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Sago Starch Bagea Cookies with Moringa Leaf Powder Composite as a Fiber and Antioxidant Enhancer

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ABSTRACT

Bagea is a traditional food typical of Eastern Indonesia such as the Ternate and Maluku regions. The addition of moringa leaf powder to bagea cookies can increase the nutritional content, so that it can meet the needs of dietary fiber and the antioxidant properties of bagea cookies. This study aims to determine the effect of adding moringa leaf powder to the physical, chemical and sensory characteristics of bagea cookies and to determine the best formulation of bagea cookies with sago starch with the addition of moringa leaf powder. This study used an experimental method with a completely randomized design (CRD) with a single factor, namely the addition of moringa leaf powder 3%, 6%, 9%, 12%, 15%. The tests included physical characteristics (color lightness, texture), chemical characteristics (moisture content, crude fiber content and antioxidant activity), sensory tests (color, aroma, texture, taste and overall) and effectiveness tests. The results showed that the addition of moringa leaf powder to bagea sago starch cookies had a significant effect on physical, chemical, sensory characteristics and gave no significant effect on the moisture content of bagea cookies. The best formulation of bagea cookies was in the L3 treatment which resulted in a color lightness characteristic of 76.42; texture; 262.92 g/2mm; moisture content 4.82%; crude fiber content 1.71%; antioxidant activity 8.52%; color preference 5.97 (slightly like-like); aroma preference 4.90 (neutral-slightly like); texture preference 5.33 (slightly like-like); taste preference 4.83 (neutral-slightly like); and overall preference of 5.57 (slightly like-like). The nutritional content of bagea cookies per 100 g is protein, fat, ash, and carbohydrates of 9.32%, 9.40%, 0,13%, and 76.30% respectively.

Keywords: Bagea cookies; moringa leaf powder; fiber; antioxidant activity

INTRODUCTION

Bagea is a traditional food typical of Eastern Indonesia such as the Ternate and Maluku regions. In addition, bagea are also found in Papua and Sulawesi. These cookies have a dry, crispy texture and are pale brown in color. The sweet taste causes bagea to be liked by children to adults (Hasriani et al., 2018). The main ingredients for making bagea are sago starch and other ingredients in the form of sugar, vegetable oil and eggs. Bagea are generally topped with peanuts or

walnuts (Metaragakusuma et al., 2015). Bagea made from sago starch produces a fairly high carbohydrate content, but the content of other nutrients is still quite low such as protein and fiber so that those who consume it can cause obesity.

Modern society today expects bagea not only to have a delicious and filling taste but also to have functional properties for health (Anggraeni, 2019). Cookies can be functional if in their manufacture are added ingredients that have a positive effect on the body such as fiber, calcium and provitamin A (Purba et al., 2017). Bagea cookies can be developed into food products with high nutritional value by adding potential food ingredients such as Moringa leaves.

Moringa is a tropical plant that has many benefits as food, has high nutritional value and also has medicinal properties. Various literatures state that Moringa leaves are rich in essential amino acids, fats, vitamins and minerals (Liu et al., 2018). Moringa leaves are known as plants that are high in protein content of 29.4 g/100g dry leaf weight and fiber around 18.1-21.1 g/100g dry leaf weight (Milla et al., 2021). Moringa leaves contain antioxidants in the form of flavonoids, polyphenols and ascorbic acid. The total phenolic content in Moringa leaves ranges from 20-122 mg GAE/g (Yazeed, 2019).

The use of Moringa leaves in food fortification programs has begun to be developed, because it has potential as a functional food product. Based on research by Azizah (2015), the substitution of 5%, 10% and 15% Moringa leaf powder in biscuit products with wheat flour substitution will affect the color, aroma and taste of the biscuits. The Moringa leaf biscuits produce a green color that is getting darker with greater substitution. The unpleasant smell of biscuits is typical of dry leaves and the more concentrated the aroma is at the higher the percentage addition. The taste of the biscuits is getting bitter when the substitution of Moringa leaf powder is getting bigger. Based on the research of Dachana et al., (2010), the manufacture of flour-based cookies with the addition of 5%, 10% and 15% Moringa leaf powder affects the physical, sensory and chemical characteristics of cookies, The increase in the addition of Moringa leaf powder from 5% to 15% increases the hardness value of the cookie texture because moringa leaf powder has high protein and fiber content, resulting in a harder dough. Sensory evaluation showed that cookies with the addition of 10% Moringa leaf powder were acceptable, while above 10% would result in unacceptable cookies. The addition of 10% Moringa leaf powder significantly increased the protein content of 11.6%, dietary fiber 4.3%, iron 5.09 mg%, calcium 272.3 mg% and b-carotene 1,600 mg% cookies. In the study of Sartina et al., (2018), sago chips products with the addition of 15% Moringa leaf powder resulted in antioxidant activity of 84.27 µg/mL.

Making bagea cookies with the addition of moringa leaf powder has never been done, but the potential for adding moringa leaf powder can increase its nutritional content, so that it can meet the needs of food fiber and antioxidant properties of bagea cookies. In addition, the addition of moringa leaf powder can also improve physical characteristics such as the color and texture of bagea cookies. Therefore, it is necessary to do research on the addition of moringa leaf powder composite in bagea cookies which can improve the quality of bagea cookies and be accepted by the community.

MATERIALS AND METHODS

Tools and materials

The tools used in this research are digital balance, mixer, oven, baking sheet, wooden rolling pin and cookie mold. Other equipment used in this test are Minolta

Colorimeter (CR-400, Japan), Rheotex type SDA-700, spectrophotometer (Thermo Sientific Genesys 10S UV-VIS, China), vortex, volumetric flask, beaker glass, volume pipette, desiccator, porcelain exchange rate, weighing bottle, erlenmeyer and filter paper.

The ingredients used in making bagea cookies are sago starch from Tani's sago brand, Moringa leaf powder from Yusron Herbamart Jember store (moisture content = 6,30%), Rose Brand refined sugar, Dorang Mas fish vegetable oil, Cap Kapal salt and domestic chicken eggs. The materials used for the analysis were distilled water, NaOH, H_2SO_4, K_2SO_4, ethanol 96%, methanol and DPPH (1,1 diphenyl-1-2-Picrylhydrazil).

Bagea Cookies Production

The process of producing bagea cookies refers to Hasriani et al (2018) and (Milla et al., 2021) with modifications. The first stage is mixing 50 grams of eggs and 60 grams of powdered sugar using a mixer at high speed for 5 minutes until it forms a cream so that the sugar dissolves in the eggs and the eggs bind the air. Then add 30 ml of vegetable oil and 1 gram of salt and mix again using a mixer 3 minutes at high speed until the resulting dough is soft and well mixed. Furthermore, the addition of dry ingredients in the form of sago starch and moringa powder, control (200 grams of sago starch), L1 (194 grams of sago starch: 6 grams of moringa leaf powder), L2 (188 grams of sago starch:12 grams of moringa leaf powder), L3 (182 grams of sago starch) grams of sago starch: 18 grams of moringa leaf powder), L4 (176 grams of sago starch: 24 grams of moringa leaf powder), L1 (170 grams of sago starch: 30 grams of Moringa leaf powder), mixed manually for 3 minutes until the dough is soft, smooth and easy to shape.

The second mixing is done manually so that the dough is mixed evenly and does not experience premature maturity which makes the dough harden. The next step, the dough is flattened using a rolling pin with the aim of flattening the surface of the dough and making it easier for printing. Furthermore, printing using a cookie cutter is round, 3 cm in diameter and 0.5 cm thick and then placed on a baking sheet that has been lined with baking paper. The last stage is roasting in the oven at 150°C for 60 minutes.

Research design

This study used an experimental method with a completely randomized design (CRD) with a single factor, namely the addition of moringa leaf powder 3%, 6%, 9%, 12%, 15%. The experiment was carried out with 3 repetitions.

Analysis Method

Parameters of analysis include physical, chemical and sensory characteristics. Physical characteristics include color lightness and texture, chemical characteristics include moisture content (BSN, 2011), crude fiber content (Fajri et al., 2018) and antioxidant activity (DPPH method) (Visita and Putri, 2014), sensory characteristics is hedonic test include color, aroma, texture, taste and overall (Setyaningsih et al., 2010) and effectiveness (De Garmo, 1984).

Sensory test data were analyzed using the Chi square method with a 95% confidence level and analyzed descriptively. Meanwhile, the data from the physical and chemical tests were analyzed using analysis of variance (ANOVA) at the test level ($\alpha \leq 0.05$) to determine the effect of treatment on the measured parameters. If the difference is significant, it is continued with Duncan's New Multiple Range Test (DNMRT).

RESULTS AND DISCUSSION

Physical Characteristics

Color Lightness (L)

Color testing is carried out to determine the color of bagea cookies products objectively. The parameter measured in the color test is L for the lightness value. The lighter the sample being measured, the L value approaches 100. On the other hand, the darker the sample, the L value approaches 0 (Saputri, 2014). The average value of the color lightness test for bagea starch sago cookies at various percentages of addition of moringa leaf powder ranged from 70.45±0.35 to 82.00±0.34, presented in Table 1.

The results of variance showed that the percentage of addition of moringa leaf powder had a significant effect on the 95% confidence level. ($\alpha \leq 0.05$)on the color lightness of sago starch bagea cookies. Duncan further test results showed that bagea cookies treatment L1 (was significantly different from treatment L2, significantly different from L3, significantly different from L4 and significantly different from the L5 treatment.

Table 1. shows that the highest lightness value of bagea cookies is found in the L1 treatment which is 82.00±0.34 while the lowest value is found in the percentage of 15% moringa leaf powder is 70.45±0.35. *Cookies* the treatment of L1, L2, L3, L4 and L5 resulted in the lightness value is lower than the control bagea cookies, namely 92.11±0.34. The lightness level of bagea cookies samples is influenced by the percentage of raw materials used. Enhancement the percentage of sago starch resulted in the lightness value of bagea cookies which tended to increase (light). The color of bagea cookies produced is greenish white to dark green (dark). This is influenced by the white color obtained from sago starch, where the lightness value of sago starch is 96.00 and the green color is obtained from the addition of moringa leaf powder with a brightness value of 63.32. Moringa leaf powder contains chlorophyll or a green pigment that causes a green color. The chlorophyll content in moringa leaves reaches 6.89 mg/kg dry matter, while 10 grams of moringa leaf powder contains 202.5 mg of chlorophyll (Krisnadi, 2012).The higher the percentage level of moringa leaf powder used will affect the color of bagea cookies to be greener (dark). This is in accordance with research (Ardianti et al., 2019), that the more use of moringa leaf powder in taro cookies, the greener (darker) cookies are produced.

Texture

The texture is one of the parameters that determine the quality and consumer acceptance of food products. Testing the texture of bagea cookies was carried out using a rheotex tool. Rheotex has the principle of product hardness level which is expressed in g/mm units, namely the amount of compressive force required to deform the product to a certain depth according to user settings. The higher the texture test value, the harder the cookie texture, on the other hand, the lower the texture value, the less hard the cookie texture. The results of the average value of texture testing of sago starch bagea cookies at various percentages of addition of moringa leaf powder ranged from 233.43±0.3g/2mm up to 340.87±0.51 g/2mm, can be seen in Table 2.

The results of variance showed that the percentage of addition of Moringa leaf powder had a significant effect on the 95% confidence level. ($\alpha \leq 0.05$)on the texture of bagea sago starch cookies. Duncan's further test results showed that bagea cookies in L1 treatment were significantly different from L2 treatment, significantly different from L3, significantly different from L4 treatment. and significantly different from L5.

Table 2 shows that the texture value of bagea cookies in treatment L5 has the

highest value of 340.87±0.51 g/2mm while the lowest texture value is found in treatment L1 which is 233.43±0.59 g/2mm, it shows that bagea starch sago cookies with the addition of 3% Moringa leaf powder are crunchier than other treatments. Bagea *cookies* the treatment of L1, L2, L3, L4 and L5 resulted in The hardness value was higher than the control bagea cookies, which was 180.63±0.31 g/2mm. The higher the percentage of sago starch, the lower the texture value of bagea cookies produced, where the product with a low texture value results in a less hard (crispy) product.This is influenced by the amount of starch content in bagea cookies. Sago starch has a starch content of about 97.68% with an amylopectin content of 75.01% and an amylose content of 24.99% (Larasati et al., 2017). Starch with a high amylopectin content will stimulate the puffing process, so that the food product will give it a light, porous, crunchy and crunchy nature (Kusnandar, 2010). The high starch content in the ingredients can increase the crispness of the resulting cookies because the amylose in the ingredients forms hydrogen bonds with more water, so that when roasting the water will evaporate and leave an empty space in the ingredients and make cookies crispier (Rosida et al., 2020).

The texture of bagea cookies is also influenced by the high protein and fiber content in moringa leaf powder. 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 levels of protein can form a harder structure as a result of the strong bond between protein and starch (Giuberti et al., 2021). Proteins that bind to starch cause cookies to become hard because of the interaction between protein and starch through hydrogen bonds. According to Kusnandar (2010), proteins bind to water in the presence of hydrophilic hydrogen groups. The hardness of bagea cookies is caused by hydrogen bonds between the amino groups of Moringa leaf powder and the hydroxyl groups of sago starch to form a complex.

The hardness of the bagea cookie products produced is also caused by the fiber content contained in the raw material for making bagea cookies. According to Astuti et al. (2019), crude fiber content causes a decrease in water absorption in starch granules. Decreased water absorption resulted in the starch gelatinization process being imperfect and causing the texture to become hard. Fiber as a compound that is not soluble in water and streng thens the material network, in food serves as a texture reinforcement. The higher the fiber content in the raw material, the resulting product with a sturdier and stronger texture will result in a harder product. During the texture formation process, starch, fiber and protein components compete with each other to bind water (Astuti et al.,2019).

Chemical Characteristics

Moisture content

Moisture content is a chemical characteristic that is very influential on food ingredients because it can affect texture, taste and shelf life food stuffs (Kusnandar, 2010). Moisture content can affect physical properties such as hardness. The results of the average value of testing the moisture content of sago starch bagea cookies at various percentages of addition of moringa leaf powder ranged from 4.58±0.28% up to 4.97±1.66% (Table 3).

The results of variance showed that the percentage of addition of moringa leaf powder had no significant effect at the 95% confidence level. ($\alpha \leq 0.05$)on water content of sago starch bagea cookies. This is due to the amount of moisture content contained in the dough does not differ much in all treatments, so that the moisture content of bagea cookies products is not significantly different. The difference in moisture content is influenced by the composition of the raw

material. Heryani and Silitonga (2017) stated moisture content of sago starch is 14% and the moisture content of moringa leaf powder is 7.5% (Rani et al., 2019).

Table 3. showed the lowest moisture content of bagea cookies was found in the L1 treatment (the addition of 3% Moringa leaf powder) which was 4.73±1.58%, while the highest water content was found in treatment L5 (addition of 15% Moringa leaf powder) which was 4.97±1.66%. *Cookies*Bagea treatment L1, L2, L3, L4 and L5 produced a higher moisture content than the control bagea cookies, which was equal to4.58±0.28%. The decrease in the moisture content of bagea cookies is caused by the composition of the raw materials, where the higher the percentage of sago starch, the lower the moisture content produced. This is because the moisture content is closely related to the starch content. According to Winarno (2004), carbohydrates (starch) is one of the important components in determining the value of water absorption. Starch is a hydrophilic compound. Starch granules have the ability to absorb very large water because of the very large hydroxyl group of starch, therefore the higher the amount of starch, the lower the water content (Rosida et al., 2020).

The increase in moisture content was caused by the higher percentage of moringa leaf powder resulting in an increasing moisture content. This is in accordance with the research of Ardianti et al., (2019) The higher concentration of Moringa leaf powder added to taro cookies, the higher the moisture content value. The increase in moisture content can be influenced by the fiber content in the material. Moringa leaf powder contains fiber around 19.2 g/100 grams (Rani et al., 2019).Fiber has water binding properties with a strong enough bond so that the more percentage of moringa leaf powder added, the higher the moisture content of the cookies produced. This is supported by the statement of Mozin et al., (2019)that fiber has the ability to bind water, water that is tightly bound in dietary fiber is difficult to be re-evaporated even with the heating process.

According to the quality standard of SNI 01-2973-2011, the maximum moisture content of cookies is 5%. Bagea cookies products with the addition of moringa leaf powder have SNI quality standards. Cookies produced must meet the specified quality requirements to be safe for consumption and have a long shelf life. The low water content in food stuffs will make the product less hard (crispy) (Nuraini, 2013).

Crude Fiber Content

Crude fiber is a part of food that cannot be hydrolyzed by strong acids or bases (Yulianti, 2016). The results of the average value of testing the crude fiber content of sago starch bagea cookies at various percentages of addition of moringa leaf powder ranged from 0.50±0.0% up to 2.80±0.03%, can be seen in Table 4.

The results of variance showed that the percentage of addition of moringa leaf powder had a significant effect on the 95% confidence level. ($\alpha \leq 0.05$) on crude fiber content of sago starch bagea cookies. Duncan's further test results showed that bagea cookies in L1 treatment were significantly different from L2 treatment, significantly different from L3 (9% addition of moringa leaf powder), significantly different from L4 treatment. (12% addition of Moringa leaf powder) and significantly different from L5 (15% addition of Moringa leaf powder).

Table 4 shows that the highest crude fiber content in the L5 treatment was 2.80±0.03% and the lowest in the L1 treatment was 0.50±0.05%. *Cookies* Bagea treatment L1, L2, L3, L4 and L5 produced higher crude fiber content than control bagea cookies, namely as big as 0.39±0.28%. The results obtained indicate that the higher the

addition of Moringa leaf powder, the crude fiber content of bagea cookies tends to increase. The increase in crude fiber content was accompanied by an increase in the percentage of Moringa leaf powder and a decrease in the percentage of sago starch. This is because moringa leaf powder has a higher fiber content about 18.1-21.1 g/100 g dry leaf weight (Milla et al., 2021) than sago starch 0.08-0.50% (Rinto et al., 2017).

According to SNI 01-2973-2011, the content of fiber in cookies maximum is 0.5%. The results showed that the crude fiber content of the L1 treatment met the SNI, but the L2, L3, L4 and L5 treatments did not meet the SNI requirements because it was more than 0.5%. Suryani et al., (2018), according the higher the fiber content, the better for digestion, so cookies with a high fiber content can be used as a snack for the diet.

Antioxidant Activity

Antioxidants are compounds that work by inhibiting the rate of oxidation of other molecules or neutralizing free radicals. The results of the average antioxidant activity of bagea starch sago cookies at various percentages of addition of Moringa leaf powder ranged from 2.67±0.21% up to 15.25±0.32%, can be seen in Table 5.

The results of variance showed that the percentage of addition of Moringa leaf powder had a significant effect on the 95% confidence level. ($\alpha \leq 0.05$)on antioxidant activity of bagea starch sago cookies. Duncan's further test results showed that bagea cookies in L1 treatment were significantly different from L2 treatment (66% addition of moringa leaf powder), significantly different from L3, significantly different from L4 and significantly different from L5.

Table 5 shows that the highest antioxidant activity was found in the L5 treatment reaching 15.25±0.32% and the lowest was in the L1 treatment bagea cookies which was 2.67±0.21%. Bagea *cookies* treatment L1, L2, L3, L4 and L5 resulted in higher antioxidant activity than the control bagea cookies, which was equal to 1.56±0.24%. The more addition of moringa leaf powder, the antioxidant activity of bagea cookies tends to increase.This is in accordance with what was reported by Sartina et al. (2018), the antioxidant activity of chips increased along with the addition of moringa leaf powder.This is because moringa leaf powder contains antioxidants such as flavonoid compounds,polyphenols and ascorbic acid.The antioxidant activity of dried moringa leaves in 100 grams is about 78.98% (Yazeed, 2019). Bioactive compounds that provide activity as antioxidants are feluric acid, gallic acid and ellagic acid, sitosterol, myricetin, niazimycin, vanillin, kaempferol, quercetin, carotene, catechin, astragalin and isoquercetin (Milla et al., 2021). Antioxidants in Moringa leaves have free radical neutralizing activity thereby preventing oxidative damage to most biomolecules and providing significant protection against oxidative damage.(Ardianti et al., 2019).

Sensory Characteristics

Sensory testing is a way of evaluating a product using the senses with sensory abilities. Rating score with 7 test scales (1 = very dislike, 2 = dislike, 3 = slightly dislike, 4 = neutral, 5 = slightly like, 6 = like, 7 = very like).

Color

Color is one of the first visual analyzes of a food product so that it greatly determines consumer preferences for the product (Winarno, 2004). The results of the analysis show that the average value of the level of preference panelists on the color of sago starch bagea cookies with various percentages of moringa leaf powder were on

a score of 4.47 - 5.97, meaning that acceptance was on the criteria of neutral-like (Table 6).

Chi-square calculation results test level (α≤0.05) arithmetic value (50.872)>table value (43.773) showed that the percentage of addition of moringa leaf powder had a significant effect on the panelists' preference for the color of bagea cookies. Panelists' assessment of the color of cookies with the lowest score was in treatment L5 with a value of 4.47 and the highest score was obtained in treatment L3 with a value of 5.97 which means the panelist acceptance rate is in the neutral - like criteria. Cookies with L3 treatment had a higher rating score than control cookies of 4.73 (neutral-slightly like). This is because the control bagea cookies produce a bright white color that is not like the color of cookies in general, the panelists' preference level decreases. Cookie products from L1 and L2 treatments produced slightly paler colors, L3 treatment resulted in light green so preferably,the L4 and L5 treatments had a dark green color which was less favored by the panelists. This is in accordance with the research of Sartina et al (2018), which states that the more number of Moringa leaves added to the manufacture of chips, the lower the panelists' preference level because the color of the chips produced is getting darker. The green color of bagea cookies is obtained from Moringa leaf powder which contains chlorophyll. Chlorophyll is a natural green leaf pigment that is generally found in leaves, so it is often called leaf green matter. Moringa leaves contain chlorophyll 6.89 mg/kg chlorophyll material (Krisnadi, 2012).

Aroma

In the food industry, odor testing is considered important because it can provide an assessment of the product regarding whether the product is acceptable or not. The average value of the panelists' preference for the aroma of cookies bagea starch sago at various percentages of addition of Moringa leaf powder is at a score of 3.87-4.93, which means that product acceptance is on the criteria of slightly dislike to like, can be seen in Table 7.

Chi-square calculation results test level (α≤0.05) arithmetic value (66.956)>table value (43.773) showed that the percentage of addition of Moringa leaf powder had a significant effect on the panelists' preference for the aroma of bagea cookies. Panelists' assessment of the aroma of cookies with the lowest value is in product L5 with a value of 3.87 and the highest value is obtained on product L1 with a value of 4.93 which means the panelist acceptance rate is in the criteria of somewhat dislike to like. Cookies bagea treatment L1, L2, L3, L4 and L5 had a lower score than the control bagea cookies of 5.47 (Slightly like-like). This is because the aroma of the control bagea cookies produces a distinctive aroma of cookies so that it is preferred by the panelists

The highest panelist acceptance rate was found in the L1 treatment because the highest percentage of sago starch, which was 97%, still produced a distinctive aroma of cookies. The addition of moringa leaf powder in the L5. The decrease in panelists' preference was due to the large percentage of addition of Moringa leaf powder resulting in a very sharp distinctive aroma of Moringa leaves so that the level of preference for aroma parameters decreased.

This is in accordance with what was reported by Sartina et al (2018), that the higher the concentration of Moringa leaves used in making chips, the more it affects the panelists' preference for the aroma of chips. Moringa leaves have a distinctive unpleasant aroma. The unpleasant smell of Moringa leaf powder is caused by moringa leaves containing lipoxidase enzymes, which are enzymes found in green vegetables, lipoxidase enzymes hydrolyze or decompose

fats into compounds that cause unpleasant odors belonging to the hexanal 7 and hexanol groups (Astutik, 2020).

Texture

Food texture is something related to the structure of the food that can be detected by tasting the food in the mouth. According to Rosida et al (2010), crispness is a the driving factor for consumers to prefer the resulting product because the crispness of dry food products shows the quality and quality of the product, so that it will attract consumers to like it more.The average value of the panelists' preference for the texture of bagea starch sago cookies with various percentages of addition of Moringa leaf powder is on a score of 4.60 to 5.40, which means that the panelists' acceptance is on the criteria of neutral to like, can be seen in Table 8.

Chi-square calculation results test level ($\alpha \leq 0.05$) arithmetic value (38.979) <table value (43.773) whichshowed that the percentage of addition of moringa leaf powder had no significant effect on the panelists' preference for bagea cookies texture. This is because the resulting bagea cookies have a crunchy texture that can still be accepted by the panelists.This is in accordance with the research of Sartina et al (2018), which states that chips with the addition of moringa leaf powder produce a crunchy texture so that it does not affect the panelists' preference for the texture of chips.

Panelists' assessment of the texture of cookies with the lowest score is on product L5 with a value of 4.60 and the highest score is obtained on product L1 with a value of 5.40 which means the panelist acceptance rate is in the neutral to like criteria. The L1 treatment bagea cookies had the same score as the control bagea cookies. This is because the percentage of sago starch in the L1 and control treatments did not differ much, resulting in a crunchy cookie texture.The crispness of a food product can be related to the water content. This is because the more water that is evaporated during roasting will form air cavities so that the resulting product is more crispy (Rosida et al., 2020). The decrease in panelists' acceptance of the L5 treatment was due to the high fiber content of moringa leaf powder which made the cookies texture harder.

Taste

Taste is one of the important factors to determine whether or not a food or food is accepted. The results of the analysis show that the average value of the panelists' preference for the taste of bagea starch sago cookies with various percentages of addition of moringa leaf powder is at a score of 3.43 to 5.43, which means that the panelists' acceptance is in the criteria of slightly dislike to like (Table 9).

Chi-square calculation results test level ($\alpha \leq 0.05$) arithmetic value (56.814)>table value (43.773) which showed that the percentage of addition of Moringa leaf powder had a significant effect on the panelists' preference for the taste of bagea cookies. Panelists' assessment of the taste of cookies, the lowest score was in treatment L5 with a value of 3.43 and the highest score on product L1 with a value of 5.43, which means that the panelists' acceptance was at the criteria somewhat dislike to like. Cookies bagea treatment L1, L2, L3, L4 and L5 had a lower score than the control bagea cookies of 5.83 (somewhat like-like). This is because the control bagea cookies produce a sweet and savory taste like cookies in general so that the panelists prefer it.

The results obtained indicate that the higher the addition of Moringa leaf powder, the panelist acceptance rate tends to decrease. This is in line with research Sartina et al (2018), that the more addition of moringa leaves will affect the taste of the chips because the nature of Moringa leaves gives

an after taste so that the taste quality of the chips decreases. This happens because of the distinctive taste caused by moringa leaves. This taste arises because in Moringa leaves there are tannin compounds which give the effect of a bitter taste. Tannins can cause a suffocating taste because when consumed, cross-links are formed between tannins and proteins or glycoproteins in the oral cavity, causing a dry and fibrous feeling or a suffocating taste.(Ardianti et al., 2019).

Overall

Rating of overall preference is accumulated from all parameters, namely color, aroma, texture and taste. The results of the analysis showed that the average value of the panelists' overall preference for bagea starch sago cookies with various percentages of addition of moringa leaf powder was on a score of 4.00 to 5.57, which means that the panelists' acceptance was in the neutral to like criteria (Table 10).

Chi-square calculation results test level ($\alpha \leq 0.05$) arithmetic value (69.568)> table value (43.773) whichshowed that the percentage of addition of Moringa leaf powder had a significant effect on the overall preference of the panelists for bagea cookies. Panelists' assessment of the taste of cookies with the lowest score is on product L5 with a value of 4.00 and the highest score is obtained on product L3 with a value of 5.57 which means the panelist acceptance rate is in the neutral to like criteria. This is because the appearance of the L3 treatment product a light green bagea cookie color, the aroma produced is still typical of cookies and a bit unpleasant but still acceptable to the panelists, the texture is crunchy and the resulting taste is sweet, savory and delicious. a little distinctive taste of moringa so that it gives the impression of liking by the panelists.

Cookies The L3 treatment bagea still had a lower score than the control bagea cookies of 5.70 (somewhat like it). This is because the control bagea cookies are still better and preferred by the panelists on the parameters of texture, aroma and taste.

Effectiveness Test

The effectiveness test is used in this study to determine the best treatment. Parameters of effectiveness testing include water content, crude fiber content, antioxidant activity and sensory test. The results of the analysis of the effectiveness of the best treatment of bagea cookies can be seen in Figure 1.

The results of the effectiveness test showed that the best formulation of bagea cookies was in the L3 treatment with an effectiveness value of 0.76. The addition of 9% Moringa leaf powder has an average value ofwater content of 4.82%, crude fiber content of 1.71%, antioxidant activity of 8.52%, preference color 5.97 (slightly like-like), aroma preference 4.90 (neutral-slightly like), texture preference of 5.33 (slightly like-like), taste preference of 4.83 (neutral-slightly like) and overall liking of 5.57 (slightly like - like).

CONCLUSION

The addition of moringa leaf powder to bagea sago starch cookies had a significant effect on physical, chemical, sensory characteristics and gave an insignificant effect on the moisture content of bagea cookies. The best treatment chosen was the L3 treatment with a color lightness of 76.42; texture; 262.92 g/2mm; water content 4.82%; crude fiber content 1.71%; antioxidant activity 8.52%. The nutrional content of bagea cookies per 100 g is protein, fat, ash, and carbohydrates of 9.32%, 9.40%, 0,13%, and 76.30% respectively.

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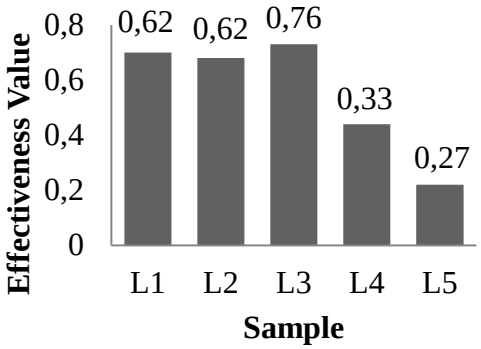

Figure 1. Effectiveness of sago starch bagea cookies with the addition of Moringa leaf powder 3% (L1), 6% (L2), 9% (L3), 12% (L4), 15% (L5)

Table 1. Color lightness of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: Moringa leaf powder)	Color Lightness	Notation
Control (100:0)	92.11 ± 0.34	
L1 (97 : 3)	82.00 ± 0.32	a
L2 (94 : 6)	81.06 ± 0.33	b
L3 (91 : 9)	76.42 ± 0.37	c
L4 (88:12)	73.92 ± 0.39	d
L5 (85:15)	70.45 ± 0.35	e

Note: Different letters show a significant effect on the 95% confidence level (α≤0.05)

Table 2. Texture of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: Moringa leaf powder)	Texture (g/2mm)	Notation
Control (100:0)	180.63± 0.31	
L1 (97 : 3)	233.43± 0.59	a
L2 (94 : 6)	242.11± 0.47	b
L3 (91 : 9)	262.92± 0.45	c
L4 (88:12)	270.58± 0.42	d
L5 (85:15)	340.87± 0.51	e

Note: Different letters show a significant effect on the 95% confidence level (α≤0.05)

Table 3. Moisture content of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: Moringa leaf powder)	Moisture content (%)	Notation
Control (100:0)	4.58 ± 0.28	
L1 (97 : 3)	4.73 ± 1.58	a
L2 (94 : 6)	4.77 ± 1.59	a
L3 (91 : 9)	4.82 ± 1.61	a
L4 (88:12)	4.92 ± 1.64	a
L5 (85:15)	4.97 ± 1.66	

Note: Different letters show a significant effect on the 95% confidence level (α≤0,05)

Table 4. Crude fiber content of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: Moringa leaf powder)	Crude fiber content (%)	Notation
Control (100:0)	0.39±0.28	
L1 (97 : 3)	0.50±0.05	a
L2 (94 : 6)	1.13±0.02	b
L3 (91 : 9)	1.71±0.09	c
L4 (88:12)	2.28 ± 0.02	d
L5 (85:15)	2.80±0.03	e

Note: Different letters show a significant effect on the 95% confidence level (α≤0.05)

Table 5. Antioxidant activity of sago starch bagea cookies at various percentages of Moringa leaf powder

Treatment (%) (Sago starch: Moringa leaf powder)	Antioxidant activity (%)	Notation
Control (100:0)	1.56±0.24	
L1 (97 : 3)	2.67±0.21	a
L2 (94 : 6)	5.34±0.28	b
L3 (91 : 9)	8.52±0.29	c
L4 (88:12)	10.18±0.21	d
L5 (85:15)	15.25±0.32	e

Note: Different letters show a significant effect on the 95% confidence level (α≤0,05)

Table 6. Panelists' level of preference for the color of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: moringa leaf powder)	Color Value	Criteria
Control (100:0)	4.73	Neutral-Slightly like
L1 (97 : 3)	4.70	Neutral-Slightly like
L2 (94 : 6)	5.50	Slightly like-like
L3 (91 : 9)	5.97	Slightly like-like
L4 (88:12)	4.87	Neutral-Slightly like
L5 (85:15)	4.47	Neutral-Slightly like

Table 7. Panelists' level of preference for the aroma of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: moringa leaf powder)	Aroma Value	Criteria
Control (100:0)	5.47	Slightly like-like
L1 (97 : 3)	4.93	Neutral-Slightly like
L2 (94 : 6)	4.77	Neutral-Slightly like
L3 (91 : 9)	4.90	Neutral-Slightly like
L4 (88:12)	4.00	Neutral
L5 (85:15)	3.87	Slightly like-dislike

Table 8. Panelists' level of preference for the texture of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: moringa leaf powder)	Texture Value	Criteria
Control (100:0)	5.40	Slightly like-like
L1 (97 : 3)	5.40	Slightly like-like
L2 (94 : 6)	5.17	Slightly like-like
L3 (91 : 9)	5.33	Slightly like-like
L4 (88:12)	4.70	Neutral-Slightly like
L5 (85:15)	4.60	Neutral-Slightly like

Table 9. Panelists' level of preference for the taste of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: moringa leaf powder)	Taste Value	Criteria
Control (100:0)	5.83	Slightly like-like
L1 (97 : 3)	5.43	Slightly like-like
L2 (94 : 6)	4.67	Neutral-Slightly like
L3 (91 : 9)	4.83	Neutral-Slightly like
L4 (88:12)	3.77	Slightly dislike- neutral
L5 (85:15)	3.43	Slightly dislike-dislike

Table 10. Panelists' level of preference for the overall of sago starch bagea cookies at various percentages of moringa leaf powder

Treatment (%) (Sago starch: moringa leaf powder)	Overall Value	Criteria
Control (100:0)	5.70	Slightly like-like
L1 (97 : 3)	5.43	Slightly like-like
L2 (94 : 6)	5.40	Slightly like-like
L3 (91 : 9)	5.57	Slightly like-like
L4 (88:12)	4.50	Neutral-Slightly like
L5 (85:15)	4.00	Neutral