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Cookies from Wheat Flour and Banana Flour with the Addition of Moringa Leaf Flour (*Moringa oleifera*)

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ABSTRACT: The dependence on the use of wheat flour in the manufacture of bakery products should be reduced to reduce wheat imports. One alternative that can be done is substituting wheat flour with other flour, for example, banana flour. In their manufacture, cookies substituted for banana flour produce a brown color that is not preferred. Therefore, to fix this, in making cookies, the addition of green moringa leaf flour is carried out. Besides being expected to improve the cookies' color, Moringa leaf flour also contains good nutrients. Moringa leaf flour contains protein, minerals, vitamins, essential amino acids, and antioxidants. The nutrients contained in moringa leaf flour have the potential to be nutritious food additives and beneficial to health. The purpose of this study was to determine the effect of the addition of moringa leaf flour on wheat flour cookies and banana flour on physical characteristics (moisture content, color, and texture), chemical characteristics (protein content and ash content), and organoleptic (color, aroma, taste, texture, and overalls). This study used a complete randomized design (CRD) with 1 factor: the percentage of addition of Moringa leaf flour, T0: 0%, T1: 2.5%, T2: 5%, T3: 7.5%, and T4: 10%. Adding Moringa leaves to manufacture cookies from wheat flour and banana flour significantly affects the moisture content, texture, color, protein content, and ash content of the cookies produced. The most preferred cookies are cookies with the addition of 5% moringa leaf flour.

Keywords: banana flour, cookies, moringa leaves, flour

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INTRODUCTION

Wheat flour consumption in Indonesia continues to increase in line with the increasing consumption of processed wheat flour food. The high consumption of wheat flour results in Indonesia's need for wheat to be high too. According to the Central Statistics Agency (2021), wheat import in Indonesia reaches 31.34 thousand tons.

Wheat flour is usually used in the bakery industry as a basic ingredient in manufacturing its products. The bakery's products include biscuits, bread, sponges, and cookies. Wheat flour is needed to manufacture bakery products because of its gluten content. Gluten is a protein that can develop and improve the texture of bakery products. The protein content in each wheat flour varies depending on the purpose for which it is used. There are three wheat flour types: high protein, medium protein, and low protein. One of the bakery products that require wheat flour is cookies.

Cookies are snacks that are usually made from low-protein wheat flour. One of the initiatives to reduce the use of wheat flour is by substituting wheat flour with other flour in the manufacture of cookies. One of the commodities that can replace wheat flour consumption is banana flour.

Banana flour has been a substitution material in manufacturing steamed sponges (Ramadhani et al., 2019). Yasinta (2017) mentioned that another food product that can be made from banana flour is cookies. Cookies created with the substitution of banana flour that is getting higher and higher will cause the color of the cookies to get darker, lower moisture content, and crispy texture in the manufacture of cookies

substitution of wheat flour with mocaf flour and banana flour. Cookies with increasing substitution of banana flour tend to be less preferred by panelists because of the browner color of the cookies (Oktaviana et al., 2017). For the cookies to have an attractive color to increase consumer attractiveness, an additional ingredient is needed, moringa leaf flour.

Moringa leaves have an attractive green color. Making yogurt by adding Moringa leaf extract by 5% can produce the highest favorability of panelists from the color parameters (Diantoro et al., 2015). Kou et al. (2018) mentioned that Moringa leaves could potentially prevent or treat some chronic diseases. Moringa leaves are rich in protein, vitamin A, minerals, essential amino acids, antioxidants, and flavonoids. The dominant lavonoid f group is kaempferol and quercitin (Rodríguez-Pérez et al., 2015). Moringa leaf extract contains six phenolic acids and their derivatives and seven flavonoids. Moringa leaves can be harvested instead of fresh vegetables but are difficult to find during the dry season in the Malawi region (Milla et al., 2021). The compounds contained in moringa leaves have the potential to become nutritious food additives and are beneficial for health.

Moringa leaf flour also has a good nutritional content. The advantages of Moringa leaf flour are that it contains protein of 23.37%, iron content (Fe), Calcium (Ca), and Sodium (Na) (Kurniawati et al., 2018). The high protein content is expected to increase and improve the cookies' texture. Moringa leaf flour can substitute for making wet noodles, steamed sponges, and cookies (Puspaningrum et al., 2019; Rahmi et al., 2019; Nwakalor, 2014).

The manufacture of cookies with the substitution of wheat flour and banana kapok flour with the addition of Moringa leaf flour has never been done. This study aims to determine the effect of the addition of Moringa leaf flour on wheat flour cookies and banana kepok flour on physical characteristics (moisture content, color, and texture), chemical elements (protein content and ash content), as well as organoleptic (color, aroma, taste, texture, and overalls).

MATERIALS AND METHODS

The tools used to manufacture cookie products are an oven (*sharp*), blender, and mixer (*Philips*). The tools used in the study were analytical balance (kern 440-35N), oven (memmert), desiccator, penetrometer (Humboldt), pressing needle (cone), and furnace (thermocline).

The main ingredients used are low-protein wheat flour, kepok banana flour, cornstarch, Moringa leaf flour (*Moringa oleifera*), powdered sugar, skim milk, margarine, egg yolk, and vanilla. The materials used for analysis include selenium, H_2SO_4, concentrated, H_3BO_3, and NaOH 30%.

Stages of Making Moringa Leaf Flour

The process of making Moringa leaf flour begins with the selection of suitable raw materials to obtain quality products. The moringa leaves used fresh Moringa leaves. After getting fresh Moringa leaves, then sorting (separating stalks and leaves), fresh moringa leaves that have been sorted and weighed and a result of 515 g is obtained after washing. Furthermore, the washed Moringa leaves are drained to reduce the amount of water on the Moringa leaves, then dried using solar drying for 6 hours at a temperature of ± 30^{o}C. After drying, grinding is carried out using a blender and sifting with a sieve of 60 mesh so that a moringa leaf flour yield of 140gr is obtained (Kurniawati et al., 2018).

Stages of Creating Cookies

The creation of *cookies* follows the research of Nihayatuzzahro et al. (2017). There are three stages in making cookies: dough making, printing, and roasting. Ingredients such as margarine, powdered

sugar, and skim milk are mixed and then the *mixer* ± 3-7 minutes, followed by inserting 16g of an egg yolk; after fluffy and changing color then, banana flour and wheat flour are put in according to the treatment, namely each treatment than in the *mixer* back up to 5 minutes. After the ingredients are mixed, moringa leaf flour is added according to the treatment, namely T0: 0%, T1: 2.5%; T2: 5%; T3: 7.5%; and T4: 10%, then stirred until smooth. The dough is then printed to get a *cookie* product in a uniform shape. The final stage in making cookies is roasting. The baking process of *cookies* is carried out in the oven with a temperature ranging from 180-200^{o}C, and the roasting process is carried out for 16-20 minutes. Furthermore, the cooked cookies are cooled to lower the temperature and harden the *cookies* due to the compaction of sugar. Moreover, cookies can analyze physical, chemical, and organoleptic characteristics.

Analysis of Texture

The texture of cookies is measured using a penetrometer according to the method carried out by Mujiono (2012).

Analysis of Colour

Color testing using *For Plant Tissues Munsell color charts* is by comparing the color of the sample with the color *of the For Plant Tissues Munsell color charts*. Then the numbers listed on the *For Plant Tissues Munsell color chart* are recorded. The numbers listed on the *For Plant Tissues Munsell color chart* are a spectrum of three variables, namely: (1) *hue*, (2) *value*, and (3) *chroma*. *Hue* is a spectrum color (red, green, or yellow) with its wavelength. *The value* indicates the light darkening of color according to the amount of light reflected. *Chroma* is defined as the gradation of purity from the degree of differentiation of the presence of a change in the color intensity.

Analysis of Water Content, Ash Content, and Protein Content

Analysis of water, ash, and protein content in cookies following Sudarmadji et al. (1997).

Organoleptic

Organoleptic tests of color, aroma, taste, texture, and overalls are carried out by method (Soekarto, 1985). The organoleptic test was carried out by 25 untrained panelists who were students of the Agricultural Industry Technology Study Program. Each panelist was asked to assess each sample in the form of *cookies* that had been provided randomly. The scale of hedonic value to color, flavor, taste, texture, and overalls can be seen in Table 1.

Table 1. Organoleptic Scale

Hedonic scale	Numeric Scale
Really Dislike	1
Dislike	2
Neutral	3
Like	4
Really Like	5

Data analysis

The data analysis used in this study was variance analysis (ANOVA) using the SPSS 24.0 application with a level of $\alpha = 5\%$ to determine the effect of the treatment. Furthermore, the results that show a real influence will be analyzed for further tests using the Duncan Multiple Range Test (DMRT) test. For data analysis on organoleptic tests using non-parametric statistical analysis (Friedman Test).

RESULTS AND DISCUSSION

Water Content

The results of the ANOVA water content showed that wheat flour cookies and coco banana flour with the addition of Moringa leaf flour had a significant effect on the moisture content of cookies ($p<0.05$). The

results of the DMRT follow-up test showed that the treatment of 50% wheat flour and 50% banana flour with the addition of Moringa leaf flour 0% was significantly different from the treatment of 2.5%, 5%, 7.5%, and 10% addition of Moringa leaf flour. The treatment of 10% Moringa leaf flour differed markedly from 0%, 2.5%, and 5% but did not differ markedly from the treatment of 7.5% moringa leaf flour.

Figure 1. shows that the moisture content of cookies decreases with the addition of more moringa leaf flour. The value ranges from the moisture content of cookies between 2.1% - 5.8%. The water content produced is influenced by raw materials, where wheat flour has a higher moisture content of 12.00% and pupa banana flour 11.20%, while the moisture content in Moringa leaf flour is lower, which is 7.50%. The moisture content of Moringa leaf flour is lower than that of Augustyn et al. (2017) at 9.57%. If a lot of Moringa leaf flour is added, the moisture content of cookies will be lower because the moisture content in Moringa leaf flour is lower when compared to the moisture content of flour wheat and banana flour. The results of this study are in line with the research of Fapetu et al. (2022), that if there is a lot of addition of Moringa leaf flour (10%) to cookies, the moisture content will be lower.

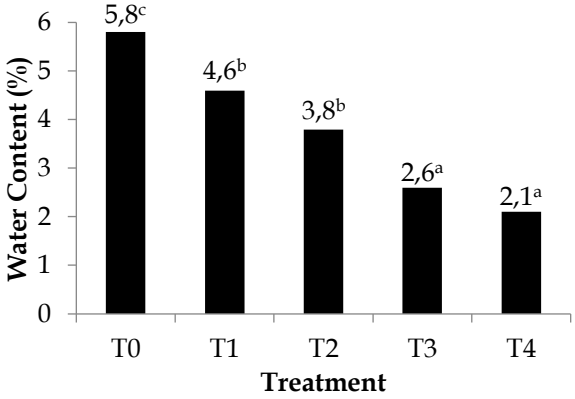

Figure 1. The water content of cookies in various ratios of wheat flour and banana flour with the addition of Moringa leaf flour

Texture

The results of ANOVA showed that wheat flour cookies and banana flour with the addition of Moringa leaf flour had a significant effect on the texture of cookies (p<0.05). The results showed that the more moringa leaf flour added, the more complex the cookies will be. The results of the DMRT follow-up test showed that the behavior of 5% Moringa leaf flour was significantly different from 0%, 2.5%, 7.5%, and 10% addition of Moringa leaf flour.

The results of observations of the texture of cookies show that the more moringa leaf flour is added, the more complex the cookies will be (Figure 2). It is due to the influence of the decreased moisture content, which can affect the texture of cookies. The moisture content of cookies decreases with the addition of Moringa leaf flour used in making cookies (Figure 2). Another suspected cause is the addition of moringa leaves flour can also increase its fiber content. Moringa's fiber leaves 7.92±1.0% (Melo et al., 2013). The fibers allegedly resulted in the texture of the cookies becoming hard. The increasingly complex surface of cookies is under the research of Hasan et al. (2020) on the manufacture of cookies with the addition of Moringa leaf flour.

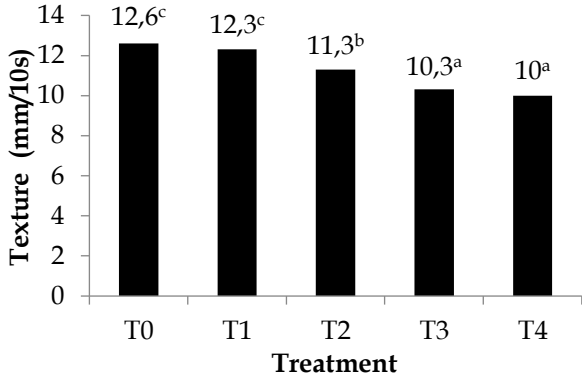

Figure 2. The texture of cookies in various ratios of wheat flour and banana flour with the addition of Moringa leaf flour

Colour of Cookies

The results showed that the color of cookies was at Hue values of 10 YR, 2.5 Y, 7.5 Y, and 7.5Y, Values of Values 4 and 5, and Chroma values were at the same values, namely 4 and 6. The greenest is found in the treatment of 7.5% and 10% moringa leaf flour. Table 2 shows that adding moringa leaves flour, will cause the resulting cookies' color greener.

Table 2. Colour of cookies in various ratios of wheat flour and banana flour with the addition of Moringa leaf flour

Treatment	Aplication *Munsell Color Chart*	Color of *Cookies*
T_0	10 YR 5/6	
T_1	2,5 Y 5/6	
T_2	7,5 Y 5/6	
T_3	7,5 Y 4/4	
T_4	7,5 Y 4/4	

Table 2. shows that the addition of Moringa leaf flour affects the color of cookies. The more Moringa leaf flour is added, the darker the color of the cookies. The color of the cookies comes from the pigment of the powdery color of moringa leaves, namely chlorophyll. Moringa leaf flour has a high chlorophyll content, affecting the cookies' color. Abdulkadir et al. (2015) grouped moringa leaves into tall chlorophyll leaves with an average of 35.40±1.20 and low chlorophyll leaves with an average of 16.25 ±1.25. Chlorophyll on moringa leaves causes the color of moringa leaves to become green. The green color of the moringa leaves caused a green color also in the cookies produced in this study.

Protein Content

The results of ANOVA protein content show that wheat flour cookies and banana flour with the addition of Moringa leaf flour have a significant effect on the protein content of cookies ($p < 0.05$). The results of the DMRT follow-up test showed that the treatment of adding Moringa leaf flour was 0% significantly different from the treatment of 2.5%, 5%, 7.5%, and 10% addition of Moringa leaf flour. Adding Moringa leaf flour 2.5% is significantly different from the treatment of 0%, 5%, 7.5%, and 10% addition of Moringa leaf flour. 7.5% moringa leaf flour treatment differed markedly from 0%, 2.5%, and 10%. Adding Moringa leaf flour by 2.5% can significantly increase the protein content of cookies produced (Figure 3).

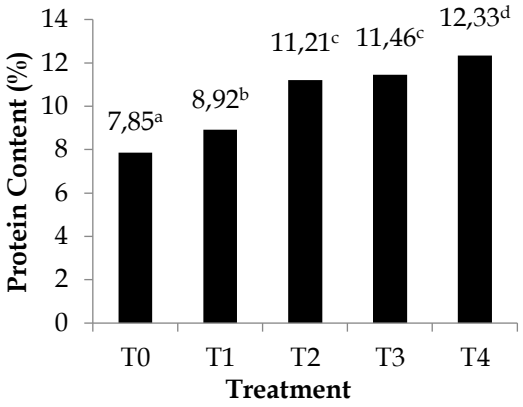

Figure 3. The protein content of cookies in various ratios of wheat flour and banana flour with the addition of Moringa leaf flour

The protein content in cookies shows that the more moringa leaf flour is added, the higher the protein in cookies (Figure 3). The protein content produced is influenced by raw materials. Moringa leaves have a higher protein content of 28.4% compared to the protein content of wheat flour and banana flour (Aminah et al., 2015; Hasan et al., 2020). Therefore, the more addition of flour and moringa, the protein content of cookies will also increase.

Ash Content

The results of the ash content ANOVA showed that wheat flour cookies and banana flour with the addition of Moringa leaf flour had a significant effect on the ash content of cookies (p<0.05). The results of the DMRT follow-up test showed that the treatment of adding Moringa leaf flour was 0%, significantly different from the treatment of 7.5% and 10%. The treatment of 10% Moringa leaf flour differs significantly from 0%, 2.5%, and 5%.

Figure 4. shows that the higher the addition of Moringa leaf flour, the higher the ash content in cookies. The ash content produced is influenced by raw materials where Moringa leaf flour has a higher ash content of 7.85% and coco banana flour of 3.1%, while the ash content in wheat flour is lower, 0.60%. This study's results align with the research of Kurniawati et al. (2018) that the ash content of Moringa leaf flour is quite high, reaching 11.67%. This ash content is influenced by the mineral content in Moringa leaves, including iron (Fe), calcium (Ca), and sodium (Na).

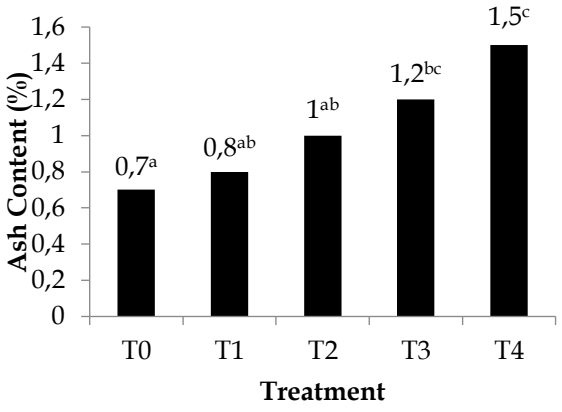

Figure 4. Ash content of cookies in various ratios of wheat flour and banana flour with the addition of Moringa leaf flour

Table 3. Organoleptic of cookies in various ratios of wheat flour and banana flour with the addition of Moringa leaf flour

Treatment	Color	Flavour	Taste	Texture	Overall
T0	3,68	4,00	3,96	4,00	4,00
T1	3,52	4,04	3,76	4,08	3,96
T2	3,80	3,44	4,08	3,92	4,04
T3	3,96	3,52	3,88	3,92	4,00
T4	4,08	3,32	3,32	3,72	3,64

Colour

The Friedman Test test results showed that adding Moringa leaf flour had an insignificant effect on the level of panelists' liking for the color of cookies (p>0.05). The banana flour used is brownish, while the Moringa leaf flour is green. The resulting cookies having different colors can be seen in Table 2; although they have different colors, the panelists like them all. Adding higher Moringa leaf flour results in a greener color of cookies. The green color is due to the presence of chlorophyll in fresh Moringa leaves. If the Moringa leaves are old or yellow, the chlorophyll content is lower (Abdulkadir et al., 2015).

Flavor

The Friedman Test test results showed that adding Moringa leaf flour significantly affected the level of panelists' liking for flavor cookies (p<0.05). It is thought to be due to the appearance of a characteristic smell from Moringa leaf flour so that the value of the aroma of cookies decreases (not liked by the panelists) with the addition of Moringa leaf flour of 10%. The aroma of Moringa leaves will evaporate when baked because Moringa leaves contain volatile compounds that can evaporate due to heating. Making cookies from Moringa leaf flour concluded that the higher the concentration of moringa leaves in addition to cookies, the more the aroma is increasingly disliked by the panelists (Dewi, 2018). This study's results align with the research of Augustyn et al. (2020) that the higher the addition of Moringa leaf flour, the organoleptic results on the aroma of Moringa leaf biscuits decrease.

Taste

The Friedman Test test results showed that adding Moringa leaf flour significantly affected the level of panelists' liking for tasting cookies (p<0.05). The results of this study align with the research of Augustyn et al. (2017), which shows that a higher addition of Moringa leaf flour will add to the distinctive taste of Moringa leaves that are less liked by the panelists. It is because there is still a distinct taste of moringa leaves, so the addition of Moringa leaf flour. In addition, idea formulations from other ingredients can not mask the distinctive flavor of Moringa leaf flour.

Texture

The Friedman Test test results showed that adding Moringa leaf flour had an insignificant effect on the panelists' favorability for texture cookies (p>0.05). The higher the concentration of Moringa leaf flour, the lower the texture value. Figure 2 shows that the more adding Moringa leaf flour is, the harder the texture of the cookies will be; although complex, the panelists like everything when viewed from the organoleptic results (Table 3). The texture of cookies is also heavily influenced by the heating process and the ingredients that make the cookie dough. The results of this study align with the research of Augustyn et al. (2020); biscuits are decreasing with the addition of Moringa leaf flour, and the resulting biscuits will be harder. It is suspected that the difference in flour content in each treatment determines the acquisition of biscuit moisture content, thus affecting the texture produced because the water content affects the appearance, texture, and taste of food.

Overalls

The results of the *Friedman Test* test showed that the addition of Moringa leaf flour had an insignificant effect on the level of panelists' favorability for texture cookies (p>0.05). The overall range of panelists' favorability level values ranged from 3.64 – 4.04, which means that overall, the panelists liked cookies adding Moringa leaf flour. Adding kelor leaf flour to 10% has no effect overall. The panelists still like it. From organoleptic overalls, adding 5% Moringa duan flour was the most preferred formula by the panelists compared to other formulas.

CONCLUSION

Moringa leaf flour added to the manufacture of cookies from wheat flour and banana flour has a significant effect on the physical characteristics of cookies, namely moisture content, texture, and color. The added Moringa leaf flour also has a significant effect on increasing the protein content and ash content of the cookies produced. The most preferred cookies are cookies with

adding Moringa leaf flour 5% while adding Moringa leaf flour by 10% is on a neutral scale.

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