

Perbandingan Penggunaan Pure Apel terhadap Kualitas Fisik dan Kualitas Sensoris Bolu Kukus

Comparison Of Apple Puree Usage On The Physical Quality And Sensory Quality Of Steamed Sponge Cake

Rachel Audina Nur'azzura Putri^{a*}, Annis Kandriasari^b, Alvina Fadila Maulida^c

Culinary Education, Faculty of Engineering, State University of Jakarta^{a,b,c}
rahelaudina@gmail.com^a

Abstract

This study aims to analyze the comparison of apple puree usage on the physical quality and sensory quality of steamed sponge cake. Steamed sponge cake generally uses eggs as a binding, leavening, and texture-forming agent, although local apples containing pectin have the potential to be used as a substitute for part of the eggs. The research method used was an experimental method with three formulations of apple puree usage at 30%, 40%, and 50% of the total egg used. Physical quality testing was carried out on the expansion ability and cracking ability, analyzed using the One-Way Anova Completely Randomized Design (CRD) test followed by Duncan's test. Sensory quality testing was conducted by 45 semi-trained panelists on the aspects of shape, aroma, taste, and texture, analyzed using the Kruskal-Wallis test. The results showed that the highest expansion ability was obtained in the 40% treatment with an average of 136.7%, while the highest cracking ability was obtained in the 50% treatment with an average of 106.31%. The Anova test results showed no significant effect of apple puree usage on expansion ability, but a significant effect on cracking ability. The Kruskal-Wallis test results showed no significant effect of apple puree usage on shape, cinnamon aroma, sweetness, apple taste, and texture, except for apple aroma, which showed a significant effect. Overall, the treatment with 30% apple puree gave the best results in shape, sweetness, and texture, so this formula is recommended for optimizing the utilization of apple puree as a local food ingredient in steamed sponge cake products.

Keywords: Apple Puree, Physical Quality, Sensory Quality, Steamed Sponge Cake

Abstrak

Penelitian ini bertujuan untuk menganalisis perbandingan penggunaan puree apel terhadap kualitas fisik dan kualitas sensori bolu kukus. Bolu kukus umumnya menggunakan telur sebagai bahan pengikat, pengembang, dan pembentuk tekstur, meskipun apel lokal yang mengandung pektin memiliki potensi untuk digunakan sebagai pengganti sebagian telur. Metode penelitian yang digunakan adalah metode eksperimental dengan tiga formulasi penggunaan puree apel, yaitu sebesar 30%, 40%, dan 50% dari total telur yang digunakan. Pengujian kualitas fisik dilakukan terhadap kemampuan mengembang dan kemampuan merekah, yang dianalisis menggunakan uji One-Way Anova dengan Rancangan Acak Lengkap (RAL) dilanjutkan dengan uji Duncan. Pengujian kualitas sensori dilakukan oleh 45 panelis semi-terlatih terhadap aspek bentuk, aroma, rasa, dan tekstur, yang dianalisis menggunakan uji Kruskal-Wallis. Hasil penelitian menunjukkan bahwa kemampuan mengembang tertinggi diperoleh pada perlakuan 40% dengan rata-rata 136,7%, sedangkan kemampuan merekah tertinggi diperoleh pada perlakuan 50% dengan rata-rata 106,31%. Hasil uji Anova menunjukkan tidak adanya pengaruh nyata penggunaan puree apel terhadap kemampuan mengembang, namun terdapat pengaruh nyata terhadap kemampuan merekah. Hasil uji Kruskal-Wallis menunjukkan tidak adanya pengaruh nyata penggunaan puree apel terhadap bentuk, aroma kayu manis, tingkat kemanisan, rasa apel, dan tekstur, kecuali pada aroma apel yang menunjukkan pengaruh nyata. Secara keseluruhan, perlakuan dengan 30% puree apel memberikan hasil terbaik pada aspek bentuk, tingkat kemanisan, dan tekstur, sehingga formula ini direkomendasikan untuk mengoptimalkan pemanfaatan puree apel sebagai bahan pangan lokal dalam produk bolu kukus.

Kata kunci: puree apel, kualitas fisik, kualitas sensori, bolu kukus

1. Introduction

Steamed sponge cake (*bolu kukus*) is one of the traditional cakes that is popular among Indonesian people and can be found in almost all regions of the country. This product is favored because of its soft texture, sweet taste, and relatively simple processing method, making it acceptable to various groups of consumers. According to Andriani (2012), sponge cake is a patisserie product made from wheat flour, eggs, and sugar, with a cooking process that can be carried out either by baking or steaming. Steamed sponge cake itself is one of the variants cooked using hot steam in a steamer, resulting in a texture that tends to be moister and softer compared to baked sponge cake.

The main components in the production of steamed sponge cake consist of wheat flour, eggs, and granulated sugar, along with supporting ingredients such as emulsifier (SP), clear soda water, and other leavening agents. Each ingredient has its own role in forming the structure and final characteristics of the cake. Eggs play a very important role because they function as a binder, emulsifier, leavening agent, and coagulant that helps form the cake structure so that it remains stable and does not collapse easily. Stadelman and Owen, as cited in Christian (2022), stated that egg protein contributes to the formation of dough structure through coagulation during heating, while fat and lecithin in egg yolk function as natural emulsifiers. In addition to ingredient composition, the success of steamed sponge cake production is also influenced by mixing techniques and the steaming process. Errors at these stages may cause the cake to fail to rise properly or produce an undesirable texture (Andriani, 2012).

Innovation in steamed sponge cake production continues to develop, both in terms of flavor, color, and the addition of other food ingredients. The use of alternative ingredients that have functions similar to eggs, but are derived from plant-based sources that are easily obtained and applicable in patisserie products, has become a potential development. As a country with abundant local food resources, Indonesia has local apples as one of the commodities that grow in highland areas and are available almost throughout the year. Apples are known to be rich in nutrients, such as vitamin C, B-complex vitamins, minerals, fiber, and dietary fiber. Consuming apples with their skin is recommended because apple skin contains higher fiber than the flesh (Khoirul Anwar, 2024). The fiber content in apples reaches 4.5 grams, which is higher than bananas, which contain approximately 3 grams of fiber (Fatma Boukid, 2022). However, local apples in Indonesia generally have a relatively sour taste, making them less preferred for direct consumption as fresh fruit.

The sour taste characteristic of local apples actually creates an opportunity for their utilization in processed forms. In culinary arts, apples have been widely used in various processed food products, such as jam, fruit juice, apple chips, and apple puree. Processing apples into food products aims to increase their utility value, extend shelf life, and adjust the sensory characteristics of apples so that they are more acceptable to consumers. One processed form of apple that has potential for use in patisserie products is apple puree, which is a semi-finished product obtained by mashing apple flesh without a filtering process.

Apple puree has a semi-liquid texture and still contains natural dietary fiber from the fruit. One important component contained in apples is pectin, a soluble fiber that has thickening and binding properties. The presence of pectin is significant in forming dough structure because it is able to bind water and help maintain the stability of product texture during heating. Due to its pectin content, apple puree has the potential

to be used as a partial egg substitute in patisserie products, particularly in steamed sponge cake products that require moisture and a soft structure.

In food processing practice, apples can be used as an egg substitute in the form of puree at a ratio of $\frac{1}{4}$ cup, or approximately 64 grams of apple puree, for each egg (America, 2009). For the pectin in apple puree to function optimally, certain processing conditions are required, such as heating and an acidic environment. The use of leavening agents containing baking soda and cream of tartar, such as baking powder, can help create conditions that support the function of pectin in the batter so that the cake structure can be formed properly (Ferrandi, 2017).

Apart from its functional aspect, the use of apple puree also offers advantages from the perspective of raw material economics. Local apples generally have relatively affordable and stable prices, especially during the harvest season. Processing apples into puree can be carried out through a simple process without requiring complex technology, so the production cost of apple puree is relatively low. This makes apple puree a potential alternative ingredient in steamed sponge cake without significantly increasing production costs, while also adding value to local apples that are less preferred as fresh fruit.

Based on the explanation above, local apples, which generally have a sour taste, have great potential to be utilized in the form of puree as a partial egg substitute in the production of steamed sponge cake. The use of apple puree is expected not only to maintain the physical quality and sensory quality of steamed sponge cake, but also to serve as an innovation in local food-based products. Therefore, this study was conducted to examine the effect of using apple puree as a partial egg substitute on the physical quality and sensory quality of steamed sponge cake, as presented in the research entitled "Comparison of Apple Puree Usage on the Physical Quality and Sensory Quality of Steamed Sponge Cake."

2. Method

This study used an experimental method to examine the effect of apple puree substitution for eggs on the physical quality and sensory quality of steamed sponge cake. The research was conducted at the Pastry and Bakery Laboratory, Building H, Culinary Education Study Program, Faculty of Engineering, Universitas Negeri Jakarta. The experimental treatments consisted of three levels of apple puree substitution, namely 30%, 40%, and 50% of the total egg used in the steamed sponge cake formulation. A control formula without apple puree was also prepared for comparison in the physical quality test.

The apple puree was prepared from fresh apples that were weighed, peeled, trimmed, cut into small pieces, boiled with sugar and cinnamon, blended until smooth, and cooked again until a stable puree consistency was obtained. The puree was then cooled to room temperature before being incorporated into the cake batter. The basic steamed sponge cake formula consisted of low-protein wheat flour, sugar, instant yeast, eggs, emulsifier, vanilla essence, and UHT milk. In the treatment formulas, part of the egg was substituted with apple puree at 30%, 40%, and 50%.

The steamed sponge cake batter was prepared by mixing eggs, apple puree, sugar, UHT milk, and vanilla essence using a hand mixer at high speed for two minutes. Low-protein wheat flour and instant yeast were then added and mixed at low speed for two minutes. Emulsifier was subsequently added, and the batter was mixed at high speed for six minutes. The batter was poured into paper-cup-lined molds with a

weight of 45 g per cup and steamed for 15 minutes over medium-to-high heat. After steaming, the cakes were cooled at room temperature for approximately 30 minutes before physical and sensory evaluation.

Physical quality was evaluated based on expansion ability and cracking ability. Expansion ability was measured by comparing the height of the batter before steaming and the height of the cake after steaming. The expansion percentage was calculated using the formula:

$$\text{Expansion ability (\%)} = [(T_b - T_a) / T_a] \times 100$$

where T_a is the batter height before steaming and T_b is the cake height after steaming. Cracking ability was determined by measuring the diameter of cracks formed on the upper surface of the steamed sponge cake using a ruler. The cracking percentage was calculated by comparing the average crack diameter of each treatment with the diameter of the control cake.

Sensory quality was evaluated using a sensory assessment sheet completed by 45 semi-trained panelists from the Culinary Education Study Program, Faculty of Engineering, Universitas Negeri Jakarta. The panelists had passed traditional cake processing and organoleptic evaluation courses. The samples were coded to conceal the identity of each treatment. The sensory attributes evaluated included appearance, apple aroma, cinnamon aroma, sweetness, apple taste, and softness. Each attribute was assessed using a five-point scale.

Data from the physical quality test were analyzed using one-way analysis of variance based on a completely randomized design. If a significant difference was found, Duncan's multiple range test was applied as a post hoc test. Sensory data were analyzed using the Kruskal-Wallis test because the data were ordinal. When significant differences were detected, a further comparison test was conducted. All statistical tests were performed at a significance level of $\alpha = 0.05$.

3. Results And Discussion

Physical Quality Analysis

Physical quality testing was conducted to evaluate the expansion ability and cracking ability of steamed sponge cake with 30%, 40%, and 50% apple puree substitution. The highest expansion ability was observed in the 40% treatment, with a mean value of 136.7%, followed by 30% at 129.9% and 50% at 108.0%. However, the ANOVA result showed that apple puree substitution did not significantly affect expansion ability because the calculated F-value was lower than the F-table value. In contrast, cracking ability was significantly affected by apple puree substitution. The 50% treatment produced the highest cracking value, with a mean crack diameter of 7.87 cm and a cracking percentage of 106.31%, followed by the 30% treatment at 100.00% and the 40% treatment at 96.40%. Duncan's test showed that all treatments differed significantly from one another in cracking ability, with the 50% treatment producing the best physical cracking quality.

Table 1. Physical quality of steamed sponge cake with apple puree substitution

Physical parameter	30% apple puree	40% apple puree	50% apple puree	Statistical result
Expansion ability (%)	129.9	136.7	108.0	Not significantly different; $F_{\text{count}} = 3.54 < F_{\text{table}} = 5.14$

Mean crack diameter (cm)	7.40	7.10	7.87	Significantly different; Fcount = 18.60 > Ftable = 5.14
Cracking ability (%)	100.00	96.40	106.31	Highest in 50% treatment
Duncan notation for cracking ability	b	c	a	Each treatment differed significantly

Sensory quality testing was conducted by 45 semi-trained panelists on six attributes: shape, apple aroma, cinnamon aroma, sweetness, apple taste, and softness. The 30% apple puree treatment obtained the highest mean scores for shape, sweetness, and softness, with values of 4.9, 4.4, and 5.0, respectively. The 50% treatment obtained the highest apple aroma score, with a mean value of 3.8, indicating that a higher proportion of apple puree increased the perceptibility of apple aroma. Meanwhile, the 40% treatment produced the highest cinnamon aroma score, with a mean value of 3.2. Apple taste showed the same mean score across all treatments, namely 2.6, indicating that the use of apple puree did not clearly increase apple taste perception in the product.

Table 2. Mean sensory scores of steamed sponge cake with apple puree substitution

Sensory attribute	30% puree	apple 40% puree	apple 50% puree	apple Highest treatment
Shape	4.9	4.8	4.7	30%
Apple aroma	2.4	2.7	3.8	50%
Cinnamon aroma	2.4	3.2	3.1	40%
Sweetness	4.4	3.8	4.0	30%
Apple taste	2.6	2.6	2.6	Equal
Softness	5.0	4.8	4.6	30%

The Kruskal-Wallis test showed that apple puree substitution had no significant effect on shape, cinnamon aroma, sweetness, apple taste, and softness. A significant effect was found only in the apple aroma attribute, where the calculated chi-square value exceeded the chi-square table value. Further comparison using Tukey's test showed significant differences among all apple puree treatments for apple aroma, indicating that the 50% treatment produced the most distinct apple aroma compared with the 30% and 40% treatments.

Table 3. Sensory hypothesis testing using Kruskal-Wallis

Sensory attribute	X ² count	X ² table	Conclusion
Shape	0.9130	5.991	Not significantly different
Apple aroma	13.118	5.991	Significantly different
Cinnamon aroma	-8.9549	5.991	Not significantly different
Sweetness	-12.7911	5.991	Not significantly different
Apple taste	0.1988	5.991	Not significantly different
Softness	2.4783	5.991	Not significantly different

Overall, the 40% apple puree treatment produced the highest expansion ability, while the 50% treatment produced the highest cracking ability and the strongest apple aroma. However, based on sensory acceptance, the 30% treatment showed the most favorable overall profile because it achieved the highest scores for shape, sweetness, and softness. Therefore, 30% apple puree substitution can be considered the most balanced formulation for maintaining the sensory quality of steamed sponge cake, while 50% substitution is more effective when stronger apple aroma and higher cracking ability are desired.

Discussion

Physical Quality

The physical quality test of steamed sponge cake with apple puree in this study included expansion ability and cracking ability. Based on the physical test results for expansion ability, the highest expansion level was found in the steamed sponge cake with 40% apple puree, with an average value of 136.7%, compared with the 30% treatment, which had an average expansion value of 129.9%, and the 50% treatment, which had an average expansion value of 108%. Referring to the ANOVA results, it can be concluded that a higher amount of apple puree does not always increase the expansion ability of steamed sponge cake, since the highest expansion was found in the 40% treatment and the lowest in the 50% treatment. Based on the ANOVA analysis, it was concluded that the use of apple puree did not significantly affect the expansion ability of steamed sponge cake.

This finding is similar to the study conducted by Torbica (2018) on the utilization of apple pomace in sponge cake production, which showed that apple-based ingredients affected product volume development, although the best texture was still found in the control sample. This is related to the fiber and pectin content in apple puree, which plays a role in water binding and may affect the ability of the batter to trap air during the steaming process (Huțu, 2024). Product expansion can be influenced by the composition of the ingredients used, in which eggs and emulsifier have an important effect because they help form the batter structure and stabilize trapped air (Ho & Halim, 2019). The partial replacement of eggs with apple puree at different percentages was assumed to affect air stability in the batter inconsistently, resulting in no significant effect on the expansion ability of steamed sponge cake.

Based on the physical test results for cracking ability, the highest cracking level was found in the steamed sponge cake with 50% apple puree, with an average value of 106.31%, compared with the 30% treatment, which had an average cracking value of 100.00%, and the 40% treatment, which had an average cracking value of 96.40%. Referring to the ANOVA results, it can be concluded that a higher percentage of apple puree increased the cracking ability of steamed sponge cake. Based on the ANOVA analysis, it was concluded that the use of apple puree had a significant effect on the cracking ability of steamed sponge cake; therefore, Duncan's test was conducted to determine which treatments showed significant differences.

According to Gusnita (2021), good cracked steamed sponge cake is characterized by an upper surface that opens into several sections as a result of optimal batter structure development. Cracks are formed due to the expansion of air and water vapor inside the batter, which pushes the surface of the cake until it splits. The high cracking ability in the 50% treatment was assumed to be caused by the higher water content in apple puree, which generated more steam during the steaming process. This increased

internal pressure in the batter and produced wider cracks on the surface of the steamed sponge cake. This is consistent with Huțu (2024), who stated that apple puree contains fiber and pectin that contribute to water binding and texture formation. At higher percentages, more water is bound and more steam is generated during steaming, pushing the cake surface to crack more widely.

Sensory Quality

The visual appearance of food products is one of the aspects that attracts consumer attention and increases appetite before the product is consumed. In the sensory quality test for the shape aspect of steamed sponge cake with apple puree, the 30% treatment obtained the highest average score of 4.93, categorized as cracked and approaching very cracked. This score was higher than the 40% treatment, which obtained an average score of 4.87 in the cracked and approaching very cracked category, and the 50% treatment, which obtained an average score of 4.73 in the cracked and approaching very cracked category. Based on the hypothesis testing using the Kruskal-Wallis test, it was concluded that apple puree did not have a significant effect on the sensory quality of steamed sponge cake in terms of shape. Gusnita (2021) stated that good-quality steamed sponge cake is characterized by the opening of the upper surface into several petals as a result of optimal batter structure development during cooking. These cracks are formed due to the pressure generated by the expansion of air and water vapor inside the batter, which pushes the surface of the steamed sponge cake until it splits during steaming. The high score for the shape aspect in the 30% treatment was assumed to be related to the maintained balance between apple puree and eggs at this proportion, allowing the batter to trap air properly and produce well-formed cracks. As the percentage of apple puree increased, the higher fiber and pectin content was assumed to interfere with the formation of an ideal batter structure, resulting in a lower shape score in the 50% treatment compared with the other treatments (Huțu, 2024).

In the sensory quality test for apple aroma, the 50% treatment obtained the highest average score of 3.87, categorized as moderately apple-scented and approaching apple-scented. This score was higher than the 40% treatment, which obtained a score of 2.73 in the not apple-scented and approaching apple-scented category, and the 30% treatment, which obtained a score of 2.47 in the not apple-scented and approaching apple-scented category. Based on the hypothesis testing using the Kruskal-Wallis test, it was concluded that apple puree had a significant effect on the sensory quality of steamed sponge cake in terms of apple aroma. The increase in apple aroma intensity along with the higher percentage of apple puree was closely related to the increased concentration of natural volatile compounds from apples in the batter, making the characteristic apple aroma more perceptible to the panelists. This is in line with the study by Torbica (2018), which reported that the incorporation of apple-derived ingredients into cake products contributed clearly to the aroma profile of the final product, with apple aroma becoming more identifiable as the concentration of apple-based ingredients in the formulation increased.

In the sensory quality test for cinnamon aroma, the 40% treatment obtained the highest average score of 3.29, categorized as moderately cinnamon-scented and approaching cinnamon-scented. This score was higher than the 50% treatment, which obtained a score of 3.14 in the moderately cinnamon-scented and approaching cinnamon-scented category, and the 30% treatment, which obtained a score of 2.29 in

the not cinnamon-scented and approaching moderately cinnamon-scented category. Based on the hypothesis testing using the Kruskal-Wallis test, it was concluded that apple puree did not have a significant effect on the sensory quality of steamed sponge cake in terms of cinnamon aroma. This condition occurred because the amount of cinnamon used in each treatment was constant and did not change; therefore, the intensity of cinnamon aroma formed in the product was not affected by differences in the percentage of apple puree used. Torbica (2018) explained that the aroma of a substitute ingredient in a food product will not have a significant effect when other ingredients with stronger and more dominant aroma characteristics are present. In this study, cinnamon, eggs, and vanilla powder were ingredients with stronger aromas than apple puree, so variations in apple puree percentage did not meaningfully affect the panelists' perception of cinnamon aroma.

Taste is one of the most important components determining the quality of a food product. Various types of taste can be recognized by the human sense of taste, including sweet, spicy, salty, bitter, and umami, all of which are strongly determined by the type and composition of ingredients used in the product-making process (Amadea, 2020). In the sensory quality test for sweetness, the 30% treatment obtained the highest average score of 4.43, categorized as sweet and approaching very sweet. This score was higher than the 50% treatment, which obtained a score of 4.00 in the sweet category, and the 40% treatment, which obtained a score of 3.86 in the moderately sweet and approaching sweet category. Based on the hypothesis testing using the Kruskal-Wallis test, it was concluded that apple puree did not have a significant effect on the sensory quality of steamed sponge cake in terms of sweetness. This was because the sweetness intensity of steamed sponge cake was mainly determined by the amount of sugar used in the formula, which was constant and equal in all treatments. The quality of food products, including their taste characteristics, will remain stable when the ingredients used are of good quality (Ramadhani, 2018).

In the sensory quality test for apple taste, the 40% and 50% treatments obtained the same highest average score of 2.67, categorized as not apple-flavored and approaching moderately apple-flavored. This score was slightly higher than the 30% treatment, which obtained a score of 2.60 in the not apple-flavored and approaching moderately apple-flavored category. Based on the hypothesis testing using the Kruskal-Wallis test, it was concluded that apple puree did not have a significant effect on the sensory quality of steamed sponge cake in terms of apple taste. The low apple taste scores across all treatments were assumed to be related to the high-temperature steaming process, which caused compounds responsible for the characteristic apple flavor to evaporate, leaving an apple flavor intensity that was not strong enough to be detected by the panelists in the final product. In addition, the presence of other ingredients in the formula, such as sugar, cinnamon, and vanilla, which have more dominant taste profiles, also contributed to masking the apple taste in the steamed sponge cake product (Amadea, 2020).

The softness level of a food product is strongly influenced by the type and composition of ingredients used during its preparation (Gusnita, 2021). In the sensory quality test for softness, the 30% treatment obtained the highest average score of 5.00, categorized as very soft. This score was higher than the 40% treatment, which obtained a score of 4.87 in the soft and approaching very soft category, and the 50% treatment, which obtained a score of 4.67 in the soft and approaching very soft category. Based on the hypothesis testing using the Kruskal-Wallis test, it was

concluded that apple puree did not have a significant effect on the sensory quality of steamed sponge cake in terms of softness. Although the pectin and fiber content in apple puree is known to bind water and support product texture formation (Huțu, 2024), a higher percentage of apple puree tended to slightly reduce the softness score of the product. This was assumed to occur because higher fiber content may affect the gluten network in the batter, resulting in a slightly denser texture compared with treatments using lower percentages of apple puree.

4. Conclusion

The use of apple puree as a partial egg substitute affected some quality characteristics of steamed sponge cake. The highest expansion ability was obtained in the 40% apple puree treatment, with an average value of 136.7%; however, ANOVA showed no significant effect of apple puree substitution on expansion ability. In contrast, the highest cracking ability was observed in the 50% treatment, with an average value of 106.31%, and ANOVA indicated a significant effect on this physical parameter. Sensory evaluation showed that the 30% treatment produced the best scores for shape, sweetness, and softness, while the 40% treatment had the highest score for cinnamon aroma and the 50% treatment had the highest score for apple aroma. Kruskal-Wallis analysis showed no significant effect on shape, cinnamon aroma, sweetness, apple taste, and softness, but a significant effect was found on apple aroma. Overall, the 30% apple puree formulation is recommended as the most balanced formulation because it maintained favorable sensory quality, particularly in shape, sweetness, and softness, while supporting the utilization of local Manalagi apple puree in steamed sponge cake production.

Further studies are recommended to evaluate the shelf life and nutritional content of steamed sponge cake with apple puree substitution. Future research may also explore the application of Manalagi apple puree in other bakery or patisserie products.

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