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Optimization of low carbohydrate and high fibre Talas Beneng (*Xanthosoma undipes K.Koch*) flour for type 2 DM patients

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Abstract

Talas beneng flour contains low carbohydrates and high fibre that can be used as snacks for type 2 DM patients. This study aimed to find the best and preferred nutritional value of Talas Beneng flour with two different treatments: steam oven-dried and oven-dried. The water content was analysed following the AOAC method; crude fibre content was analysed following the gravimetric method; fat content was estimated following the Soxhlet extraction method; protein content was estimated following the Kjeldahl method; carbohydrate content was estimated following the Luff Schoorl method. The organoleptic test was performed using the scoring method. The results of the analysis were presented descriptively. The results showed that the oven-dried Talas Beneng flour produced organoleptic characteristics that were most favoured by the panellists, with the characteristics of having a bright light brown colour (3.98/5), savoury aroma (3.97/5), and slightly rough (3.92/5). The results of the analysis of nutrients in the oven-dried Talas Beneng flour resulted in lower moisture content of 9.89%, higher protein content of 9.29%, lower fat content of 0.8%, lower carbohydrate content of 26.56%, higher fibre content of 14.3%, and starch content of 18.03% compared to the steaming and then drying method. The best Talas Beneng flour was the oven-dried because it had a low carbohydrate content, high protein, low fat, high fibre, and sufficient starch that can be used as a food product to control blood sugar levels such as in diabetes mellitus patients.

1. Introduction

Diabetes mellitus (DM) is a group of metabolic diseases characterized by increased blood sugar levels (hyperglycaemia) due to insulin abnormalities, insulin action, or a combination of insulin abnormalities and insulin action. According to Puspitaningrum's (2015) research, one of the factors that cause DM is genetic (heredity) (Puspitaningrum *et al.*, 2015). While the results of the research by Ishak *et al.* (2014), reported that 20 samples of Javanese patients were found to have gene mutations and 20 Gorontalo patients did not find gene mutations in DM patients in Gorontalo due to environmental factors or other behaviour (Ishak *et al.*, 2014). DM is also known as the silent killer because it can affect all organs of the body and cause various kinds of disorders that are often not realized by the patient until diagnosed after complications.

DM is also known as the silent killer because it can attack all organs of the body and cause various kinds of disorders that are often not realized by sufferers, so they are only diagnosed after complications. The world's prevalence of DM in 2012 was 371 million people, where the proportion of type 2 diabetes mellitus was 8.5% and there was an increase of 12.70% in 2017 to 425 million people and it is estimated that there will be an increase to 643 million people in 2030 and is the seventh leading cause of death in the world (International Diabetes Federation, 2021). Meanwhile in Southeast Asia, from 82 million in 2017, it is estimated that there will be an increase to 151 million in 2045. Of the 10 major countries that are estimated to have many DM sufferers 5.4 million in 2045 and Indonesia is ranked 7th. Based on data from the Riset Kesehatan Dasar (Riskesdas) in 2008, shows that the prevalence of DM in Indonesia has increased to 57% (Kementerian Kesehatan Republik Indonesia, 2008).

Control of blood sugar levels is needed to reduce the risk of complications, and one of the ways is to choose foods with a low glycaemic index and diet regulation through the intake of foods that contain balanced nutrients between macronutrients and micronutrients, especially fibre (Manullang *et al.*, 2020). The glycaemic

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index (GI) is a measure developed to classify carbohydrate foods based on their physiological effects on blood glucose levels (Winarni *et al.*, 2019). WHO (World Health Organization) recommends foods with a low GI for blood glucose control, while still paying attention to the amount of carbohydrate intake. A study by Riccardi *et al*. (2008) reported that low GI foods can improve insulin sensitivity, reduce the rate of glucose absorption and control glucose. The results of Utari's research showed that a low GI modified diet alone did not reduce insulin resistance in obese adolescents, but glycaemic status should be monitored regularly to determine its development (Utari *et al.*, 2019). Other studies on fibre have shown that fibre can improve glucose control and significantly decrease postprandial plasma glucose levels (Kusumaningrum and Muin, 2019). Fibre foods have a lower GI. Other studies have shown that fibre can improve glucose control and significantly lower postprandial plasma glucose levels (Wijayanti *et al.*, 2020). Food sources of fibre also have a lower glycaemic index and provide metabolic effects, namely reducing the occurrence of hypoglycemia (Giacco *et al.*, 2002).

In general, drying using a dryer is better than using sunlight. The advantages include the drying temperature and hot air flow rate that can be controlled, cleanliness is more maintained, and heating occurs evenly. However, the operation of the dryer sometimes requires the user's expertise and is more expensive. The drying process in the manufacture of Talas flour is one of the crucial stages because it determines the quality and durability of further processed products from the flour. Temperature and drying time are important factors in drying that will affect the quality of the final product (Heldman *et al.*, 2006). The most optimal drying process according to Mohamed and Hussein (1994) which was at a temperature of 60°C for 22 hrs able to produce a flour with moisture content of 9.89%. The results of the drying are then milled with a pin disc mill (Mohamed and Hussein, 1994). This study aimed to determine the nutritional value of the best and preferred Talas Beneng flour of two different treatments; steam oven dried, and oven dried.

2. Materials and methods

2.1 Sample preparation and Talas Beneng flour processing

Old Talas Beneng were chosen, peeled and then washed thoroughly using running water. It was then sliced thinly with a thickness of 1.5 cm and soaked in 10% saltwater to remove the itching taste for 10 mins. Then, rinsed with running water and dried.

For the steam oven-dried treatment, the dried Talas Beneng slices were steamed for 20 mins, and then removed to cool at room temperature. Then, it was placed in a cabinet dryer at 60°C for 22 hrs, floured using a Disc mill and sieved using an 80-mesh sieve.

For the oven-dried treatment, the steaming process was skipped, and the dried Talas Beneng slices were placed in a cabinet dryer at 60°C for 22 hrs. Then, floured using a Disc mill and sieved using an 80-mesh sieve.

2.2 Proximate analysis

Analysis of water content was conducted using the AOAC method. Analysis of crude fibre and total starch content was conducted using the gravimetric method. Whereas the measurement of fat content was done using the Soxhlet extraction method. Analysis of protein content was estimated following the Kjeldahl method, and the analysis of carbohydrate content was estimated following the Luff Schoorl method.

2.3 Talas Beneng flour organoleptic hedonic test

The organoleptic test for colour, aroma and texture of the two different treated Talas Beneng flour was tested. The organoleptic test uses a variance test with thirty trained panellists to assess the products that have been produced. The results of the panellists' assessment were then analysed to find out which product the panellists liked the most based on texture, aroma, and colour. The scale used was (1) disliked, (2) less liked, (3) liked, (4) very much liked and (5) very much liked.

2.4 Data analysis

Data from organoleptic and acceptability test results were processed and analysed descriptively in tabular form including colour, aroma, texture, and taste.

3. Results and discussion

The results show certain nutritional components contained in Talas Beneng flour in Table 1. The results of the analysis of nutrients in the oven-dried Talas Beneng flour resulted in 9.89% moisture content and lower than the steam oven-dried Talas Beneng flour. Based on SNI 3751:2009, the maximum water content of Talas Beneng flour is 14.5%, it is still within the safe range of flour to prevent mould growth.

The oven-dried Talas Beneng flour contains 9.29% protein, which is higher than the steam oven-dried Talas Beneng flour. Protein content below 9% in flour has a lower swelling power (U.S. Wheat Associates, 1981). If consumed high protein content also tend to have a low GI value because the rate of gastric emptying becomes

DOI

slow, and digestion and the increase in blood glucose are also slow.

Table 1. Nutrient content of the Talas Beneng flour in 100 g.

Nutrient content	Treatment	
	Steam oven-dried	Oven-dried
Water content (%)	10.2	9.89
Proteins (%)	8.77	9.29
Fat (%)	0.85	0.8
Carbohydrates (%)	26.7	26.56
Fibre (%)	13.65	14.3
Starch (%)	16.02	18.03
Amylose (%)	0.5	0.7

The fat content affects the quality of starch in the Talas Beneng flour. According to Lisa's (2015) research, the very low-fat content makes the Talas Beneng flour not easily rancid due to an oxidation reaction, thus, it can be stored for a long time. The fat content in the oven-dried Talas Beneng flour obtained lower levels than the steam oven-dried Talas Beneng flour, which was 0.8% (Table 2). The fat content in flour can affect the gelatinization process because fat can form complexes with amylose and inhibits the starch gelatinization process because most of the fat will be absorbed by the surface of the granule, and a hydrophobic fat layer is formed around the granule. The high-fat content in Talas Beneng flour will reduce the amylose's tendency to bind, form a gel, and be retrograded and it will inhibit its' viscosity during heating. The results showed that the amylose content in the oven-dried Talas Beneng flour was 0.7% higher than in the steam oven-dried Talas Beneng flour by 0.5%.

Table 2. Organoleptic test of the Talas Beneng flour.

Treatment	Score		
	Colour	Flavour	Texture
Steam oven-dried	2.00	2.84	2.87
Oven-dried	3.98	3.97	3.92

Carbohydrates are nutrients contained in each tuber, including Talas Beneng. It can be used as an alternative staple food because most of the content of Talas is carbohydrates. According to Dawam's (2010) research, carbohydrates in Talas are a result of being influenced by the number of nutrients that can be absorbed. If vegetative activities during the rainy season can carry out photosynthesis optimally and have little budding, then the carbohydrate content of the tubers will be high. However, if there is a lot of budding, potential carbohydrates are used for budding activities.

The results of this study indicate that the oven-dried Talas Beneng flour has a carbohydrate content of 26.56% lower than the steam oven-dried Talas Beneng flour. The yield was higher when compared to several other types of tubers but still lower when compared to the carbohydrate in rice (28%), and the carbohydrate in porang (33.39%). This is supported by research conducted by Purwantoro (2014) that the nutritional content of suweg, which contains carbohydrate ranging from 10.66%.

The high carbohydrate content in Talas Beneng flour is expected to be used as an alternative carbohydrate source, or as a diversification of food ingredients, industrial raw materials, and so on. The type of carbohydrate contained in Talas Beneng flour is a complex carbohydrate and has a low GI level (55%) when compared to the GI value of one serving of boiled sweet potato of 63%. The GI value is categorized as low if the GI value is < 55%, moderate 55-70%, and high >70%. Other studies have shown that low GI foods can improve insulin sensitivity and reduce the rate of glucose absorption, which is useful in controlling blood glucose in people with type 2 diabetes. Low GI foods will be digested and converted into glucose gradually, therefore, peak blood glucose levels will also be low. It means that fluctuations in the increase of glucose levels are relatively low. Conversely, foods with a high GI will be digested and converted into glucose quickly (Giacco *et al.*, 2002). Because of that, to control blood glucose levels, people with type 2 diabetes, are recommended to eat foods with low GI (Riccardi *et al.*, 2008). Complex carbohydrates also contain enough fibre. The results showed that the fibre content in Talas Beneng flour showed a fairly high amount of 14.3%. Fibre affects the GI of food related to its role as a physical inhibitor in the digestive process (Mahan *et al.*, 2012). Consumption of fibre in sufficient quantities can provide benefits for controlling blood glucose and plasma lipid levels (Margareth, 2006). Fibre has a hypoglycaemic effect because able to slow gastric emptying, glucose diffusion, and glucose absorption to reduce the increase in blood glucose (Gropper *et al.*, 2009).

Complex carbohydrates also contain starch. The main constituent polysaccharides of starch are amylose and amylopectin. Total starch content is the amount of amylose and amylopectin in starch. The results of this study showed that the starch content in oven-dried Talas Beneng flour was 18.03%, consisting of 0.7% amylose and 17.33% starch. The high total starch content in the Talas beneng flour can be used as raw material for making vermicelli.

The result of the organoleptic test is shown in Table 2. The oven-dried Talas Beneng flour was the most favoured by the panellists. It has a bright light brown colour (3.98/5), a savoury aroma (3.97/5), and a slightly rough texture (3.92/5). Meanwhile, the steam oven-dried

DOI

Talas Beneng flour has a greyish-brown colour (2.80/5), a pungent aroma (2.84/5), and a soft texture (2.87/5).

The average value of the oven-dried Talas Beneng flour produced better colour, aroma, and texture. This is because the oven-dried Talas Beneng flour is affected by the even distribution of heating at the time of drying, before going through the grinding process. The brightness of the colour is also influenced by the hydrolysis process and enzymatic reactions. In the heating process of carbohydrates, there is a change from polysaccharides to simple sugars with the help of temperature, acids, and enzymes. Changes in colour during the drying and heating process will produce a brownish colour, and change in flavour and texture (Kusnandar, 2019).

4. Conclusion

Diabetics are advised to maintain a balanced nutritional intake of food and choose foods that are low in sugar. The results of this study indicated the potential of Talas Beneng flour as a good food ingredient for consumption by type 2 DM patients because it has low carbohydrate content, high protein, low fat, and high fibre to control blood sugar levels.

Conflict of interest

The authors declare no conflict of interest.

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