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Effect of Modification of Banana Kepok (*Musa paradisiaca* L.) Starch Substitution on Ash, Water, and Protein Content in Cookie Products †

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Abstract: Starch is composed of two types of carbohydrates, amylose and amylopectin. Improvements in the physical and chemical properties of natural starch can be made by modifying the starch. The modified starch has a healthy effect on the colon. The goal of this research is determine the effect of modified kepok banana starch substitution on ash, water, and protein content in cookies. The research used a completely randomized design (CRD). Comparison of modified kepok banana starch and wheat flour of 0%:100%, 25%:75%, 50%:50%, and 75%:25%. The highest cookie protein content was 6.26%; ash content was 2.97%; and water content was 8.83%. The conclusion is There is a relationship between the substitution of modified kepok banana starch and the protein content and ash content of the cookies. There was no effect of substitution of modified kepok banana starch on the moisture content of the cookies.

Keywords: cookies; water content; ash content; protein content; modified kepok banana starch

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1. Introduction

Bananas have a fairly high starch content, namely around 80% when bananas are still green or young. The starch and carbohydrate content in kepok bananas can be used as a basic ingredient for making starch [1]. Starch is composed of two types of carbohydrates, amylose and amylopectin, in different compositions [2]. Natural starch from various plant sources generally has properties that limit its use in various food products. Improvements in the physical and chemical properties of natural starch can be made, including by modifying the starch [2]. Modification of banana starch can go through various quite lengthy processes using physical, chemical, and enzymatic methods [3]. Banana starch can be modified using physical methods via autoclaving cooling, starting with making kepok banana starch; heating banana starch using an autoclave; cooling at room temperature; transfer of cooling to the refrigerator; and sieving to become a modified banana starch product [4].

Modification of banana starch using the autoclaving-cooling method will cause gelatinization of the compounds contained in kepok bananas and cause retrogradation during the cooling process. Retrogradation is a process that causes re-crystallization of starch after going through the gelatinization process and is influenced by certain temperatures [5]. Modified starch is more resistant to digesting than natural starch because it leaves parts of resistant starch (RS), which then have a healthy effect on the colon in the food digestive system [2].

Cookies are foods that are made from wheat flour and baked, have a crunchy texture, and are very popular among all age groups [6]. According to the Ministry of Agriculture of the Republic of Indonesia, 2020, in 2016–2020 there continued to be an increase in the average consumption of cookies in a week.

The addition of modified kepok banana starch will affect the content of cookie products [7]. According to a previous study [8], the water content in cookie products with the addition of kepok banana starch is lower when compared to products that only use regular starch or flour. Low water content in cookies will affect the crispness and hardness of the cookie product. The addition of banana flour causes the level of hardness of the texture of the resulting banana cookies to decrease [9].

When viewed in terms of the ash content, kepok banana starch has a high ash content [10]. Increasing the ash content in a product can affect the color of the biscuits produced. The higher the ash content, the darker the color of the cookies, the poorer the texture, and the less crunchy they are [11].

The greater the substitution of modified kepok banana starch in the cookie product, the lower the protein content will be. Protein content can affect the swelling power of cookie products. This is because the protein will experience denaturation, making it difficult for the cookies to rise and become hard [12].

2. Material and Methods

2.1. Research Design

This study was experimental research using a completely randomized research design with four comparisons of modified kepok banana starch and wheat flour, namely 0%:100%, 25%:75%, 50%:50%, and 75%:25%. For each treatment, 2 repetitions of the analysis were carried out.

2.2. Material and Research Stage

2.2.1. Materials

The ingredient used for modified kepok banana starch was raw kepok banana obtained from Kleco Market, Solo. Cookies were made from wheat flour, modified kepok banana starch, tapioca flour, powdered sugar, margarine, eggs, backing powder, skim milk, and salt. The ash content analysis material was a sample of the cookies. The material for analyzing water content was a cookie sample. Materials for protein content analysis were cookie samples, Na_2SO_4, HgO, sulfuric acid, distilled water, NaOH, Na_2S2O_3, sorbet acid, bromine cresol green and methyl red, and HCl.

2.2.2. Research Stage

Stages of Making Kepok Banana Starch

The process of making banana starch is done by: selecting young bananas; peel the banana using a knife; slice the banana into small pieces 1 × 1 cm; Soak banana slices in water for 5 min; drain and weigh the soaked bananas; Puree the banana pieces using a blender until they become puree with adding water; filter the mashed banana pulp using a filter cloth to separate starch and banana dregs; The starch obtained is left for 12 h until it settles; throw water on the sediment and take out the starch sediment at the bottom of the container; dry the starch precipitate in a cabinet dryer at 60° C for 24 h until the starch; flour the starch using a grinder and sift the starch with an 80 mesh sieve (Figure 1).

Stages of the Process of Making Modified Banana Starch

According to [13], the process of making modified banana starch is carried out in this way: kepok banana starch is conditioned with a water content of 20%; packing kepok banana starch into HDPE plastic and storing in the refrigerator at 4 °C for 12 h; heating the starch in an autoclave at 121 °C for 15 min; cool the starch at room temperature for 1 h to prevent further gelatinization; carry out the starch retrogradation process by cooling it at 4 °C for 24 h; drying using an oven at 50 °C for 4 h; dry starch using a grinder and sifting using an 80 mesh sieve (Figure 2).

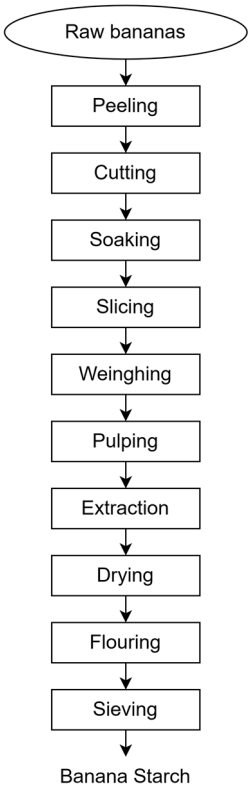

Figure 1. Flowchart of the process making kepok banana starch.

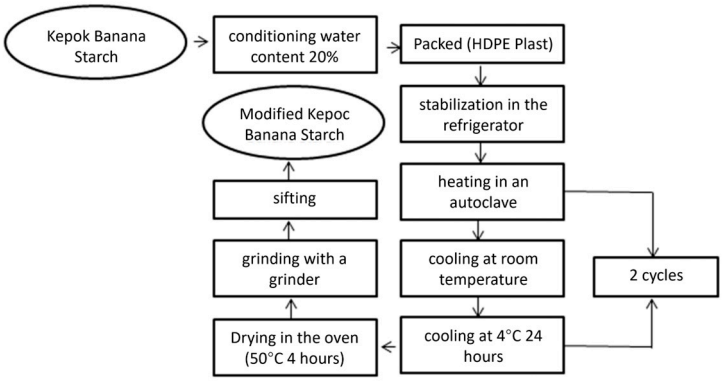

Figure 2. Flowchart of the process of making modified kepok banana starch (Source: [14]).

Stages of the Process of Making Cookies

The process of making cookies is done by: preparing ingredients such as modified kepok banana starch, wheat flour, tapioca flour, powdered sugar, margarine, eggs, backing powder, skim milk, salt; weighing materials using digital scales; Mix ingredients such as chicken eggs, powdered sugar, margarine, backing powder and skim milk into the flour using a mixer at Low Speed for 2 min and High Speed for 3 min; mix wheat flour, modified kepok banana starch, and tapioca flour; The concentration ratio of kepok banana starch to wheat flour is as follows: (1) 0% kepok banana starch: 100% wheat flour, (2) 25% kepok banana starch: 75% wheat flour, (3) 50% kepok banana starch: 50% wheat flour, (4) 75% kepok banana starch: 25% wheat flour; Mix the homogenized dough and flour until smooth; mold the dough into a flat circle with a diameter of 3 cm and a thickness of 0.75 cm; Bake the printed cookies in the oven at 150 °C for 1 h (Figure 3).

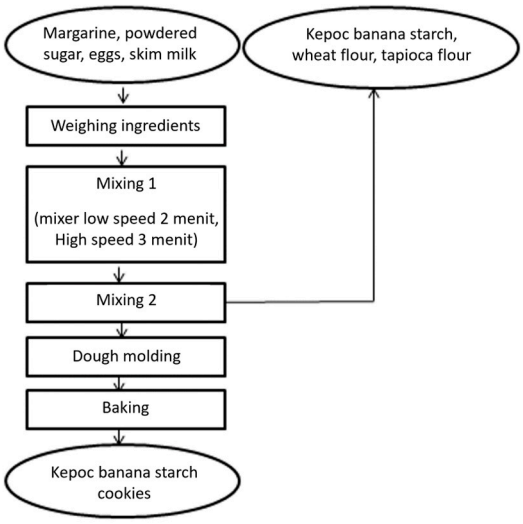

Figure 3. Flowchart of the cookie-making process.

2.2.3. Analysis Sample

Analysis of protein levels in cookie samples was carried out using the Kjeldahl method. Meanwhile, analysis of water content and ash content uses the gravimetric method.

3. Result and Discussion

3.1. Protein Content

The average protein content in cookies was obtained by conducting protein analysis on cookie samples. The average protein content of cookies is presented in Table 1.

Table 1. Average protein content of cookies with modified kepok banana starch substitution.

Percentage of Modified Kepok Banana Starch and Wheat Flour	As Much Protein (%)	*p* Value
0%: 100%	6.26 ± 0.221^{a}	0.000
25%: 75%	5.57 ± 0.324^{b}	
50%: 50%	5.77 ± 0.195^{b}	
75%: 25%	4.76 ± 0.385^{c}	

Different letter notations indicate significant differences in DMRT follow-up test results.

Based on the one-way ANOVA test data, a value of $p = 0.000$ ($p < 0.05$) was obtained, which shows that the substitution of modified kepok banana starch has an effect on the protein content of the cookie product. The greater the substitution of modified kepok banana starch in the cookie product, the lower the protein content will be. This is because the protein content in modified Kepok banana starch is lower than the protein in wheat flour [15].

Protein is one of the benchmarks used in determining the quality requirements for cookies. Flour with low protein or gluten content (low gluten) has better quality when compared to flour with high protein content (high gluten) [16]. Protein content can affect the swelling power of cookie products. This is because the protein will experience denaturation, making it difficult for the cookies to rise and become hard [12].

3.2. Ash Content

The average ash content in cookies was obtained by analyzing the ash content of cookie samples. The average ash content of cookies is presented in Table 2.

Table 2. Average ash content of cookies with modified kepok banana starch substitution.

Percentage of Modified Kepok Banana Starch and Wheat Flour	Ash Content (%)	*p* Value
0%: 100%	2.59 ± 0.050 [a]	0.000
25%: 75%	2.34 ± 0.155 [b]	
50%: 50%	2.13 ± 0.136 [c]	
75%: 25%	1.76 ± 0.062 [d]	

Different letter notations indicate significant differences in DMRT follow-up test results.

Based on the one-way ANOVA test data, a value of $p = 0.000$ ($p < 0.05$) was obtained, which shows that the substitution of modified kepok banana starch has an effect on the ash content of cookie products. The greater the substitution of modified kepok banana starch in the cookies, the lower the ash content in the cookies.

The ash content of a food indicates the mineral content of the food [17]. Total ash content is a proximate analysis metric used to determine the nutritional value of a food ingredient, as well as indicating the total minerals contained in the ingredient that are toxic [18]. Increasing the ash content in a product can affect the color of the biscuits produced. The higher the ash content, the darker the color of the cookies, the poorer the texture, and the less crunchy they are [11].

3.3. Water Content

The average water content in cookies was obtained by analyzing the water content of cookie samples. The average moisture content of cookies is presented in Table 3.

Table 3. Average water content of cookies with modified kepok banana starch substitution.

Percentage of Modified Kepok Banana Starch and Wheat Flour	Water Rate (%)	*p* Value
0%: 100%	8.83 ± 0.734 [a]	0.125
25%: 75%	6.80 ± 1.957 [a]	
50%: 50%	6.28 ± 0.432 [a]	
75%: 25%	6.43 ± 2.250 [a]	

Different letter notations indicate significant differences in DMRT follow-up test results.

Based on the one-way ANOVA test data, a value of $p = 0.125$ ($p > 0.05$) was obtained, which means that the substitution of modified kepok banana starch did not affect the moisture content of the cookie product. According to [19], the greater the kepok banana starch substitution in cookies, the lower the moisture content of the cookies. Low water content in cookies will also affect the crispness and hardness of the cookie product. The addition of banana flour causes the level of hardness of the texture of the resulting banana cookies to decrease [9]. This is because kepok banana starch has a high amylose content. The higher the amylose content in the material, the weaker its ability to bind water, resulting in cookies with low water content [9].

4. Conclusions

Based on the results of the one-way ANOVA test, the *p*-value of the protein content of cookies was $p = 0.00$, that of the ash content of cookies was $p = 0.00$, and that of the water content of cookies was $p = 0.125$. These values show that there is a relationship between the protein content and ash content of cookies with the substitution of modified kepok banana starch. The moisture content result of the cookie product showed that there was no influence on the moisture content of the substitution of modified kepok banana starch.

Researchers suggest that the best quality can be obtained by making cookie products with a substitution of modified kepok banana starch, namely a ratio of modified kepok banana starch to wheat flour of 75%:25%. This can be seen based on the lowest protein, ash, and water content values among the four treatments.

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