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Effect of strawberry fruit substitution (Fragaria x ananassa) on organoleptic, proximate levels and dietary fiber levels for diabetes mellitus patients

Efek subsitusi buah stroberi (Fragaria x ananassa) terhadap organoleptik, kadar proksimat dan kadar serat snack bar untuk penderita diabetes mellitus

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Abstract

Strawberry is a nutritious food, but the variety of processed foods is still limited; therefore, innovation is required to develop a wider range of strawberry-based products. This study aimed to analyze the effect of strawberry substitution on the characteristics of snack bars. The experimental design employed a completely randomized design (CRD) with three levels of strawberry fruit substitution on the flour: F0 (without strawberries), F1 (25%), F2 (50%), and F3 (75%). All snack bar ingredients were mixed until it became a smooth dough, then baked at 180°C with a low heat setting for 30 minutes. The study was conducted in March-June 2022, with 35 respondents. The organoleptic test data were analyzed with the Kruskal Wallis test and the Mann-Whitney test (data was not normal), the proximate content and dietary fiber were analyzed with a t-test. The result, the organoleptic test revealed that the snack bar with the selected formula was F1 (25%) with proximate results of 5,65% water content, 0,45% ash content, 2,7% protein, 13,93% fat, 27,26% carbohydrates, and food fiber content of 5,68%. Based on the proximate test and dietary fiber content, there was no statistically significant (p= 0,112) difference between the control and F1 formulas. In conclusion, strawberry fruit substitution affects the characteristics of snack bars.
Keywords: Blood sugar, fiber, food, health

Abstrak

Stroberi merupakan makanan bergizi, namun variasi makanan olahannya masih terbatas; oleh karena itu, diperlukan inovasi untuk mengembangkan produk berbahan dasar strawberry yang lebih luas. Tujuan penelitian untuk menganalisis pengaruh substitusi strawberry terhadap karakteristik snack bar. Metode yang digunakan adalah Rancangan Acak Lengkap (RAL) dengan tiga dosis substitusi buah stroberi terhadap tepung terigu: F0 (tanpa stroberi), F1 (25%), F2 (50%), dan F3 (75%). Semua bahan *snack bar* dicampur hingga menjadi adonan yang kalis, dan dipanggang dengan suhu 180^{0}C selama 30 menit. Penelitian dilakukan pada bulan Maret-Juni 2022, dengan jumlah responden sebanyak 35 orang. Data uji organoleptik dianalisis dengan uji Kruskal Wallis dan uji Mann Whitney (data tidak normal), kadar proksimat dan serat pangan dianalisis dengan uji-t. Hasil, uji organoleptik menunjukkan snack bar dengan formula terpilih adalah F1 (25%) dengan hasil proksimat kadar air 5,65%, kadar abu 0,45%, protein 2,7%, lemak 13,93%, Karbohidrat 27,26%, dan kadar serat pangan 5,68%. Berdasarkan uji aproksimasi dan kandungan serat makanan, tidak terdapat perbedaan yang bermakna secara statistik

(p=0,112) antara formula kontrol dan formula terpilih. Kesimpulan, substitusi buah stroberi berpengaruh terhadap karakteristik snack bar.
Kata Kunci: Gula darah, kesehatan, makanan, serat

Introduction

Diabetes Mellitus (DM) is a non-communicable disease that remains a problem in Indonesia. According to (Karuranga et al., 2017), diabetes can occur when there is an increase in blood glucose levels, also known as hyperglycemia, and the body cannot produce enough insulin or effectively use insulin. Type 2 diabetes is characterized by insulin resistance and decreased insulin production and is accompanied by low-grade chronic inflammation in peripheral tissues (muscle, adipose tissue, and liver) (PERKENI, 2021). The number of type 2 diabetes patients in Indonesia is expected to increase from 8,4 million in 2000 to 21,3 million in 2030, according to the World Health Organization. The number of DM patients will increase from 10,7 million to 13,7 million between 2019 and 2030, as predicted by the International Diabetes Federation (IDF).

An irregular consumption pattern is one of the causes of the high prevalence of diabetes mellitus. Foods with a high glycemic index can raise blood glucose levels, resulting in various diabetes-related complications (Suloi et al., 2020). Some researchers suggest that low-glycemic foods can increase insulin sensitivity in the body system (Olagunju et al., 2022). After consuming foods or fruit with a low glycemic index, people with diabetes can maintain normal blood sugar levels (Mayawati & Isnaeni, 2017). Strawberries are one of the foods with a low glycemic index, as they have a glycemic index of 40.

The Central Statistics Agency (or BPS) estimates that Indonesia produced 8.350 tons of strawberries in 2020. Compared to the previous year, this number increased by 10,17%. West Java Province produced 5.955 tons of strawberries by itself, making it the province that produces the most strawberries. Binawan Agro is one of the agrotourism operations that cultivate strawberries in the Cianjur, West Java highlands. Despite rising strawberry yields, there has been no development and processing of strawberries into a marketable product at Binawan Agro. It causes the harvested strawberries to be numerous and damaged, decreasing their market value.

Strawberries have a short shelf life and are perishable. Consequently, the processing is necessary to extend shelf life and preserve nutritional value (Aminah, 2019). One method of processing strawberries is to transform them into snack bars. Snack bars are snacks or snacks in the form of bars made from a mixture of various dry ingredients, can satisfy consumer demand, are convenient for consumption, and can quickly alleviate hunger (Basuki et al., 2013). Highly qualified foods have essential nutrients for health, one of which is bars formulated according to existing regulations (Green et al., 2017). Nutritious snacks should potentially prevent disease, be delicious, flavorful, attractive and easy to carry (Kahlon et al., 2016). Strawberry fruit is used as a snack bar because its high fiber content provides a satiating effect that can help people with diabetes delay hunger.

Dietary fiber, also called dietary fiber, is a component of plant matter resistant to enzymatic digestion. Dietary fiber has a function for health, one of which is by binding carbohydrates and slowing the absorption of glucose so that it helps lower blood sugar levels (Dhingra et al., 2012). Dietary fiber can be found in fruit and vegetables, and food fiber can be undamaged when processing (Mustofa & Suhartatik, 2020). Strawberries contain 2 grams of dietary fiber per 100 grams of fresh fruit. Strawberries' fiber content benefits a diet by providing a satiating effect with relatively few calories. Additionally, strawberries' high fructose or fruit sugar content can help people with diabetes maintain their normal blood sugar levels (Cassidy et al., 2018).

In this study, wheat flour was substituted for strawberries because people with diabetes required a carbohydrate restriction. Strawberries were replaced with wheat flour because the amount of carbohydrates in wheat flour was higher than in strawberries. Frequently, people with diabetes experience hunger because there is insufficient insulin available for energy. Eating food in small portions is necessary to prevent impaired glucose metabolism (Centofanti et al., 2018; Puspaningtyas et al., 2022). Snack bars are suitable because they can be consumed as snacks and provide a feeling of fullness. Snack bar

products should be able to meet 10–15% of the snack needs of people with diabetes. It will help them avoid hunger (Hamidah et al., 2019; Nurdin et al., 2022). In this research, the researcher wished to determine the effect of wheat flour and strawberry substitution on the organoleptic properties, proximate content, dietary fiber, and nutritional value of snack bar products.

Methods

This research employed an experimental study to determine which strawberry snack bar offered the highest quality. This study was conducted between March and June of 2022. In the Culinary and Dietetics Laboratory of Binawan University.

The process of producing strawberry snack bars and organoleptic testing were conducted. Proximate analysis and fibre content were conducted at the Saraswanti Indo Genetech Laboratory (SIG) in Bogor. This study employed a straightforward completely randomized design (CRD) with one control and three treatment formulations.

The first step in producing a snack bar was preparing all the ingredients, which included crushed strawberries, wheat flour, oats, sugar, butter, eggs, and vanilla. All ingredients are combined until it creates a smooth dough. To make snack bars, prepare all the ingredients, substituting flour for F0 (control), wheat flour for F1 (25% strawberries), F2 (50% strawberries) and F3 (75% strawberries). Mix the dough until it is smooth using a food processor, then line a rectangular baking sheet with parchment paper, add the dough, and press it until it is solid. Bake at 180°C with a low heat setting for 30 minutes. After cooking, allow it to cool in the pan for 20 minutes, then remove it and place it in the refrigerator overnight before slicing it into pieces.

Table 1. Formulation of *snack bar*

Ingredients (g)	Control (F0)	F1 (25%)	F2 (50%)	F3 (75%)
Strawberry	0	12,5	25	37,5
Wheat flour	50	37,5	25	12,5
Oatmeal	50	50	50	50
Low-calorie sugar	5	5	5	5
Butter	50	50	50	50
Egg	30	30	30	30
Baking powder	1,25	1,25	1,25	1,25
Vanilla	5	5	5	5
Total	191,25	191,25	191,25	191,25

This study utilizes primary data, which consists of organoleptic data (hedonic and hedonic quality), proximate data, and dietary fiber. Organoleptic data were collected using organoleptic test questionnaires, and laboratory results provided proximate data and dietary fiber. In this study, six- and eight-semester nutrition students at Binawan University who had taken 35 Food and Nutrition Technology courses served as semi-trained panelists, and the subject was chosen randomly.

The data were processed using Microsoft Excel 2010 and computer statistical data processing software. The data of organoleptic results were analyzed for normality with Kolmogorov Smirnov, and the result showed that the data were not normally distributed (p>0,007); therefore, the data analyzed by Kruskal-Wallis to see the differences of the treatments; and further analyzed using Mann Whitney. The proximate and fiber content data from the control and chosen formulas were analyzed using Independent Simple T-test. This research has been granted ethical approval for this study from The Health Research Ethics Committee, Faculty of Medicine, University of Indonesia – Dr. RSUPN. Cipto Mangunkusumo (KET-636/UN2.F1/ETIK/PPM.00.02/2022).

Result and Discussion

According to the results of the hedonic test in Table 2, regarding the color of the strawberry snack bar, F1 (25% strawberries) received the highest preference value for color, 3,49 (likes). In contrast, F0 received the lowest favorite value,

2,5 (disliked). According to the results of the Kruskal-Wallis test, the formulation affected the color appearance significantly. According to the results of the hedonic quality test (table 2), F0 (control) is yellow, F1 is brownish yellow, and both F2 and F3 are light brown. The aroma aspect of the organoleptic hedonic test presented in Table 1 reveals that the strawberry snack bar containing F1 (25% strawberries) has the highest preference value of 3,51 (likes). In comparison, F2 (50% strawberries) has the lowest favorite value of 2,50. According to the results of the Kruskal-Wallis test, the formulation affected the aroma. Based on the results of the hedonic quality test (table 2), F0 and F1 have a strawberry flavor that is not very strong, while F2 and F3 have a pretty strong strawberry flavor.

In Table 2, the results of the organoleptic taste test reveal that F3 has the highest preference value, 3,77 (like), while F0 has the lowest preference value, 3,26 (dislike) (slightly like). The Kruskal-Wallis test revealed that the formulation affected the flavor. According to the results of the hedonic quality test (table 2), F0 (control) has a slightly sweet taste, while F1 (25% strawberries), F2 (50% strawberries), and F3 (75% strawberries) have a sweet taste. As the organoleptic results of the hedonic test (table 1) showed, F0 had the highest preference value of 3,60 (like), while F4 had the lowest favorite value of 2,89 (disliked). According to the results of the Kruskal-Wallis test, the formulation affected the texture. Table 2 shows the results of the hedonic quality test. F0 has a crunchier texture than F1, F2, and F3.

Table 2. The results of the strawberry snack bar hedonic test

Formula	Aspect			
	Color	Aroma	Flavor	Texture
F0 (0%)	2,50 ± 0,951^{b}	2,66 ± 1,187^{b}	3,26 ± 0,78^{b}	3,60 ± 0,976^{b}
F1 (25%)	3,49 ± 0,818^{a}	3,51 ± 0,818^{a}	3,74 ± 0,657^{a}	3,34 ± 0,968^{a}
F2 (50%)	3,29 ± 0,860^{a}	3,49 ± 0,981^{a}	3,71 ± 0,860^{a}	2,89 ± 1,183^{a}
F3 (75%)	3,29 ± 0,926^{a}	3,49 ± 0,951^{a}	3,77 ± 1,060^{a}	2,89 ± 1,022^{a}

Note: The scale ranges from 1 (extremely dislike) to 5 (extremely like). Different letters in the same column displayed statistically significant differences (Kruskal Wallis, p<0,05).

Table 2. The results of a strawberry snack bar hedonic quality test

Formula	Aspect			
	Color	Aroma	Flavor	Texture
F0 (0%)	2,20 ± 0,719^{a}	1,97 ± 0,822^{a}	3,46 ± 0,505^{a}	2,09 ± 0,702^{a}
F1 (25%)	2,97 ± 0,707^{b}	2,31 ± 0,832^{a}	3,77 ± 0,690^{a}	2,60 ± 0,497^{ab}
F2 (50%)	3,74 ± 0,657^{c}	2,63 ± 0,843^{b}	3,89 ± 0,676^{b}	2,29 ± 0,667^{a}
F3 (75%)	4,23 ± 0,598^{a}	2,89 ± 1,051^{c}	4,03 ± 0,707^{a}	2,14 ± 0,845^{a}

Note: Color scale 1 = very yellow, 5 = very brown; fragrance scale 1 = no strawberry aroma, 5 = very strong strawberry aroma. 1 = extremely bitter, 5 = extremely sweet; 1 = very crunchy, while 5 = extremely hard. Different letters in the same column displayed statistically significant differences (Kruskal Wallis, p<0,05).

Along with adding strawberries, there is a change in color from yellow to dark brown. It can occur because of the Maillard reaction, in which flour reacts with sugar to produce a browner hue (Midlanda et al., 2014). In terms of aroma, the snack bar will be more strawberry scented after the addition of strawberries. Novia (2018) states that a product's aroma is affected by its constituent ingredients.

In terms of flavor, adding strawberries makes the snack bar sweeter because 100 grams of strawberries contain 4,89 grams of sugar, which significantly increases the sweetness of the snack bar.

Meanwhile, wheat flour only contains 0,18 grams per 100 grams. Mikasari et al. (2013) state that the taste of each food product varies according to its ingredients and processing method. Regarding texture, panelists prefer the strawberry snack bar, which has a slightly crunchier texture than other formulations. Low friability is desirable for snack bars (Coello et al., 2022). Friability is also essential for choosing the optimal formulation (Kumar et al., 2018). It is because eggs, baking powder and flour can also affect the texture of bars (Novia 2018). Also, the amount of carbohydrates used can affect the texture of snack bars (Heenan et al., 2012).

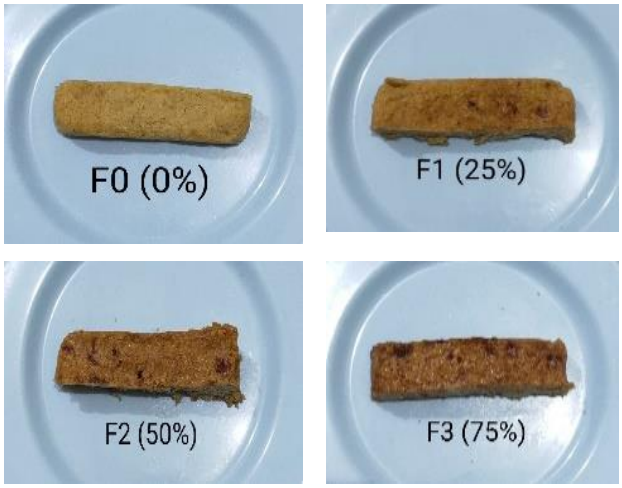

Figure 1. Snack bar appearance

The selected formulation was determined based on the results of the hedonic test, which measured preference, color, aroma, flavor, and texture. According to the results of the hedonic test, the F1 snack bar (25% strawberries) received the highest preference scores for color (3,49), aroma (3,51), flavor (374), and texture (3,34), all of which fall under the category of "like".

According to Table 4, the water content of the control formula was determined to be 7,38%, while the selected formula contained 11,30%. According to the test results (Independent Sample t-test), there was a significant difference between the water content of the control and selected formulas. With the addition of strawberries, the total amount of liquid increases. Low water content is significant in improving the keeping quality of a product (Momanyi et al., 2020). Less than 14% water content is safe for food ingredient storage (Winarno, 2008). Based on this, the strawberry snack bar with a total moisture content of 11,30% is safe for storage.

Table 4. Results of proximate analysis and dietary fiber

Component	Control Formula (%)	Selected Formula (&)	p-value
Water content	7,38	11,3	0,038*
Ash content	0,93	0,9	0,000*
Protein content	5,49	5,4	0,713
Fat content	27,95	27,86	0,231
Carbohydrate content	58,2	54,52	0,002*
Fibre content	10,46	11,36	0,113

* Significant difference (p<0,05)

Table 3. The energy and nutrient content of the snack bar per 50 grams, as well as its RDA contribution

Nutrients	Energy and nutrient content (per 50 grams)		% RDA*		Commercial *Snack Bar* (25 gram)
	Control	Selected Formula	Control	Selected Formula	
Energy (Cal)	253,26	245,24	5,88	5,70	4,19
Protein (g)	2,74	2,70	1,44	1,12	5,01
Fat (g)	13,97	13,93	5,21	5,19	3,73
Carbohydrate (g)	29,1	27,26	2,33	2,09	4,31
Food fibre (g)	5,23	5,68	4,35	4,73	3,33

According to Table 4's analysis of the ash content, the control formula is 0,93%, whereas the selected formula is 0,9%. The different test (Independent Sample t-test) revealed a significant difference in the water content between the control and selected formulas. The decrease in ash content may be attributable to adding strawberries to the selected formula, which increased the snack bar's water content from 12,5 grams to 11,25%. Increased water content is associated with the growth of microorganisms, which also require minerals and carbohydrates to survive (Pramusita et al., 2017).

Table 4 shows the protein content analysis results for the control formula are 5,49%, while the results for the selected formula are 5,4%. Based on the different test results (Independent Sample t-test), there was no significant difference in the protein content

of the control formula strawberry snack bar. Strawberry snack bars have a lower protein content (1,12%) than commercial snack bars. Commercial snack bars have a lower protein content (5%). It resulted from the reduction in wheat flour and the addition of strawberries. One hundred grams of strawberries contain 0,67% protein, while 100 grams of wheat flour contain 10,33% protein; consequently, the protein content of snack bars is lower (USDA, 2018).

The analysis of fat content in Table 4 reveals that the control formula has a fat content of 27,95%, while the selected formula has a fat content of 27,86%. According to the results of a different test (Independent Sample t-test), there was no significant difference between the fat content of the control and selected strawberry snack bars. According to the quality requirements of the Indonesian National Standard (SNI) 01-4216-1996, the snack bar contains between 1,4 and 14% fat. Adding strawberries raises the snack bar's fat content to 5,19%, which falls within the SNI range.

In Table 4, the analysis results of the carbohydrate content analysis for the control formula are 58,2%, whereas, for the chosen formula, it is 54,82%. According to the results of the different tests (Independent Sample t-test), there was a significant difference between the water content of the control formula and the selected variables' water content. It can be attributed to the addition of strawberries, which per 100 grams contain significantly fewer carbohydrates (7,68 grams) than wheat flour (76 grams), and thus contribute less to the carbohydrate content of strawberry snack bars. The decrease in the snack bar's carbohydrate content is associated with increased water content (Pramusita et al., 2017).

The results of the fiber content analysis for the control formula were 10,46%, while the selected formula had 11,36%. Based on the results of a different test (Independent Sample t-test), there was no significant difference between the dietary fiber content of the control and selected strawberry snack bar formulations. The snack bar's high fiber content is due to the addition of strawberries, which are high-fiber fruits. The dietary fiber content protects against chronic disease (Sousa et al., 2019). It is also essential in preventing and treating diabetes (He et al., 2022). Strawberry snack bars qualify as a source of dietary fiber because they contain at least 3 grams of fiber per 100 grams of the solid form (BPOM, 2022).

Table 5 shows that the control formula has nearly identical amounts of energy, protein, and fat to 25% of strawberries substitution. Even though the quantity of carbs and dietary fiber tends to be higher in snack bars with a strawberry content of 25%, this is possible as strawberries have more fiber than wheat flour. The strawberry snack bar control formula contains 253.26 calories, 2.74 grams of protein, 13,97 grams of fat, 29.1 grams of carbohydrates, and 5,23 grams of dietary fiber per 50 grams. Regarding the 50g strawberry snack bar, the chosen formulation contains 245,24 kcal of energy, 2, 7 g of protein, 13,93 grams of fat, 27,26g of carbohydrates, and 5,68 g of dietary fiber. In this study, the snack bar with strawberry substitute has a serving size of 50g, which accounts for 10% of the diabetic snack calorie requirement of 2150 kcal. 10-15% of the daily nutritional adequacy rate is recommended for diabetics' snacking needs (PERKENI, 2021).

Conclusion

There is an effect of substituting strawberry flour for wheat flour in snack bars. Formula F1 (25% strawberries) has a higher favorability score than the other formulations in the category of likeability and acceptability of snack bars that have been substituted with strawberry fruit. Therefore, the fiber and proximate content of the control and F1 snack bars were not significantly different.

The F1 snack bar with a serving size of 50 grams contains 245,24 kcal of energy, which is equivalent to 11% of the snack needs of diabetics, 2.7 grams of protein, 13.93 grams of fat, 27,26 grams of carbohydrates, and 5,68 grams of dietary fiber.

In this study, the amount and antioxidant activity of snack bar products were not analyzed, hence the potential impact of snack bar products on the inflammation that typically occurs in people with diabetes could not be determined. Therefore, conducting the antioxidant test before intervention would be preferable.

For future research, it is anticipated that the shelf life of the product should be examined

to determine its age and proper storage method. It is also necessary to ensure food safety and its relationship with the fiber content of stored foods and need to calculate wheat flour consumption concerning carbohydrate restriction for diabetic patients.

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