Test Effect of Type of Materials and Cooking Process Ipomoea Batatas Spirulina Mix for Diabetes Mellitus Preventive

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Abstract. Management of Diabetes Mellitus is the focus of attention worldwide. Indonesia ranks 7th in the world. Complications can attack all organs of the body and will worsen the patient's quality of life. The objectives of the research are: 1) Acceptability of products related to organoleptic and hedonic tests, 2) Proximate test results, 3) GI level of the product, and 4) Product formula to be recommended. The main ingredients are red sweet potato in flour or porridge form and spirulina. The additional ingredients are cornstarch, flour, eggs, honey, CMC, and margarine. The product formula consists of three kinds of red sweet potato content (40%, 50%, and 60%). Processing of products by frying, steaming, and roasting. Measurements are 1) organoleptic test, 2) hedonic test. 3) proximate test and 4) glycemic index test. Different tests were carried out with the Anova test and Post Hoc test.The statistical test showed a significant difference of 0.000 ($p<0.55$) in each product. The content of carbohydrates, protein, water, and ash with frying, roasting, or steaming is higher in those made from red sweet potato porridge. The production process by steaming produces more crude fiber. All Glycemic Indexes tested were in a low category for the steamed (48.56) and the fried (23.90). So it can be recommended for preventive consumption of Diabetes Mellitus.

Keywords: Diabetes mellitus, Glycemic Index, Red Sweet Potato, Spirulina, Type of Material Effect, Cooking Process Effect

1 Introduction

Diabetes Mellitus is a group of Non-Communicable Diseases (NCDs) and includes degenerative diseases, which are the focus of attention worldwide. According to WHO, DM cases have increased very sharply, so it is estimated that in 2015 among 11 people, there will be one person with diabetes. Indonesia ranks 7th in the world. The impacts, such as treatment for patients for life, will result in a family financial burden [1],[2]. In addition, complications that can attack all organ systems of the body will worsen the quality of life of the patient.

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Lifestyle-related diet is the main factor in the DM cases increases besides other unhealthy living habits [3],[4],[5],[6],[7],[8]. Habits in main meals and snacks consumed with high-carbohydrate, high-fat portions increase blood sugar or Glycemic Index [8]. On the other hand, the results obtained from several local food ingredients are known to have a low glycemic index, including sweet potato flour [9],[10],[11],[12],[13]. The lowering blood glucose effect in sweet potatoes is associated with an increase in Adiponectin, an adipocyte hormone that functions in insulin metabolism [10]. The carbohydrate content of sweet potatoes can be used as a source of calories and has a Low Glycemic Index value (51), which is a type of carbohydrate and will not increase blood sugar levels drastically [14].

The research related to Spirulina (Athrospira Plantesis), a type of blue-green algae or microalgae and is one of the biological resources of marine biota in Indonesia, showed it can break radical chain reactions. It can inhibit oxidative stress in people with Diabetes Millitus [15],[16],[17]. The ingredients selected in this study were red sweet potato and spirulina. They are widely available in almost all agricultural and marine areas in Indonesia. The local food ingredients can be utilized to function optimally. Utilization of local food ingredients is needed for enrichment and diversity of snack foods on the market and improving blood sugar levels so that it can be preventive against DM. The selection of shapes and flavors favored by the community at this time is in the form of bars (stems), with various processing processes (fried, boiled, and burned) to get maximum results. The research problems are: 1) How is the target consumer's acceptance of products related to organoleptic and hedonic tests, 2) How are the results of the proximate test on each product, 3) What is the GI level in the two selected products, 4) Which product formula will be recommended.

The urgency of this study is an increase in DM cases related to the consumption of unhealthy food, the existence of local food ingredients that can be used for preventive purposes and to support the success of treatment for DM sufferers. So it is necessary to test the product.

2 Method

Materials/Ingredients: The main ingredient is red sweet potato, selected based on its nutritional content and good color, then mixed with spirulina. The additional are cornstarch, flour, eggs, honey, baking powder/baking soda, and margarine. The formula for sweet potato content in the initial test consisted of 40%, 50%, and 60%. The laboratories used are the Nutrition Laboratory and the Biology Laboratory of UNNES. While the process of making is carried out together with SME partner "Billis Kaasstengels".

2.1 Product making process

Table 1. Product Formula

No	Ingredients	Formula 1	Formula 2	Formula 3
1.	Red Sweet Potato Flour/Porridge	40 gr (40%)	50 gr (50%)	60 gr (60%)
2.	Spirulina	100 mg	100 mg	100 mg
3.	Cornstarch	14 gr	14 gr	14 gr
4.	Flour	22,5 gr	12,5 gr	2,5 gr
5.	Baking powder/baking soda	0.5 ts	0.5 ts	0.5 ts
6.	Margarine	10 gr	10 gr	10 gr
7.	Honey	1 ts	1 ts	1 ts
8.	Egg	0,5 ts	0,5 ts	0,5 ts

The process begins by mixing all the ingredients according to the formula to become a dough. The product tested initially consisted of six formulas. Three used red sweet potato porridge, three used red sweet potato flour. Each was cooked in three ways. They were fried, roasted and steamed, initial product tested were 18 formulas.

2.2 Organoleptic Test, Hedonic Test, and Proximate Analysis

The organoleptic test was carried out to determine the preferred product, while the hedonic test was to obtain the preferred product (color, texture, taste, aroma, and overall quality). The proximate analysis objective was to get carbohydrate content using carbohydrate by difference [18], protein content using the Micro Kjeldahl method [18], fat content using the Soxhlet method[19], moisture and ash content using the oven[18] method, and analysis of dietary fiber content[20].

Organoleptic tests were carried out on trained panelists aged 25-40 years. Five men and five women. The instrument used a 9-point quality scale. Namely 1 for "very-low quality" up to 9 for "very very-good quality"[21]. The analysis was repeated three times with a 30-minute break. The preference level assessment was carried out to 80 consumer panelists with an acceptance test on a preference scale of 1 to 9 [21],[22].

2.3 Glycemic Index (GI) Assesment

Panelists are adults. For each product, there were five women and five men. Provided that: healthy, not with DM, age 25-40 years, whose Body Mass Index is in the standard category. Panelists undergo a night fast first from 20.00 to 08.00. At the beginning of the activity and for 2 hours, with 30 minutes intervals of giving the product tested, with a carbohydrate content equivalent to 50 grams. A blood sample is taken then blood sugar is checked with a glucose meter. As a standard, blood sugar levels were measured after giving 50 g of pure glucose (anhydrous d-glucose) to the panelists. Measurement of blood glucose levels between the reference food, and the simulated product, was given a 7-day gap for each food. Different tests were analyzed by Anova and Post Hoc tests. The research has passed the Research Ethics test with certificate No. 165/KEPK/EC/2021 from the Health Research Ethics Commission (KEPK) Semarang State University.

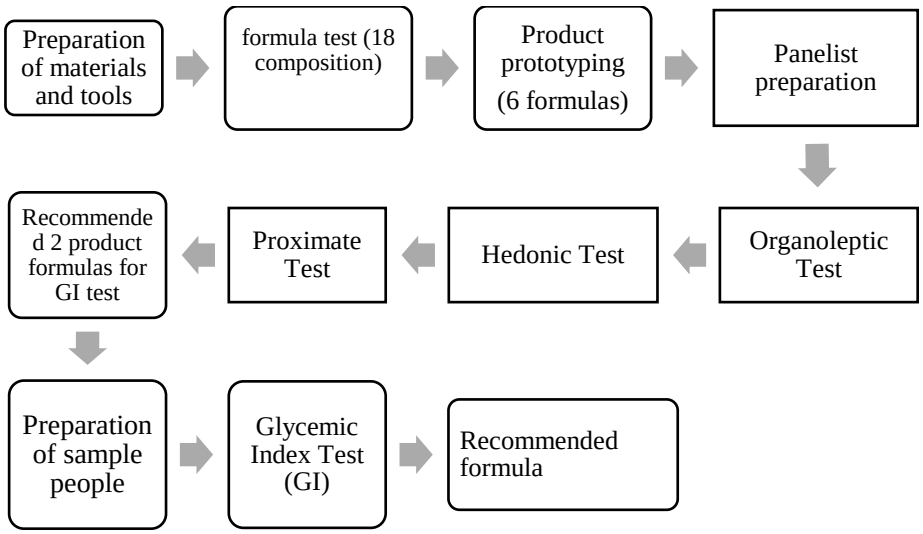

Fig. 1. Research Flowchart

3 Result

The results of three formulas with three cooking processes (fried, roasted, and steamed) with several changes to the use of red potato porridge and flour, and additional ingredients (18 recipes), then obtained six selected recipes representing three cooking processes and the base ingredients using red potato porridge or flour. The product is fried using Formula 1 (40% red potato porridge). To get a better taste and crispness, the size is thinner (0.5 cm). Products with roasted and steamed using Formula 3 (60% red potato porridge). The formula using red potato porridge results in a softer product, strong red potato taste, but less crispness and shorter shelf-life. Particularly the form of steamed (1 day), when the formula made from red sweet potato flour results in a crispier product, longer shelf-life (2 days), and a subtle red sweet potato taste.

3.1 Organoleptic Test, Hedonic Test

The test used three formulas with red sweet potato porridge and three more formulas with red sweet potato flour. Namely, by using F1 for fried products and F3 for baked and steamed products. The results of the organoleptic (sensory) test on the highest overall score (517), while the highest total score (3307) is the products that were processed by frying in the form of sticks. Hedonic test results (preferred) overall highest value in processed products with fried (517), while the highest total value is found in processed products by steaming (3261).

3.2 Proximate Test

Table 4. Proximate Test Result (ANOVA TEST)

Code	Cookie Variation	Average					
		Carbohydrate (%)	Protein (%)	Fat (%)	Water (%)	Ash (%)	Crude Fibre (%)
1	Fried products from red sweet potato porridge	14,0223[b]	19,0717[a]	2,0167[f]	0,0367[e]	18,730[b]	46,0453[c]
2	Baked products from red sweet potato porridge	14,1423[a]	18,494[b]	6,0467[d]	0,110[C]	20,390[a]	40,7117[e]
3	Steamed product from red sweet potato porridge	11,847[e]	14,1027[e]	4,0133[e]	0,5333[a]	13,0307[c]	56,337[b]
4	Fried products from red sweet potato flour	12,7367[d]	18,2983[c]	19,9633[a]	0,0267[e]	10,1833[f]	38,5073[f]
5	Baked products from red sweet potato flour	13,066[c]	17,9187[d]	14,0433[b]	0,0633[d]	10,5633[e]	44,1773[d]
6	Steamed product from red sweet potato porridge	12,736[d]	6,086[f]	8,0467[c]	0,1533[b]	12,0333[d]	60,91[a]
	p-value	0,000	0,000	0,000	0,000	0,000	0,000

Remark : Different letter notation ([a,b,c,d,e] and [f]) indicates significant variation on *Post-Hoc* test, and notation [(a)] is the higher score.

Proximate test results on three products made from red sweet potato pulp and three products made from red sweet potato flour. The Anova Statistical Test and the Post Hoc Test showed a significant difference of 0.000 ($p<0.55$) for each product. Overall, the following results were obtained:

The average content of carbohydrates, protein, water, and ash in the fried, roasted, and steamed production process is higher for those made from red sweet potato porridge.
The average fat content in the fried, baked, or steamed production process is higher for those made from red sweet potato flour.

As for the crude fiber content in each cooking process and the ingredients used, different results are obtained. The highest is in steamed products of red sweet potato flour (60.91). Then the second order is for steamed products with red sweet potato porridge (56.337). So the production process by steaming will produce more crude fiber content.

3.3 Glycemic Index Test (GI)

The selection of the product to be tested is based on the results of sensory tests, preference tests that are acceptable to consumers, and proximate test results, especially related to low carbohydrate content and high crude fiber. The GI test on the product was fried in the form of sticks using F1 (40% red sweet potato porridge) and the product was steamed in the form of a bar using F3 (60% red sweet potato porridge). The results of the GI calculation for both products are all in the Low category (23.90 and 48.56).

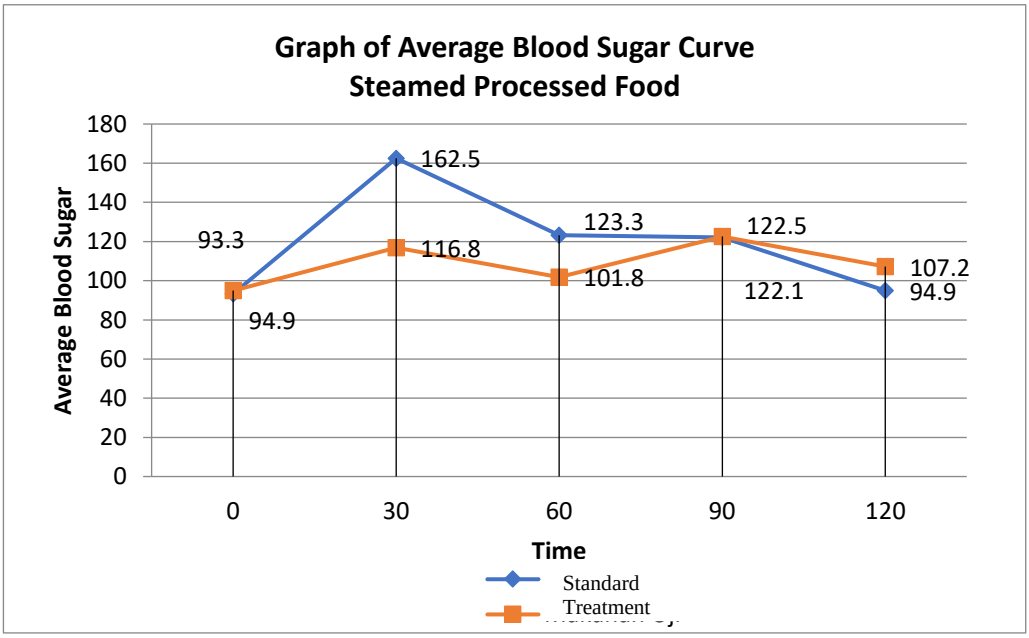

Fig. 2 Graph of Average Blood Sugar Curve of Steamed Food

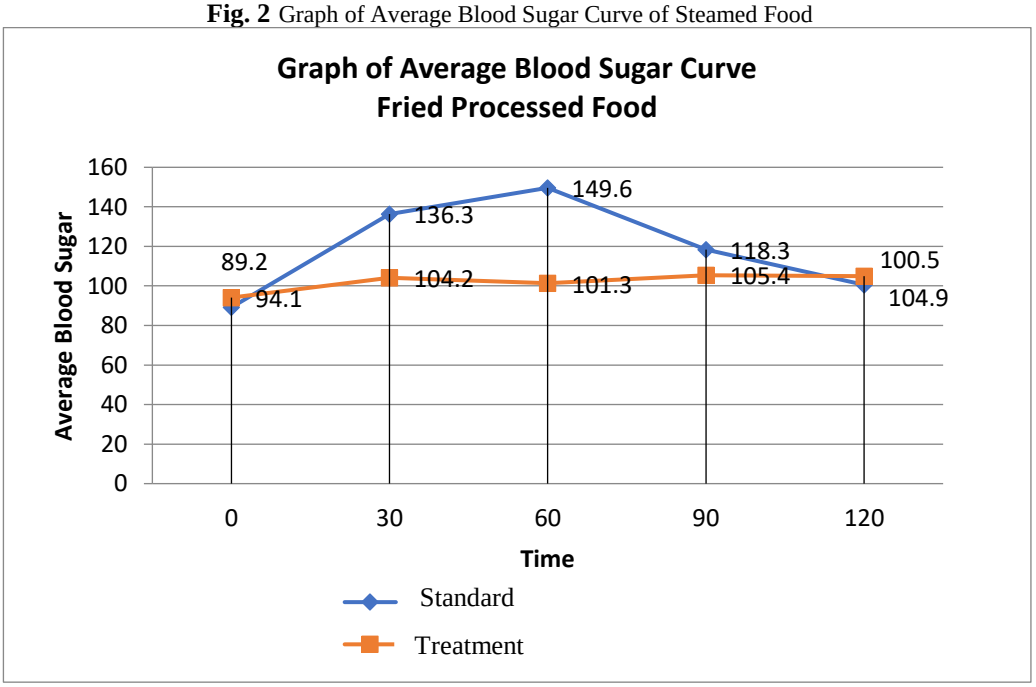

Fig. 3 Graph of Average Blood Sugar Curve of Fried Food

4 Discussion

The sensory and the preference test result that the product with the fried process made in the form of sticks is the most preferred (acceptable), and the overall assessment gets the highest score (517). But of the total value of each item assessed (color, aroma, texture, sweetness, yellow sweet potato taste, and overall value), the steamed product had the highest score (3216). In more detail, the steamed product has the highest score on assessment items related to color, aroma, sweetness, and taste of red sweet potato. The lack of the product with the steamed process is that it does not have a long shelf-life due to the high water content of the main ingredient used, which is in the form of red sweet potato porridge and the water content will increase due to the steaming process.

The results of the Glycemic Index examination of the two products tested, all had low categories, namely those with the steaming process (48.56), and those for the fried process (23.90). The Glycemic Index with the steamed process got a higher value than the fried process, it was possible due to the higher carbohydrate content (14.0223%) and lower crude fiber content (46.045%), based on the results of the proximate test. Meanwhile, with the steaming process, the carbohydrate content is 11.847% and the crude fiber content is 56.337%. The difference in content may also occur because the fried product uses a formula with a lower red sweet potato porridge (40%) when the steamed product uses higher (60%). The content of sweet potato porridge used will affect the crude fiber content, which then affects the speed of the glucose metabolism process in the digestive system. In addition, the types of sweet potato variants used have different qualitative and quantitative in nutritional content, including in this study the form of the ingredient used will affect some of the nutritional content produced (in this study using the red sweet potato flour and red sweet potato porridge). In addition, according to Murtiningsih, the composition of sweet potatoes is highly dependent on the variety and level of maturity and storage time. The darker color of sweet potatoes, the higher the beta-carotene level functioning as provitamin A. Compared to white sweet potatoes, they only contain beta-carotene as much as 260 mg/100 grams, red sweet potatoes 2900/100 grams, while purple sweet potatoes do not contain beta-carotene[14].

The cooking process can affect the nutritional content of the food produced. The results showed that the cooking method by roasting, grilling, frying or boiling would affect the Glycemic Index of 10 sweet potato cultivars commonly consumed in Jamaica. Consumption of boiled sweet potatoes can minimize the postprandial rise in blood glucose. So it can be used in the management of type 223 Diabetes Mellitus. It is partly due to the formation of AGEs (Dietary advanced glycation end products), which are part of normal metabolism. But if the level of AGEs is too high, it can cause become a pathogen because it will bind to the surface of the receptor cell or cross-link with body proteins so that it will change its structure and function. The pathological effects of AGEs are related to their ability to increase oxidative stress, which is associated with the epidemic of diabetes mellitus and cardiovascular disease[23].

The results of the proximate analysis of red sweet potato per 100 grams were: carbohydrates 20.12 g, Protein 1.57 g, fiber 3 g, lipids 0.05 g, various vitamins such as Thiamin, Riboflavin, Niacin, B6, B9, vitamin C, vitamin K and most of them are vitamins A 14187 IU, various minerals such as Calcium 30.78 mg, Iron 0.61 mg, Magnesium 25.70 mg, Phosphorus 47.81 mg, Potassium 337 mg, Sodium 55 mg. The effect of lowering blood glucose in red sweet

potatoes is associated with increased levels of adiponectin, which is an adipocyte hormone that functions in the process of insulin metabolism [10]. Red sweet potato dietary fiber is a polysaccharide that cannot be digested and absorbed in the small intestine. So it will be fermented in the large intestine and will be used to balance the intestinal flora and as a prebiotic that can stimulate bacterial growth to support good absorption of nutrients. Red sweet potatoes contain strong antioxidants to neutralize malignant free radicals that cause premature aging and trigger various degenerative diseases such as cancer and heart disease.

The Spirulina addition to this product is to strengthen the effect of the resulting Glycemic Index value. Spirulina is known to be a food supplement that is safe or without side effects[17], [19]. Spirulina supplementation, three grams for four weeks, can significantly reduce fasting blood sugar levels [15],[16],[17]. Spirulina can break the radical chain reaction. So it can inhibit oxidative stress in people with Diabetes Mellitus. The results showed it has biological activities such as preventing viral replication, lowering blood glucose, and lipid profile [24],[25]. Spirulina contains active ingredients, especially phycocyanin and -carotene having antioxidant and anti-inflammatory activities[26]. Research conducted by Guan Y also found that the high calcium and low sodium content of spirulina has a positive effect on blood pressure [27].

5 Conclusion

The Anova Statistical and the Post Hoc Test on three products made from red sweet potato porridge and three products made from red sweet potato flour showed a significant difference of 0.000 ($p<0.55$) for each product. The average content of carbohydrates, protein, water, and ash in the fried, roasted or steamed production process is higher in the red sweet potato porridge. The fat content in the fried, baked, or steamed production process is higher than that made from red sweet potato flour. The production process by steaming produces more crude fiber content. The results of the Glycemic Index examination were all in the low category. For the steamed process (48.56) and the fried process (23.90). So it can be recommended for Diabetes Mellitus preventive.

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