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Physicochemical Characteristics and Formulation of Bagea Cookies With Moringa Leaf Flour Addition (*Moringa oleifera*)

Andi Tenrimega Tjalo[1], Andi Hasizah[1]*, Salengke[1], Andi Amijoyo[2], Jumriah Langkong[1],

[1]Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University,
[2]Departement of Mechanical Engineering, Faculty of Engineering, Hasanuddin University
Jl. Perintis Kemerdekaan Km. 10 Tamalanrea Makassar, Sulawesi Selatan, Indonesia, 90245
*E-mail: andihasizah@gmail.com

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ABSTRACT

Bagea is a traditional Indonesian snack that is popular for its sweet, savory and crunchy taste. The addition of moringa flour to bagea was investigated to improve its nutritional content. This study aimed to analyze the nutritional content of bagea with moringa flour addition, and evaluate the effect of moringa flour addition on the chemical characteristics of formulated bagea. This research method uses six treatments with a ratio of sago flour, moringa flour and dried coconut. The analysis carried out was organoleptic analysis, moisture content, ash, fat, protein, carbohydrates, fiber, iron, and antioxidant activity. Organoleptic test results, the best results are P0, P1 and P2 which have moisture content ranging from 6.3-6.6%, ash content ranging from 0.53-1.81%, fat content ranging from 15.85-19.45%, protein content ranging from 3.29-6.16%, carbohydrate content ranging from 73.44-69.74%, iron 0.63-9.45 mg/L, and antioxidant activity ranging from 322.56-245.17 ppm. This study concluded that based on the parameters tested, the best formulations based on organoleptic tests were formulations (97% sago flour: 3% moringa flour), (94% sago flour: 6% moringa flour) and formulations with the addition of moringa flour had an influence on the sensory and chemical quality of bagea cake.

Keywords: antioxidant activity, bagea, moringa leaf powder, sago.

INTRODUCTION

Food is everything that comes from biological sources such as several agricultural, plantation, forestry, livestock, aquatic and fishery products, whether processed or unprocessed for food or beverages for human consumption, including food additives, food raw materials, and other materials as a process of preparing, processing or making food and beverages (Indonesian Law No. 18 of 2012 concerning food). Based on several processing methods and materials used, several terms such as traditional food and local food are known. Traditional food is food that has been consumed or produced for generations, uses locally produced ingredients, and is processed in a typical way in several regions of Indonesia. Meanwhile, local food is food developed in several regions whose processing is modern (not using traditional processing in the region). An easy factor in the popularity of a region is the existence of traditional food, because these foods have different characteristics in each region (Suter, 2014).

Traditional food products are products made with recipes that have been frequently consumed or served for generations. Traditional Indonesian food has many different types according to its diverse ethnic and multicultural regions. Traditional foods contain a variety of Indonesian spices, different ways of making them and local ingredients used, some of which come from India, the Middle East and Europe (Indonesian Embassy). Traditional food is often defined as food to showcase the characteristics and values of each region (Adiasih & Ritzky, 2015). The processing method uses frying, steaming, grilling and roasting. Traditional product development is the modification of food ingredients using local food ingredients to increase the nutritional value of food.

The types of traditional Indonesian cuisine are divided into two categories, namely, heavy food and light food (Nitisuari & Wardono, 2014). The heavy category includes rice and several other side dishes such as fried rice, yellow rice and others. In Indonesia, the spread of traditional culture through its culinary is quite good with the presence of restaurants or restaurants that serve a variety of food menus from several Indonesian regions. As for snacks such as market snacks, desserts and snacks, for example pastries, cold drinks, wet cakes and others. The spread is quite easy with enough public attention with several other traders (Tyas, 2017). One of the traditional foods that can be developed is bagea cake.

Bagea cake is one of the traditional cakes that can be found in the Indonesian regions of Central Sulawesi, Southeast Sulawesi, South Sulawesi and Maluku. Bagea cake is generally made from sago flour, where the function of sago in addition to being the main ingredient is also the material forming the structure of bagea cake. This bagea cake has a slightly hard dry texture and tastes sweet and savory because the basic ingredients use sago flour (Santosa, 2010). However, some still use a mixture of wheat flour and sago flour. Bagea cake is a traditional cake that uses ingredients and the way it is made is still known to be traditional, and uses simple techniques (Bunta, 2013). Because it is made from sago flour, most of whose nutritional content is carbohydrates, this product can be substituted with moringa flour as an increase and enhancement of the nutritional value of begea cake products.

Sago (Metroxylon sago) is one of the local food staples (Figure 2). Sago flour is obtained from the extraction of stem pith which is processed into dry starch through a drying process (Wahab et al., 2016). The principle of sago starch extraction starts from cleaning the sago stem from the rough fiber skin, then splitting the sago stem into several parts. After that, the sago starch is grated and separated from the fiber and then the sago starch is dried (Heryani & Silitonga, 2018). Some forms of traditional food made from sago are kapurung, dange and bagea cake. sago flour has a fairly high carbohydrate content, for other nutritional content is very less. The calorie content of sago starch every 100 grams is not inferior to the calorie content of other foods, the comparison of calorie content every 100 grams: corn 361 calories, milled rice 360 calories, cassava 195 calories, sweet potato 143 calories and sago 353 calories (Soeparyo et al., 2018). The content obtained in sago flour per 100 grams is 14% moisture content, 0.408% ash content, 0.5 grams fiber content, 1.2 mg iron, 94 grams carbohydrate and 0.3 grams protein (Assagaf et al., 2013).

Moringa (Moringa oleifera) is one of the tropical plants that can grow in Indonesia. Moringa is called a plant that has nutrients in all parts of the Moringa plant and Moringa plants are often called “miracle trees” which are beneficial for the human body. Moringa is a natural food that has potential as a functional food because it contains nutrients needed by the body and has many properties. In addition, moringa leaves contain a lot of vitamin A, vitamin C, 27% protein, 2% fat, 38% carbohydrates, 19% fiber, 28 mg iron in 100 grams (Mazidah et al., 2018). Moringa can also be used as a natural medicine because it has a fairly high protein content from other medicinal plants (Toripah et al., 2014). Moringa leaves also contain a number of antinutrients such as tannins (0.003-8.22%), flavonoids (2.7-14.07%), polyphenols (2.02%); oxalates (22.3 mg/g), phytic acid (0.001 to 0.49%) and trypsin inhibitors (0.66 mg/100g) (Lin et al. 2018; Moyo et al. 2011; Su and Chen 2020; Tesfaye et al. 2013; Veronika. 2017). Moringa leaves also contain antioxidants such as flavonoids and polyphenols (Yazeed, 2019). The utilization of moringa leaves as food development has begun to be applied, because moringa has the potential as a functional food product. Parts of moringa leaves that have high nutrients for nutritional value are minerals and carbohydrates.

Desiccated coconut is coconut meat that is finely grated, dried and processed in a hygienic way so that it can be used as a food raw material. The moisture content in making desiccated coconut is a maximum of 3% so that the storage can last a long time. Dried grated coconut can be used as a food ingredient for example for cakes and other dishes. The purpose of processing dried grated coconut is to reduce business losses by going through the preservation stage by reducing the water content (Palungkun, 2003). The process of making dried shredded coconut goes through several stages such as coir removal, coconut shell, testa removal, washing, blanching, grating drying, sieving and packaging. The average content of dried coconut for moisture content is 1.70%, crude fiber is 30.34%, ash content is 3.95%, and fat content is 64.52% (Arista, 2021).

The use of additional ingredients in making bagea cake are eggs, sugar, baking powder, margarine. Eggs are a commonly used ingredient in baking. Eggs have a role as a framework or structure of the cake, add moisture and improve the taste, color aroma and nutritional value of the cake (Viani, 2022). One of the food ingredients that has high nutritional value including containing 10% fat, 12% protein, 0.70% carbohydrates, 3 mg iron is eggs (Wulandari et al., 2022). The function of eggs as a food ingredient is as an adhesive and thickener. Fructose is a simple sugar that gives natural sweetness to foods such as fruits, honey, seeds and vegetables. According to Prahastusi (2011), that fructose consumed in small amounts can reduce blood glucose levels because it causes an increase in glucose uptake by heptarm stimulation of the enzyme hexokinase and an increase in insulin concentration so that fructose is used to sweeten the use of diabetics. Baking powder is a baking ingredient that produces a reaction between acid and sodium bicarbonate. Baking powder in the batter releases carbon dioxide gas, then releases the gas sequentially during baking so that the batter expands completely. This makes the cake less susceptible to falling and maintains the shrinkage and uniformity of the crumb. Margarine is a food product in the form of a solid or semi-solid emulsion made from vegetable fat and water, with or without the addition of other permitted ingredients. Margarine is intended as a substitute for butter with similar appearance, odor, taste consistency, and nutritional value to butter. Margarine is an emulsion with a water in oil (w/o) emulsion type, which is the water phase in the oil or fat phase. Margarine contains 80% fat, 16% water and some other substances.

This study aims to utilize the potential of Moringa which has a high nutritional content and to find out the best formulation in making bagea cake using Moringa leaf flour, and to find out how much nutritional value of bagea cake. Therefore, the research "Physicochemical Characteristics and Formulation of Bagea Cake Making with the Addition of Moringa Leaf Flour (Moringa oleifera)" was conducted.

MATERIAL AND METHODS

Materials

The materials used in this study are water, distilled water, moringa leaves, Tani brand sago flour, fructose sugar, chicken eggs, baking powder, vegetable oil, margarine, baking soda, 96% ethanol, chloroform, potassium sulfate (K_2SO_4), mercury (II) oxide (HgO), sulfuric acid (H_2SO_4), sodium hydroxide (NaOH), boric acid (H_3BO_3), hydrochloric acid (HCl), methanol, DPPH (1,1 diphenyl-1-2- picrylhydrazyl), potassium permanganate ($KMnO_4$ 0.1 N).

Research Procedure

This research design uses a complete randomized design (CRD) with 6 treatments and 3 repetitions to obtain 18 bagea cake samples. Based on preliminary research for the formulation obtained in making bagea cakes, namely:

P0 : Sago flour 100 grams: Moringa leaf flour 0 grams

P1 : Sago flour 97 grams : Moringa leaf flour 3 grams

P2: Sago flour 94 grams : Moringa leaf flour 6 grams

P3: Sago flour 91 grams : Moringa leaf flour 9 grams

P4: Sago flour 88 grams : Moringa leaf flour 12 grams

P5: Sago flour 85 grams : Moringa leaf flour 15 grams

Making Moringa leaf flour

Moringa leaves are washed with running water, then separated from the stalk. After that, the moringa leaves were weighed as much as 300 grams. Then put into a fluidized bed dryer with a treatment temperature of 45ºC. The dried leaves were measured for moisture content, then ground using a grinder, then sieved using an 80 mesh sieve and put into a glass jar.

Bagea Cake Making

The first step is to mix 50 grams of eggs and 30 grams of powdered sugar using a mixer on high speed for 5 minutes to form a cream so that the sugar dissolves easily in the eggs and the eggs bind air. Then add 30 ml of vegetable oil and 1 gram of vanilla and stir again using a mixer for 3 minutes at high speed until the resulting dough is soft and well mixed. Next, add dry ingredients such as sago flour and moringa flour in accordance with the specified formulation.

The mixing stage of dry ingredients is done manually so that the dough is evenly mixed and does not experience premature maturity which causes the dough to harden. In the next step, the dough is flattened using a rolling pin in order to flatten the surface of the dough and facilitate molding. Next, it is printed using a round cake mold with a diameter of 3 cm and a thickness of 0.5 cm and then placed on a baking sheet lined with baking paper. The last stage is baking in the oven at 150ºC for 60 minutes.

Analytical Methods

Organoleptic Test

Organoleptic test is determined based on the level of liking or feasibility of a product by panelists. Organolpetic testing was carried out using the hedonic test method. The panelists used were 25 semi trained panelists. The assessment used a scale of 1-7: very like (7), somewhat like (6), like (5), neutral (4), somewhat dislike (3), dislike (2), and very dislike (1).

Physical Test

Hardness

The texture test on this sample uses a textur analyzer. The texture analyzer was prepared and then placed on a flat surface. After that, the needle was attached to the tool and a weight of 150 g was added. Then the weight of the needle, test rod (plunger), and sample weight is recorded. Next, the sample is prepared and then placed at the base of the penetrometer until the pointer needle and the sample surface are exactly related and the needle on the scale shows zero. The lever (lever) is pressed until the sample is broken then read and recorded the scale on the tool indicates the depth of penetration of the needle into the sample.

Color Test

The color test was conducted using the hunter system method using a digital colorimeter. The sample is put into a plastic bag until it is full and compacted. Furthermore, in the clourimeter tool, the selection of black or white base color is adjusted to the base color that appears in the sample. After the color calibration is carried out, then the tip of the colorimeter tool is pressed against the sample which has previously been inserted into the plastic cetik until the color results appear on the tool display. The results of the color test analysis obtained data on the value of L * (black and white), a * (red-green) and b * (yellow-blue).

Chemical Test

Water Content

The analysis of water content in this study refers to BSN (2015). The oven is conditioned at the temperature to be used until it reaches a stable condition. The empty cup was put into the oven for at least 2 hours. The empty cup is put into the desiccator for about 3 minutes until it reaches room temperature and weigh the empty bottle. Samples that have been mashed weighed as much as ± 2 g into the cup. The cup that has been filled with the sample is put into a vacuum oven at a temperature of. 95°C-100°C, with air pressure not more than 100 mmHg for 5 hours or put in a non-vacuum oven at 105°C for 16 hours-24 hours. The cup is moved using a tweezer into a desiccator for ± 30 minutes and then weighed. Do the test at least duplo (twice). The percentage of moisture content is calculated using the following formula:

$$\%\text{Water Content} = (B-C)/(B-A) \times 100$$

Description:

A: weight of empty cup in grams

B: weight of cup + initial sample, expressed in grams

C: weight of cup + dry sample, expressed in grams

Ash Content

The empty porcelain cup was dried in the oven for 30 minutes at 105°C then cooled in a desiccator for 30 minutes and then the porcelain cup was weighed. Next, the sample was weighed as much as 5 grams and put into a porcelain cup. The cup containing the sample was then put into the furnace for 4 hours or until the sample became ash. Then the ash obtained was cooled in a desiccator and weighed until a constant weight was obtained. Ash content was obtained using the formula:

$$\%\text{ Ash content}=((C-A))/((B-A)) \times 100$$

Description:

A : Weight of empty cup (g)

B : Weight of cup and sample before ashing (g)

C: Weight of the cup and sample after ignition (g)

Protein Levels

The ingredients were weighed at 0.1–0.2 grams then put into a 100 ml kjedhal flask. Then 2 grams of K_2SO_4, 40 mg HgO and 25 ml of concentrated H_2SO_4 were added and then homogenized. Then digest for 30 minutes until the liquid is clear green. The ingredients were allowed to cool, then 30 ml of distilled water and 10 ml of concentrated NaOH were added until blackish brown in color, then distilled. The distillation results are stored in. A 125 ml Erlenmeyer containing 5 ml H_3BO_3 and indicator was then titrated with 0.02 N HCl. The blank was analyzed like a sample and the nitrogen content was calculated using the following formula:

$$\%N =((HCL-\text{Blank}) \times NHCL \times 14.007)/(\text{sample weight (g)}) \times 100$$

Fat Content

Fat content testing in this study used the Soxhlet method. The fat flask was dried in an oven for 30 minutes at 105°C and then cooled in a desiccator for 15 minutes and weighed. Then, the sample was weighed as much as 5 grams and wrapped in filter paper and then put into the extraction device. Then the extraction device was installed on the condenser. Next, diethyl ether solvent was poured into the fat flask. After that, reflux is carried out for at least 5 hours until the solvent that returns to the fat flask becomes clear. The solvent was then wetted and the fat flask was put into an oven at 105°C or until the weight was constant. After that, the flask and fat were put into a desiccator and weighed. Fat content is obtained by the formula:

$$\%\text{Fat Content} = (W3-W2)/W1 \times 100$$

Keterangan :

W1 : sample weight (g)

W2 : weight of empty fat flask (g)

W3 : weight of fat flask containing extraction results (g)

Carbohydrate Content

Carbohydrate content was determined using the by difference method. Carbohydrate content was obtained using the formula:

$$\%\text{Carbohydrate Content} = 100\%-(\text{water}+\text{grease}+\text{fat}+\text{protein})$$

Crude Fiber Content

A total of 1 gram of sample was put into the backer and added 100 ml of 0.325 N H_2SO_4. Then refluxed for 30 minutes and then filtered. Next, distilled water was added until the pH of the filtered solution became neutral. After that, 50 ml of 1.25N NaOH was added and refluxed again for 30 minutes. Next, the solution was filtered with whattman filter paper (previously dried and known by weight) which was placed in a funnel. The precipitate obtained was then washed with 25 ml of distilled water, 25 ml of 95% ethanol and 25 ml of 10% K_2SO_4. After that, the filter paper containing the residue was dried in an oven for 2 hours at 105°C. Then cooled in a desiccator for 15 minutes and weighed. The filter paper containing the residue was dried and weighed until a constant weight was obtained. Crude fiber content was obtained using the formula:

$$\%\text{ crude fiber} = (a-b)/c \times 100$$

Description :

a : weight of residue in filter paper (g)

b : weight of dry filter paper (g)

c : weight of starting material (g)

Iron Content

The porcelain cup was dried in an oven at 105oC for 2 hours. Then the cup was put into a desiccator for 30 minutes and then weighed. Next, the sample was weighed as much as 1 gram and put into a porcelain cup. Then the cup containing the sample was put into the furnace for

5 hours at 600oC or until ash was obtained. After that, it was cooled in a desiccator. The results of the ashing then up to overnight. Then poured into a measuring flask and filtered using filter paper and injected into an atomic absorption spectrophotometer and measured the absorbance at a wavelength of 248.3 nm with an air-acetylene flame. After that, concentrations of 0.25; 0.5; 1; 2; 4; 8; 10 ppm of Ca standard solution were made and the absorbance was measured. The concentration of calcium in the samples was determined using the regression line equation from the calibration curve.

Antioxidant Activity

- Preparation of 0.4 mM DPPH solution

Weigh 0.015 g of dpph powder then dissolved with methanol p.a in a 100 ml volumetric flask then homogenized.

- Preparation of 1000 ppm sample solution

Weigh 0.01 g sample then dissolved with methanol p.a as much as 10 ml in a test tube homogenize.

- Determination of antioxidant activity IC_{50}

Sample extracts with a concentration of 1000 ppm were respectively pipetted as much as 0.2 ml, 0.4 ml, 0.8 ml, 1.6 ml, and 3.2 ml to make a measuring series of 10 ppm, 20 ppm, 40 ppm, 80 ppm, and 160 ppm. After that, the measuring series solution was added to each 1 ml of 0.4 mM dpph solution and added methanol p.a until a volume of 5ml was obtained.

Made control solution by pipetting dpph 0.4 mM solution as much as 1 ml into a test tube. After that, it is sufficient to 5 ml using methanol p.a..

The measuring series solution of the sample and dpph control solution were incubated at room temperature for 30 minutes in a dark room. Then measured at a wavelength of 515-517 nm.

Data Analysis

This study used a completely randomized design (CRD) with 3 replications. The data obtained in this study will be analyzed using Analysis of Variance (ANOVA) and continued with Duncan's Test if it has a significant effect using SPSS and Microsoft excel applications.

RESULT AND DISCUSSION

Sensory Analysis

Sensory analysis, also known as organoleptic testing, is a test carried out using the five human senses as a sensory attribute to measure panelists' acceptance of product quality. The organoleptic testing method used in this study is the hedonic method. The hedonic method was used to assess the level of liking for bagea products using 25 panelists from Food Science and Technology students, Faculty of Agriculture, Hasanuddin University. The rating scale of the level of liking used is 1 to 7; very like (7), like (6), somewhat like (5), neutral (4), somewhat dislike (3), dislike (2) and very dislike (1). The results obtained from several parameters of panelist observations are as follows:

Color

Color is one of the parameters of food products that can attract taste buds through the sense of sight. Color has an important role in the selection of preferred products. The color of a food product can be influenced by the manufacturing process of the product, such as the heating process or the addition of components (Winiastri, 2021). Color in food has a very important role because it can determine the sensory profile of the food.

An ingredient that is considered nutritious, tasty, and has an excellent texture will not be eaten if it has an unsightly color or gives the impression that it has deviated from the color it should be. Attractive and natural-looking food colors can enhance taste. Based on the results of organoleptic testing on color parameters using the hedonic method, the results of testing bagea cake products are shown in Figure 2 below:

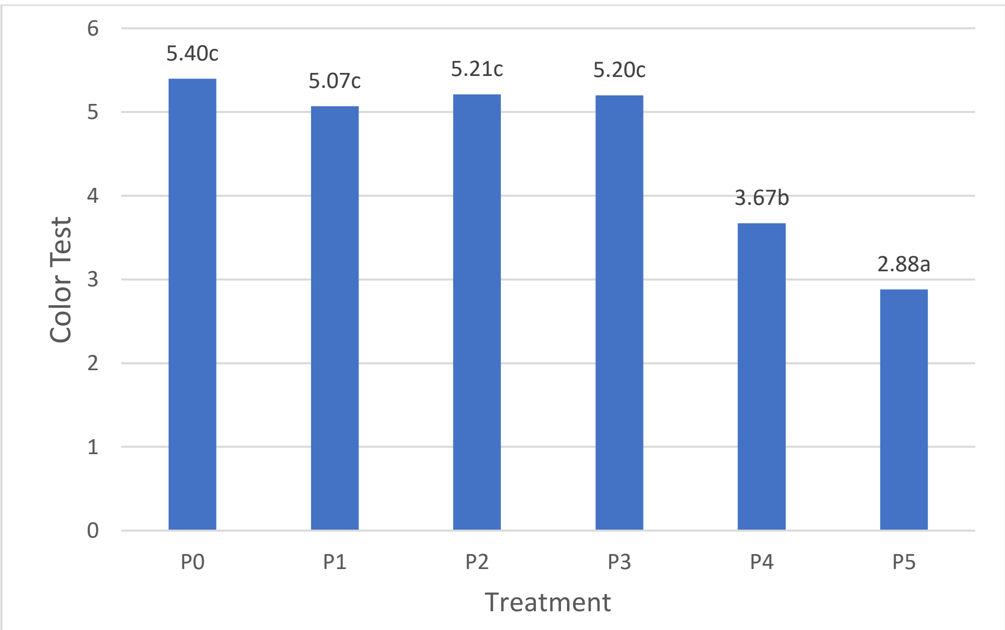


Figure 1. Effect of Moringa Leaf Flour Addition Concentration on the Color of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

P3 : (91 gram Sago Flour & 9 gram Moringa Leaf Flour)

P4 : (88 gram Sago Flour & 12 gram Moringa Leaf Flour)

P5 : (85 gram Sago Flour & 15 gram Moringa Leaf Flour)

Based on the results of the tests carried out in Figure 2, the organoleptic results of color in bagea cake products with the comparison of sago flour with moringa flour show the average level of panelist preference of the 6 treatments ranging from 2.88 to 5.4 (dislike - very like). In the treatment (100 grams of sago flour) obtained a level of preference of 5.4 (very like). The treatment (Sago flour 97 grams: Moringa leaf flour 3 grams) obtained a favorability level of 5.07. The treatment (94 grams of sago flour: 6 grams of moringa flour) obtained a favorability level of 5.21. The treatment (91 grams of sago flour: 9 grams of moringa leaf flour) obtained a favorability level of 5.2. The treatment (88 grams of sago flour: 12 grams of moringa leaf flour) obtained a level of preference of 3.67. The treatment (Sago flour 85 grams: Moringa leaf flour 15 grams) obtained a level of preference of 2.88. From these results, it was obtained that the highest level of panelists' liking for the color parameter was in the treatment (100 grams of sago flour) or without the addition of moringa leaf flour. While the lowest level of liking was in the treatment (85 grams sago flour: 15 grams moringa flour).

Based on the results of the analysis of variance (ANOVA), a significant value ($p < 0.05$) was obtained, indicating that the treatment had a significant effect on the color parameters of Bagea Cake products with moringa flour substitution, for this reason it is necessary to conduct a further test (Duncan) to determine the differences between all treatments. The results of Duncan's test obtained three different treatment groups. The first group is (Sago flour 85 grams: Moringa leaf flour 15 grams). The second group is in the formulation (Sago flour 88 grams: Moringa leaf flour 12 grams). While in the third group obtained in the formulation (100 grams of sago flour), treatment (97 grams of sago flour: 3 grams of moringa leaf flour), treatment (94 grams of sago flour: 6 grams of moringa leaf flour) and treatment (91 grams of sago flour: 9 grams of moringa leaf flour).

This is influenced by the amount of moringa flour added to the Bagea cake. The test results showed that panelists preferred Bagea cakes with a neutral color or without the addition of moringa flour. The addition of moringa flour can improve the color of sago cakes to be brighter and more attractive. The green color of the cake is due to the natural color of moringa leaves. This is due to the chlorophyll content in moringa leaves which is able to give a green color to the product (Tawar et al., 2022). So that the addition of 12 grams and 15 grams of moringa flour is the lowest because it produces a different color from the original bagea cake so that it is less preferred by panelists. If the concentration of moringa flour addition is too high, the resulting color can become darker and unbalanced. This is caused by the excessive addition of moringa flour so that it can change the color of the product (Tawar et al., 2022). The higher the minerals in the ingredients, namely in bagea cake, the darker the product color according to research (Prabawo, 2010 in Kurniawan et al., 2018).

Texture

Texture is one of the observation parameters of the hedonic method organoleptic test related to the senses associated with touch and touch. Texture parameters are divided into two, namely texture sensed by mouth (mouth feel) and texture sensed through finger feel. Texture can be interpreted as a sensation of pressure that can be felt with the mouth (when bitten, chewed and swallowed) and finger feeling (Noviyanti et al., 2016). Based on the results of organoleptic testing on texture parameters using the hedonic method, the test results in Figure 3 are as follows.

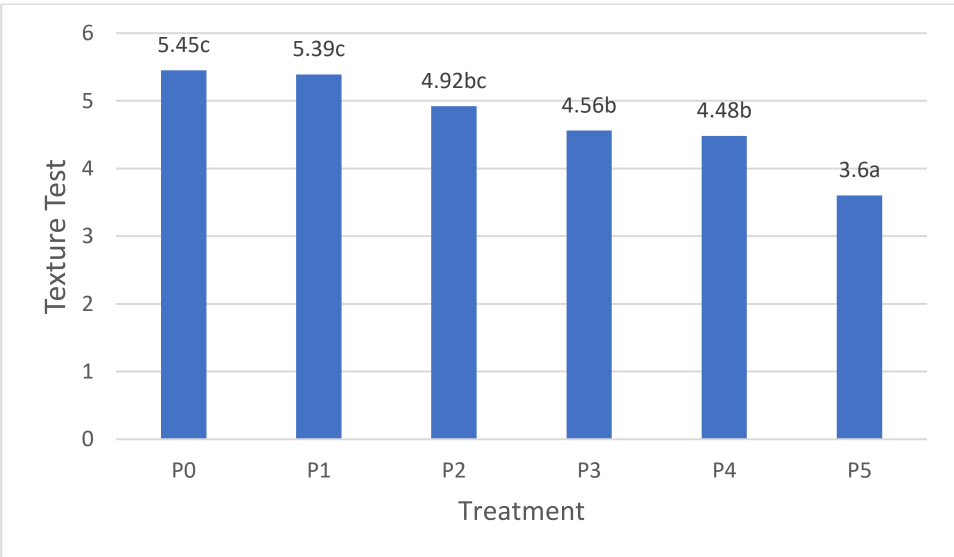


Figure 2. Effect of Moringa Leaf Flour Addition Concentration on Bagea Cake Texture

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

P3 : (91 gram Sago Flour & 9 gram Moringa Leaf Flour)

P4 : (88 gram Sago Flour & 12 gram Moringa Leaf Flour)

P5 : (85 gram Sago Flour & 15 gram Moringa Leaf Flour)

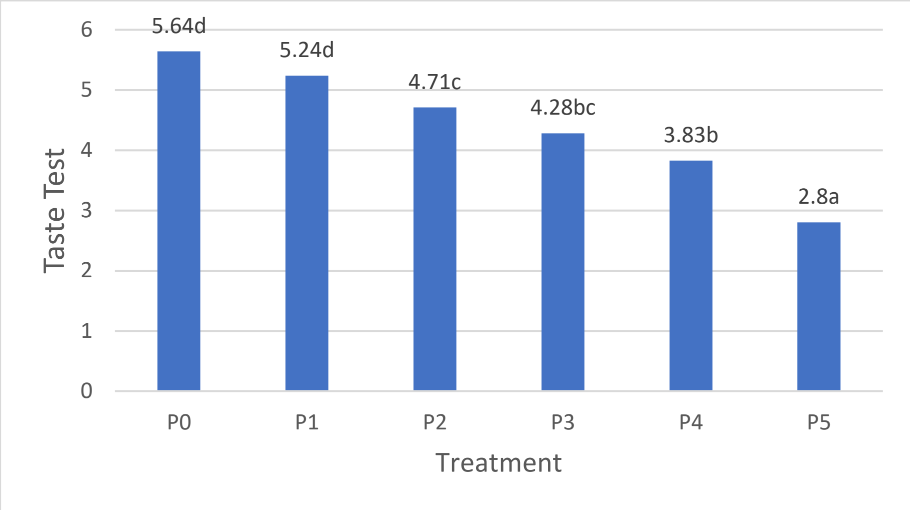
Based on the research results in Figure 3, the results of organoleptic texture testing on bagea cake products with a comparison of moringa flour substitutions show the average level of panelist liking of the five samples, which is between 5.45-3.6. In the treatment (100 grams of sago flour) obtained a level of preference of 5.45 (like). The treatment (97 grams of sago flour: 3 grams of moringa flour) obtained a favorability level of 5.39. The treatment (sago flour 94 grams: moringa leaf flour 6 grams) obtained a favorability level of 4.92. The treatment (91 grams of sago flour: 9 grams of moringa leaf flour) obtained a favorability level of 4.56. The treatment (sago flour 88 grams: moringa leaf flour 12 grams) obtained a level of preference of 4.48. The treatment (sago flour 85 grams: moringa leaf flour 15 grams) obtained a level of preference of 3.6.

Based on the results of analysis of variance (ANOVA) obtained a significant value ($p<0.05$). However, the less the addition of moringa flour in making bagea cakes, the more the level of panelists' liking for the texture of the resulting bagea cakes. Duncan's test results obtained three different treatment groups. The first group is (85 grams sago flour: 15 grams moringa flour). The second group is in the formulation (88 grams sago flour: 12 grams moringa leaf flour), treatment (91 grams sago flour: 9 grams moringa leaf flour) and treatment (94 grams sago flour: 6 grams moringa leaf flour). While the third group was obtained in the formulation (sago flour 100 grams), treatment (sago flour 97 grams: moringa leaf flour 3 grams) and treatment (sago flour 94 grams: moringa leaf flour 6 grams).

The results showed that the results of the texture test had a significant effect on the texture of the bagea cake. This is in line with the statement of erniyanti and sadimantara, 2019 which states that the crispness of bagea cake can be affected by the moisture content of the ingredients used. Dry products are said to have an acceptable level of crispness if the moisture content is less than 5%, where in this condition the material can still be cut which means the product still has good crispness (Maltz, 1962 in Muchtar et al., 2017). The lower the moisture content, the crispier the product will be. The texture of bagea with the use of moringa flour affects the decrease in texture quality in bagea.

Flavor

Flavor is an important sensory attribute to determine the level of preference of panelists for food products and is a specific assessment of food selection by consumers. The taste of food can be changed with natural or artificial flavorings added so that it can affect the sense of taste. Based on the results of organoleptic testing on flavor parameters using the hedonic method, the results of testing bagea cake products are shown in Figure 4.



Gambar 3. Effect of Moringa Leaf Flour Addition Concentration on the Taste of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

P3 : (91 gram Sago Flour & 9 gram Moringa Leaf Flour)

P4 : (88 gram Sago Flour & 12 gram Moringa Leaf Flour)

P5 : (85 gram Sago Flour & 15 gram Moringa Leaf Flour)

Based on the research results in Figure 4, the results of organoleptic testing of taste in bagea cake products with a comparison of moringa flour substitution show the average level of panelist liking of the six samples, which is between 5.64-2.8. In the treatment (100 grams of sago flour) obtained a level of preference of 5.64 (like). The treatment (97 grams of sago flour: 3 grams of moringa flour) obtained a favorability level of 5.24. The treatment (sago flour 94 grams: moringa leaf flour 6 grams) obtained a favorability level of 4.71. The treatment (91 grams of sago flour: 9 grams of moringa flour) obtained a favorability level of 4.28. The treatment (sago flour 88 grams: moringa leaf flour 12 grams) obtained a level of preference of 3.83. The treatment (sago flour 85 grams: moringa leaf flour 15 grams) obtained a level of preference of 2.8.

Based on the results of analysis of variance (ANOVA) obtained a significant value ($p < 0.05$). However, the less the addition of moringa flour in the making of bagea cake, the more the level of panelists' liking for the taste of the resulting bagea cake. Duncan's test results obtained four different treatment groups. The first group is (85 grams sago flour: 15 grams moringa flour). Group two in the treatment (88 grams of sago flour: 12 grams of moringa flour) and (91 grams of sago flour: 9 grams of moringa flour). The third group was treated with (91 grams of sago flour: 9 grams of moringa flour) and (94 grams of sago flour: 6 grams of moringa flour). The fourth group was treated with (97 grams of sago flour: 3 grams of moringa flour) and (100 grams of sago flour).

The results showed that the addition of moringa flour greatly influenced the level of favorability of the panelists. The treatment (100% sago flour) became the most preferred formulation because it used moringa flour. The addition of moringa flour gives a slightly bitter taste to the bagea cake product so that it is less preferred by panelists. Moringa leaf flour added gives a flavor effect so that the panelists' liking for bagea cake products decreases. This is in accordance with the statement (Sartina, 2018) which states that the more the addition of moringa leaves will affect the taste of moringa leaves because the nature of moringa leaves provides an aftertaste that affects the quality of bagea cake products. The bitter aftertaste on the cake is influenced by the tannin content contained in moringa leaves. Tannins cause a bitter taste in moringa leaves because tannins can form bonds with proteins in the body, which produce a bitter taste. Tannins found in Moringa (Moringa oleifera) leaves are one of the main causes of the bitter taste caused by these leaves. In addition, tannins also have antioxidant properties that can act as antioxidants in the body. However, its bitter taste can interfere with the absorption of essential nutrients such as protein. The tannin content consumed then becomes bitter and can cause dryness due to the formation of cross-links between tannins and proteins or glycoproteins that occur in the mouth. Based on the results of Veronika's research (2017), it shows that the tannin content in moringa leaves is 8.22%. The use of additives in cake processing can affect flavor parameters. The use of margarine in the manufacturing process helps improve the taste and acts as an emulsifier to improve the taste of the cake. The fat content in eggs and margarine in food products can affect the taste of food, because the presence of fat can improve the taste of a food.

Scent

Aroma is an important organoleptic test parameter because it affects the level of consumer liking for the product and determines whether the product is accepted or rejected by consumers. Aroma is the smell of food products which is a response to food volatile compounds that degrade due to heating which enter the nasal cavity and are perceived by the olfactory system (Santosa, C. W., 2019) The results of organoleptic testing on the aroma parameter using the hedonic method, obtained the results of testing bagea cake products in Figure 4.

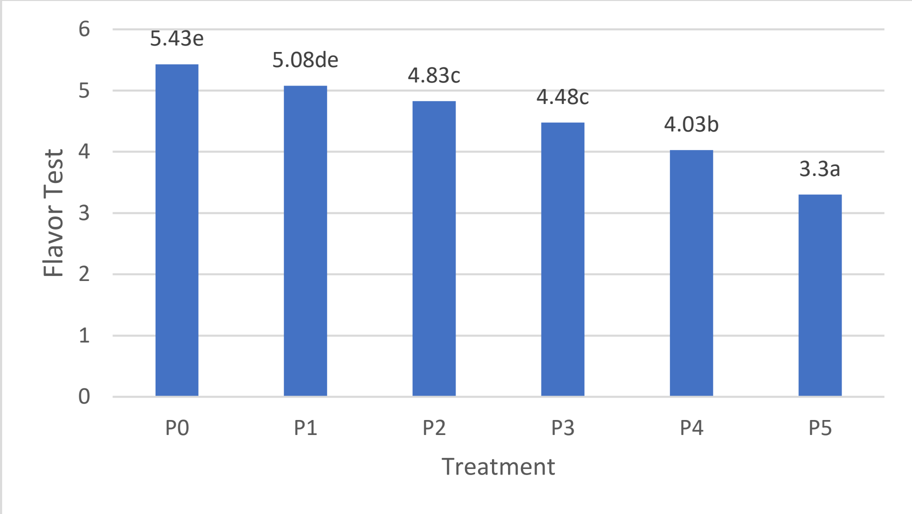


Figure 4. Effect of Moringa Leaf Flour Addition Concentration on the Aroma of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

P3 : (91 gram Sago Flour & 9 gram Moringa Leaf Flour)

P4 : (88 gram Sago Flour & 12 gram Moringa Leaf Flour)

P5 : (85 gram Sago Flour & 15 gram Moringa Leaf Flour)

Based on the research results in Figure 5, the results of organoleptic testing of aroma in bagea cake products with a comparison of moringa flour substitution show the average level of panelist liking of the five samples, which is between 5.43-3.3. In the treatment (100 grams of sago flour) obtained a level of preference of 5.43 (like). The treatment (97 grams of sago flour: 3 grams of moringa flour) obtained a favorability level of 5.08. The treatment (sago flour 94 grams: moringa leaf flour 6 grams) obtained a favorability level of 4.83. The treatment (91 grams of sago flour: 9 grams of moringa leaf flour) obtained a favorability level of 4.48. The treatment (sago flour 88 grams: moringa leaf flour 12 grams) obtained a level of preference of 4.03. The treatment (sago flour 85 grams: moringa leaf flour 15 grams) obtained a level of preference of 3.3.

Based on the results of analysis of variance (ANOVA), a significant value was obtained ($p<0.05$). However, the less the addition of moringa flour in the making of Bagea Cake, the more the level of panelists' liking for the taste of the bagea cake produced. Duncan's test results obtained five different treatment groups. The first group is (85 grams sago flour: 15 grams moringa flour). Group two in the treatment (88 grams of sago flour: 12 grams of moringa flour). The third group in the treatment (91 grams sago flour: 9 grams moringa leaf flour) and (94 grams sago flour: 6 grams moringa leaf flour). The fourth group was treated with (94 grams of sago flour: 6 grams of moringa flour) and (97 grams of sago flour: 3 grams of moringa flour). The fifth group was treated with (97 grams of sago flour: 3 grams of moringa flour) and (100 grams of sago flour).

Aroma is an attraction that can stimulate the sense of smell so that it can affect the tastes of consumers. Through aroma, it can have an impact on consumers because of their sense of smell that is able to recognize food that is not yet visible but has been smelled by the nose as a sense of smell from a distance. The use of moringa flour has a significant impact on the aroma found in bagea cake. The strong aroma of moringa leaves can be minimized from desiccated coconut, because desiccated coconut has a distinctive aroma, which is produced due to the content of α-tocopherol and free fatty acids (Rezy, 2019). This aroma can increase with high temperature roasting and the right time, so that the aroma of Kue bagea is more fragrant and sharp (Rezy, 2019). According to (Sartina et al, 2018) stated that the higher the concentration of moringa leaves added that will affect the panelists' liking of the aroma of bagea. There are several factors that affect the aroma of bagea cake produced by additional ingredients used such as baking soda, vanilla, margarine, vegetable oil, and eggs. The roasting process can change the structure of the compounds contained in the raw materials, resulting in a number of aroma components obtained from the combination of raw materials used in the processing process. This is in accordance with (Hakimah & Dahlia, 2024) which states that roasting will result in a process of aroma formation that occurs when the ingredients in food products react with the heat generated by the oven, resulting in a distinctive aroma.

Determination of the Best Treatment in Organoleptic Testing

Bagea is a traditional food that has a distinctive flavor of sago and has a crunchy texture that is easy to chew. Having a taste in food products makes the main factor in determining consumer preference (Herdhiansyah et al., 2021). Bagea cake products with the addition of moringa flour are one of the innovative products developed afar to improve nutritional quality and can have a good impact on human health. The addition of moringa leaves is expected to increase the content of protein, iron, and antioxidants. However, the addition of moringa leaves is still considered so that the sensory appearance of the cake product remains in accordance with the original product. Some attributes used in sensory assessment such as color, aroma, taste, and texture. Determination of the best formulation can be done with the overall average value of the treatment of the assessment results that have been rated on the panelists. The average value for all parameters of organoleptic test results on bagea cake products with the addition of moringa flour can be seen in Figure 5.

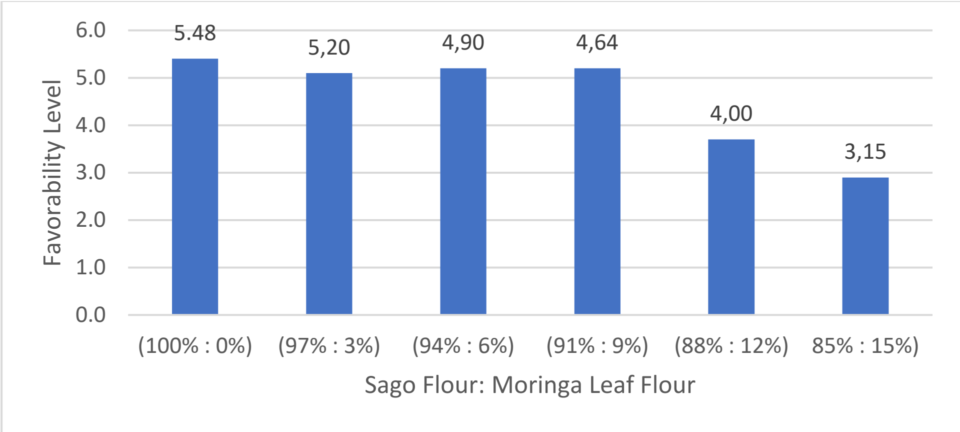


Figure 5. Organoleptic Value of Best Treatment of Bagea Cake Product with Moringa Leaf Flour Addition

Based on the results of the overall average value in the treatment of panelist assessment of organoleptic tests (color, aroma, texture, and taste parameters), the 3 best treatment formulations obtained can be seen in Figure 6, which shows that the bagea cake product obtained the highest level of assessment, namely in the treatment (100 grams of sago flour), namely 5.48 (Like), (97 grams of sago flour: 3 grams of moringa flour), namely 5.20 (like), treatment (94 grams of sago flour: 6 grams of moringa flour), namely 4.90 (neutral). After, three of the six best treatments were obtained comparing the formulation of bagea cake making to the organoleptic test. The best results obtained were carried out chemical testing, namely water content test, ash content test, protein content test, fat content test, fiber content test, carbohydrate content test, iron test and antioxidant activity test. The results of the bagea cake with the addition of moringa can be seen in Figure 6.

Figure 6. Results of Making Bagea Cake with the Addition of Moringa Leaf Flour

Physical Test

Proximate test or proximate analysis is a test of the chemical content of a material based on the method to be used.

Hardness

Hardness is the amount of compressive force to break a food product (Indiarto et al., 2012). Hardness of food products is one of the factors that influence consumer acceptance of food products. Hardness testing of bagea cake was carried out using a texture analyzer. Texture analyzer is used as a determination of the physical properties of a food product that has a relationship with the durability or strength of a product against pressure. The higher the texture test value, the harder the cake texture, conversely the lower the texture value, the less hard the cake texture.

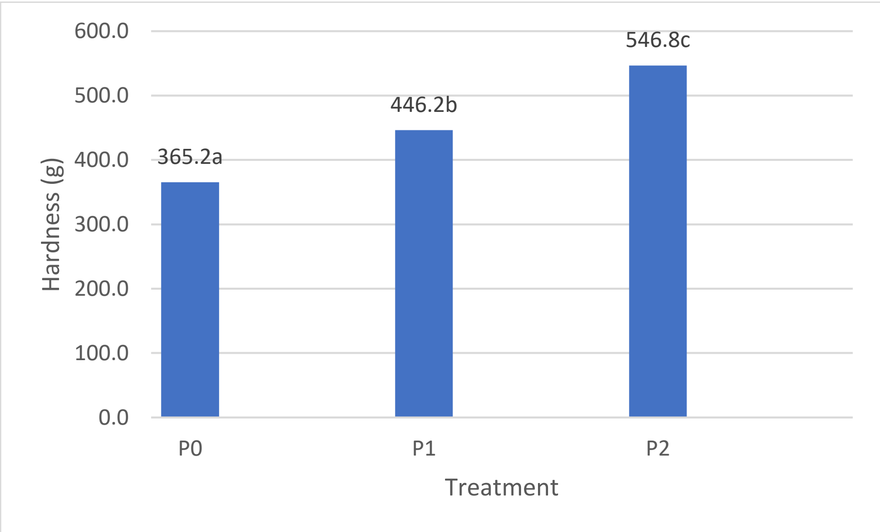


Figure 7. Effect of Moringa Leaf Flour Addition Concentration on Bagea Cake Hardness Test

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

Based on the results of Figure 8, it can be seen that the average hardness contained in bagea cake products ranges from 365.2 to 546.8g. The treatment (94 grams sago flour: 6 grams moringa flour) produced the highest bagea cake product, while the low level for hardness was (100 grams sago flour). The formulation (94 grams of sago flour: 6 grams of moringa flour) produced the highest level of hardness, while the lowest level of hardness was in the formulation (100 grams of sago flour: 0 grams of moringa flour). The results of the analysis of variance (Anova) showed that the addition of moringa flour had a significant effect on the hardness of bagea cake.

Based on the results of analysis of variance (ANOVA), a significant value ($p<0.05$) was obtained. Hardness test results obtained in the treatment (100 grams of sago flour: 0 grams of moringa flour) obtained 365.2 g, treatment (97 grams of sago flour: 3 grams of moringa flour) and treatment (94 grams of sago flour: 6 grams of moringa flour) produced a hardness level of 546.8 g, this indicates that the addition of moringa flour as much as 3 grams (97 grams of sago flour & 3 grams of moringa flour) is crisper than the addition of 6 grams of moringa leaves (P2). Bagea cakes with treatments (97 grams of sago starch & 3 grams of moringa flour) and (94 grams of sago starch & 6 grams of moringa flour) produced higher hardness values compared to the control. The use of more sago starch resulted in a lower texture value of the resulting bagea cake. This is influenced by the amount of sago starch content in the bagea cake. Sago starch contains 97.68% starch with several other contents such as amylopectin 75.01% and amylose content 24.99% (Larasati et al., 2017). The texture of bagea cake is also influenced by the high protein and fiber content in moringa flour. Moringa leaves contain about 29.4 g/100 g protein and 18.1-21.1 g/100 g dry leaf weight (Milla et al., 2021). High protein levels can form a harder structure due to the strong bond between protein and starch (Giuberti et al., 2021). Protein that binds to starch causes the cake to become hard due to the interaction between protein and starch through hydrogen bonds. The hardness of the resulting bagea cake product can also be caused by the high fiber content in the raw materials used for making bagea cake. This is in accordance with (Astuti et al., 2019), which states that cakes that have a very hard texture are caused by ingredients that have a high fiber content.

Color Test

Hunter's Lab color system was used to test the color parameters. The chromometer used was the Color Instrument CS-10. In Hunter's color notation system, the three parameters consist of L* (brightness/clearness), a* (redness/wrinkles), and b* (yellowness/clearness). This is in accordance with the opinion of Ulyarti et al. (2021), which states that each parameter of the Hunter color notation system has a different range of color values. Color value: L* notation produces brightness values from 0-100, which means from dark to light; a* notation produces reddish values from -80 to +100, which means from green to red; and b* notation produces yellowish values from -70 to +70, which means from blue to yellow.

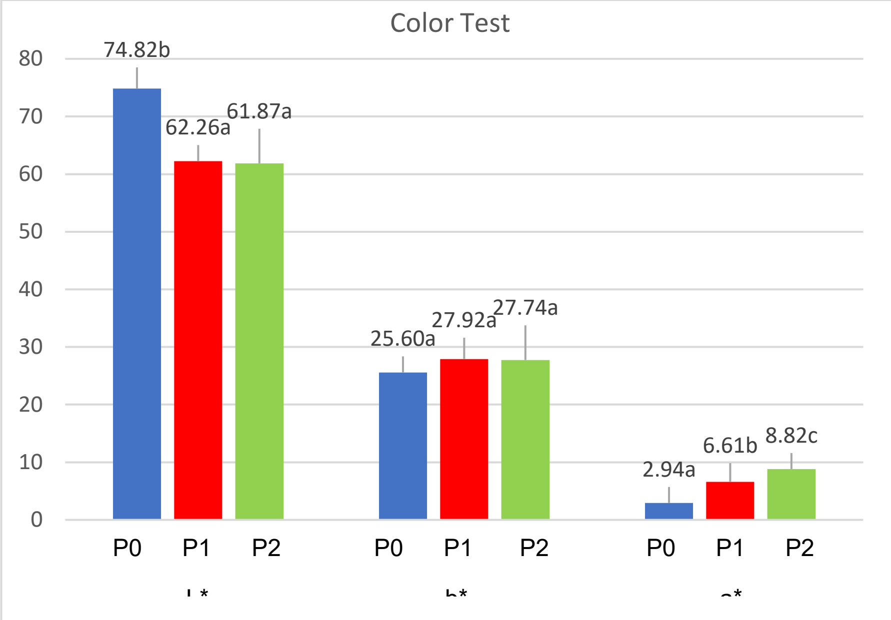


Figure 8. Effect of Moringa Leaf Flour Addition Concentration on Color Test of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

Based on the graphic image of the research results, it is found that the best treatment based on color testing using the parameters L * (brightness / clarity), a * (redness / wrinkles), and b * (yellowish / clarity) is the treatment (sago flour 100 grams). The results of the analysis of variance (ANOVA) showed that each treatment of moringa flour addition had a significant effect on the resulting bagea cake product. The brighter the product produced, the higher the value obtained (L value close to 100). Vice versa, if the lower the L value obtained, the lower the brightness of the bagea cake product. The L value obtained ranges from 61.87 to 74.82. The treatment (100 Gram Sago flour) is the best formulation/treatment obtained objectively because the resulting product is the same as the color of bagea cake products in general. The treatment (97% sago flour & 3% moringa flour) and (94% sago flour & 6% moringa flour) obtained a decreasing or darker brightness level value. This is influenced by the formulation of the use of raw materials, namely the decreasing concentration of sago flour. sago flour has a brightness value of about 96.00 while moringa flour has a brightness value of 63.32 (Herlina, 2022). The decreasing level of brightness of the bagea cake is influenced by the more moringa leaf flour due to the presence of chlorophyll content which causes the bagea cake product to get darker greenish. This is also in accordance with the results of research (Ardianti et al, 2019), that the more the addition of moringa leaf flour formulations to taro cake products, the more green (dark) the resulting cake will be. According to (Krisnadi, 2012), 10 grams of moringa flour contains 202.5 mg of chlorophyll. So that the bagea cake product obtained based on the hunter notation color testing system and also the sense of sight obtained the control treatment (100 Gram sago flour) to be the most preferred formulation compared to other treatments with the addition of moringa flour which changes the color of the cake to be darker (green).

Chemical Test

Proximate test or proximate analysis is a test of the chemical content of a material based on the method to be used. Proximate testing on moringa flour tested are water content, ash content, protein, fat, fiber, carbohydrates, iron and antioxidant activity.

Moisture Content

Moisture content is one of the important things to determine a product's quality or shelf life. Water is one of the most important components contained in food ingredients. Moisture content has the total percentage of free water content contained in a food ingredient. Moisture content in food ingredients can affect the texture, appearance and taste of a product (Damodaran & Parkin, 2017). The moisture content of bagea in this study uses the oven method of heating with a temperature of 105oC until it reaches a constant weight. This is in accordance with the statement (Daud et al., 2019) which states that the principle of the drying method using the oven method in the measurement of weight loss occurs due to the evaporation of water from the dried material using a temperature of 105-110oC. The results of the analysis of water content in various treatments of bagea cake can be seen in Figure 10.

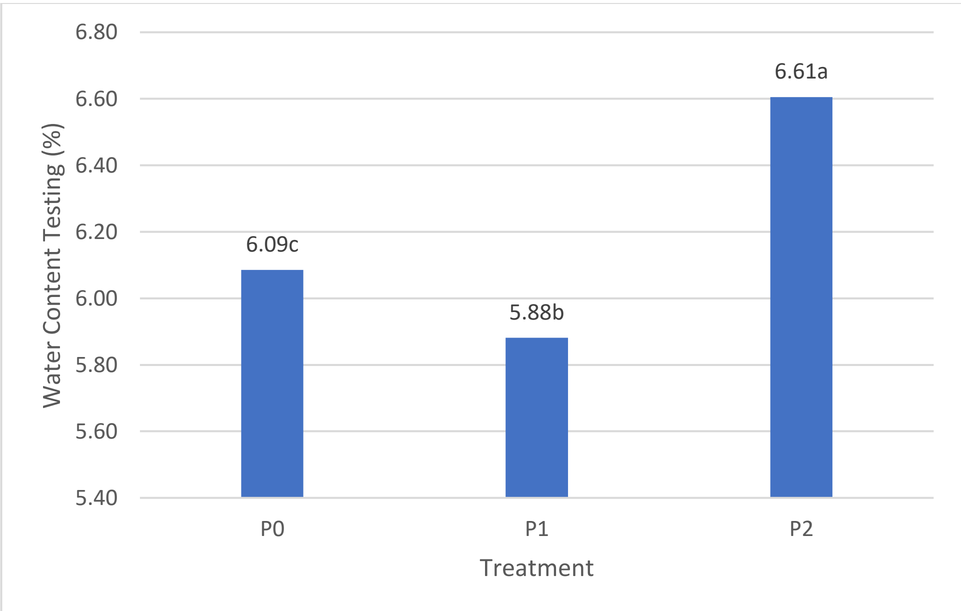


Figure 9. Effect of Moringa Leaf Flour Addition Concentration on Bagea Cake Moisture Content

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

The moisture content obtained based on the results of the study affects the level of acceptance value of the panelists, therefore it can be seen based on Figure 10 that the highest moisture content is (94 grams of sago flour & 6 grams of moringa flour) with a value of 6.6, while the lowest moisture content value is the treatment (97 grams of sago flour & 3 grams of moringa flour) with a value of 5.6. The results of the analysis of variance (ANOVA) showed that the formulation with the addition of moringa flour had a significant effect at a significant level (α<0.05) on the water content parameters of the bagea cake product. The difference in moisture content obtained in bagea cake products is influenced by the addition of moringa flour, as well as the composition of the raw materials used. (Tjalo, 2022) states that the water content of moringa flour is in the range of 7.68-11.71%. While the water content for sago flour is 14% (Heryani & Silitonga, 2017).

The increased water content is influenced by the increase in water content from the control cake to the cake with the addition of moringa flour, this is thought to be due to the absence of gluten content in sago flour, so that the resulting cake is less fluffy. According to Hemeto et al (2019), gluten content can develop cake dough when water is added because it forms air cavities that cause water to evaporate properly to produce delicious, savory and crispy cakes. The cause of the increase in water content during the addition of moringa flour can also be caused because moringa leaves do not contain gluten which can increase the elasticity of the product (Yanti and Prisla, 2020). The cause of the high bagea cake without the addition of moringa flour is because sago has a fairly high amylopectin content, which is around 73%. Amylopectin retains water during the baking process, resulting in high water content in sago cakes (Bitin, 2009). The starch content contained in sago flour can affect the increase in water content contained in bagea cakes because the starch content in sago is 86.9% (Gruben and Partohardjono, 1996 in Rodisi et al., 2006). Flour containing high levels of starch can absorb large amounts of water, because due to the ends of the amylose and amylopectin molecular chains there are hydroxyl groups contained in the disperse system of water and starch, causing hydroxyl groups to interact with hydrogen groups from water and vice versa (Winarno, 1992 in Rodisi et al., 2006). In addition, the increase in water content can also be influenced by the fiber content of the raw materials used. The high content of moringa flour produces high water content of bagea cake products due to the ability of fiber to bind water with strong binding power. This is clarified by the statement (Mozin et al, 2019) which states that fiber has the ability to bind water tightly to dietary fiber which is difficult to evaporate even though it has gone through a heating process. Based on the quality standards of SNI 01-4290-1996 regarding bagea, the maximum water content is 7% so that the cake products produced from this study have met SNI standards. This needs to be considered in order to produce bagea cake products that are safe for consumption and have a long shelf life.

Ash Content

Ash content is a mixture that comes from organic or mineral components and is found in a food ingredient. The purpose of measuring ash content is to determine the amount of mineral components in organic samples that remain during the sooting process. A perfect ignition is characterized by a change in the shape of the sample to ash and its color becomes grayish (Rahayu, 2021). The function of minerals for the human body is as a regulating and building substance. The results of ash content analysis in various treatments of bagea cake can be seen in Figure 10.

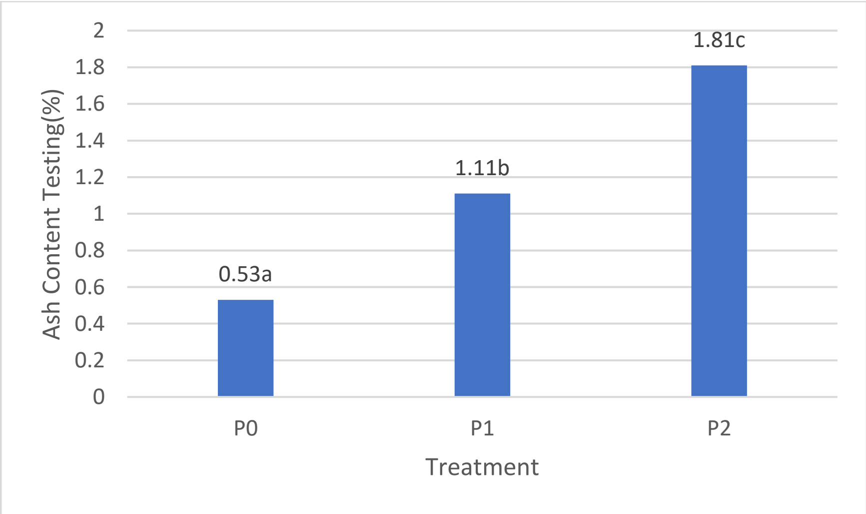


Figure 10. Effect of Moringa Leaf Flour Addition Concentration on Ash Content of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

The analysis results that can be seen from the table show that the P2 formulation (94 grams of sago flour & 6 grams of moringa flour) contains the highest ash content with a value of 1.81% compared to the treatment (100% sago flour) with an ash content value of 0.53%.

Based on the results of the ANOVA test, it shows that the addition of moringa flour has a significant effect (α<0.05) on the ash content of bagea cake products.

The higher the substitution of moringa flour, the higher the ash content. The ash content of bagea cake is thought to come from the ash content of the ingredients used in making bagea cake, namely moringa leaves. According to Angelina et al (2021), stated that the ash content of moringa flour is 7.95%. According to Manggara and Shofi (2018) moringa leaves have a fairly high calcium and potassium content of 603.77 96 mg/100gram (Ca) and 264.96 mg/100gram (K), and the content of other minerals, namely iron (Fe), zinc (Zn), sulfur (S) and phosphorus (P). the high ash content of bagea cake using moringa flour can provide benefits when viewed in terms of nutrition because moringa leaves contain calcium and other minerals needed by the body. Based on SNI regarding bagea cakes that are good for consumption, they contain a maximum ash content of 3%, so the results obtained based on this research are in accordance with SNI standards.

Fat Content

Fat content is a class of lipids, which are organic compounds that have one distinctive property, namely insoluble in water, but soluble in organic solvents such as benzene, chloroform, ether, and others. Fat has an effective source of energy compared to protein and carbohydrates. 1gram of fat will produce 9 kcal while protein and carbohydrates produce approximately 4 kcal calories. All types of food contain fat with different amounts of content. Fat serves to improve the physical structure of the food. Therefore, it is very important to analyze the fat content of food ingredients so that the calorie needs of food ingredients can be calculated properly. The results of the analysis of fat content in various treatments of bagea cake can be seen in Figure 11.

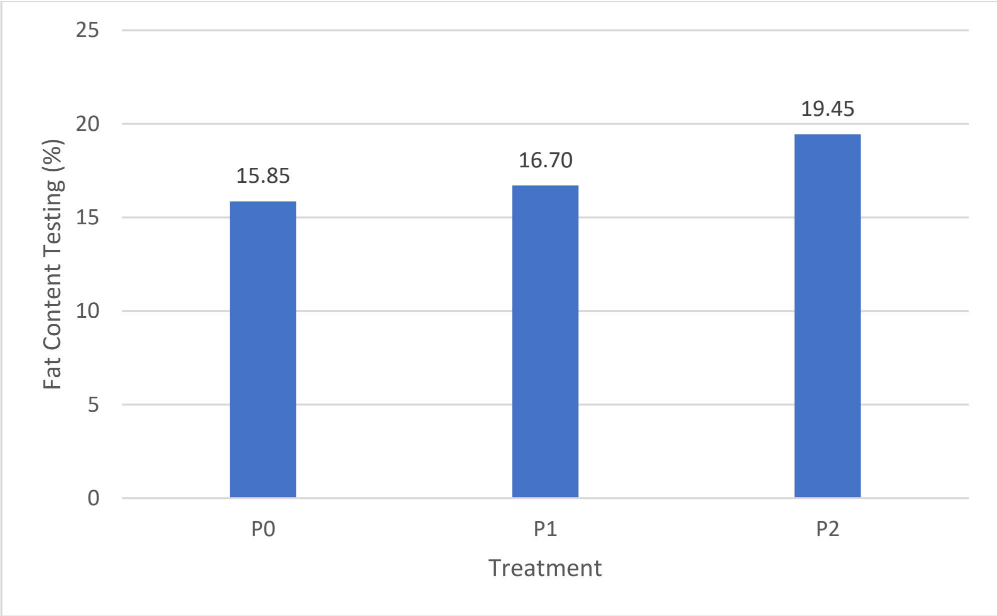


Figure 11. Effect of Moringa Leaf Flour Addition Concentration on Fat Content of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

The highest fat content was obtained in the formulation (94 grams of sago flour & 6 grams of moringa flour) with a fat content of 19.45% while the lowest fat content was in the fomulation (100 grams of sago flour) with a fat content of 15.85%. Based on the results of the analysis (ANOVA), it shows that the addition of moringa flour has a significant effect (α<0.05) on the fat content of bagea cake products.

The fat content contained in bagea cake with moringa flour substitution has met the standard (SNI 01-4290-1996) with a minimum fat content of 7%. The high fat content in bagea cakes is obtained by the substitution of ingredients, namely by using moringa leaves with a fat content of 2.74%. The fat content in sago flour is about 0.2% while moringa flour contains about 2.30% fat. The cause of the increase in fat content in bagea cake is the addition of additional ingredients such as dried coconut which has a fat content of 67.50%, the addition of margarine 81%, vegetable oil and eggs 10%. So that the addition of additional ingredients to bagea cake products results in increased fat content. This is in accordance with the statement (Lopulalan et al, 2013) which states that the cause of high fat content in cakes is caused by the use of margarine and eggs.

Protein Level

Protein levels are a component of food substances that are important for the body, because these substances function as fuel in the body. Protein is a macromolecule of amino acids with peptide bonds composed of elements C, H, O and N which are important food substances for the body because in addition to functioning as fuel in the body, as a building substance, regulating substance and replacing damaged cells or body tissues. Protein building substances function as new tissue building substances that always occur in the body. While protein regulating substances are the formation of enzymes and hormones, both of which work as metabolic regulators in the body (Adam, et al., 2020). The results of the analysis of fat content in various treatments of bagea cake can be seen in Figure 12.

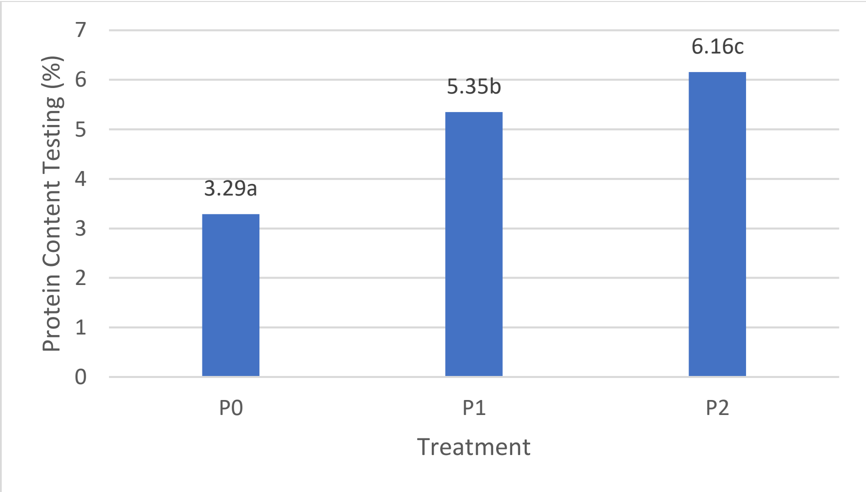


Figure 12. Effect of Moringa Leaf Flour Addition Concentration on Protein Content of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

The results of the protein analysis of the bagea cake, namely the formulation (94 grams of sago flour & 6 grams of moringa flour) contains the highest protein of 6.16%, then (97 grams of sago flour & 3 grams of moringa flour) 5.35%, while the lowest protein content is in the treatment (100 Gram sago flour) of 3.29%. Furthermore, the analysis test (ANOVA) showed that the treatment had a significant effect (α<0.05) on the protein content of bagea cake products with the addition of moringa flour. The protein content in bagea sourced from moringa flour is expected to be an inhibitor of the alpha glucosidase enzyme in the breakdown of carbohydrates into glucose.

Moringa leaves contain about 29.4 grams/100 grams of protein and 18.1-21.1 grams/100 grams of dry leaf weight (Milla et al., 2021). Based on the crude protein content of the best extraction of moringa leaf protein concentrate obtained (Rimbawanto et al., 2022), the essential amino acid leucine (67.50 mg/g protein) dominates, while non-essential amino acids are aspartic acid, glutamine, and glycine (67.90; 79.00; 73.60 mg/g protein). The amino acid content of the protein contained in Moringa leaves is divided into two, namely essential amino acids and non-essential amino acids. Crude protein contained in essential amino acids are leucine, valine, lysine, isoleucine, phenylalanine, threonine and arginine. While in crude protein non-essential amino acids are glutamine, glycine, alanine, aspartate, serine and tyrosine (Rimbawanto et al., 2022). The more concentration of moringa flour added in making bagea cake can increase the protein content of bagea cake. High protein levels can form a harder structure due to the strong bond between protein and starch (Giuberti et al., 2021). Proteins that bind with starch cause the cake to become hard due to the interaction between protein and starch through hydrogen bonds. Proteins bind water with hydrophilic hydrogen groups (Kusnandar, 2010). The effect of the low protein content in the resulting bagea cake can be influenced by the relatively low addition of sago flour and desiccated coconut. Sago flour has a protein content of about 0.3 grams, while desiccated coconut has a protein content of about 5.9 grams. In addition, the higher the roasting temperature, the protein denaturation will occur which results in changes in protein structure by high roasting temperatures. This is in accordance with the statement (Palupi et al, 2007) which states that the protein content will be degraded due to the heating process where protein is a reactive compound composed of several amino acids that have reactive groups that can bind with other components during the heating process.

Carbohydrate Content

Carbohydrates are macronutrient compounds in food that are most needed by the body as a source of energy. Carbohydrates play an important role in nature because they are the main source of energy for animals and humans. Carbohydrates contain compounds formed from carbon, hydrogen and oxygen molecules. The main function of carbohydrates is to provide energy for the body, some carbohydrates in the body are in the blood circulation in the form of sucrose to be used immediately and some are stored in the form of glycogen in the liver and muscle tissue, some are converted into fat and then stored as energy reserves (Nurul et al., 2019). Another function of carbohydrates is to give sweetness to food, save protein and regulate fat metabolism. Carbohydrates are the main source of calories because 1 gram of carbohydrates produced is 4 kcal. The results of fat content analysis on various treatments of bagea cake can be seen in Figure 13.

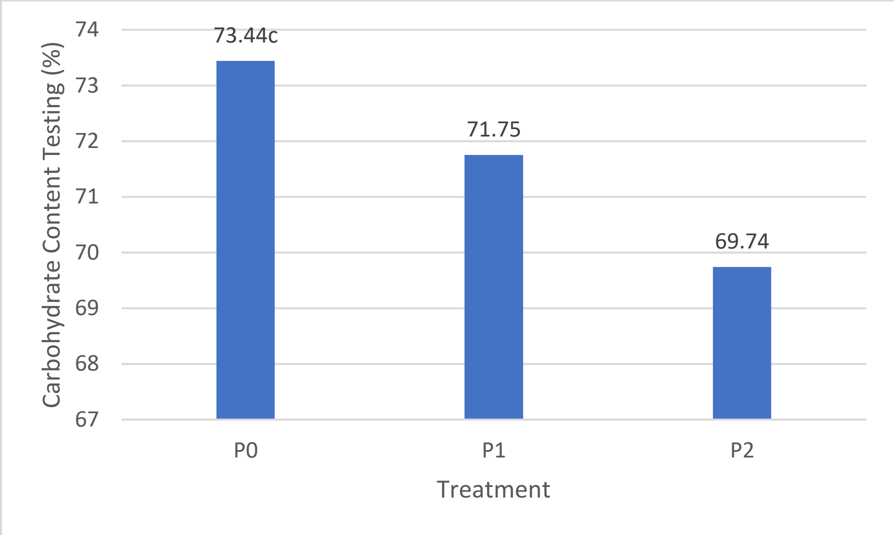


Figure 13. Effect of Moringa Leaf Flour Addition Concentration on Carbohydrate Content of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

Based on the data analysis table, it shows that the highest carbohydrate content is in the treatment (100 Gram sago flour) with a carbohydrate content of 73.44% while (97% sago flour & 3% moringa flour) and (94% sago flour & 6% moringa flour) obtained a carbohydrate content of 71.75% and 69.74% respectively. The results of the analysis of variance (ANOVA) showed that the treatment had a significant effect (α<0.05) on the carbohydrate content of moringa flour products.

The carbohydrate content obtained in this study is very high when compared to the quality standard of pastries, which is a minimum of 60% (BSN, 2006). Formulation P0 (100 grams sago flour) produced the highest carbohydrate content compared to treatments P1 (97% sago flour & 3% moringa flour) and P2 (94% sago flour & 6% moringa flour). Carbohydrate levels in bagea cake decreased as the concentration of moringa flour substitution increased and the concentration of sago flour used decreased. Carbohydrate levels in bagea cake are thought to come from the sago flour used in the process of making bagea cake. According to Astuti et al (2009) the carbohydrate content of sago flour is 84.7%. While the carbohydrate content of moringa leaves is 51.66%.

Fiber Content

Fiber is one of the important indicators in determining the quality of food products. Fiber is obtained from several classes of carbohydrates that are not easy to digest, namely polysaccharides as texture enhancers that can affect digestive health when consumed (Polnaya & Breemer, 2015). The results of bagea cake research with the addition of Moringa leaf flour can be seen in the table below.

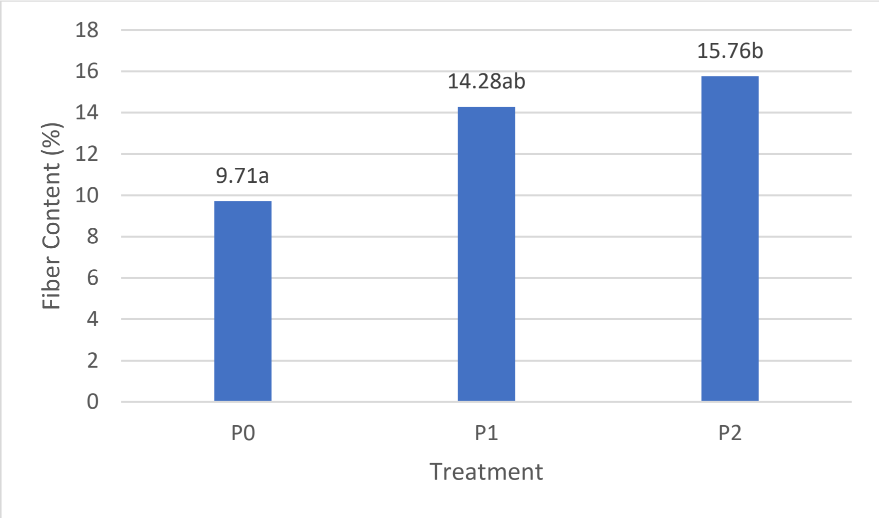


Figure 14. Effect of Moringa Leaf Flour Addition Concentration on Fiber Content of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

The results of the analysis of fiber content in bagea cake products with the addition of moringa flour ranged from 9.71% to 15.76%. Formulation (94% sago flour & 6% moringa flour) obtained the highest fiber content of 15.76%, (97% sago flour & 3% moringa flour) obtained a fiber content of 14.28%, while (100 Gram sago flour) obtained a fiber content of 9.71%. The results of analysis of variance (ANOVA) showed that the addition of moringa flour had a significant effect (α<0.05) on the fiber content contained in bagea cake products.

Based on SNI 01-2973-2011, it states that the maximum fiber in the content of cookies is 0.5%, so the results obtained exceed the standard limit. This is due to the addition of moringa leaf flour, which is known as a plant with a high fiber content of around 18.1-21.1 grams / 100 grams of dried moringa leaf weight (Milla et al., 2021). The addition of desiccated coconut in the process of making bagea cake also has an influence on the fiber content of bagea cake. Desiccated coconut contains 20% fiber (Afrianti & Efendi, 2016). Desiccated coconut is used to improve texture, as well as add flavor and have a distinctive aroma to bagea cake. In addition to adding flavor to bagea cakes, the high fiber content will also be better when consumed because it improves digestion.

Iron Content

Consumption of moringa leaves can have an impact on improving health in the human body, especially reducing cholesterol and triglyceride content in the blood, as well as providing vitamins and minerals to control the physiological conditions of the human body. Moringa leaves can also provide anti-aging and anti-inflammatory effects and substances that can function as anticancer in the human body (Suwahyono, 2008). Iron plays an important role in maintaining the immune system. The content contained in moringa flour is 28.20mg (Mazidah et al, 2018). Bagea cake products contain very little iron to increase the iron content in bagea cake, it is necessary to add moringa flour. The following table shows the results of research on bagea cake products with the addition of moringa leaves.

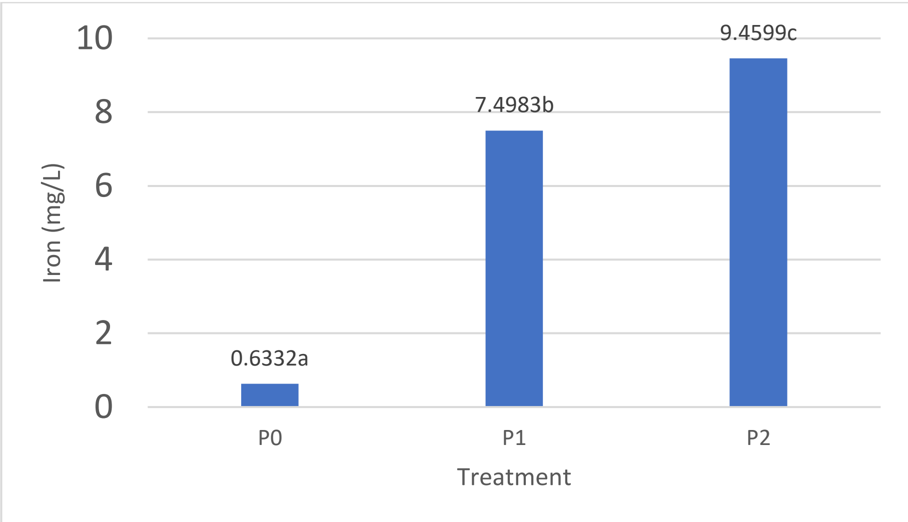


Figure 15. Effect of Moringa Leaf Flour Addition Concentration on Iron Content of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

Based on the results of the study, it can be seen that the formulation with the highest iron is (94% sago flour & 6% moringa flour) which is 9.4599mg, the formulation (97% sago flour & 3% moringa flour) obtained iron of 7.4983mg, while the control treatment (100 Gram sago flour) obtained iron of 0.6332mg. Furthermore, further tests (ANOVA) were carried out which obtained the results that each treatment of adding moringa leaves in making bagea cakes had a significant effect (α<0.05) on the iron contained in the product.

The addition of moringa leaves to the formulation (94% sago flour & 6% moringa flour) can increase the iron content of bagea cake. This is because based on the results of raw material analysis that moringa contains very high iron, which is 27mg based on Indonesian National Standard 9228: 2023. The more the addition of moringa flour, the higher the iron content of the resulting bagea cake. While the addition of sago flour used more resulted in the iron content of bagea cake decreased. The iron content contained in sago is 1.5mg (Auliah, 2012). Iron consumed is contained in erythrocyte cells, so consuming products with high iron content can increase hemoglobin levels, so as to prevent anemia.

Antioxidant Activity

Compounds that can counteract free radicals are antioxidants. Antioxidants are compounds derived from natural food ingredients that can provide a distinctive taste, aroma and color. Antioxidants are important as a defense of the quality of food products as well as health and beauty. Antioxidants are compounds that can counteract or reduce the negative effects of oxidants. Antioxidants work by donating one electron to the head of the oxidant compound so that the activity of the oxidant compound can be inhibited (Winarti, 2010). Antioxidants are needed by the body because they can protect the body from free radical attacks.

For food, antioxidants can function to inhibit the oxidation of fats and oils, minimize the occurrence of deterioration processes in food, extend the service life in the food industry, increase the stability of fats contained in food and prevent the loss of sensory and nutritional qualities. Antioxidant activity can be affected by several factors such as lipid content, antioxidant concentration, temperature, oxygen pressure and chemical components of food in general such as water and protein (Susanty et al., 2019).

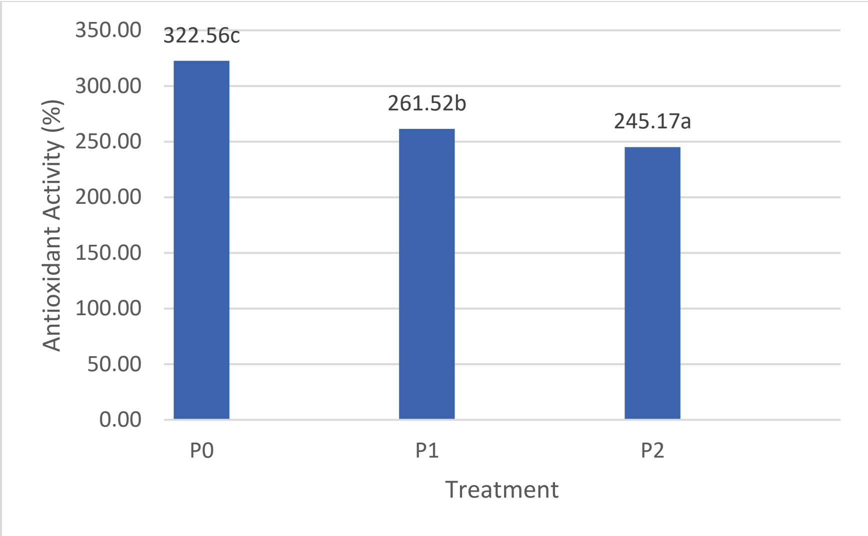


Figure 16. Effect of Moringa Leaf Flour Addition Concentration on Antioxidant Activity of Bagea Cake

Description:

P0 : (100 gram Sago Flour)

P1 : (97 gram Sago Flour & 3 gram Moringa Leaf Flour)

P2 : (94 gram Sago Flour & 6 gram Moringa Leaf Flour)

Based on the research data in the table, it can be seen that the treatment (94% sago flour & 6% moringa flour) obtained the highest antioxidant activity of 245.17 ppm, the treatment (97% sago flour & 3% moringa flour) obtained an antioxidant content of 261.52 ppm, while the control treatment (100 Gram sago flour) obtained the lowest antioxidant content compared to other formulations, namely 322.56 ppm. Further further test (ANOVA) which then obtained the results that each treatment is significantly different. The higher the addition of moringa leaf flour concentration, the higher the antioxidant content. This is influenced by the content of flavonoid compounds, polyphenols, and also ascorbic acid contained in moringa leaves (Herlina, 2022). The antioxidant activity contained in 100 grams of dried moringa leaves is 78.98% (Yazeed, 2019).

The addition of moringa flour in making bagea cakes can have a good impact on human health due to antioxidant activity. The increase in antioxidant activity in the formulation (94% sago flour & 6% moringa flour) greatly affects the value of antioxidants. The more the addition of moringa flour, the antioxidant activity of bagea cake tends to increase. This is in accordance with (Sartina et al, 2018), the antioxidant activity of chips increases with the addition of moringa flour. Moringa leaf flour contains antioxidants such as flavonoids, beta carotene and tannins (Mazidah et al, 2018). The cause of low antioxidant activity results can also occur when drying moringa leaves using a fluidized bed dryer which uses a long drying time which can affect the low antioxidant activity in moringa leaves (Phongpaichit et al., 2007). This shows that the degradation of antioxidant activity is more influenced by drying time than drying temperature. This is in accordance with the statement (Wijana et al., 2015) which states that the temperature and duration of drying have a significant effect on the antioxidant activity of bagea cake.

CONCLUSIONS

The best nutritional content was obtained from bagea cake with the addition of moringa flour, namely formulation P0 (100gram): moisture content 6.3%, ash content 0.53%, fat content 15.85%, fiber content 9.71%, protein content 3.29%, carbohydrates 73.44%, iron 0.63 mg and antioxidants 322.56 ppm). Formulation P1 (97gram: 3gram): water content 5.6%, ash content 1.11%, fat content 16.70%, fiber content 14.28%, protein content 5.35%, carbohydrates 71.75%, iron 7.49 mg and antioxidants 261.52 ppm). While P2 formulation (94gram: 6gram): moisture content of 6.6%, ash content of 1.81%, fat content of 19.45%, fiber content of 15.76%, protein content of 6.16%, carbohydrates 69.74%, iron 9.45 mg and antioxidants 245.17 ppm. The effect of adding moringa flour to bagea cake products is very influential on sensory quality and chemical content, which can be seen with the content (antioxidant activity, protein and iron) which increases with the addition of moringa, the content of bagea has good benefits when consumed.

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CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

ETHICAL CONSIDERATION

The authors have confirmed ethical issues, such as plagiarism, misconduct, fabrication and falsification of information, consent to publish, duplication of publication and submission, and redundancy.

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