

# Frozen Brownies with Fat Replacer of Pineapple Puree as an Alternative to Low Fat Wet Cake Products

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**Abstract.** Frozen brownies are modified products that can be consumed directly in cold, thawed, and warm conditions. Therefore, this study aims to produce frozen brownies with high fibre content and low fat by reducing their total intake using margarine. The is a single factor study arranged in a Completely Randomised Block Design with four replications. The factor studied was the proportion of pineapple puree and margarine, which was divided into 5 groups with ratios of 10:90, 20:80, 30:70, 40:60, and 50:50, respectively. The products were also analysed for their sensory characteristics (hedonic test), physical characteristics (hardness level), nutritional analysis. Analysis of acceptance and  $\beta$ -sitosterol was carried out. The sensory evaluation results showed that the proportion of fat replacer had a significant effect ( $p < 0.05$ ) on the product acceptance. The physical characterisation of the hardness level ranged from 8.74 to 11.39 kgm/s<sup>2</sup>. The proportion of fat replacer also has a significant effect on the nutritional value, namely ash content, protein, fat, and carbohydrates. The energy content of the products ranged from 480 – 603 kcal/100g. The best-frozen brownies had a fat replacer and margarine ratio of 50: 50, and it contains  $\beta$ -sitosterol of 912.6883 mg/kg, which is higher than that of the control, namely 161.7127 mg/kg. The fat adequacy level of the best-frozen brownies was 12.5% lower, but it has a high fibre content of 3.31 g/100g than regular brownies. Therefore, the product can be recommended as a healthy food.

**Keywords:** frozen brownies, pineapple, reduced fat, sweet potato flour

## 1 Introduction

Healthy foods that are practical, effective, efficient, fast as well as delicious are rarely found in the modern society. In the food industry competition, especially cake, brownies are greatly demanded by consumers. Furthermore, based on the statistical data on food consumption in 2018, a consumption rate of 1,345 kg/capita/week was recorded and then categorized as increasing throughout the year. The intake of wet cakes, especially brownies, is favoured because of their thick chocolate taste and soft texture. The brownies in circulation have a short shelf life, hence, they can become mouldy within a week [1] They also have a relatively high-fat content [2], consequently, modifications need to be carried out to obtain healthy products rich in fibre and have low fat. One of which is frozen brownies, and the advantages of its processing include being practical because it can be consumed directly. It is also safe due to the freezing process, which helps to reduce harmful bacteria without the addition of artificial preservatives.

Products processed from wheat flour often have a low fibre content. However, frozen brownies can be used as a healthy food because they are rich in the nutrient and helps to reduce total fat intake. Changes in their main ingredient, namely reducing the amount of wheat flour as well as other food ingredients with higher fibre content can increase the functional value of the products. A study by Putri & Muliani (2021) reported that modified purple sweet potato flour contains 11.69% resistant starch with a total dietary fibre of 28.58%.

The survey results from the Indonesian Ministry of Health revealed that the prevalence of CHD, such as obesity and coronary heart disease as well as degenerative including hypertension and stroke has continued to increase annually [4]. The Dietary Guidelines for Americans emphasised on replacing saturated fat with unsaturated variants. Brownies products often have more than 60% fat content of the total dough because it is added to improve their sensory quality. Furthermore, it is generally in the forme of margarine, which contains long-chain saturated fatty acids. Making frozen reduced-fat brownies is one of the ways to reduce the total fat intake for consumers. The sensory quality of the products needs to be

maintained by adding replacers of the nutrient [5]. [6] revealed that fruits must have three factors before it can be used as a substitute for fat, namely fibre, pectin, and sugar, which have been fulfilled by pineapple fruit. It has relatively high pectin of 29% as well as 1.4g and 9.85g/100g of dietary fibre and 9.85 sugar, respectively [7]. This study used a natural fat replacer, namely puree fruit pulp from pineapple. Furthermore, this was because it is natural, economical, and cheaper than fabricated replacers and margarine.

According to the American Dietetic Association in Wylie-Rosett, 2002, dietary fibre and pectin that are present in pineapples can function as fat mimetics. Furthermore, the properties that can be replaced include its texturizing and tenderizing effect. A product is labeled as a reduced-fat when the total fat is 25% lower than the original product [8]. Previous study of [9] reported that in the manufacture of steamed brownies, there are five treatments proportion of papaya puree and margarine, namely 10:90, 20:80, 30:70, 40:60, and 50:50. The substitution of margarine by pineapple puree is assumed to affect the physicochemical and organoleptic properties of the products. Based on the benefits of modified sweet potato and pineapple flour, the development of frozen brownies is considered a very good choice. Therefore, this study aims to analyse the sensory properties, physical characteristics, nutritional content, contribution of nutritional needs, and the acceptance level of frozen brownies as well as to recommend them as food healthy.

## 2 Materials and Methods

### Ethical aspects

This study was approved by the Ethics Committee for System of Information Health Research Ethics Management Ministry of Health Indonesian, (Ethics Number.187/KEPK-TJK/VII/2021).

### Study Design and Frozen Brownies Formulation.

This is a single factor experimental study, which was arranged in a Completely Randomised Block Design (CRBD) with four replications. The factor studied was the fat replacer's proportion of puree pineapple: margarine, which was divided into 5 groups, namely P1, P2, P3, P4, and P5 with ratios of 10:90, 20:80, 30:70, 40:60, and 50:50, respectively. The proportion of flour and modified purple sweet potato flour used was 50:50. Furthermore, the frozen brownies formula used followed the measurements proposed in [9].

### Ingredients and Production of Frozen brownies.

Modified purple sweet potato (*Ipomoea batatas*. L) flour with certificate number Intellectual property rights: 000179513, as well as honey pineapple, were purchased from the Gintung local market in Bandar Lampung. Meanwhile, other ingredients for frozen brownies, such as chicken eggs, granulated sugar, medium protein flour, Van Houten brand cocoa powder, and tulip brand chocolate blocks were obtained at the supermarkets in Bandar Lampung. The method used for producing modified purple sweet potato flour was proposed in [3] Meanwhile, the manufacture of pineapple puree, peeling as well as the removal of "eyes" and pith were carried out as reported in [10] and [11]. The fruit was washed, cut into small pieces, blanched by steaming for 5 minutes, after which it was cooled. It was then pulverised using a blender at 6,000 rpm for 5 minutes until a smooth pineapple pulp was obtained. Frozen brownies were produced by previously providing sweet potato flour, 360 g of chicken eggs, 6 g ovalett as well as 250 g sugar in a bowl. They were then mixed for 15 minutes until the dough was white and fluffy. Subsequently, modified purple sweet potato flour was mixed with wheat flour in a ratio of 50:50 and then added to the bowl. 50 g of cocoa powder, fat replacer of pineapple puree, liquid margarine according to the treatment, 250 g melted chocolate block, and 0.5 g vanilla powder were also added using a low-speed mixer. After the dough was well mixed, it was poured into a rectangular pan lined with parchment paper with a size of 20 cm x 20 cm x 4 cm. It was then placed in an oven for 30 minutes at 180°C. Subsequently, the samples were removed, stored at room temperature, and then cut into a size of 1 x 1 x 1 cm to facilitate the next process. The brownies were then packaged using aluminium foil, and frozen at 0°C.

### Sensory Analysis

Sensory evaluation was carried out on five frozen brownies formulas using the hedonic test method formulated by 80 untrained panelists, which signed informed consent. Furthermore, the test was performed by placing P1, P2, P3, P4, and P5, which had been cut into pieces at a size of 1 x 1 x 1 cm into a plate. They were then taken directly from the freezer with random coding using 3 digit numbers. The test was carried out to evaluate the preference level of the sample in terms of texture, colour, aroma, taste, and texture. The characteristics were then rated on a scale of 1 to 9, namely 1 - extremely dislike, 2 - very dislike, 3 - dislike, 4 - slightly dislike, 5 - neutral, 6 - slightly like, 7 - like, 8 - very like, and 9 - extremely like [12].

### Nutrient content [13]

The moisture, ash, and protein content of the samples were evaluated using the gunning method, while the amount of fat and fibre were evaluated with the Soxhlet and fibre gravimetric method, respectively. Furthermore, the total carbohydrates were calculated using by-difference, while the calorific value analysis was carried out using the bomb calorimeter method. Analysis of Physical Properties with the penetrometry method using a digital GY4 Hardness tester.

### Acceptance Analysis

The acceptance analysis was carried out using a formula with good sensory and high nutritional value. Furthermore, the analysis of the preference level was performed using a hedonic test associated with colour, aroma, texture, taste, and serving temperature. The samples were then rated on a scale of 1 to 5, where the acceptance level was assessed by serving 50 g of frozen brownies with a rating scale of 0 to 100%. The 100% level represents the least preferred, while the 0% level indicates the most favoured acceptance level. The test was carried out at the Hajimena Health Center in Pemunjukan Village, South Lampung, using the age of the respondents as an inclusion criterion, namely 20-59 years, as proposed in [14].

### Beta-Sitosterol

Analysis of  $\beta$ -sitosterol was carried out using the HPLC brand Shimadzu LC-20AD produced from Japan by weighing 1 g of mashed brownies sample. Subsequently, 10 ml of Chloroform PA was added and heated in a water bath for 1 hour. It was then cooled for a few minutes and strained using a filter paper. The filtrate was evaporated using a rotary evaporator, after which the residue was dissolved in 1 ml of Methanol PA. 10  $\mu$ l of the extract and brownies was injected into HPLC under the following conditions; Column c-18 capillary 30 m x 0.25 mm, RTX-1, film thickness of 0.25  $\mu$ m, wavelength = 210 nm, oven temperature of 40°C, mobile phase = methanol: acetonitrile, and water rate = 1ml/min. Calculations were then performed by comparing the mooring time to the height or area of the chromatogram peaks obtained with the reference standard solution.

### Statistic analysis

The analysis of variance (ANOVA) test was used to evaluate the organoleptic, nutritional content, and physical properties. It was then continued with the DMRT (Duncan Multiple Range Test) at a 5% level. Furthermore, energy data from the five formulas, acceptance, as well as fatty acid composition for the best-frozen brownies and controls were analysed descriptively.

## 3 Results

### Sensory test

Table 1 show the panelists average preference level for frozen brownies. The results of the Anova statistical test obtained p-value = <0.05, which indicates that the fat replacer of pineapple puree has a significant effect on the colour, taste, aroma, texture, and overall acceptance of frozen brownies at the 5% alpha. Furthermore, the best result was obtained from the frozen brownies in group P5.

Table 1. The panelists average preference level for frozen brownies

Formul a	Colour	Taste	Aroma	Texture	Overall Receipt	Averag e
P1	6.91 $\pm$ 0.68 (ab)	6.86 $\pm$ 0.74 (a)	6.70 $\pm$ 0.68 (a)	6.68 $\pm$ 0.84 (a)	6.86 $\pm$ 0.71 (a)	6.80
P2	6.78 $\pm$ 0.69 (a)	6.79 $\pm$ 0.81 (a)	6.64 $\pm$ 0.73 (a)	6.72 $\pm$ 0.83 (a)	6.81 $\pm$ 0.66 (a)	6.75
P3	6.81 $\pm$ 0.66 (a)	6.79 $\pm$ 0.85 (a)	6.74 $\pm$ 0.72 (a)	6.75 $\pm$ 0.75 (a)	6.86 $\pm$ 0.72 (a)	6.79
P4	7.05 $\pm$ 0.65 (bc)	6.93 $\pm$ 0.70 (a)	6.82 $\pm$ 0.79 (a)	6.91 $\pm$ 0.78 (ab)	6.98 $\pm$ 0.74 (ab)	6.98
P5	7.17 $\pm$ 0.59 (c)	7.23 $\pm$ 0.80 (b)	7.06 $\pm$ 0.70 (b)	7.13 $\pm$ 0.79 (b)	7.19 $\pm$ 0.71 (b)	7.17
p-value	0.001	0.002	0.003	0.002	0.006	

Description: The mean  $\pm$  standard deviation (SD) of the four replicates. The difference in superscripts in one column showed that there was a significant difference (P<0:05).

### Nutrient content

Table 2 show the nutritional content of frozen brownies at several levels of pineapple puree addition. The results of the ANOVA statistical test obtained p-value < 0.05 for the ash, protein, fat, and carbohydrate, which indicates that the pineapple puree fat replacer has a significant effect on the parameters at the 5% alpha. Meanwhile, p-value > 0.05 was recorded for the water and fibre content, which implies that the fat replacer has no significant effect on the parameter. The energy analysis assessment of the frozen brownies ranged from 480 – 603 kcal/100g. The highest average score was obtained at P1, while

the lowest was recorded in P5. Physical properties of frozen brownies, show frozen brownies hardness level, the results of the Anova statistical test obtained p-value = 0.0005, which indicates that the fat replacer of pineapple puree has a significant effect on the hardness level of frozen brownies.

Table 2. The nutritional content of frozen brownies at several levels of pineapple puree addition

Formulation (Frozen brownies)	Water content (%)	Ash content (%)	Protein content (%)	Fat content (%)	Fibre content (%)	Carbohydrate content (%)	Energy (kkal/100g)	Texture (kgm/s <sup>2</sup> )
P1	22.89 ±0.47	1.63 ±0.08 (a)	4.66 ±0.25 (b)	20.82 ±0.26 (d)	1.47 ±0.99	45.65 ±2.43(a)	603	8.74 ± 0.19 (a)
P2	22.96 ±0.30	1.65 ±0.03 (a)	4.26 ±0.23(b)	18.76 ±0.12 (c)	2.25 ±1.10	49.14 ±5.25 (ab)	554	9.69 ± 0.37 (b)
P3	23.95 ±3.82	1.59 ±0.03 (a)	3.47 ±0.29 (a)	16.69 ±0.69 (b)	2.46 ±1.22	49.90 ±2.27(ab)	551	10.41 ± 0.60 (b)
P4	24.48 ±1.09	1.97 ±0.19 (b)	4.56 ±0.45 (b)	15.46 ±0.02 (a)	2.74 ±1.43	52.54 ±1.59 (b)	505	10.42 ± 0.56 (b)
P5	26.87 ±1.71	1.74 ±0.01 (a)	4.65 ±0.19 (b)	15.06 ±0.03 (a)	3.31 ±0.11	52.32 ±0.46 (b)	480	11.39 ± 0.47 (c)
<i>p-value</i>	0.067	0.0005	0.0005	0.0005	0.231	0.025		0.0005

Description: The mean ± standard deviation (SD) of the four replicates. The difference in superscripts in one column showed that there is a significant difference (P<0:05).

#### Acceptance of frozen brownies

Figure 1 show the acceptance rate of frozen brownies. The best-frozen brownie products were accepted by the adult respondents. Generally, the subjects were within the age range of 20-59 years and consisted of 9 boys and 52 girls. The group also contain 31 young adults aged 20-30 years, 18 middle adults aged 40-50 years, and 12 late adults aged 50-59 years. At the overall preference level, the young adults scored higher than the middle and late adulthood. On the aroma parameter score, the highest value was obtained from the middle adults. Furthermore, the late adults had lower scores than the middle and late groups, as shown in Figure 1a. Furthermore, the data showed that the acceptance rate for consuming a one-serving product was 80.64% in young adults, 66.66% in middle adulthood, and 50% in late adulthood individuals. The older ages had lower acceptance rates compared to the young and middle adults, as shown in Figure 1b.

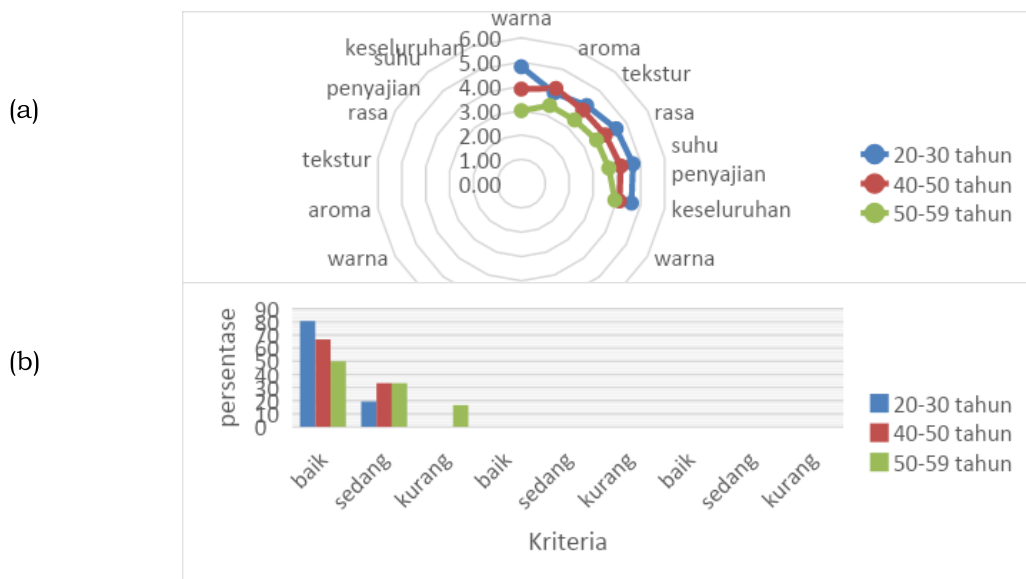


Figure 1. The acceptance rate of frozen brownies Level of preference (a) and acceptance (b) of adults towards frozen brownies

#### β-sitosterol

The best β-sitosterol content in the frozen brownies was 912.6833 mg/kg, while the control was 161.7127 mg/kg

## Discussion

Sensory tests were carried out to determine the preference level of the panelists on the frozen brownies produced in terms of their colour, taste, aroma, texture, and overall acceptance. Furthermore, during the roasting process, a caramelization reaction (burning) occurred, which led to the formation of brown colour on the products. They also lose their moisture content due to drying, which causes colour changes [15]. Fat replacer of pineapple puree affected the panelists' preference for frozen brownies differently. The addition of different concentrations gives the frozen brownie a pineapple taste. Substitution of the margarine fat with pineapple puree causes a sweet taste in the product. This is caused by the sugars present, namely 2.32% glucose, 1.42% fructose, and 7.89% sucrose [16]. The respondents preferred the P5 group to the other products. Furthermore, the overall acceptance was due to the assessment of the organoleptic parameters, such as colour, taste, aroma, and texture. 50 g of frozen brownies with a 50:50 ratio of pineapple puree: margarine met 10% of the Indonesian recommended adult dietary allowance (RDA) in terms of protein, carbohydrates, fat, energy, and fibre. The fat adequacy level of the best formula was 12.5% lower than the regular brownies. It also has a high fibre content of 3.31 g/100g, hence, it can be recommended as a healthy food.

The Indonesian Food Composition Table, 2018 stated that the water content of pineapple fruit and margarine are 88.9% and 16%, respectively. This indicates that a high proportion causes an increase in the water content of the product. These compounds reduce the amount of moisture that can be evaporated during the steaming process [17]. Based on data [18], wheat flour contains 9% protein and 3.92% mosep flour [3]. The protein content of the products increased along with the concentration of the fat replacer. A high proportion of pineapple puree as well as a decrease in the margarine can significantly reduce the fat content in frozen brownies. Furthermore, the two types of ingredients have very different content. [18]) stated that pineapple contains 0.3% fat and 81.6% in margarine. The fat content in "Blueband" margarine is 66.67%, while dark chocolate and egg yolks have a total of 36% and 34%, respectively [19].

The use of mosep flour increased the content of the frozen brownies, where the model flour and food fibre contains a total of 5.26% and 28.58% fibre, respectively [3]. Meanwhile, a value of 0.3% was obtained from the wheat flour [18]. The decrease in caloric value was caused by the decrease in the amount of fat used. It was the nutrient that produced the highest energy of 9 kcal/gram compared to carbohydrates and protein, where a value of 4 kcal/gram was recorded [20]. Ingredients that can affect the energy produced by fat include margarine, dark chocolate compounds, and egg yolks. The higher the pectin and fibre content in the frozen brownies, the higher the hardness. This finding indicates that at the 50% pineapple puree, a high value was obtained.

The best treatment of chemical parameters (proximate analysis) and organoleptic, the P5 with pineapple puree and margarine ratio of 50: 50 had the highest value compared to others. There is no SNI (Indonesian National Standard) quality standard requirement for brownies. The best water content obtained in this study was lower compared to the results in [21] and [22] where values of 31.94% and 24.51% were recorded, respectively. Subsequently, the protein obtained was higher by 3.81% compared to that of [21]. The best fat content was lower than that of [21] and [22] by 18.42% and 26.56%, respectively. Meanwhile, the final products in this study contain the same amount of water, protein ash, carbohydrates as well as low fat and high fibre of 3.31%. The best-frozen brownies with pineapple puree were labelled reduced-fat. This is in accordance with the statement in [8]) that the criteria for a product to be placed in the category is when the total fat in the product is 25% lower than the original/similar variant. Pineapple puree can be used as a fat replacer for margarine in frozen brownies because the most preferred product was P5 with the formulation of pineapple puree and margarine at 50: 50.

The late adulthood group has a lower perception compared to the other categories. Moreover, their vision declines [23] due to yellowing of the eye lens. They also lose part of their sense of taste and/or smell [24]. These brain functions are reduced in healthy older adults at a faster rate compared to their less healthy counterparts [25]. The best content of  $\beta$ -sitosterol in the frozen brownies was higher than that of the control. Natural phytosterols within the usual dietary intake range of 150-450mg/day had a negative correlation with cholesterol absorption. Diets rich in this compound can also limit cholesterol absorption and lower serum levels by competing for intestinal absorption. Additionally,  $\beta$ -sitosterol is the main sterol present in vegetable oil [26].

## 4 Conclusion

The results showed that the proportion of fat replacer has a significant effect ( $p < 0.05$ ) on the sensory value of the product acceptance. The physical characterization of the frozen brownies' hardness level ranged from 8.74 to 11.39 (kgm/s<sup>2</sup>), and it had a significant effect with a p-value of 0.0005. The proportion of the pineapple puree also has a significant effect on the organoleptic test of the product's nutritional content, such as ash, protein, fat, and carbohydrates. The energy content in the formulation of fat replacer ranged from 480 – 603 kcal/100g. The best-frozen brownies had a pineapple puree and margarine ratio of 50:50. It also contains 912.6883mg/kg of  $\beta$ -sitosterol, which was higher than that of the control, namely

161.7127 mg/kg. Furthermore, 50g of the product met 10% of the Indonesian recommended dietary allowance (RDA) for people in terms of protein, carbohydrates, fat, energy, and fibre. The fat adequacy level of the best product was 12.5% lower, and it also has a high fibre content than others, hence, it can be recommended as a healthy food.

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## 6 Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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