Original Research Article

Fortification of Red Tilapia Bone Flour as a Source of Calcium on Donut Preference Level

ABSTRACT

This research aims to determine the percentage of addition of red tilapia bone flour as a source of calcium in the most preferred donut. The research was conducted on January and February 2022 at the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran and the Test Services Lab, Faculty of Agricultural Industrial Technology, Universitas Padjadjaran. The method used in this research is an experimental method, that is making donuts with different levels of addition of red tilapia bone flour, which consists of 5 treatments (0%; 2.5%; 5%; 7.5%; and 10%) with 20 panelists semi-trained as a test to determine the preference level of the panelists to donuts. Observations were made on organoleptic tests and chemical tests. The most preferred fortification of red tilapia bone flour on donut was the 5% treatment with the value of the preference level on appearance, texture, and aroma being 7 (preferred) and taste was 9 (very preferred). The results of the chemical test analysis of water content, ash content, protein content, fat content, carbohydrate content, and calcium content in the 5% treatment were 18.91%; 2.97%; 6.29%; 27.95%; 43.88%; and 0.1007% or 1006.60 mg/kg.

Keywords: *Bonefish; calcium; donut; fortification; red tilapia*.

1. INTRODUCTION

Tilapia production in Indonesia increased by 3.05% during the period from 2015 to 2018. The largest number of tilapia production in 2018 was dominated by the regions of West Java, West Sumatra, South Sumatra, Central Java, North Sulawesi, North Sumatra, West Nusa Tenggara, East Java, South Kalimantan, Bengkulu, and DI Yogyakarta. Tilapia is an export commodity, especially to the United States in the form of filets with the highest demand in the global market in 2018 reaching 123,752,000 kg [1].

The demand for tilapia in the form of frozen filets and product processing with tilapia meat as raw material along with the amount of waste produced in the form of fish bones. Fish bone waste can be utilized optimally by processing the waste into flour so that the bone waste produced is not wasted, because it can cause environmental pollution if not handled properly [2].

Fish bones contain high calcium phosphate, which is 14% of the total bone composition [3] and can be well absorbed by the human body about 60-70% [4]. Calcium is a micronutrient (mineral) that the body needs and is most abundant in the human body [5]. Based on data from the Nutrition Research Center of the Ministry of Health of the Republic of Indonesia, osteoporosis sufferers in Indonesia have reached 19.7% and are in the sixth largest after China [6].

Red tilapia bone flour can be added to a product as an ingredient for making products, one of which is donut. Donut have been widely produced in Indonesia and marketed to the public. The main ingredient in making donut is wheat flour which contains macronutrients, there are carbohydrates, protein and fat, and contains micronutrients such as calcium, but in very small amounts.

A product with good nutritional content but is not liked by many people, then the function of adding nutrients to the product will not be useful [7]. The level of preference can be measured using an organoleptic test through the senses. Based on this description, it is necessary to conduct research to

determine the level of preference for donut with the addition of red tilapia bone flour as a source of calcium so that it can produce donut that have high calcium and delicious taste.

2. MATERIALS AND METHODS

This research was conducted on January and February 2022 at the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran for the manufacture of red tilapia bone flour, making donuts with the addition of red tilapia bone flour and organoleptic tests on donuts and the Test Services Laboratory of the Faculty of Agricultural Industrial Technology, Universitas Padjadjaran for analysis of water content, ash content, protein content, fat content, carbohydrates and calcium test.

2.1 Tools and Materials

The tools used in this research are sieve (80 mesh), blender, donut mold, measuring cup, cloth, gas stove, electric oven, pan, plate, knife, pressure cooker, rolling pin, spoon, spatula, stopwatch, cutting board, scale digital, container, and frying pan. The materials used in this research are red tilapia bone, wheat flour, margarine, eggs, yeast, sugar, salt, water, and cooking oil.

2.2 Research Methods

The method used in this research is an experimental method, that is making donuts with different levels of adding red tilapia bone flour. The level of preference for donuts was analyzed by Friedman's non-parametric statistical method consisting of 5 treatments and 20 semi-trained panelists as a test. The treatment of adding red tilapia bone flour to the donuts is as follows:

Treatment A : 0% or without the addition of red tilapia bone flour.
Treatment B : 2.5% addition of red tilapia bone flour.
Treatment C : 5% addition of red tilapia bone flour.
Treatment D : 7.5% addition of red tilapia bone flour.
Treatment E : 10% addition of red tilapia bone flour.

2.3 Research Stages

This research consists of three stages, the first stage is making of red tilapia bone flour which refers to Asni [8]. The second stage is making donuts with the addition of red tilapia bone flour which refers to Wardani et al. [7]. The formulation of ingredients for making donuts refers to Bakhtiar et al. [9]. The third stage is organoleptic test with parameters of appearance, aroma, texture, and taste, then chemical test with parameters of water content, ash content, protein content, fat content, carbohydrate content, and calcium content.

2.4 Observed Parameters

The parameters observed in this research are organoleptic characteristics that are appearance, aroma, texture, and taste of donut with the addition of red tilapia bone flour using a hedonic test (organoleptic test), and also chemical parameters that are water content, ash content, protein content, fat content, carbohydrate content, and calcium content [10]. Organoleptic characteristics were tested using a hedonic test with 20 semi-trained panelists consisting of students from the Faculty of Fisheries and Marine Sciences, Padjadjaran University, Indonesia.

2.5 Data Analysis

The data from the calculation of the donut chemistry test will be analyzed descriptively and compared with the quality requirements of the donuts based on the Standar Nasional Indonesia (SNI), while the organoleptic observation data were analyzed using non-parametric statistics, that is the two-way analysis of variance Friedman test with *Chi-square* test [11]. Friedman test was used to determine the effect of adding red tilapia bone flour to the level of preference for the donuts produced. The statistics used in the Friedman test are defined by the following formula:

$$Xr^2 = \frac{12}{nk\ (k+1)} \sum_j^k = 1\ (Rj)^2 - 3\ n\ (k+1)$$

Description:
Xr2 = Friedman Test Statistics
N = Deuteronomy
K = Treatment
Rj = Total ranking of each treatment

The panelist's decision making on the criteria for the preferred donut product was carried out by multiple comparisons, then the Bayes method was used to determine the best treatment. The calculation results from the Bayes test will show that the element that has the highest priority value is the most preferred by the panelists [12]. The Bayes equation is as follows:

$$XG = \sqrt[n]{\Pi . Xi}$$

Description:
XG = Geometric mean
Π = Permutation
n = Number of panelists
Xi = Rating from the 1st panelist

3. RESULTS AND DISCUSSIONS

3.1 Hedonic Test

3.1.1 Appearance

Appearance is an organoleptic parameter that is quite important, because if the panelists give the impression of a good and preferred appearance, then the panelists will see the other organoleptic parameters, that are aroma, texture, and taste [13]. The results of the assessment of the average appearance of the donuts are presented in Fig. 1.

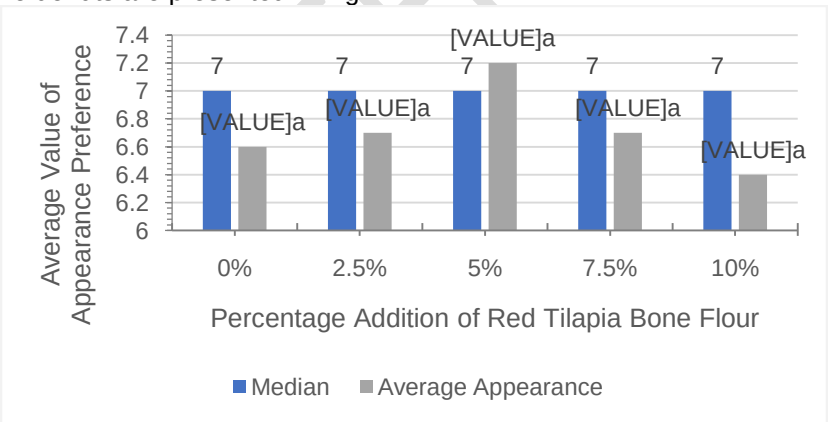

Fig. 1. The average appearance of donut

Based on the panelists' assessment of the appearance of the donuts, it was found that all treatments had a median value of 7 (preferred). The highest average appearance value of 7.20 was found in donuts with 5% treatment, while the lowest average value of 6.40 was found in donuts with 10% treatment. Friedman's statistical test results showed that all treatments were not significantly different. This can be because the red tilapia bone flour used is white or almost the same color as wheat flour, so the red tilapia bone flour does not affect the appearance of the donuts. Baskoro [14] stated that red tilapia bone flour had a pure white color.

The surface of the donut is brownish yellow due to the *Maillard* reaction during the frying process. Winarno [15] said that protein (primary amine group) meets reducing sugar derived from carbohydrates if it meets at high temperatures during the frying process it will produce a brown material which is called a *Maillard* reaction or non-enzymatic browning (browning process). The inside

of the donut in each treatment is yellowish white, because the red tilapia bone flour used is white so it doesn't affect the color of the inside of the donut as well.

3.1.2 Aroma

Aroma is one of the factors that will determine consumers to choose a product because the aroma can attract consumers attention to the food product [9]. The aroma in food products is produced from the main ingredients and complementary ingredients added to the dough [16]. The results of the average donut aroma assessment are presented in Fig. 2.

Based on the panelists' assessment of the donut aroma, it was found that the median value ranged from 5 to 7 (ordinary to preferred). The highest average value of aroma is .10 found in donuts with 5% treatment, while the lowest average value of aroma is 5.70 found in donuts with 7.5% treatment. Friedman statistical test results showed that all treatments were not significantly different, meaning that the addition of red tilapia bone flour had no significant effect on the donuts. The aroma produced has a distinctive aroma of donuts and the aroma of fish bones that were not smelled by the panelists, because the red tilapia bone flour used had been through a repeated washing process so that there was no fishy smell. Baskoro [14] said that red tilapia bone flour has a tasteless and fishy aroma that is not smelt.

Organic acids in the form of esters and volatiles are components that give aroma. The degraded starch content makes extensive changes with the elimination of water molecules and the fragmentation of sugar molecules where the carbon bonds are broken which produces carbonyl and volatile compounds resulting in a distinctive aroma on donuts [15]. The use of margarine in donut dough can also strengthen the aroma of the donuts. Fat is an important component because it functions as an aroma enhancer [17].

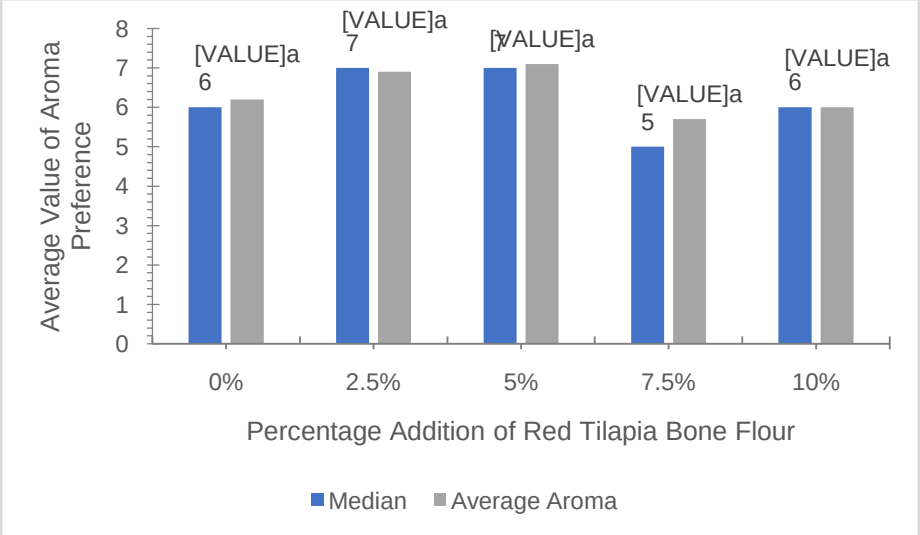

Fig. 2. The average aroma of donut

3.1.3 Texture

The texture of an ingredient will affect the taste produced by the food ingredient. Changes in the texture of a material will change the aroma and taste, because the texture can affect the speed of stimulation of the olfactory cells and salivary glands [15]. The results of the average donut texture assessment are presented in Fig. 3.

Based on the panelists' assessment of the texture of the donuts, it was found that the median value was 7 (preferred). The highest average texture value of 7.10 was found in donuts with 5% treatment, while the lowest average texture value of 6.60 was found in donuts with 10% treatment. Friedman's statistical test results showed that all treatments were not significantly different, but seen from the value of the average level of preference for donut textures, it decreased with increasing addition red tilapia bone flour. The 5% treatment can increase the donut preference level, but with further additions

such as 7.5% and 10% treatment will reduce the donut preference level. This is caused by the addition of red tilapia bone flour which is getting higher, it will result in lower gluten content.

The lower gluten content can result in a decrease in the elastic properties of the dough, so that the texture of the donut becomes harder. The protein in wheat flour can form gluten when added to water and produce a dough that is elastic and able to hold gas, but if the amount of gluten in the dough is only small, then the dough is less able to hold gas so that the pores formed in the dough are also small and the dough does not expand properly [18]. Rochima et al. [13] said that the presence of high calcium and phosphorus content will cause the bonding power or structure of the dough made by gluten to become less united or less compact so that the texture becomes harder.

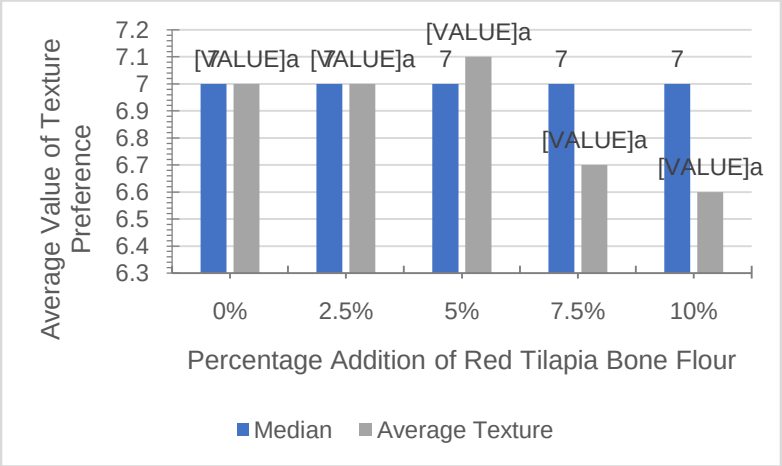

Fig. 3. The average texture of donut

3.1.4 Taste

Taste is a parameter that is assessed using the sense of taste and is an important factor in determining whether a product is accepted or rejected by consumers. The taste of a product can affect the level of consumer acceptance, although other parameters are good, but if the taste is not liked then the product will be rejected [16]. The results of the average donut taste assessment are presented in Fig. 4.

Based on the panelists' assessment of the donut taste, it was found that the median value ranged from 6 to 9 (liked to very liked). The highest average taste value of 7.60 was found in donuts with 5% treatment, while the lowest average value of 5.70 was found in donuts with 7.5% treatment. Friedman's statistical test results showed that the fortification of red tilapia bone flour on donuts did not give a significant difference in taste in the 0%, 2.5%, and 10% treatments, while the 7.5% treatment was significantly different from the 5%. The 5% treatment still had a sweet, slightly savory donut taste and there was no fishy smell of red tilapia bone flour which could affect the taste of the donuts, while the donuts treated with the addition of red tilapia bone flour were 7.5% had slightly sweet and savory taste. This is because the more addition of red tilapia bone flour, the more fishy the donuts taste and disguise the original taste of the donuts. Wardani et al. [7] said that the taste produced from bone flour will tend to have a strong fish-like taste and can affect the taste of the donuts.

3.2 Bayes Test

Decision making on the relative weight value and the appearance, aroma, texture, and taste criteria of red tilapia bone flour donuts was carried out by pairwise comparison of the 20 panelists. The results of the calculation of the weight of the appearance, aroma, texture, and taste criteria of donuts are in Table 1.

Based on the results of the Bayes test calculation, the highest number of criteria weights is the taste parameter of 0.61, which means that the taste parameter is the most important assessment or as the

main consideration in the selection of donut. The second most important parameter is aroma with a criterion weight of 0.17, then followed by appearance and texture parameters with a criterion weight of 0.12 and 0.10 respectively. The results of calculations in determining the best treatment using the Bayes method by considering the appearance, aroma, texture, and taste criteria of red tilapia bone flour donuts are listed in Table 2.

Score value is obtained based on the best treatment results for each parameter. The highest alternative value as a result of multiplying the weight value with the score value indicates the best donut [12]. Based on the calculation of the Bayes method, it was found that all the red tilapia bone flour fortification treatments on the donut were still accepted or favored by the panelists, but the donut with 5% red tilapia bone flour fortification treatment were the most preferred treatment with alternative values and the highest priority values were 8.23 and 19.17. The 2.5% treatment is in second place with alternative values and priority values 7.00 and 16.31, then followed by 0% and 10% treatment with alternative values and the same priority value, namely 6.83 and 15.92, then 7.5% treatment with alternative values and priority values of 6.05 and 14.10.

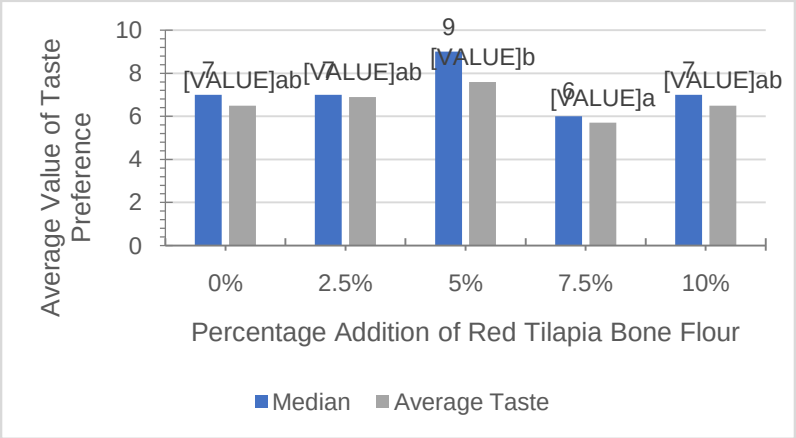

Fig. 4. The average taste of donut

Table 1. Donut criteria weight value

Criteria	Criterion weight
Appearance	0,12
Aroma	0,17
Texture	0,10
Taste	**0,61**

Table 2. Donut scoring decision matrix by Bayes test

Treatment (%)	Criteria				Alternative Value	Priority Value
	Appearance	Aroma	Texture	Taste		
0	7	6	7	7	6,83	15,92
2,5	7	7	7	7	7,00	16,31
5	7	7	7	9	**8,23**	**19,17**
7,5	7	5	7	6	6,05	14,10
10	7	6	7	7	6,83	15,92
Criterion Value	0,12	0,17	0,10	**0,61**	0,43	1,00

3.3 Chemical Test

Chemical tests include water content, ash content, protein content, fat content, carbohydrate content, and calcium content in the donuts. Chemical tests were carried out on donut with 0% treatment and the most preferred donuts by the panelists were donut with 5% treatment. The results of the donut chemistry test can be seen in Table 3.

Table 3. Donut chemistry test results

No.	Analysis Parameters	Chemical Analysis Results (%)	
		Donut 0%	Donut 5%
1	Water content	17,78	18,91
2	Ash content	1,41	2,97
3	Protein content	5,59	6,29
4	Fat content	32,01	27,95
5	Carbohydrate content	43,21	43,88
6	Calcium content	0,0090	0,1007

The water content of 0% donut is 17.78%, while the water content of 5% donut is 18.91%. Donuts with both treatments still have water content that meets the quality requirements of donut based on SNI 01-2000 (Standar Nasional Indonesia) which states that the maximum water content in donut is 40%. Water content in 5% donut have a higher water content than 0% donut. This is because the water content contained in red tilapia bone flour also accumulates [19]. The increase in water content in red tilapia bone flour donut can also be caused by the length of time of fermentation due to the increasing activity of *Saccharomyces cereviceae* so that the water content produced will also increase. This is because in the fermentation process there is a breakdown of glucose into carbon dioxide (CO_2) and water (H_2O) so that it will increase the water content in dry matter [20].

The ash content of 0% donut is 1.41%, while the 5% donut ash content is 2.97%. The 5% donut have a higher ash content than 0% donut. The ash content in these donuts tends to increase along with the addition of red tilapia bone flour. This is because the main component in fish bones is minerals [9], so the ash content in the donut will increase with the increase in the percentage of red tilapia bone flour used.

The protein content of 0% donut is 5.59%, while the 5% donut protein content is 6.29%. The 5% donut have a higher protein content than 0% donut. The protein content in these donuts tends to increase along with the addition of red tilapia bone flour. This is due to the protein content contained in the added red tilapia bone flour. Fish bone flour is known to have a high protein content [21]. The protein content contained in tilapia bones is known to have a value of up to 40.8% [22].

The fat content of 0% donut is 32.01%, while the 5% donut fat content is 27.95%. Donuts with both treatments still had fat content that met the quality requirements of donuts based on SNI 01-2000 which stated that the maximum fat content in donuts with the frying process was 33%. The 5% donut have lower fat content than 0% donut. The fat content in donut tends to decrease with the addition of red tilapia bone flour. This is thought to be caused by the fermentation process in the donut, because during fermentation, the fat is broken down by yeast into simpler compounds, because yeast is lipolytic which can hydrolyze fat and the yeast uses fat as a source of energy [23].

The carbohydrate content of 0% donut is 43.21%, while the carbohydrate content of 5% donut is 43.88%. Carbohydrate content in 5% donut has a value that is not much different from 0% donut. Carbohydrate content is highly dependent on the reduction factor. The lower the nutritional content such as water, ash, protein, and fat content, the carbohydrate content will increase, conversely the higher the nutrient content of water, ash, protein, and fat, the lower carbohydrate content [24]. The carbohydrate content in 100 grams of fish bones is 0.1 mg [25].

The 5% donut have higher calcium content than 0% donut. This can be seen from the total calcium content in 0% donut is 0.0090% or 90.23 mg/kg, while the calcium levels in 5% donut is 0.1007% or 1006.60 mg/kg, so it can be said that the more the amount of addition of red tilapia bone flour, the calcium levels in the donut will increase. The main constituents of fish bones are calcium, phosphorus, and carbonate, while those present in small amounts are sodium, chloride, hydroxide, and sulfate [26].

4. CONCLUSION

Fortification of red tilapia bone flour on donuts, all treatments were still accepted by the panelists with the most preferred treatment being the 5% treatment which had a preference level value on appearance, texture, and aroma, that is 7 (preferred) and taste that is 9 (highly preferred). The results of the chemical test analysis of water content, ash content, protein content, fat content, carbohydrate

content, and calcium content in the 5% treatment each were 18.91%; 2.97%; 6.29%; 27.95%; 43.88%; and 0.1007% or 1006.60 mg/kg.

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