level α = 0,05.
H_1 = Treatment makes a real difference in level α = 0,05

If the price of Hc<Chi. table, then H_0 is accepted and H_1 is rejected, and if the price of Hc>Chi. table, then H_0 is rejected and H1 is accepted. Treatments that give a real difference (if H_1 is accepted) will be further tested to find out the differences between treatments using a multiple comparison test with the formula presented in Eq 5. [5].

(5)

Description:

[Ri-Rj] = friction of rank sums
Ri = sum of ranks of the i sample
Rj = sum of ranks of the j sample
α = experiment-wise *error*
b = number of data
k = number of treatments

2.4.4 Bayes Method

The Bayes method is a technique used to carry out analysis in making the best decision from several alternatives to produce optimal results by considering various criteria [12]. The formula for the Bayes method is presented in Eq 6. [12].

(6)

Description:

Total of value $_i$ = final value total from i-alternative
value $_{ij}$ = value from i-alternative on j-criteria
criteria $_j$ = level of importance (weight) j-criteria
i = sum of alternative
j = sum of criteria

2.4.5 Calcium Content

Calcium content was tested to determine the percentage of calcium content contained within the sample and how much calcium content was added to the white bread sample before and after the addition of shrimp shell flour. The method used in testing calcium levels was the AAS method with the following formula presented in Eq 7. [6].

(7)

Description:

C = Concentration of titration reading results
O = Parent dilution (1 ml)
F = Final dilution, reading (250 ml)
W = weight of samples
A = the solution for dilution (25 ml)

3. results and discussion

3.1 Yield of Shrimp Shells Flour

The yield was obtained by comparing the weight of shrimp shell flour with the weight of shrimp shells. The yield of shrimp shell flour, based on calculation results, yielded 27.8% or 139 gr of shrimp shells flour from 500 gr of shrimp shells. This percentage result is close to the percentage yield of shrimp shell flour produced in another research, which is namely 26.15% [20]. The purpose of observing the yield is to determine the efficiency of raw materials from shrimp shells. The shrimp shell flour produced is then used to fortify white bread.

3.2 Bread Volume Development

The volume of white bread is one of the important characteristics of white bread because consumers judge the quality of the product by what they see first. The increase in the volume of white bread is caused by yeast fermentation within the dough which produces CO_2 gas, where this gas is retained by the gluten in the dough until the dough rises [10]. The assessment results of the volume development of white bread fortified with shrimp shell flour are presented in Fig. 1.

The result shows an influence, where the higher the percentage of shrimp shell flour, the lower the development of white bread. The highest percentage for development volume of white bread is the white bread without the addition of shrimp shell flour (0%) with a value of 136.433%. The lowest percentage for development volume is the 10% treatment with a value of 111.504%.

The decrease in volume is due to the weakening of the dough's gluten tissue which weakens its ability to hold gas, so that dough expansion during fermentation is hampered and the volume becomes low [21]. This weakening is because shrimp shell flour does not contain gluten-forming proteins, namely gliadin and glutenin proteins. The proteins gliadin and glutenin, which are contained in wheat flour, when mixed with water will form an extensible and elastic mass or dough (gluten) [32]. A weak or poor gluten tissue will produce a dough that fails or has a low capacity to retain CO_2 gas by yeast during fermentation, resulting in decreased bread volume [24].

Fig. 1. White Bread Volume Development

3.3 Preference Test

3.3.1 color

The first characteristic of a product that is assessed first by the consumers is its appearance, such as color. Color plays an important role; because a product that is nutritious and has a very good texture will not be accepted by consumers if the color of the product is not pleasing to look at or has a color that deviates from the color that the product is supposed to have [33]. The calculations result in the preference level for the color of white bread presented in Fig 2.

The results of the statistical analysis test on the color of white bread added with shrimp shell flour showed a significant difference in the treatment with the addition of 10% shrimp shell flour with other treatments, except for the 7.5% treatment based on the notes. The median value obtained from all treatments ranged from 5 (usual) to 9 (very liked), so the appearance of the color of white bread in all treatments was still preferred. The highest average value was in the 2.5% treatment, with a 7.7 average value and the lowest average value was in the 10% treatment, with 5.8. The results table shows that the color of white bread in the 0% treatment; 2.5%; 5%; and 7.5 are not significantly different, but the treatments 0%; 2.5%; and 5% are significantly different from the 10% treatment based on the level of preference for white bread by the panelists. The result table also shows a decrease in the panelists' preference level along with an increase in the percentage of shrimp shell flour content in each treatment. It is likely caused by the changes in the color of the white bread, especially in the bread crumb section, where the higher the addition of shrimp shell flour, the darker or yellowish the color of the bread crumb becomes.

The color change influences the preference level of panelists for white bread which becomes increasingly darker and yellowish as the percentage of shrimp shell flour increases, where an ideal white bread has a bright white color [31]. The color change is likely caused by the color of the shrimp shell flour, which is pale yellow. This color comes from shrimp shell pigment, namely Astaxanthin, which is a carotenoid compound and is often found in microalgae, crabs, shellfish, salmon, and shrimp found in nature [11]. Carotenoids are a group of pigments that are yellow, orange, red-orange, and soluble in oil (lipids) [33]. The pale-yellow color of shrimp shell flour is caused by the high temperature used in making the flour, where the higher the drying temperature, the lower the b (yellowness) value obtained from carotenoid pigments [27].

The dark color change is likely the result of a browning reaction, such as the Maillard reaction. Maillard reaction is a nonenzymatic browning reaction that occurs between carbohydrates and proteins through high heat [22]. White bread generally contains high carbohydrates and low protein, due to the chemical composition of the ingredients, such as wheat flour which contains 67.67% carbohydrate and 10.24% protein [30]. Shrimp shell flour has a high protein content of 37.44% in its chemical composition [2]. This explains the dark color change on the breadcrumb due to the presence of the two chemicals where the color becomes darker due to the increases of protein with each new treatment.

Note: Numbers that have the same letter are not significantly different based on a multiple comparison test at the 5% level

Fig. 2. Color Preference Value of White Bread

Characteristics of white bread that can be seen apart from color are the size and pores of bread. The size and pores of the white bread showed a decrease, along with the increase of shrimp shell flour added. Bread pores are a collection of air holes found in the bread crumb and are formed during the fermentation and baking processes [1]. Bread pores are formed during the baking and fermentation process of dough, where CO_2 gas is retained by gluten until the bread dough expands [10]. This shows the relationship between pores and bread size, where the smaller the pores, the smaller the bread size. This shrinkage is because shrimp shell flour does not have gliadin and glutenin proteins which form gluten when mixed with water [32]. A small gluten content results in a weak gluten tissue and causes the dough to be less able to retain CO_2 gas during baking and fermentation so that the pores and size of the bread formed are small [1].

3.3.2 Aroma

The aroma of a product is also an important characteristic for a consumer in determining their preference for the product. Aroma is one of the parameters in organoleptic testing using the human sense of smell or nose [9]. The aromas that humans can smell are mostly a mixture of four aromas, namely fragrant, sour, rancid, and burnt [33]. The calculation results for the aroma of white bread are presented in Fig 3

The results of statistical analysis tests on the aroma of white bread showed significant differences between treatments based on the notes. The median value ranges from 5 (usual) to 7 (like), which means that the aroma of white bread in all treatments is still considered favorable. The highest average value was in the 2.5% treatment with an average value of 6.9 and the lowest was in the 10% treatment with an average value of 4.8. The test results also showed a real difference in aroma preference between the treatments where the treatment 0%; 2.5%; and 5% are not significantly different, but the 0% and 2.5% treatments are significantly different from the 7.5% and 10% treatments.

The results of this data can be concluded that the addition of shrimp shell flour influences the aroma of white bread, whereas the typical shrimp aroma in shrimp shell flour influences the fragrant aroma of white bread. The aroma of white bread is caused by alcoholic fermentation and additional flavor ingredients such as salt, wheat flour, milk powder, bread improver, and fat [10]. This fermentation gives white bread its aroma by breaking down sugar or starch, which produces CO_2 gas and ethanol compounds, where these compounds play a role in giving flavor to white bread [15].

Note: Numbers that have the same letter are not significantly different based on a multiple comparison test at the 5% level

Fig. 3. Aroma Preference Value of White Bread

The level of preference for the aroma of white bread decreased due to the distinctive aroma of shrimp shell flour which influenced the fragrant aroma of white bread. An ideal bread aroma has that smell like wheat and yeast [31]. The higher the addition of shrimp shell flour to white bread, the lower the level of preference for the aroma of white bread. The aroma of shrimp shells comes from volatile components produced by the lipid oxidation process and the Maillard reaction during the baking process of white bread, where the main result of the Maillard reaction

is the melanoidin compound which does not affect the flavor, but the intermediate compounds and volatile compounds in small amounts gives a significant flavor [34].

3.3.3 Texture

Texture is one of the characteristics of food in determining the level of liking of a food. Texture has an important role because the texture and consistency of ingredients can influence the taste of food, whereas changes in food texture can change the taste and smell of food [26]. The results of calculations of the texture of white bread are presented in Fig 4.

The results of statistical analysis tests on the texture of white bread showed a real difference between the treatment of adding shrimp shell flour to white bread based on the notes. The median value obtained ranges from 5 (normal) to 9 (very like it), which means that the texture of white bread in all treatments is still preferred. The highest average value among the treatments with the addition of shrimp shell flour was in the 2.5% treatment with an average value of 7.1 and the lowest was in the 10% treatment with an average value of 4.1. The test results also showed a real difference between the treatments in the taste of white bread with added shrimp shell flour, where the 0%, 5%, and 10% treatments were significantly different from each other

Note: Numbers that have the same letter are not significantly different based on a multiple comparison test at the 5% level

Fig. 4. Texture Preference Value of White Bread

These results show that the addition of shrimp shell flour to white bread influences the level of preference for the texture of white bread, where the greater the addition of shrimp shell flour, the lower the level of preference for the texture of white bread. An ideal white bread has a soft and elastic texture [15]. White bread with added shrimp shell flour has a rough texture and is slightly doughy, whereas defective bread has a rough, hard texture, doughy, crumbly, and lumpy. This is because the bread does not rise due to the gluten's ability to hold CO_2 gas produced by yeast decreases [13]. Shrimp shell flour does not contain gluten-forming proteins, namely gliadin and glutenin [32].

The drawback can be counter-measured by increasing and adding several ingredients. Two examples of such ingredients are fat (butter) and eggs. Butter in high amounts can produce highly soft breadcrumbs and give a shortening effect on the breadcrumb [10]. eggs have a role in bread expansion and giving a soft texture to the bread [15]

3.3.4 Taste

The taste of food is the most important characteristic in determining the level of consumer preference. This is because food that tastes good will have a positive impact on the level of food preference; and taste plays an important role in determining whether food is good or not, even if food has poor color, aroma, and texture [29]. Humans can taste 5 basic tastes, namely salty, sour, sweet, bitter, and umami [7]. The calculation results of taste preference for white bread are presented in Fig 5.

The results of statistical analysis tests on the taste of white bread showed a real difference between treatments based on the notes. The median value obtained ranges from 3 (dislike) to 7 (like). The highest average value of the treatment with the addition of shrimp shell flour is 2.5% treatment with an average value of 6.4 and the lowest is 10% treatment with an average value of 3.7. The test results showed a real difference based on the level of preference between treatments for the taste of white bread with added shrimp shell flour, where the 0%, 5%, and 10% treatments were significantly different from each other.
The results showed that the addition of shrimp shell flour influences the level of preference for the taste of white bread. The ideal white bread has a plain or wheat taste [31]. The taste of white bread is influenced by salt, wheat flour, milk powder, raising agents, and fat [10]. Shrimp shell flour which has a shrimp taste can affect the taste of white bread, where the greater the addition of shrimp shell flour, the lower the level of preference for the taste of white bread. The taste of shrimp is caused by the amino acid content in the shrimp shell protein, namely methionine (sulfur, meaty, slightly sweet), cysteine (sulfur), and tryptophan (bitter and sweet) [20].

The taste of shrimp can be concealed by adding another ingredient to the mixture. One such ingredient is food essence which gives flavor to any product including bread [10]. A common essence that is used on bread is vanilla essence which adds the vanilla taste and hides the bitter and sulfur taste of shrimp.

Note: Numbers that have the same letter are not significantly different based on a multiple comparison test at the 5% level

Fig. 5. Taste Preference Value of White Bread

3.4 Bayes Test

Decision-making regarding the relative weight values of the criteria of color, aroma, texture, and taste of white bread was carried out using a pairwise comparison of 20 semi-trained panelists regarding the preference for white bread with the addition of shrimp shell flour. The results of matrix calculations in determining the best treatment by considering several criteria for white bread are presented in Table 1

The table of matrix calculation results for the weight criteria of color, aroma, texture, and taste of white bread with the addition of shrimp shell flour shows that the taste criterion has a higher weight criterion value compared to other criteria, with a value of 0.5933. These criteria were then followed by the criteria for aroma (0.1717), texture (0.1245), and color (0.1105). These results show that taste has a greater influence compared to other criteria on the preference for white bread. It is stated that even though the other criteria assessment is good if the taste is not liked or accepted by the consumers, then the product will still be rejected [13].

Another result obtained from the table of calculation results using the Bayes method is the alternative value that can be used to determine the treatment most preferred by the panelists. The table shows that the treatment without adding shrimp shell flour and the 2.5% treatment; 5%; and 7.5% were still favored by the panelists based on their alternative values which are above 5, except 10% who were no longer liked by the panelists which is below 5. The treatment most preferred by the panelist from all the treatments based on alternative values was the

treatment without the addition of shrimp shell flour (0%) with a value of 7.47; However, the treatment with the addition of shrimp shell flour that was most preferred by the panelists was 2.5% with an alternative value of 7.22. This concludes that among the treatments of adding shrimp shell flour to white bread, the 2.5% treatment is the best or most preferred treatment by the panelists based on the results of organoleptic tests.

Table 1. Bayes Test Results

Treatment (%)	Median Values				Alternative Value
	Color	Aroma	Taste	Texture	
0	9	7	7	9	7.47
2.5	9	7	7	7	7.22
5	7	7	5	7	5.81
7.5	7	5	5	5	5.22
10	5	5	3	5	3.81
Criterion Weight	0.1105	0.1717	0.5933	0.1245	

3.5 Calcium Content

The 2 white breads used in measuring calcium contents are the white bread without the addition of shrimp shell flour (0%) and the most preferred white bread, which is the 2.5% treatment or addition of 12.5 grams of shrimp shell flour. The test used 100 grams or around 3 slices from each bread for calcium measurement. The results are presented in Table 2.

These data results show an increase in calcium content; where the calcium content of white bread added with 2.5% shrimp shell flour has a higher calcium content with a total content of 30.095 mg/100 grams or 10.031 gr/slice; compared to the white bread without the addition of shrimp shell flour with a total content of 1.465 mg/100 grams or 0.488 gr/slice. The calcium content contained in the 2.5% treatment can help meet the calcium needs of the human body, which is $\geq$1000 mg/day [16]. An individual can practically meet their daily calcium intake by ingesting around 100 slices from the 2.5% treatment itself. The high calcium content in the 2.5% treatment is because shrimp shell flour has an ash content of 33.28%, where the ash content contains calcium [2].

Table 2. Calcium Content

Treatment (%)	Calcium Contents (mg/100gr)
0	1.465
2.5	30.095

3.6 Overall Observation Results

The addition of shrimp shell flour as a source of calcium to white bread influences several aspects of white bread. This influence can be seen from the results of physical tests, preference or hedonic tests, and chemical tests on white bread. These results are presented in Table 3.

Table 3. Overall Observation Results

Observation	Treatments (%)				
	0	**2.5**	**5**	**7.5**	**10**
Physical test Development Volume of White bread (%)	136.433	128.023	124.324	113.470	111.504
Hedonic Test					
Color	7.9 b	7.7 b	7.4 b	6.4 ab	5.8 a
Aroma	7.1 b	6.9 b	6.3 ab	5.7 a	4.8 a
Taste	7.1 c	6.4 bc	5.7 b	4.5 ab	3.7 a
Texture	7.8 c	7.1 bc	6.3 b	5.6 ab	4.1 a
Chemical Test Calcium content (mg/100 grams)	1.465	30.095	-	-	-
Bayes Test Alternative Value	7.47	7.22	5.81	5.22	3.81

The results of the physical test of white bread based on the volume development of white bread showed that the percentage value of volume development for the 0% treatment was 136.433% and for the 10% treatment was 111.504%. This shows a decrease in the volume development of white bread, where the greater the percentage of shrimp shell flour, the more the volume of white bread decreases.

The results of chemical tests on white bread with the addition of shrimp shell flour showed an increase in the calcium content. Treatment with the addition of 2.5% shrimp shell flour had a calcium content of 30.095 mg/100 grams or 10.031 gr/slice. The calcium within the shrimp shells flour is calcium carbonate, which is a food additive used for nutritional benefit, thus it's safe for human consumption [4]. The calcium content from the 2.5% treatment can help humans meet their daily calcium needs (≥1000 mg/day) [16].

The results of the organoleptic (hedonic) test using the Bayes method showed that in the decision-making by the panelists, the taste criterion is the first consideration or prioritized when choosing the most preferred white bread, with a priority value of 0.5933. The priority criteria are followed by aroma (0.1717), texture (0.1245), and color (0.1105) of the white bread. White bread with the addition of shrimp shell flour, based on these 4 criteria, shows that the 2.5% treatment is not significantly different from the 0% treatment. White bread with an additional 2.5% shrimp shell flour has the highest alternative value with a value of 7.22, among other white bread with other shrimp shell flour added, so this treatment is the best or most preferred white bread with additional shrimp shell flour. This is because the 2.5% treatment is the closest treatment to the white bread without the addition of shrimp shell flour where the panelists are more familiar with the taste, aroma, texture, and color of what normal white bread should be.

4. Conclusion

The research results on shrimp shell flour fortification on white bread show that the 2.5% treatment is the best or most preferred white bread by the panelists. This treatment (2.5%) has a percentage of volume expansion of 128.023% and a calcium content of 30.095 mg/100gr. The treatment is not significantly different in terms of preference from the normal one or without the addition of shrimp shell flour based on the notes of all criteria (taste, aroma, texture, color), however based on the purpose of this research which is to increase the calcium content of white bread, the most delicious white bread with high calcium is the 2.5% treatment.

References

- Arifin HR, Lembong E, and Irawan AN. Physical Characteristics of White Bread Based on Substituting Wheat with Composite Flour of Breadfruit (*Artocarpus atilis* F.) and Banana (*Musa paradisiaca* L.) as an Effort to Utilize Local Commodities. Journal of Food Research. 2023;3(1): 20-26
- Fitri D, Karnila R, and ilza M. Chemical Composition of Carapace Flour of Vanname Shrimp (*Litopenaeus vannamei*). Students Online Journal, Fishery Product Technology. 2021;8(1): 1-11.
- Food and Nutrition Board. Dietary Reference Intakes for Calcium and Vitamin. National Academy Press: Washington D.C; 2011.
- Fritz K, Taylor K, Parmar M. Calcium Carbonate. StatPearls Publishing: USA; 2023
- Gaspersz, V. Experiment Design Methods. CV Armico: Bandung; 1991.
- Justicia A. Fortification of Red Tilapia Bone Flour as a Source of Calcium on the Level of Preference of White Bread. Faculty of Fisheries and Marine Sciences. Padjadjaran University; 2012.
- Kemp S E., Hollowood T, and Hort J. Sensory Evaluation a Practical Handbook. A John Wiley & Sons, Ltd., Publication: Singapore; 2009.
- [KKP] Marine and Fisheries Ministry. Indonesia's Rank as a World Exporter of Fishery Products Increases during the Pandemic. 2021. Accessed 14 Feb 2022. Available: https://kkp.go.id/djpdspkp/artikel/33334-peringkat-indonesia-sebagai-
- Lamusu D. Organoleptic Test of Jalangkote Purple Sweet Potato (*Ipomoea batatas* L) as a Food Diversification Effort. Journal of Food Processing. 2018;3(1): 9-15.
- Lange M. Bread. Gaya Favorit Press: Jakarta; 2004.
- Maharani N R, Kurniasih R A, and Sumardianto. Extraction of Astaxanthin at Different Temperatures from Vanname Shrimp (*Litopenaeus vannamei*) Shells Using Coconut Oil Solvent. Journal of Fisheries Science and Technology. 2023;5(1): 26-31.
- Marimin. Techniques and Applications of Compound Criteria Decision Making. Grasindo: Jakarta; 2022.
- Marisa O. Fortification of Crab Shell Flour on White Bread and Its Effect on the Level of Preference. Faculty of Fisheries and Marine Sciences. Padjadjaran University; 2009.
- Mayo Clinic. Calcium and calcium supplements: Achieving the right balance. 2022. Accessed 3 Feb 2024. Available: https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/calcium-supplements/art-20047097#:~:text=As%20an%20example%2C%20calcium%20carbonate,500%20mg%20of%20elemental%20calcium.
- Mudjajanto ES and Yulianti LN. Making of Various Breads. Swadaya Publication: Jakarta; 2008.
- National Institutes of Health. Calcium. 2024. Accessed 3 February 2024. Available: https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/
- Noroul-Asyikeen Z, Zubir HSM, and Hoon HL. Nutritional Value and Physicochemical Properties of White Bread Incorporated with *Hevea brasiliensis* (Rubber Seed) Flour. Journal of Agrobiotech. 2018;3(1s): 102-113.

- Nurrahmani U. Stop! Osteoporosis. Familia Publication: Yogyakarta; 2020.
- Pascasia, RCL. Fortification of Shrimp Shell Flour as a Source of Calcium on Wet Noodles. Faculty of Fisheries and Marine Sciences. Padjadjaran University; 2008.
- Permana AZ, Liviawaty E, and Iskandar. Fortification of Shrimp Shell Flour as a Source of Calcium on the Level of Preference of Ice Cream Cones. Journal of Fisheries and Marine Sciences. 2012;3(4): 29-39.
- Putri DA, Komalasari H, and Heldiyanti R. Review: Evaluation of the Physical Quality of Bread Influenced by the Addition of Composite Flour. Journal of Food and Agro-industry. 2022;3(1): 1-18.
- Ridhani M A, Vidyaningrum I P, Akmala N N, Fatihatunisa R, Azzahro S, Aini N. Potential of Adding Various Types of Sugar on the Sensory and Physicochemical Properties of Sweet Bread Review. Pasundan Food Technology Journal (PFTJ). 2021; 8(3): 61-68.
- Sani RN, Fithri CN, Ria DA, and Jaya MM. Yield Analysis and Phytochemical Screening of Ethanol Extract of Marine Microalgae Tetraselmis chuii. Journal of Food and Agroindustry. 2014;2(2): 121-126.
- Sim SY, Noor AA.A., and Cheng LH. Quality and functionality of Chinese steamed bread and dough added with selected non-starch polysaccharides. Journal of Food Science and Technology. 2015;52(1): 303–310.
- Šimat V, Rathod NB, Čagalj M, Hamed I, Generalić Mekinić I. Astaxanthin from Crustaceans and Their Byproducts: A Bioactive Metabolite Candidate for Therapeutic Application. Marine Drugs. 2022; 20(3):206
- Sofiah BD. and Achyar TS. Sensory Assessment Lecture Textbook. Publication of UNPAD Department of Food Industry Technology: Jatinangor; 2008.
- Song XD, Mujumdar AS, Law CL, Fang, XM, Peng WJ, Deng, LZ, Wang J and Xiao HW. Effect of drying air temperature on drying kinetics, color, carotenoid content, antioxidant capacity, and oxidation of fat for lotus pollen. Journal of Drying Technology. 2019;38(9): 1151-1164.
- Sugiyono. Nonparametric Statistics for Research. Alfabeta Publication: Bandung: 2018.
- Sunarya I and Puspita WL. Comparison of Food Acceptability and Factors That Influence Self-Managed and Outsourced Food Delivery Systems. Pontianak Nutrinion Journal. 2018;1(2): 74-77.
- Tivde Benedict Verem, Igbabul Bibiana Dooshima, Eke Michael Ojoutu, Oladapo Okanlawon Owolabi, Adetunji Onigbajumo. Proximate, Chemical, and Functional Properties of Wheat, Soy, and Moringa Leaf Composite Flours. Agricultural Sciences; 2021:12(1): 18-38.
- U. S. Wheat Associcates. Bread and Cake Baking Guide. Djambatan Publication: Jakarta; 1983.
- Wahyudi. Producing Bread. Directorate General of Education, Ministry of Education: Jakarta; 2003.
- Winarno FG. Food Chemistry and Nutrition. Gramedia: Jakarta; 1991.
- Wirawan P, Sari NI, and Desmelati. Utilization of White Shrimp Shell Flour (*Litopenaeus vannamei*) as a Flavor with the Addition of Dextrin and Its Application in Taro Chips. Student Online Journal, Faculty of Fisheries and Marine Sciences, Riau University. 2015;2(1): 1-6.
- Yuniarifin H, Bintoro VP, and Suwarastuti A. The Effect of Various Phosphoric Acid Concentrations in the Process of Soaking Beef Bones on the Yield, Ash Content and Viscosity of Gelatin. Indon Trop Anim Agric Journal. 2006;31(1): 55- 61