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BOBIKU BROWNIE FROM YELLOW SWEET POTATO FLOUR AS A HIGH-FIBER SNACK

Meilinasari[1*], Nanda Syura Putri P[1], Muntikah[1], Fairuz Dhia Rabbani[1]

[1]Department of Nutrition, Health Polytechnic Ministry of Health Jakarta II, Hang Jebat III Rd. Number 29, South Jakarta, 12120

*E-mail: srmeilina07@gmail.com

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ABSTRACT

Diabetes mellitus (DM) is a non-communicable disease that is still a problem in Indonesia, with 19.5 million people aged 20 – 79 years in Indonesia suffer from it. Fiber is known to produce short-chain fatty acid which is beneficial for people with DM. Bobiku brownie with yellow sweet potato flour and stevia sweetener is an alternative snack for people with DM to meet the recommendations regarding fiber consumption. This study aims to determine the effect of the amount of yellow sweet potato flour used on the organoleptic quality and preference level of Bobiku brownies as a high-fiber snack. This research was experimental with completely randomized design by using 3 treatments and 3 replications. Organoleptic test was conducted by panelists. Energy and nutrient analysis were conducted a Saraswanti Indo Genetech Laboratory. The organoleptic test analysis results showed that different amount of yellow sweet potato flour used affected the aroma, texture, and preference level of Bobiku brownies (p<0.05). However, different amounts of yellow sweet potato flour used did not affect color and taste of Bobiku brownies. The product that panelists liked most was the brownie with 50 g of yellow sweet potato flour and 50 g of wheat flour. One serving (75 g) of brownies contained 228 kcal of energy, 7.6 g of protein, 6.14 g of fat, 34.7 g of carbohydrates, and 6.54 g of fiber. In the future, it is necessary to test the preference level on panelists who suffer from diabetes.

Keywords: *brownies, yellow sweet potato flour, fiber*

INTRODUCTION

Type 2 diabetes mellitus is a metabolic disorder characterized by high blood glucose levels (hyperglycemia) and insulin levels (hyperinsulinemia), also known as insulin resistance. The term insulin resistance is used to explain why the blood glucose level remains high despite no decrease in insulin production or deficiency.(1) The root cause of insulin resistance is still unknown, but it is suspected that excessive consumption of refined sugar and starch may cause hyperinsulinemia which leads to insulin resistance and Type 2 DM.

Globally, according to the International Diabetes Federation (IDF), the prevalence of Type 2 DM in adults reached 536.6 million people (10.5%) in 2021 and it is estimated that there will be 783.2 million adults with Type 2 DM globally by 2045.(2) Meanwhile, in Indonesia, IDF stated that there were 19.5 million people aged 20 – 79 years who suffered from diabetes with 14.3 million of them (73.7%) had never received an official diagnosis from doctors or only 5.2 million diabetics were diagnosed by doctors.(3) It puts Indonesia as the 5th most diabetic country in the world after the United States. The prevalence of diabetes diagnosed by doctor increased when compared to data from Riskesdas 2018 that as many as 713.783 Indonesians aged ≥15 years were diagnosed with diabetes mellitus.(4)

Adequate fiber consumption can improve blood sugar control in diabetics and even reduce plasma cholesterol levels.(5) However, the result of research on Type 2 DM patient at Puskesmas Payung Rejo, Central Lampung proved that the average fiber intake of Type 2 DM patients was still below the recommendation, which was only 10.4 g from the 20 – 25 g per day as PERKENI recommended.(6),(7) Fiber will be fermented in the colon by microbiota to produce short chain fatty acids (SCFA) including acetate, propionate, and butyrate. SCFAs act as modulator of gut-related hormones, one which is glucagon like peptide (GLP-1) that increases insulin secretion, inhibits pancreatic beta cell apoptosis, and improves peripheral insulin sensitivity. SCFAs have metabolic effects in influencing glucose storage in muscle, liver, and fat tissues.

Brownies are one of the sweets that are favoured by the Indonesian people. Indonesians' fondness for sweets and breads such as brownies is proved by 2020 Food Consumption Statistics, increases in the consumption of sweet breads, pastries, and traditional cakes happened since 2016 and in 2020.(8) Developing brownies by utilizing

yellow sweet potato flour and sweetener from stevia can encourage diabetics to increase their fiber intake while satisfying cravings for sweet foods that are often experienced by people with DM.

Yellow sweet potato (*Ipomoea batatas L*) contains a variety of nutrients ranging from fiber to beta carotene and even complex carbohydrates with a fairly low glycemic index of 54. Food with low glycemic index will prevent blood sugar spikes after meals, making them suitable for improving blood sugar control in diabetics. Research by Pradana et al. revealed that purple and yellow sweet potato juices can significantly reduce blood sugar levels in hyperglycemic mices.(9) Yellow sweet potato has higher fiber content, about 4.2 g per 100 g of sweet potato, when compared to other types of sweet potatoes such as white sweet potato at 4 g per 100 g of sweet potato, red sweet potato at 0.7 g per 100 g of sweet potato, and cilembu sweet potato at 3.4 g per 100 g sweet potato. Research by Puspita et al. showed that fiber from sweet potatoes acted as a prebiotic and significantly increased the concentration of *Lactobacillus* and *Bifidobacterium* bacteria in rats.(10) Yellow sweet potato also contains beta carotene at 794 mg per 100 g which is a precursor of vitamin A and antioxidant in fighting the reactive oxygen species (ROS). Higher intake of beta carotene is known to be associated with lower risk of Type 2 DM.(11) Antioxidants play a role in preventing cell damage due to reactive oxygen species (ROS) that increase due to inflammation associated with insulin resistance and also preventing the inflammations to worsen. In addition, yellow sweet potato has the starch structure that is similar to wheat flour, so it can be used to reduce the risk of failure in substituting wheat flour. Stevia leaf (*Stevia rebaudiana*) is a low-calorie sweetener that is stable with heat up to 200°C and 250 – 300 times sweeter than sucrose.

This study aims to produce high-fiber brownie products from yellow sweet potato flour as an alternative snack for people with DM and to determine the effect of using different amounts of yellow sweet potato flour on the organoleptic quality and preference level towards the brownies.

METHODS

This research was an experimental study with the complete randomized design (CRD) method to formulate the ratio of yellow sweet potato flour to wheat flour in the brownies based on the calculation of fiber requirements and the results of organoleptic tests conducted.

The main research which included making yellow sweet potato flour, making Bobiku brownies, and organoleptic tests was carried out in May 2022 at the Food Laboratory and Taste Test Laboratory of the Nutrition Department of the Health Polytechnic MOH Jakarta II. Analysis of energy, macronutrients, and fiber content in Bobiku brownies were carried out at the Saraswanti Indo Genetech (SIG) Laboratory.

Based on the recommendation from PERKENI (Indonesia Endocrinology Society) and conversion according to the snack portion, the results showed that the fiber requirement that needed to be met from the brownies was 6 g. Based on the calculation, 1 g of yellow sweet potato flour contains about 0.134 g of fiber. The researchers finally decided to test three ratios for the brownies, which were T1 (50 g of yellow sweet potato flour and 50 g of wheat flour), T2 (55 g of yellow sweet potato flour and 45 g of wheat flour), and T3 (60 g of yellow sweet potato flour and 40 g of wheat flour).

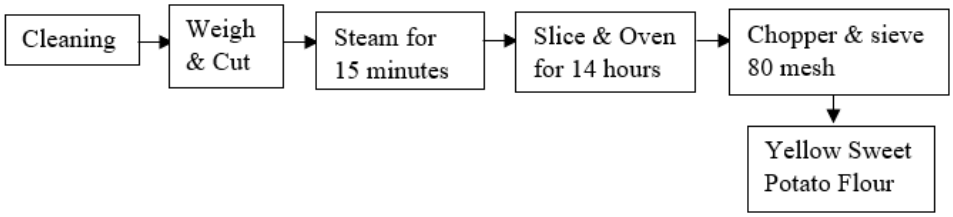

Figure 1 The Scheme of Yellow Sweet Potato Flour Production

The independent variable in this study is the treatments in the form of brownies with different ratios of yellow sweet potato flour and wheat flour. Each ratios were replicated 3 times, so there were 9 experimental units. To make Bobiku brownies, in addition to the yellow sweet potato flour, there were several additions, which were 'Segitiga Biru' wheat flour, 1 g of stevia leaf powder, 30 g of 'The Belgian' 70 % dark chocolate, 5 g of 'Tropicana Slim' corn sugar, 100 g of eggs, 5 g of 'Blueband' margarine, and 3 g of 'Kupu-Kupu' baking powder. It begun with preparing and weighing the necessary ingredients, including wheat flour and yellow sweet potato flour according to the predetermined ratios. The dark chocolate and margarine would be melted and mixed. Beat the egg until stiff and mixed the dry ingredients and melted dark chocolate into the egg, then stir until the batter was evenly mixed. Pour the Bobiku brownie batter into a baking sheet lined with parchment paper and baked at 140°C for 15 minutes.

The dependent variable in this study is the characteristics tested in the organoleptic test, including color, aroma, taste, and texture, as well as the preference level of panelists. The organoleptic test was conducted by 30 semi-trained panelists who met the inclusion criteria, which were willing and having the time to conduct organoleptic test, not suffering from certain diseases that could interfere with the organoleptic assessment, having an interest in the organoleptic quality of the yellow sweet potato flour brownies, not being hungry or full, and not suffering from color blindness. Exclusion criteria for panellists were suffering from diseases, such as influenza, toothache, or mouth ulcer; not present during the study; and being involved in the making process of the brownies. Panelists filled out the organoleptic form with a score from 1 to 5 for each criterion tested.

The results of the organoleptic test by the panelists were then analysed using the Friedman test to determine whether there was an effect of substitution by using yellow sweet potato flour on the organoleptic quality and preference level of panelists towards the brownies. In addition, the Wilcoxon test was also carried out to determine the significance of differences in color, aroma, taste, texture, and the preference level of panelists towards the Bobiku brownies which were significantly influenced by the different amounts of yellow sweet potato flour used.

RESULTS AND DISCUSSIONS

Regarding the color of Bobiku brownies, most panelists considered that T1 brownies had a brown color (50%) and dark brown (43.3%). About 70% panelists considered that T2 brownies were dark brown and 66.7 % of panelists considered that T3 brownies were dark brown. In this study, different amounts of yellow sweet potato flour used did not significantly affect the color of Bobiku brownies ($p<0.05$). The similar result was shown in the research by Selvakumaran et al. that there was no effect of different amount of orange sweet potato puree on the color aspects of the brownies with orange sweet potato puree.(12) Beta carotene in yellow sweet potato is decomposed due to the drying process at high temperatures, so the intensity of yellow in yellow sweet potato flour tends to decrease.(13) Non enzymatically, the Maillard reaction due to combination of the high temperature used during the drying and baking process, the carbohydrate that breaks down into simple sugars, and the amino acid

groups causing the brownish color of yellow sweet potato flour and produce brown cakes when used.(14)

Table 1 Organoleptic Test Results on Color, Aroma, Taste, Texture, and Preference Level towards Bobiku Brownies

Organoleptic Criteria	Treatements					
	T1		T2		T3	
	n	%	n	%	n	%
Color						
1. Yellowish Brown	0	0	0	0	0	0
2. Light Brown	2	6.7	1	3.3	1	3.3
3. Brown	15	50	7	23.3	6	20
4. Dark Brown	13	43.3	21	70	20	66.7
5. Blackish Brown	0	0	1	3.3	3	10
Aroma						
1. No Typical Sweet Potato Smell	12	40	5	16.7	0	0
2. Slight Sweet Potato Smell	13	43.3	14	46.7	2	6.7
3. Sufficient Sweet Potato Smell	2	6.7	9	30	7	23.3
4. Sweet Potato Smell	0	0	1	3.3	3	10
5. Strong Sweet Potato Smell	3	10	1	3.3	18	60
Taste						
1. Sweet with Strong Bitter Aftertaste	0	0	0	0	0	0
2. Sweet with Bitter Aftertaste	0	0	0	0	0	0
3. Sweet with Sufficient Bitter Aftertaste	7	23.3	4	13.3	2	6.7
4. Sweet with Slight Bitter Aftertaste	14	46.7	14	46.7	16	53.3
5. Sweet Without Bitter Aftertaste	9	30	12	40	12	40
Texture						
1. Very Hard	0	0	0	0	0	0
2. Hard	0	0	2	6.7	2	6.7
3. Slightly Soft	4	13.3	11	36.7	12	40
4. Fairly Soft	20	66.7	17	56.7	16	53.3
5. Soft	6	20	0	0	0	0
Preference Level						
1. Disliked	0	0	2	6,7	3	10
2. Somewhat Liking	2	6,7	5	16,7	8	26,7
3. Sufficiently Liking	13	43,3	13	43,3	12	40
4. Liked	15	50	10	33,3	7	23,3
5. Strongly Liking	0	0	0	0	0	0
Total	30	100	30	100	30	100

Regarding the aroma, 43.3% and 46.7% of panelists said that the T1 and T2 brownies had a slight sweet potato smell and 60% of panelists considered that the T3 brownies had a strong sweet potato smell. The distinctive aroma of yellow sweet potato flour comes from degraded starch and the limiting aromatic amino acids such as lysine, methionine, cysteine, and threonine that undergo Maillard reaction due to the high temperature during the drying

process of sweet potato.(15) In this study, different amounts of yellow sweet potato flour used affected the aroma of Bobiku brownies with a *p*-value of 0.000 and in details, there were differences of aroma in each brownies ($p<0.05$). As the amount of yellow sweet potato flour used increased, the greater the number of panelists who said that the distinctive aroma of sweet potato smelled very strong. A similar result was shown in a study by Heryani and Santi that differences in the amount of yellow sweet potato flour used (25 – 75%) affected the aroma of the putu ayu cake.(16) However, different result was shown in a study by Lee et al. that there was no effect of substituting wheat flour with orange sweet potato flour (20%) on the aroma of the sponge cake.(17)

Table 2 Friedman Test Results based on Color, Aroma, Taste, Texture, and Preference Level towards Bobiku Brownies

Criteria	Treatments	n	Mean	Std. Deviation	Mean Rank	Chi Square	df	*p*-value
Color	T1	30	1.75	.751	1.73	5.067	2	0.079
	T2	30	2.05	.634	2.03			
	T3	30	2.23	.666	2.23			
Aroma	T1	30	1.46	.524	1.48	25.289	2	0.000
	T2	30	1.98	.425	2.00			
	T3	30	2.50	.572	2.52			
Taste	T1	30	1.68	.759	1.68	5.939	2	0.051
	T2	30	2.06	.666	2.08			
	T3	30	2.21	.750	2.23			
Texture	T1	30	2.73	.486	2.73	33.979	2	0.000
	T2	30	1.93	.468	1.87			
	T3	30	1.50	.601	1.40			
Preference Level	T1	30	2.48	.662	2.48	25.118	2	0.000
	T2	30	2.18	.622	2.18			
	T3	30	1.33	.442	1.33			

Note:
Significant if *p*-value<0.05

From Table 1, 46.7% of panelists each rated that T1 and T2 brownies had a sweet taste with slight bitter taste and 53.3% said that T3 brownies also had a sweet taste and slightly bitter aftertaste. The greater the amount of sweet potato flour used, the bitter aftertaste tended to be reduced. Different amounts of yellow sweet potato flour used did not affect the taste of Bobiku brownies in this study ($p>0.05$). A similar result was shown on the research by Mulyadi et al. that different amounts of yellow sweet potato flour used did not affect the taste of the dry noodles.(18) Research by Lee et al. also stated that substitution with orange sweet

potato flour did not have a significant effect on the taste of sponge cake.(19) However, this result was different from the result of research by Herryani and Santi that the different amount of yellow sweet potato flour used affected the taste of putu ayu cake.(16)

Dark chocolate, that is used in the brownies, tends to be more bitter when compared to other types of chocolates because it contains phenolic components, catechins, caffeine, epitechins, flavonoids, and polyphenols from cocoa beans and minimal additions of other ingredients.(20) The sweetness of the brownies comes from the combination of oligosaccharides and raffinose from sweet potato and stevia leaf powder as the sweetener, so that it can be an alternative sweet for diabetics without the threat of blood sugar spikes.(21) Stevia has antihyperglycemic benefits by increasing insulin levels and inhibiting glycogenolysis and gluconeogenesis by absorbing glucose in the duodenum.(22) In addition, steviosides from stevia leaves also act as antioxidants by reducing pro-inflammatory cytokines levels, which affects inflammations and affect blood sugar control for diabetics.(23)

Regarding textures, 66.7%, 56.7%, and 53.3% of panelists stated that brownies T1, T2, and T3 had fairly-soft textures respectively. The texture of the brownies was harder as the amount of yellow sweet potato flour increased and the wheat flour reduced. In this study, the different amounts of yellow sweet potato flour used affected the texture of Bobiku brownies (p=0.000). In details, there were differences of textures between treatments (p<0.05). A similar result was shown in the research by Selvakumaran et al. that different amounts of orange sweet potato puree used did not affect the texture of brownies with 50 and 75 % concentrations.(24) However, it differed from the research by Lee et al. that the substitution of wheat flour with orange sweet potato flour (20%) did not affect the texture of sponge cake.(19)

The soft and fluffy texture of brownies is caused by using eggs that contain lecithin, a protein that causes the air bubbles from the whisking to become more stable, so the brownies become light and soft after it is baked.(25) Baking powder will form carbon dioxide in the pores, so the brownies will be softer. Gluten from wheat flour can hold the carbon dioxide and air bubbles from eggs during the cooking process, so that the texture of the dough becomes soft even after it is cooked.(26) With increasing amount of yellow sweet potato flour

used, the amount of wheat flour and gluten will reduced, so the texture of the brownies will be harder.

Regarding the level of preference, 50% of panelists stated that they like the T1 brownies while 43.3% and 40% of the panelists liked the T2 and T3 brownies. The number of panelists who liked Bobiku brownies decreased along the increasing amount of yellow sweet potato flour used. It could be attributed to the stronger aroma of yellow sweet potato and the harder texture as more sweet potato flour used. The preference level can be influenced by color, aroma, taste, and texture of the products and whether those aspects of the product can be accepted by the public. In this study, different amounts of yellow sweet potato flour used affected the preference level towards Bobiku brownies (p=0.000). In details, there were differences of preference level between the T1 with T3 brownies and T2 with T3 brownies (p<0.05). A similar result was shown in the research by Selvakumaran et al. that different amounts of orange sweet potato puree used affected the preference levels towards the brownies.(24) However, the result was different from the result of research by Lee et al. that there was substituting wheat flour with orange sweet potato flour (20%) did not affect the preference level of the sponge cake.(19)

Table 4 The Analysis Results of Nutrients in Bobiku Brownies (T1)

Parameters	Unit	Laboratory Analysis Results		
		165 g (1 Recipe)	**100 g**	**75 g (1 serving size)**
Water	g	32,63	32,63	32,63
Ash	g	3,4	2,11	1,58
Fat	g	14,3	8,72	6,54
Protein	g	16,9	10,25	7,6
Carbohydrates	g	76,3	46,29	34,71
Energy	kcal	502,5	304,64	228,48
Fiber	g	14,3	8,72	6,54

Energy and nutrients analysis of Bobiku brownies was carried out on T1 brownies which was the most preferred by the panelists. Based on the Nutrition Adequacy Requirement (AKG) in 2019, the requirements for adults who aged 19 – 49 years are 2250 – 2650 kcal of energy, 60 – 65 g of protein, 65 – 75 g of fat, and 340 – 430 g of carbohydrate. One serving of Bobiku brownies weighing 75 g can meet 8.6 – 10.5% of energy requirements, 11.5 –

12.6% of protein requirements, 8.1 – 9.4% of fat requirements, and 8 – 10.2% of carbohydrate requirements of adults aged 19 – 49 years a day.

A total of 100 g of Bobiku brownies contains 8.72 g of fiber. When compared with the recommended fiber consumption for diabetics according to PERKENI 2019 of 20 – 35 g a day or 6 g for a snack (20% of requirement a day), one serving of Bobiku brownies contains 6.54 g of fiber (109%). Bobiku brownies can be claimed as a high-fiber snack because it meets the rules for the inclusion of high-fiber claims based on the Regulation of the Head of BPOM (Food and Drug Administration) Number 13 of 2016, which contains at least 6 g of fiber per 100 g of the product.(27)

Compared to the regular brownies from wheat flour in the stores, 75 g of regular brownies contain 341.2 kcal of energy, 3.3 g of protein, 15 g of fat, 48.75 g of carbohydrates, and 1.65 g of fiber. Bobiku brownies have lower calories, so it can be an alternative for diabetics and consumer who are undergoing calorie deficit. The higher protein content in Bobiku brownies can be related to the use of egg and yellow sweet potato flour. Apart from its functions as binder and giving savory taste, eggs can also increase the protein contents in Bobiku brownies. With a lower fat and carbohydrate and higher fiber content than the regular brownies, Bobiku brownies can be an alternative snack for diabetics since the recommendation is to consume a diet low in saturated fat and simple carbohydrates and high in fiber.(28)

Fiber is known to affect blood glucose levels through two mechanisms. In the digestive tract, water-soluble fiber will absorb water and form a gel that slows down the gastric emptying and absorption of nutrients from food, including glucose, thus preventing blood glucose spike, creating longer satiety, and reducing food intake. In addition, fiber that cannot be digested will be fermented in colon by bacteria that will produce short chain fatty acids (SCFA). SCFA encourages secretions of GLP-1(Glucagon Like Peptide-1), GIP (Gastric Inhibitory Polypeptide), and PYY (Peptide YY) hormones that increase insulin sensitivity and lead to decreased blood glucose levels while improved its control.(29)

Another advantage from Bobiku brownies is that it uses stevia leaves which act as antioxidant in reducing systemic inflammation and is proven to reduce fasting blood glucose and postprandial blood glucose levels by consuming 1 g of stevia leaf powder for 30 and 60

days.(30),(22) In diabetics, stevia lowers blood sugar levels by inhibiting the glycogenolysis and gluconeogenesis, while absorbing glucose in the gut. These advantages make Bobiku brownies as an alternative to satisfy the cravings of diabetics for cakes and sweet foods, without sacrificing their blood sugar control.

During the research, there were several limitations, one of which was the condition of the COVID-19 pandemic which hampered researchers from gathering panelists to conduct organoleptic tests on Bobiku brownies. In addition, there was no organoleptics test conducted by diabetic panelists as the target of Bobiku brownies.

CONCLUSION

From the results of the research, it can be concluded that different amounts of yellow sweet potato flour used affected the aroma, texture, and preference level towards Bobiku brownies. However, different amounts of yellow sweet potato flour did not affect the color and taste of Bobiku brownies. Based on the panelists' assessment, Bobiku brownies with 50 g of yellow sweet potato flour and 50 g of wheat flour is the most preferred brownies with 1 serving size (75 g) contains 6.54 g of fiber and can be categorized as high-fiber snack. For further research, it is necessary to test the preference levels on targets who have diabetes mellitus.

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