

Proceeding Paper

Effect of Modified Banana Kepok (*Musa paradisiaca* L.) Starch Substitution on Resistant Starch, Protein, and Water Content in Steamed Brownies [†]

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Abstract: A completely randomized design was used with four treatments including the control. The percentage of modified kepok banana starch substitution of the four treatments was 0%, 25%, 50%, and 75%, respectively of the total weight of wheat flour. Data of the resistant starch test were analyzed using the one-way ANOVA statistical test followed by the Duncan test. Results: The highest resistant starch content was 6.27% at the 75% treatment, while the lowest resistant starch content was 3.98% at 0% treatment with a value of $p = 0.000$. The highest protein content was 9.16% at the 0% treatment, while the lowest protein content was 7.08% at 75% treatment with a value of $p = 0.000$. The highest water content was 30.11% at the 25% treatment, while the lowest water content was 26.91% at 75% treatment with a value of $p = 0.112$. Conclusions: There was an effect of the kepok banana starch substitution treatment on the resistant starch and protein content of steamed brownies, but there was no effect of the kepok banana starch substitution treatment on the water content of steamed brownies.

Keywords: steamed brownies; modified kepok banana starch; protein content; resistant starch content; substitution; water content



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1. Introduction

Bananas are the fruit commodity with the largest production in Indonesia [1]. The high rate of banana production is not balanced with public consumption; therefore, many bananas cannot be used optimally. This is also supported by the relatively short shelf life of bananas [2]. The quality value of bananas can be increased by making banana-based flour. The advantages of banana flour include that it is more economical, can increase banana yields, is easy to mix with other ingredients, is easier to process into products, and has a longer storage duration [3].

Bananas have the potential to be a source of resistant starch because they have a starch content of more than 20% [4]. One type of banana that is popular with people is the kepok banana. Raw kepok bananas have a low glycemic index value and are high in fiber. Based on research by Diyah et al. (2018), the glycemic index value of kepok bananas is 43. While, food fiber including resistant starch in kepok bananas is quite high, namely 27.7% [5].

The level of resistant starch in a food ingredient can be increased through a modification process [6]. Starch modification can be carried out in several ways via enzymatic, chemical, physical, and irradiation methods, or a combination of several of these methods [7]. Physical modification can be made using the autoclaving cooling method. The heating process followed by a cooling process (autoclaving cooling) causes the starch to experience retrogradation. The retrogradation process occurs due to the formation of compact hydrogen bonds in starch molecules so that starch is difficult to hydrolyze and is resistant [8]. Based on research conducted by Musita et al. (2012), it is known that the

resistant starch content in kepok banana flour is 12.2% [9]. Based on research by Nurhayati (2014), the resistant starch content of kepok bananas modified using a two-cycle process of pressure heating–cooling (retrogradation) and a fermentation process was able to increase the resistant starch content of banana flour from 10.32% to 42.68% [10].

Modified banana starch can be used as a substitute ingredient in foods that are usually made from wheat flour such as biscuits, cookies, and brownies [6]. Brownies are a cake that is loved by various levels of society. Brownie cakes are made from various ingredients, namely eggs, wheat flour, granulated sugar, chocolate, and margarine. The structure of brownie cakes is the same as that of cakes in general; namely soft texture, attractive color, and good aroma and taste [11]. Apart from that, adding starch is an effective way to produce flour with low protein and gluten content to meet the needs of the cake industry. Based on research by Liu (2022), the addition of starch can produce an ideal cake texture with low hardness [12].

Brownies have good nutritional value for the body. However, consuming too many brownies can cause diseases such as obesity and diabetes mellitus [13]. Functional foods contain nutritional value and can reduce the risk of chronic disease [10]. It is hoped that the substitution of kepok banana starch into the steamed brownie formulation can become a functional food product for the community. Research conducted by Fida (2019) found that banana starch substitution affects the chemical, physical, sensory properties, and acceptability of food products. Based on this background, it is necessary to conduct research on the effect of modified kepok banana starch substitution on the levels of resistant starch, protein, and water in steamed brownies [14].

2. Material and Methods

This research was an experimental study that aimed to determine the effect of modified kepok banana starch substitution on the levels of resistant starch, protein, and water in steamed brownies. This research design used a completely randomized design (CRD) with research factors of modified kepok banana starch substitution variations. According to Muhammad et al. (2020), the variations in substitution contained in this study were 0% (code P1), 25% (code P2), 50% (code P3), and 75% (code P4). This study used 2× experimental repetitions and 2× repeated analyses so that the total number of experiments in this study was 16 trials [15].

The ingredients for making modified kepok banana starch were raw kepok bananas and water. The ingredients for making steamed brownies were modified kepok banana starch, wheat flour, chicken eggs, margarine, vanilla, sugar, baking powder, chocolate powder, and chocolate bars. The tools for making modified kepok banana starch were knives, cutting boards, bowls, sieves, autoclaves, refrigerators, and cabinet dryers. The tools for making steamed brownies were a pan, basin, steamer, spoon, spatula, mixer, baking sheet, and stove. The tools for measuring resistant starch levels included analytical scales, centrifuges, 50 mL centrifuge tubes, pipettes, incubators, volumetric flasks, and test tubes. The tools used to measure protein levels included Kjeldahl flasks, analytical scales, Erlenmeyer flasks, electric stoves, Kjeldahl distillers, staves and burettes. The tools for measuring water content included analytical scales, weighing bottles, ovens, and desiccators.

Based on research by Musita (2012), the kepok banana starch was made through a series of processes. These processes included peeling kepok banana skin, slicing, soaking, and crushing bananas with a banana to water ratio of 1:3, filtering, adding water and dregs in a ratio of 1:1, settling the filtered results for 12 h, separating the water from the starch that settled, drying the results using a cabinet dryer at 60 °C for 24 h, grinding the dry sediment using a grinder, and sieving banana starch using an 80-mesh sieve [9]. Based on research by Wiadnyani (2017), kepok banana starch was modified using the autoclaving cooling method [16]. The modification stage began with the starch being treated with a moisture content of 20%, then packaged in HDPE plastic. The starch was stored in the refrigerator at 4 °C for 12 h, heated in an autoclave at 121 °C for 15 min, and cooled at room

temperature for 1 h. Cooling was then continued in the refrigerator at a temperature of 4 °C for 24 h and drying was carried out using an oven at a temperature of 50 °C for 4 h, before grinding the dried starch using a grinder and sifting using an 80-mesh sieve.

The method for making steamed brownies was based on research by Muhammad et al. (2020) [15] and had several stages; namely, melting the margarine, sifting the dry ingredients, mixing the dough, then molding and steaming the brownies for 50 min over low heat. Resistant starch levels were tested using an enzymatic method with several stages; namely, the stage of grinding the material, adding a solution of pepsin and alpha-amylase, and going through several stages of centrifugation [17]. Protein content was tested using the micro-Kjeldahl method with several stages; namely, inserting the sample into a Kjeldahl flask, boiling in an acid chamber, cooling, distillation, dilution, and titration [17]. Water content was tested using the thermogravimetric method with several stages; namely, verifying the weight of the porcelain rate, inserting the sample into the porcelain rate, and drying it in an oven at a temperature of 100–105 °C for 6 h [17].

3. Result

3.1. Resistant Starch Content

The research data in the form of resistant starch levels in brownies were analyzed using a normality test. The Shapiro–Wilk test result was $p = 0.096$ (p value > 0.05), showing that the data were normally distributed. Because the data were normally distributed, testing was continued using the one-way ANOVA test. The results of testing resistant starch levels in brownies can be seen in Table 1.

Table 1. Resistant starch content of modified kepok banana starch steamed brownies.

Treatment Variations	Resistant Starch Content (%)	p Score
P1	3.98 ± 0.03^a	0.000
P2	4.73 ± 0.06^b	
P3	5.50 ± 0.11^c	
P4	6.27 ± 0.13^d	

Source: Data from analysis of resistant starch levels. The different notations in each column show significant differences. P1: Treatment 1 (substitution of modified kepok banana starch 0%). P2: Treatment 2 (substitution of modified kepok banana starch 25%). P3: Treatment 3 (substitution of modified kepok banana starch 50%). P4: Treatment 4 (substitution of modified kepok banana starch 75%).

Based on the test results in Table 1, it was found that the highest levels of resistant starch were found in brownies with 75% substitution of kepok banana starch (P4), while the lowest levels of resistant starch were found in brownies with 0% substitution of kepok banana starch (P1). The one-way ANOVA test produced a value of $p = 0.000$ ($p < 0.05$), which means that there was an effect of modified kepok banana starch substitution on the resistant starch content of steamed brownie products. Further tests using the Duncan test showed that there were significant differences in each variation of modified kepok banana starch substitution treatment.

The test results showed that the brownie treatment with a kepok banana starch percentage of 75% (P4) had the highest level of resistant starch. Syafii (2019) found that the resistant starch content in making kabosol increases along with the amount of modified kepok banana flour used. The high content of resistant starch indicates that there is a lot of starch that cannot be absorbed in the body. Foods that have high levels of resistant starch can regulate blood sugar levels easily so they are good for consumption by diabetes patients [18]. Research by Mahmud et al. (2019) found that the substitution of modified kimpul starch has an effect on biscuit-making [19]. Substitution of modified kimpul starch can increase the resistant starch content of biscuits to two times that of unmodified kimpul starch biscuits.

3.2. Protein Content

The research data in the form of brownie protein levels were analyzed using a normality test. The Shapiro–Wilk test result was $p = 0.476$ (p value > 0.05), showing that the data were normally distributed. Because the data were normally distributed, we continued testing using the one-way ANOVA test. The results of testing protein levels in brownies can be seen in Table 2.

Table 2. Protein content of modified kepok banana starch steamed brownies.

Treatment Variations	Protein Content (%)	p Score
P1	9.16 ± 0.26^a	0.000
P2	8.21 ± 0.14^b	
P3	7.66 ± 0.13^c	
P4	7.08 ± 0.19^d	

Source: Data from analysis of protein levels. The different notations in each column show significant differences. P1: Treatment 1 (substitution of modified kepok banana starch 0%). P2: Treatment 2 (substitution of modified kepok banana starch 25%). P3: Treatment 3 (substitution of modified kepok banana starch 50%). P4: Treatment 4 (substitution of modified kepok banana starch 75%).

The test results in Table 2 show that the highest protein content was found in brownies with 0% substitution of kepok banana starch (P1), while the lowest protein content was found in brownies with 75% substitution of kepok banana starch (P4). Based on the results of the one-way ANOVA test, a value of $p = 0.000$ ($p < 0.05$) was obtained, which shows that there was an effect of modified kepok banana starch substitution on the protein content of steamed brownie products. The results of further tests using the Duncan test showed that there were significant differences in each variation of modified kepok banana starch substitution treatment.

The results showed that the high substitution of kepok banana starch resulted in low protein content in steamed brownies. These results are in line with research by Ramadhani et al. (2019), which explains that the protein level decreases as banana flour substitution increases [20]. This decrease was due to the protein content in banana flour being lower than the protein content in wheat flour. This is in accordance with the research of Antarlina et al. (2004), who explained that the protein content of wheat flour varies between 8% and 9%, while the protein content of banana flour varies between 3.36% and 4.12% [21]. The high amount of banana flour substitution resulted in a low amount of protein in the steamed cake.

Pratomo (2013) found that the addition of banana flour causes the protein content in steamed sponge cake products to decrease [22]. Silfia's research (2012) also stated that the large amount of added banana flour had an effect on the protein content of banana kepok brownies, which decreased because the protein content of banana kepok flour was lower than that of wheat flour [23].

Flour with low protein and gluten content is suitable to meet the needs of the cake industry [13]. Based on research by Liang (2022), adding starch can produce an ideal cake texture with low hardness. Based on the SNI 01-3840-1995 reference standard for semi-wet products, the maximum permitted protein content is 9% (w/w). Thus, the protein content of steamed brownies P2, P3, and P4 met the quality content requirements, while P1 brownies did not meet the quality content requirements.

3.3. Water Content

Brownies have good nutritional value for the body. However, consuming too many brownies can cause diseases such as obesity and diabetes mellitus [13]. Functional foods contain nutritional value and can reduce the risk of chronic disease [2]. It is hoped that the substitution of kepok banana starch into the steamed brownie formulation can become a functional food product for the community. The research data in the form of water content of modified kepok banana starch brownies were analyzed using a normality test. The Shapiro–Wilk test result was $p = 0.007$ (p value < 0.05), confirming that the data were not

normally distributed. Because the data were not normally distributed, we continued with testing using the Kruskal–Wallis test. The results of testing the water content of brownies can be seen in Table 3.

Table 3. Water content of modified kepok banana starch steamed brownies.

Treatment Variations	Water Content (%)	<i>p</i> Score
P1	27.74 ± 1.11	0.112
P2	30.11 ± 1.19	
P3	28.60 ± 2.26	
P4	26.91 ± 0.05	

Source: Data from analysis of water levels. P1: Treatment 1 (substitution of modified kepok banana starch 0%). P2: Treatment 2 (substitution of modified kepok banana starch 25%). P3: Treatment 3 (substitution of modified kepok banana starch 50%). P4: Treatment 4 (substitution of modified kepok banana starch 75%).

Based on the test results in Table 3, it was found that the highest water content was found in brownies with a kepok banana starch substitution of 25% (P2), while the lowest resistant starch content was found in brownies with a kepok banana starch substitution of 75% (P4). The Kruskal–Wallis test produced a value of $p = 0.112$ ($p > 0.05$), which means that there was no effect of modified kepok banana starch substitution on the water content of steamed brownie products. The water content of chocolate steamed brownies according to SNI ranges from 36% to 40%. Based on research conducted by Putri (2022), the longer the steaming process, the more the water content in the brownies will decrease [10].

Water content is a very important characteristic because it is closely related to the shelf life of a food ingredient. Appearance, texture, and taste are also influenced by the amount of water content a material contains. Based on SNI 01-3840-1995 regulations, the maximum water content in bread is 40%. Therefore, the water content of the four steamed brownies produced met the established quality standards [10].

4. Conclusions

Based on the research results, it can be concluded that there was an effect of modified kepok banana starch substitution on the levels of resistant starch and protein in steamed brownie products. It was concluded that there were significant differences in each variation of modified kepok banana starch substitution treatment. The results of the research also showed that there was no effect from the kepok banana starch substitution treatment on the water content of steamed brownies.

Researchers suggest that when making steamed brownies with the substitution of modified kepok banana starch, an organoleptic quality test needs to be carried out to determine the best treatment for steamed brownies. In addition, it is necessary to test the levels of resistant starch, protein, and water in modified kepok banana starch so that it can be used as a reference in further research.

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