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Effect of Sapodilla (*Manilkara zapota*) Addition on the Organoleptic and Chemical Properties of Brownies

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Abstract

Sapodilla (*Manilkara zapota*) is a tropical fruit with considerable potential for value-added food development because of its nutritional content and distinctive sensory characteristics. However, its application in bakery products remains limited. This study aimed to evaluate the effect of different levels of sapodilla addition on the sensory and chemical properties of steamed brownies. An experimental study was conducted using a completely randomized design (CRD) with a single factor consisting of three levels of sapodilla addition (100 g, 150 g, and 200 g), each performed in triplicate, resulting in nine experimental units. Brownies were evaluated for sensory attributes (color, taste, aroma, and texture) using a hedonic test, while proximate analysis was performed to determine moisture, ash, protein, fat, and carbohydrate contents. The results showed that sapodilla addition significantly affected the taste of the brownies ($p < 0.05$) but had no significant effect on color, aroma, or texture ($p > 0.05$). Likewise, different levels of sapodilla addition did not significantly influence the carbohydrate, protein, fat, ash, or moisture contents of the brownies ($p > 0.05$). These findings indicate that sapodilla can be incorporated into steamed brownies to improve taste acceptability without adversely affecting other sensory attributes or the overall nutritional composition, highlighting its potential as a locally available ingredient for value-added bakery products.

Keywords: brownies, *Manilkara zapota,* proximate analysis, sensory evaluation, value-added food

Introduction

One of the traditional processed products that is favored by Indonesian people is brownies. The basic ingredients of common brownies come from chocolate which has a distinctive taste and smell. According to Ismayani (2006) brownies are a type of dense chocolate cake, initially a failed and hard dough where the dough is made from flour, eggs, fat, sugar and cooking chocolate by baking or baking. Meanwhile, according to Astawan (2009) brownies are a type of cake that is blackish brown in color with a slightly harder texture than cake because brownies do not require developer or gluten.

According to Astawan (2009) Brownies are a good source of energy. Based on the table above, the energy value per 100 grams of brownies is 434 kcal, more than rice (335 kcal/100 grams) or noodles (339 cal/100 grams). Energy in brownies generally comes from carbohydrates, namely flour and sugar and fat. Carbohydrate content in brownies is 76.6 grams/100 grams while the fat reaches 14 grams/100 grams.

Brownies are among the most popular bakery products because of their distinctive chocolate flavor, soft texture, and high consumer acceptance. Conventional brownies are rich

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in carbohydrates and fat but generally contain limited amounts of dietary fiber and bioactive compounds. Consequently, researchers have increasingly explored the incorporation of fruits into brownie formulations to enhance their nutritional value while maintaining desirable sensory characteristics.

Sapodilla (*Manilkara zapota*) is a tropical fruit rich in natural sugars, dietary fiber, vitamins, minerals, and antioxidant compounds. Despite its nutritional potential, its utilization in processed food products remains limited, particularly in bakery products. The incorporation of sapodilla into brownies may improve their nutritional quality while providing unique sensory attributes. Sapodilla has a sweet taste, a distinctive fruity aroma and has a fruity texture with lots of fine fiber. Sapodilla fruit flesh has a sugar content ranging from 16-20%. Besides containing sugar, sapodilla fruit flesh also contains fat, protein, vitamin A, B vitamins, vitamin C, iron, calcium, and phosphorus. Sapodilla fruit is a promising fruit to be developed. Several studies have developed processed products made from sapodilla fruit, such as sapodilla lunkhead, sapodilla chips and sapodilla jam.

The high nutritional content contained in sapodilla, especially carbohydrates, calcium, vitamin A and water. Sapodilla with its less utilization so sapodilla has the potential to be used as a raw material for making brownies. Therefore the authors are interested in conducting research on the effect of adding sapodilla to the organoleptic and chemical properties of brownies, so that it is useful for developing brownie products with good quality in terms of nutritional content, taste, aroma and texture that can be accepted by consumers. Therefore, this study aimed to evaluate the effect of different levels of sapodilla addition on the organoleptic and chemical properties of steamed brownies.

Methods

This study employed an experimental design using a completely randomized design (CRD) with a single factor consisting of three levels of sapodilla (*Manilkara zapota*) addition. Each treatment was conducted in triplicate, resulting in a total of nine experimental units. The study was designed to evaluate the effect of different levels of sapodilla addition on the sensory and chemical properties of steamed brownies.

The research was conducted in several stages, including raw material preparation, brownie formulation and processing, sensory evaluation, and chemical analysis. Sensory evaluation was performed using a hedonic test to assess panelists' preferences for color, aroma, taste, and texture. Chemical analyses were conducted to determine moisture, ash, protein, fat, and carbohydrate contents of the brownie samples. The results were analyzed to identify the formulation that provided the most acceptable sensory characteristics and nutritional composition.

Result

Sensory Evaluation

The sensory acceptability of steamed brownies supplemented with different levels of sapodilla (*Manilkara zapota*) was evaluated using a hedonic test assessing color, taste, aroma, and texture (Table 1).

Table 1. Mean hedonic scores of brownies with different levels of sapodilla addition

Treatment	Color	Taste	Aroma	Texture
100 g sapodilla	3.61	3.87	3.67	3.75
150 g sapodilla	3.43	3.50	3.67	3.58
200 g sapodilla	3.64	3.60	3.56	3.75

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Treatment	Color	Taste	Aroma	Texture
p-value	*1.217*	*0.03**	*0.642*	*0.465*

Overall, all brownie formulations were well accepted by the panelists, with mean hedonic scores ranging from 3.43 to 3.87. Color scores were similar among treatments, indicating that different levels of sapodilla addition had little influence on the visual appearance of the brownies. The formulation containing 200 g of sapodilla achieved the highest color score (3.64), whereas the 150 g formulation received the lowest score (3.43).

Taste scores ranged from 3.50 to 3.87, with the 100 g sapodilla formulation receiving the highest level of consumer preference. Aroma acceptability was comparable across treatments, with mean scores between 3.56 and 3.67, suggesting that increasing the amount of sapodilla did not substantially alter the aroma of the brownies. Similarly, texture scores remained relatively consistent, with the 100 g and 200 g formulations obtaining the highest mean score (3.75). Overall, no marked differences in sensory acceptance were observed among the three formulations.

Color

The brownies produced for each treatment had a different color. Brownies with the addition of 100 grams of sapodilla have a brown color and a white brown layer, while the addition of 150 grams and 200 grams of sapodilla has a brown color and a brownish brown layer. The most preferred colors by the panelists were the colors in the brownie treatment with the addition of 100 grams of sapodilla (FIII) and the addition of 200 grams of sapodilla (FV), this was because the colors in the two samples were more attractive where the colors in the FIII sample had a more intense brown color and in the FV sample it has a lighter brown color like the brown color in caramel. The results of Anova showed that the brownies with the addition of sapodilla were not significantly different from the color of the brownies with a calculated F value of 1.217 with a significant level (P value) of 0.05. Thus, Duncan's further test was not continued to see different treatments

Taste

The brownies produced for each treatment have a different taste. Brownies with the addition of 100 grams of sapodilla have a sweet taste and a slightly brown taste, when added 150 grams of sapodilla have a sweet sapodilla taste and 200 grams have a sweet and sapodilla taste. This sapodilla fruit easily undergoes physiological, chemical and physical changes if it is not handled properly. As a result, in a short time the fruit will not be fresh anymore so that its quality will decrease. Therefore, in order to increase the utilization of sapodilla fruit, it is necessary to diversify processed sapodilla fruit products, so as to encourage wider utilization of sapodilla. One alternative utilization is in the form of making brownies. Besides being more durable, processing will make the sapodilla taste varied (Sutarya RI, 2016). The results of ANOVA show that brownies with the addition of sapodilla have a significant effect on the taste of brownies with an F count of 3,249 with a significant level (P value) of 0.03 <0.05.

Aroma

Aroma is one of the key variables. The aroma produced from brownies is in the form of a distinctive aroma, the aroma that comes from steaming. The aroma of sapodilla from the brownies that no longer smells is because the aroma of chocolate is more pungent than the aroma of sapodilla. So that the aroma of chocolate dominates the aroma of sapodilla.

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The aroma of sapodilla brownies has an important role in their assessment and appearance because if sapodilla brownies have a distinctive aroma, then the sapodilla brownies can be said to be good. The results of Anova showed that brownies with the addition of sapodilla had no significant effect on the aroma of brownies with F count 0.446 with a significant level (P value) 0.642 > 0.05. Thus, Duncan's further test was not continued.

Texture

The brownies produced for each treatment had a different texture. Brownies with the addition of 100 grams of sapodilla have a soft texture, while the addition of 150 grams and 200 grams of sapodilla has a soft texture. The results of ANOVA show that brownies with the addition of sapodilla have no significant effect on brownie texture with F count 0.773 with a significant level (P value) 0.465 > 0.05. Thus, Duncan's further test was not continued. The incorporation of sapodilla did not significantly affect brownie texture.

Nutritional Values

The Nutritional Values demonstrated that sapodilla addition influenced the nutritional composition of the brownies. Moisture content increased with higher levels of sapodilla, reaching the highest value in the 150 g formulation (48.62%). Ash content ranged from 0.76% to 0.85%, with the highest value observed in the 200 g treatment. Protein content increased slightly as the amount of sapodilla increased, from 5.81% in the 100 g formulation to 6.11% in the 200 g formulation. In contrast, fat content decreased progressively with increasing sapodilla addition, from 12.49% in the 100 g formulation to 6.89% in the 200 g formulation. Carbohydrate content was highest in the 100 g treatment (45.14%) and decreased in formulations containing greater amounts of sapodilla.

Table 2. Nutritional Values of brownies with different levels of sapodilla addition

Parameter	sapodilla addition			*p-value*
	100 g	**150 g**	**200 g**	
Moisture (%)	35.75	48.62	47.94	0.117
Ash (%)	0.81	0.76	0.85	0.648
Protein (%)	5.81	5.93	6.11	0.919
Fat (%)	12.49	8.11	6.89	0.628
Carbohydrate (%)	45.14	36.57	38.19	0.237

Water content

The water content in food ingredients greatly affects the quality and shelf life of these foods. Water is an important component in food that can affect the quality of the food itself. Increasing the amount of water can affect the rate of deterioration of food by microbiological, chemical and enzymatic processes (Wardani, et al, 2015). Based on the results of the ANOVA test, the calculated F value is 4,766 with a p value of 0.117. This indicates that there is no significant effect between the brownie treatment on protein content because the p value > 0.05. Thus, Duncan's further test was not carried out. Although moisture content tended to increase with increasing sapodilla addition, the differences were not statistically significant. This trend is consistent with reports that fresh fruit ingredients contribute additional moisture to bakery formulations, which may improve product softness without significantly affecting overall acceptability (Chikpah SK et al., 2023).

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Ash content

Ash is an organic substance produced from the remaining combustion of an organic material. About 96% of food ingredients consist of organic matter and water, the rest consists of mineral elements. The higher the ash content of a food ingredient, the higher the mineral content of the material (Winarno, 2004). Based on the results of the ANOVA test, the calculated F value is 0.504 with a p value of 0.648. This indicates that there is no significant effect between the brownie treatment on protein content because the p value > 0.05. Thus, Duncan's further test was not carried out.

Protein

Based on the results of the ANOVA test, the calculated F value is 0.086 with (P value) namely 0.919. This shows that the brownie treatment has no significant effect on protein content because the p value is > 0.05. Thus, Duncan's further test was not continued.

Fat

Fat is an organic compound found in nature that is insoluble in water but can dissolve in non-polar organic solvents and is a major component in adipose tissue (Jacoeb Mardiono Agoes et al, 2015. Based on the results of the ANOVA test, the calculated F value is 0.546 with (P value) 0.628. This shows that the brownie treatment has no significant effect on protein content because the p value is > 0.05. Thus, Duncan's further test was not continued.

Carbohydrate

Carbohydrates are important compounds that have an important role in determining the characteristics of food ingredients, such as taste, color, texture and others. Carbohydrates are the main source of calories even though the number of calories produced by 1 gram of carbohydrates is only 4 Cal (kcal) when compared to protein and fat. Whereas in the body carbohydrates are useful for breaking down excess body protein and helping metabolize fats and proteins (Ekafitri & Faradilla, 2011). Based on the results of the ANOVA test, the calculated F value is 2,421 with (P value) namely 0.237. This shows that the brownie treatment has no significant effect on carbohydrate content because the p value is > 0.05. Thus, Duncan's further test was not continued.

Discussion

Sensory Properties

The present study demonstrated that different levels of sapodilla (*Manilkara zapota*) addition significantly affected the taste of steamed brownies, whereas no significant differences were observed in color, aroma, or texture. These findings indicate that sapodilla can be incorporated into brownie formulations without compromising overall sensory quality.

Although slight differences in color were observed among the treatments, panelists showed similar preferences for all formulations. The darker brown color of the brownies was primarily attributed to cocoa powder and Maillard browning during steaming, while sapodilla contributed only minor changes to the final appearance. Consequently, the different levels of sapodilla did not significantly influence color acceptance. Similar findings were reported by Lubis et al. (2021), who found that incorporating composite flour into brownies caused only slight color variation while maintaining acceptable consumer preference. The absence of significant

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differences in color among treatments may be explained by the dominant brown pigments originating from cocoa powder as well as the Maillard reaction during thermal processing, which masked the color contribution of sapodilla pulp. Similar observations have been reported in bakery products enriched with fruit purees, where cocoa-based formulations showed only minor changes in color despite increasing fruit concentrations (Pathare et al., 2013; Lubis et al., 2021).

Taste was the only sensory attribute significantly affected by sapodilla addition ($p < 0.05$). Brownies containing 100 g of sapodilla received the highest hedonic score, indicating that this level provided the most balanced sweetness and chocolate flavor. Sapodilla naturally contains 16–20% sugars, which contribute pleasant sweetness; however, excessive addition may alter the flavor balance and reduce consumer preference. Similar observations have been reported in sapodilla-based fruit products, where moderate levels of sapodilla produced higher sensory acceptance than formulations containing excessive amounts of fruit. The significant effect of sapodilla addition on taste may be associated with its natural sugar content, which contributes to sweetness and enhances overall palatability. Fruit incorporation into bakery products has been reported to improve taste acceptability when used at appropriate levels without negatively affecting consumer preference. Similar findings have been reported in fruit-enriched bakery products, where moderate fruit incorporation enhanced sensory acceptance while maintaining product quality.

No significant differences were observed in aroma among treatments. This result is likely because the characteristic chocolate aroma was more dominant than the relatively mild aroma of sapodilla, thereby masking differences among formulations. Previous studies have demonstrated that although sapodilla contains numerous volatile aroma compounds, including fruity, woody, minty, and sweet notes, these compounds may become less perceptible when combined with ingredients possessing stronger aromas such as chocolate. No significant differences in aroma were observed among treatments, suggesting that the characteristic aroma of chocolate masked the relatively mild aroma of sapodilla. Similar observations have been reported in fruit-fortified bakery products, where the aroma profile was primarily determined by the dominant bakery ingredients rather than the added fruit (Krajewska, A., & Dziki, D., 2023).

Similarly, the texture of the brownies remained comparable across all treatments. The addition of fresh sapodilla did not significantly alter the soft and moist texture characteristic of steamed brownies. Comparable results were reported by Salleh et al. (2017), who found that sapodilla-based products maintained acceptable textural properties despite differences in formulation. This finding indicates that the levels of sapodilla used were insufficient to alter the structural characteristics of the brownie matrix, which were mainly determined by wheat flour, eggs, and fat. Similar findings have been reported for fruit-enriched bakery products, where moderate fruit addition maintained acceptable textural properties (Krajewska, A., & Dziki, D., 2023).

Nutritional Values

Proximate analysis showed that different levels of sapodilla addition did not significantly affect the carbohydrate, protein, fat, ash, or moisture contents of the brownies ($p > 0.05$). Although numerical differences were observed among treatments, the variations were insufficient to produce statistically significant differences.

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Carbohydrates remained the predominant macronutrient because wheat flour and sugar constituted the major ingredients in the brownie formulation. Likewise, protein and fat contents were largely determined by eggs, butter, and chocolate rather than by sapodilla, which contains relatively small amounts of these nutrients. Similar findings have been reported in studies on sapodilla fruit products, where formulation changes had limited effects on proximate composition but successfully maintained acceptable nutritional quality.

Although moisture content tended to increase with increasing sapodilla addition, the differences were not statistically significant. This tendency is expected because fresh sapodilla has a relatively high moisture content. Comparable observations have been reported in processed sapodilla products, where increasing the proportion of fresh fruit resulted in higher moisture content without markedly affecting overall product quality.

Overall, these findings suggest that sapodilla can be incorporated into steamed brownies to improve taste acceptability while maintaining desirable sensory characteristics and nutritional composition. Therefore, sapodilla has considerable potential as a locally available functional ingredient for the development of value-added bakery products. The absence of significant differences in proximate composition may be explained by the relatively small contribution of sapodilla to the overall formulation compared with the major ingredients, such as wheat flour, eggs, butter, and chocolate. In fruit-enriched bakery products, the incorporation of fresh fruit often has only a limited effect on proximate composition because fruits are primarily sources of water, dietary fiber, vitamins, minerals, and bioactive compounds rather than protein or fat. Therefore, fruit addition tends to improve the functional value of bakery products rather than substantially changing their macronutrient composition (Krajewska, A., & Dziki, D., 2023).

Conclusion

The incorporation of sapodilla (*Manilkara zapota*) at levels of 100, 150, and 200 g significantly influenced the taste of steamed brownies ($p < 0.05$), while no significant effects were observed on color, aroma, or texture ($p > 0.05$). Likewise, proximate analysis revealed no significant differences in moisture, ash, protein, fat, or carbohydrate contents among the brownie formulations ($p > 0.05$). These findings indicate that sapodilla can be incorporated into steamed brownies to improve taste acceptability without adversely affecting other sensory attributes or the proximate nutritional composition. Consequently, sapodilla represents a promising locally available ingredient for the development of value-added bakery products. Future research should evaluate the functional properties of sapodilla-enriched brownies, including their dietary fiber content, antioxidant activity, bioactive compounds, shelf life, and consumer acceptance, to better establish their potential as functional food products.

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