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Marshmallow characteristics from mackerel fish bone gelatin with the addition of calamansy orange extract and sucrose

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Abstract. Mackerel is a marine fish whose meat is widely used in making processed food products such as pempek, crackers, dumplings, and otak-otak. In making this product, there is still residual waste in the form of bones, tails, and fish heads that have yet to be utilized. Fishbone waste can be used as an ingredient for making gelatin. Gelatin can be used as a raw material for making marshmallows. Marshmallows produced from mackerel bone gelatin have a fishy aroma. The effort made to reduce the fishy smell is by adding calamansy orange. Apart from that, add sucrose to lessen the sour taste of kalamansi oranges. This research aimed to determine the effect of adding calamansy orange extract and sucrose on the physical, chemical, and organoleptic properties of the marshmallows produced. The experimental design used was a Completely Randomized Design (CRD) with two factors, namely the addition of calamansy orange extract (13%, 15%, and 17%) and the addition of sucrose (30%, 35%). The research results showed that adding calamansy orange extract and sucrose naturally affected water content, texture, ash content, vitamin C content, pH, taste, texture, aroma, and overal.

1 Introduction

Mackerel is a fish whose meat is usually processed into food products. In 2021, mackerel production in Bengkulu will be 74.66 tons yearly [1]. The increasing production of mackerel fish is also accompanied by increased waste from mackerel fish in the form of bones. Mackerel fish bone waste can also make gelatin [2].

Gelatin is a material that can form foam and a gel that is chewy, elastic, and related to texture [3]. The raw materials for gelatin are bones and skin fish from red tilapia, niletilapia, sea bass, mackerel, and croaker fish skin waste [4–8]. Gelatin is a type of protein obtained from collagen hydrolyisis. Mackerel fish bones have a protein content of 23.07% (wb) which has the potential to be a raw material for making gelatin [2].

Gelatin from fish which made marshmallows [9–11]. Marshmallow is a sponge-shaped confectionery product made from sucrose and glucose syrup through shaking to form foam with the gelatin [12]. The gelatin in marshmallows forms an elastic texture, because gelatin has a springiness texture profile [5,13].

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Marshmallows made from mackerel bone gelatin had a favorite score for aroma parameters that the panelists did not like. The aroma comes from the fishy aroma of fish [9]. Efforts that can be made to reduce the fishy aroma of mackerel include adding other raw materials. One of the raw materials is calamansy orange. Calamansy oranges are used as raw materials for processed syrup developed by people in Bengkulu. Adding calamansy orange to jelly candy can increase the nutritional value and provide a distinctive taste and aroma of calamansy orange at the best concentration of 15% % [14]. Gelatin added with calamansy orange and sucrose will interact with the soft gel in marshmallows [15].

Another raw material that can be added to marshmallows is sucrose. Sucrose influence sweet taste and texture marshmallows [13]. Therefore, this research aims to determine the effect of adding calamansy orange extract and sucrose on the physical, chemical, and organoleptic characteristics of the marshmallows produced.

2 Materials and methods

2.1 Materials

The materials are mackerel fish bones, calamansy orange, sucrose, syrup glucose, and citric acid 6%. Chemicals for analysis were starch 1%, iodine 0.01 N, and distilled water.

The equipment used in making marshmallows is a Miyako mixer, a Miyako grinder, and a refrigerator. The tools used for analysis are ovens, desiccators, analytical scales, and Steven LFRA texture analyzers.

2.2 Experimental design

The experimental design in this research was a Completely Randomized Design (CRD) with two factors. The treatment factor was sucrose concentration (30%, 35%), and extract calamansy (13%, 15%, 17%). Each treatment was repeated three times so that there were 18 experimental units.

2.3 Experimental procedure

2.3.1 Production of gelatin mackerel fish bone

Gelatin is made from mackerel fish bones, according to modified research conducted [16]. The process of making gelatin using the 6% citric acid method includes preparation of raw materials, washing, soaking in a lime solution, washing and cleaning, swelling, washing, extraction, filtration, drying, and grinding.

2.3.2 Production of marshmallow

Marshmallows are produced using the modified method [17]; 12 g of gelatin is heated with water for 2 minutes. Sucrose (S) (30%, 35%) and calamansy extract (JK) (13%, 15%, 17%), according to the formula, are heated for 1 minute. Next, 15 g of glucose syrup was added to the mixture. All ingredients are mixed and stirred using a mixer for 8 minutes until smooth and fluffy.

2.4 Parameters

2.4.1 Physical characteristics

a. Water content analysis

Analysis of water content according to [18]. The marshmallow weighed 2 g. The marshmallow is placed in a container of known weight and placed in an oven at 100 °C for 5 hours. The marshmallows were dried in the oven until a constant weight was achieved, then the final weight was recorded. Water content can be calculated using the formula:

$$Water\ content\ (\%) = \frac{initial\ wight - final\ weight}{initial\ weight}\ x\ 100 \quad (1)$$

b. Texture analysis

Analysis of texture marshmallow used texture analyzer. Marshmallows were formed into squares and placed on the table, then pressed. After that, the measurement results are obtained by reading the resulting graph. The hardness value is expressed in gF units [12].

2.4.2 Chemical characteristics

a. Ash content analysis

Ash content analysis according to the method [18]. Marshmallows were weighed at as much as 1 g and put into a crucible that had been weighed. The sample was then put into the furnace at 550 °C for 5 hours. The sample was then cooled first, and then the sample was weighed as the weight of the ash. Ash content can be calculated using the following formula:

$$Ash\ content\ (\%) = \frac{Ash\ weight}{Sample\ wegiht}\ x\ 100 \quad (2)$$

b. Vitamin C analysis

Vitamin C levels were obtained using the titration method. Marshmallows were reduced in size and weighed 10 g. The finely ground sample was then added to distilled water in a 100-ml volumetric flask. The material is then filtered to obtain the filtrate. 5 ml of the filtrate was taken, 2 ml of 1% starch indicator, and 20 ml of distilled water were added. The solution was titrated with 0.01 N iodine until a color change occurred (purple-blue). Vitamin C levels were calculated by standardizing a 1 ml iodine solution of 0.01 N, equivalent to 0.88 mg of vitamin C. The formula for calculating vitamin C levels is as follows:

$$Vitamin\ C\ (\%) = \frac{a\ x\ b\ x\ c}{d} x100 \quad (3)$$

Note: a = iodine titration volume
b = equivalen weight
c = dilution ratio
d = sample weight

c. pH

Analysis of pH marshamallow used pH meter.

2.4.3 Organoleptic testing

Organoleptic testing was done by 25 semi-trained panelists from the University of Bengkulu's students. Organoleptic testing was carried out on the parameters of taste, color, texture, aroma, and overal by 25 semi-trained panelists from the University of Bengkulu's students [19]. Each panelist was requested to give scores based on five hedonic (really like, like, neutral, dislike, and immensely dislike) scores for marshmallows.

2.5 Data analysis

The organoleptic testing data were analyzed using non-parametric statistical methods with Friedman test. Water content, texture, ash content, vitamin C, pH data were analyzed with Analyisi of Variance (ANOVA) at the 5% level. The significant influences were compared with Duncan's Multiple Range Test (DMRT).

3 Results and discussion

3.1 Physical characteristics

The interaction between calamansy extract and added sucrose significantly affected marshmallow moisture content ($p<0.05$). The results of the DMRT test between treatments can be seen in Table 1. JK1S1 is significantly different from JK3S2, meaning that the higher the calamansy orange and sucrose used, the water content of the marshmallows produced also increases. The increase in water content is caused because extract calamansy contains a water component. This aligns with research [20], which states that the more fruit juice added to an ingredient, the more water content the ingredient can increase.

Table 1 showed that more sucrose added, the lower the water content. This is because sugar can bind water to the ingredients. The ability to bind water is the property that causes sugar to reduce the water content of food [21].

Table 1. Water content and texture of marshmallow.

Sample	Water content (%)	Texture (gF)
JK1S1	15.83^{b}	178.00^{d}
JK1S2	15.00^{a}	169.00^{d}
JK2S1	17.00^{c}	163.33^{c}
JK2S2	16.67^{c}	161.67^{c}
JK3S1	19.00^{e}	154.00^{b}
JK3S2	18.50^{d}	150.00^{a}

Note: different superscripts on the same column show that the values are significantly different at $p<0.05$ DMRT test.

The interaction between calamansy extract and added sucrose significantly affected marshmallow texture ($p<0.05$). The DMRT test results in Table 1 show that the greater the calamansy and sucrose extract concentrations, the lower the texture value. This research [22], stated that adding more calamansy oranges caused a decrease in gel strength, which was thought to be due to the higher water content and increased acidity levels. The calamansy extracts effected on water binding properties of gelatin and it determined the textural properties [23].

3.2 Chemical characteristics

Marshmallow ash content was influenced by the addition of calamansy extract and sucrose ($p<0.05$). The DMRT test results can be seen in Table 2, which shows that increasing the calamansy extract and sucrose will increase the marshmallow ash produced. The increase in ash content produced is thought to be due to an increase in the amounts of raw materials used, which are thought to contain minerals, for example, calamansy orange and sucrose. According to [24], if the minerals contained in food are high, then the ash content produced will also be high. Therefore, it will increase. The results of this research align with those of [25], which shows that there is a real influence on marshmallows and the addition of sucrose concentration to Robusta coffee marshmallows, which increases the resulting ash content.

The interaction between calamansy extract and added sucrose significantly affected marshmallow vitamin C ($p<0.05$). The DMRT test results, which show differences between treatments, can be seen in Table 2. The addition of calamansy orange juice is increasing because calamansy orange juice has high levels of vitamin C. This is in line with research by [26]. The higher the addition of lemon juice, the more significant the increase in vitamin C. Apart from that, the higher the addition of sucrose, the lower the vitamin C levels, resulting in a decrease in vitamin C. This is in line with research by [27], which states that as the addition of sucrose increases, vitamin C decreases; this is because ascorbic acid (vitamin C) will be damaged by the presence of high levels of sucrose followed by the heating process

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Table 2. Ash content, vitamin C, pH of Marshmallow.

Sample	Ash content (%)	Vitamin C (%)	pH
JK1S1	1.01^{a}	11.73^{ab}	6.07^{d}
JK1S2	1.20^{a}	8.80^{a}	6.03^{cd}
JK2S1	1.40^{b}	17.6^{b}	5.93^{bc}
JK2S2	1.46^{b}	14.67^{ab}	5.90^{b}
JK3S1	1.71^{c}	29.33^{c}	5.73^{a}
JK3S2	1.94^{d}	26.40^{c}	5.70^{a}

Note: different superscripts on the same columnshow that the values are significantly different at $p<0.05$ DMRT test.

The interaction between calamansy extract and added sucrose significantly affected marshmallow pH ($p<0.05$). The results of the DMRT test, which show differences between treatments, can be seen in Table 2. The analysis results of the pH value of mackerel fish bone marshmallows decreased along with adding calamansy orange and sucrose. The more extract calamansy adds, the lower the pH because oranges taste sour (low pH). The lower pH results also align with the research results of higher vitamin C levels. Apart from that, the higher the sucrose, the lower the pH value. That is common with [28] , who stated that pH values can also have structural effects. It was established that lowering pH value caused an exsicate in the bloom power of gelatin. The effects of pH on foaming capacity and structure stability in marshmallows [29].

3.3 Organoleptic testing

The results of the Friedman test showed that the addition of calamansy extract and sucrose had a significant effect on taste, texture, aroma, and overall parameters. The highest preference level is because extracted calamansy gives the marshmallow its distinctive sour taste. In contrast, sucrose gives the marshmallow a sweet taste to reduce the sour taste of calamansy extract.

Figure 1 showed that the highest level of texture preference is due to the addition of calamansy extract, and the low sucrose is due to the small amount of calamansy extract due to the high content of calamansy extract, which makes the marshmallow chewy. That is common with [30], namely a study of making marshmallows with sucrose concentration, which shows that the higher the sucrose concentration, the lower the texture value.

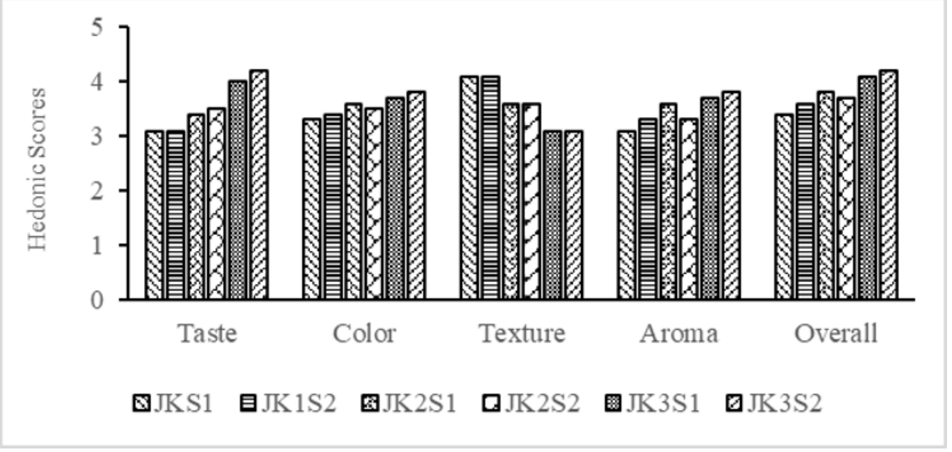

Fig. 1. Concentration calamansy and sucrose to taste, color, texture, aroma, overal in marshmallow.

The mackerel fish, a bone marshmallow product, has a fishy aroma, with the addition of extract giving a distinctive aroma of extract calamansy. This is due to the use of extract calamansy. Then, increasing amounts of extract calamansy will provide different aroma intensities to reduce the fishy aroma of mackerel fish bones. That is common with [22], who stated that the greater the concentration of extract calamansy, the more pronounced the aroma of extract calamansy in jelly drinks.

The Friedman test results showed that adding calamansy extract and sucrose had no significant effect on the color parameters. Color did not affect the panelists' favorite scores because the color of the marshmallow produced by adding calamansy extract and sucrose did not change color (Figure 1). That was thought to be because calamansy extract and sucrose only give the marshmallows a white color, so they do not affect the panelists' liking scores.

4 Conclusion

Addition of calamansy extract and sucrose significantly affected water content, texture, ash content, vitamin C content, pH, and organoleptic (taste, texture, aroma, and overall). However, it has no significant effect on the organoleptic (color) of the marshmallows produced.

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