The Effect Of A Food Bar Made From Kepok Banana Flour And Butterfly Pea Flower On Blood Glucose Levels In Patients With Diabetes Mellitus type II

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ABSTRACT

Diabetes mellitus is a degenerative disease with a globally increasing prevalence. In Indonesia, the prevalence reached 8.5% in 2018. The management of type II diabetes mellitus requires non-pharmacological approaches, including the consumption of low glycemic index foods. Kepok banana and butterfly pea flower have the potential to be used as functional snack ingredients in the form of a food bar to help control blood glucose levels. To determine the effect of a food bar made from kepok banana flour and butterfly pea flower on blood glucose levels in patients with type II diabetes mellitus in the working area of UPTD Puskesmas Delima, Pidie District. This study used a quasi-experimental design with a pre-post test control group approach. The sample consisted of 30 patients with type II diabetes mellitus, divided into two groups: treatment and control. The treatment group was given 25 grams of food bar daily for 7 consecutive days, while the control group received standard therapy only. Random blood glucose levels were measured before and after the intervention using the Easy Touch GCU device. The average decrease in blood glucose levels in the treatment group was 63.27 mg/dL, while in the control group it was 21.13 mg/dL. There was a significant difference between the two groups after the intervention. The administration of a food bar made from kepok banana flour and butterfly pea flower significantly reduced blood glucose levels in patients with type II diabetes mellitus. This food bar can be considered a healthy snack alternative for individuals with type II diabetes mellitus.

Keywords: Kepok Banana Flour and Butterfly Pea Food Bar, Blood Glucose Level, Diabetes Mellitus Type II

INTRODUCTION

Diabetes mellitus is a degenerative disease that has a significant global impact, and the number of sufferers continues to increase annually. The International Diabetes Federation (IDF) estimates that in 2019, there were approximately 463 million people aged 20–79 years worldwide living with diabetes mellitus, with a prevalence of 9.3% in that age group. Based on gender, the prevalence of diabetes in the same year was recorded at 9% in women and 9.65% in men. This figure is projected to continue to increase as the population ages, with the prevalence reaching 19.9%, or approximately 111.2 million people, in the 65–79 age group. Globally, the number of people with diabetes is estimated to reach 578 million in 2030 and increase to 700 million in 2045 (Ministry of Health of the Republic of Indonesia, 2020). Furthermore, the IDF also noted that this disease causes approximately 6.7 million deaths, or the equivalent of 1 in every 5 deaths worldwide (1).

The International Diabetes Federation (IDF) estimates that in 2019, the prevalence of diabetes mellitus among people aged 20–79 in Southeast Asia reached 11.3 million. Globally, China ranks highest with 116.4 million sufferers, followed by India with 77.0 million, the United States with 31.0 million, Pakistan with 19.4 million, Brazil with 16.8 million, Mexico with 12.8 million, and Indonesia with 10.7 million. With these figures, Indonesia ranks seventh out of the ten countries with the highest number of diabetes mellitus sufferers in the world (2).

Based on 2018 Basic Health Research (Riskesdas), the prevalence of diabetes mellitus in Indonesia among residents aged 15 years and older diagnosed by a doctor reached 2%, an increase from 1.5% in the 2013 Riskesdas.

Meanwhile, the prevalence based on blood sugar tests also increased, from 6.9% in 2013 to 8.5% in 2018. These findings indicate that only around 25% of people with diabetes are aware of their disease status. In the same year, the prevalence of diabetes in men (1.78%) was higher than in women (1.21%). Regionally, DKI Jakarta ranked highest with a prevalence of 2.6%, while East Nusa Tenggara (NTT) was the province with the lowest prevalence, at 0.6% (3).

The prevalence of diabetes mellitus in Aceh itself has increased significantly. Based on data from the 2018 Basic Health Research (Riskesdas), the prevalence of diabetes mellitus in Aceh increased from 1.8% in 2013 to 2.5% in 2018. This prevalence increase in Aceh is much more striking than the national average. This situation calls for a review of diabetes mellitus management in Aceh province (3). Meanwhile, according to data obtained from the Delima Community Health Center (UPTD) in Pidie Regency, the prevalence of diabetes in 2023 was 234 people, representing all 21 villages in the Delima sub-district.

Understanding the risk factors for type 2 diabetes mellitus is crucial for preventing this disease. These risk factors are divided into two categories: modifiable and non-modifiable. Modifiable factors include a sedentary lifestyle, a lifestyle with low physical activity that contributes to weight gain and obesity, an unbalanced diet, stress, a history of impaired glucose tolerance or impaired fasting blood glucose, and smoking. Meanwhile, non-modifiable factors include age, gender, and family history of diabetes mellitus (4).

iabetes mellitus management is based on five main pillars: education, medical nutrition therapy, increased physical activity, pharmacological therapy, and regular blood glucose monitoring. Medical nutrition therapy plays a central role in diabetes mellitus management, one of which is achieved through dietary adjustments. This strategy includes selecting complex carbohydrate sources with a low glycemic index and increasing the consumption of high-fiber foods to help maintain stable blood glucose levels (5).

One food ingredient high in fiber and with a relatively low glycemic index (GI) is the banana (Musa paradisiaca), especially the kepok banana variety, making it suitable for consumption by people with diabetes. Bananas are also rich in essential nutrients such as vitamin C, vitamin B6, potassium, complex carbohydrates, and iron. Bananas can also be processed into flour as part of a semi-finished product process. Kepok banana flour is a recommended option for developing various banana products because it has a long shelf life, is easy to mix, and is molded, making it more practical to use (6).

Besides kepok bananas, there are other natural ingredients with the potential to be used as raw materials for low-sugar and carbohydrate foods suitable for people with diabetes, namely butterfly pea flowers (Clitoria ternatea L.). In addition to functioning as a natural coloring agent in food products, butterfly pea flowers are also known to have antidiabetic properties that can support blood sugar management. The anthocyanin compound found in butterfly pea flowers has the ability to increase insulin sensitivity and reduce blood glucose levels.

Food bars are a type of processed food product in the form of dry, convenient bars, specifically designed as snacks. This product is ideal for people with type II diabetes mellitus who require controlled nutritional intake without having to skip meals. Because they are easy to carry and consume at any time, food bars are an ideal choice for maintaining stable blood glucose levels throughout the day. With their high fiber content and low glycemic index, food bars help regulate post-meal blood sugar spikes, thus playing a vital role in diabetes management. Regular consumption of food bars as a substitute for high-calorie snacks can help people with diabetes maintain nutritional balance and prevent further complications (5).

Research conducted by Marbun et al., (2023) on the effect of high-fiber food bars on blood glucose levels in patients with type 2 diabetes mellitus showed a significant difference between blood glucose levels before (pretest) and after (posttest) intervention in both the treatment and control groups. The difference in blood glucose levels between the two groups also showed a significant difference. In the treatment group, blood glucose levels decreased by 51.53 mg/dL, significantly greater than the control group, which only experienced a decrease of 17.17 mg/dL. These findings indicate that consuming a high-fiber food bar twice daily, each 25 grams in portion, as a snack replacement for seven

consecutive days, can lower blood glucose levels by up to 51.53 mg/dL.

METHODS

This is a descriptive analytical study with a quasi-experimental design using a pretest and posttest approach with a control group. The objective was to assess the effect of providing a food bar made from banana flour and butterfly pea flowers on blood sugar levels for patients with type II diabetes mellitus in the Delima Community Health Center (UPTD) work area, Pidie Regency. The experimental group received an intervention in the form of consuming the food bar for 7 consecutive days accompanied by blood sugar-lowering medication.

This study was conducted in the Delima Community Health Center (UPTD) work area, Pidie Regency, from December 5–31, 2024, with the intervention lasting 7 days, December 19–25, 2024. The population in this study was all patients with type II diabetes mellitus seeking outpatient treatment at the Delima Community Health Center (UPTD) work area,

Pidie Regency. A sample of 30 individuals was drawn using purposive sampling.

The first stage of the study was to measure blood sugar levels before administering the food bar made from banana flour and butterfly pea flowers. Second, provide a 25-gram meal bar containing kepok banana flour and butterfly pea flower flour once daily for seven consecutive days at 10:00 a.m. Western Indonesian Time. Third, blood sugar levels are rechecked after seven days of administering the kepok banana flour and butterfly pea flower flour. Fourth, compare blood sugar levels before and after treatment in subjects given the kepok banana flour and butterfly pea flower flour.

Data processing included editing, coding, entry, cleaning, and processing. Data were analyzed using the Dependent Paired Samples T-Test and Independent Samples T-Test with a 95% confidence level. Data are presented in tabular and textual formats.

RESULT

Table 1. Average Blood Sugar Levels Before and After in the Treatment and Control Groups

Blood Sugar Levels	Group									
	Treatment					Control				
	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
Before	15	232.07	19.263	201	266	15	223.80	16.666	201	249
After	15	168.80	29.018	117	240	15	202.67	44.378	140	300

Table 1 shows that the average blood sugar level before the intervention in the treatment group was 232.07 mg/dL. After 7 days of intervention, blood sugar levels decreased to 168.80 mg/dL. The average decrease was 63.27 mg/dL. Meanwhile, in the control group, the average

blood sugar level before the intervention was 223.80 mg/dL and after the intervention it was 202.67 mg/dL. The average decrease in the control group was 21.13 mg/dL. A greater decrease was seen in the treatment group compared to the control group.

Table 2. Effect of Providing Kepok Banana Flour and Butterfly Pea Flower Food Bars on Blood Sugar Levels in Type II Diabetes Mellitus Patients Before and After in the Treatment and Control Groups

Blood Sugar Levels	Group									
	Treatment					Control				
	n	Mean	Mean Difference	Nilai t	P_{value}	n	Mean	Mean Difference	Nilai t	P_{value}
Before	15	232.07	63.267	8.627	0,0001	15	223.80	21.133	2.210	0,044
After	15	168.80				15	202.67			

Table 2 shows that the average reduction in blood sugar levels in the treatment group was 63.27 mg/dL, with a p-value of 0.0001 (p < 0.05). This analysis was conducted using a paired t-test to determine the difference in blood

sugar levels before and after the intervention. This reduction demonstrated statistical significance. The treatment group in this study also continued to take blood sugar-lowering medica-

tion according to recommended medical therapy, in addition to being given a food bar containing kepok banana flour and butterfly pea flowers for 7 days.

Meanwhile, in the control group, the average reduction in blood sugar levels was 21.13 mg/dL with a p-value of 0.044 ($p < 0.05$), which also indicates a significant reduction based on the paired t-test results, although not as significant as in the treatment group.

These results support the research hypothesis: "There is a significant effect of administering a food bar containing kepok banana flour and butterfly pea flowers on reducing blood sugar levels in patients with type II diabetes mellitus." The greater reduction in the treatment group suggests that the food bar may provide an additional effect in lowering blood sugar levels in addition to routine drug therapy.

Table 3. Differences in Blood Sugar Levels between the Treatment Group and the Control Group

Blood Sugar Levels	n	Mean	Mean Difference	Nilai t	P_{value}
Treatment Group	15	168.80	-33.867	-2.474	0,021
Control Group	15	202.67			

Table 3 shows the results of the analysis using an independent t-test to see the difference in post-intervention blood sugar levels between the treatment and control groups. The results indicate that blood sugar levels in the treatment group (mean = 168.80 mg/dL) were significantly lower than those in the control group (mean = 202.67 mg/dL), with a mean difference of -33.867 mg/dL, a t-value of -2.474, and a p-value of 0.021 ($p < 0.05$). This indicates a statistically significant difference between the two groups after the intervention, indicating the effectiveness of providing the food bar in reducing blood sugar levels.

DISCUSSION

Respondent characteristics in this study included age, gender, education level, occupation, nutritional status, and history of diabetes mellitus. In the treatment group, the majority of respondents were aged 46–50 years and 56–59 years (33.3%, respectively), female (66.7%), with primary education (66.7%). In terms of occupation, more than half of the respondents were unemployed (53.3%), and most had normal nutritional status (53.3%) and no previous history of diabetes (66.7%). Meanwhile, in the control group, most respondents were aged 56–59 years (40%), predominantly male (60%), with the highest level of education being primary education (53.3%). Respondents were predominantly farmers (40%), with the highest nutritional status being overweight (53.3%), and the majority also had no history of diabetes (66.7%).

Most respondents were in their later productive years, aged 46–59, which is a high-risk group for developing type II diabetes mellitus. Research by Watta et al. (2020) states that individuals over 45 are at higher risk for this disease. Degeneratively, insulin resistance, which causes unstable blood sugar levels, is influenced by advanced age (7). Furthermore, Wulandari & Kurnianingsih (2018) stated that each one-point increase in age contributes to a 0.831 increase in blood sugar levels. Decreased pancreatic β-cell function, a 35% reduction in muscle mitochondrial activity, and an increase in intramuscular fat of approximately 30% in the elderly contribute to worsening glucose metabolism.

In terms of gender, the treatment group was predominantly female, while the control group was predominantly male. Women are at higher risk of developing diabetes mellitus due to hormonal influences, such as premenstrual syndrome and postmenopausal changes, which accelerate body fat accumulation, particularly in the visceral region (9). Watta et al. (2020) also stated that women aged 46–55 years were more likely to develop diabetes than men of the same age, suggesting that gender is an important factor in metabolic risk.

Most respondents had a primary education. Low education contributes to a lack of understanding of health, including chronic disease management. Watta et al. (2020) revealed that people with diabetes mellitus were more likely to come from low-educated groups due to limited access to health information and the ability to make informed decisions about maintaining a healthy lifestyle.

In terms of occupation, many in the treatment group were unemployed, while the control

group was predominantly farmers. Occupation type plays a role in determining physical activity levels, which can affect insulin sensitivity. Adequate physical activity can lower blood glucose levels, but if accompanied by an unhealthy diet or insulin resistance, it still carries a high risk of developing diabetes mellitus (9).

Nutritional status is also an important factor. Most respondents were in the normal and overweight categories, with some being obese. Isnaini & Ratnasari (2018) explained that increased BMI due to excess calorie intake and lack of physical activity leads to an increase in free fatty acids (FFAs), which can inhibit glucose uptake by cells and trigger insulin resistance, particularly in muscle and adipose tissue.

Furthermore, 33.3% of respondents in both groups had a family history of diabetes mellitus. Family history increases the risk of type II diabetes by up to 10.938-fold due to genetic and lifestyle influences inherited within the family, including dietary habits and activity patterns (7).

This finding is supported by the 2018 Basic Health Research (Riskesdas), which states that diabetes prevalence increases sharply in people over 45 years of age, particularly in groups with low education and unhealthy lifestyles (3). Therefore, the characteristics of the respondents in this study reflect a vulnerable group and are suitable subjects for interventions to lower blood sugar levels through a functional food approach.

Based on the research results, the average pre-intervention blood sugar level in the treatment group was 232.07 mg/dL and decreased to 168.80 mg/dL after the 7-day intervention, for a total decrease of 63.27 mg/dL. Meanwhile, in the control group, the average pre-intervention blood sugar level was 223.80 mg/dL, decreasing to 202.67 mg/dL after the intervention, for an average decrease of 21.13 mg/dL.

This significant decrease in the treatment group was analyzed using a paired t-test, which yielded a p-value of 0.0001, indicating a significant difference between pre- and post-intervention blood sugar levels. Similarly, the control group showed a significant decrease with a p-value of 0.044, although the magnitude of the decrease was smaller. Furthermore, a comparison between the two groups was conducted using an independent t-test, which yielded a p-value of 0.021. This indicates a significant difference between the treatment and control groups after the intervention, with an average reduction in blood sugar levels of 33.87 mg/dL.

The greater reduction in blood sugar levels in the treatment group strengthens the hypothesis that administering a food bar made from kepok banana flour and butterfly pea flowers significantly reduces blood sugar levels in people with type II diabetes mellitus. This can be explained by the nutritional content and active compounds found in both ingredients. Kepok banana flour is known to have a low glycemic index, is high in fiber, and contains resistant starch, which can slow the absorption of glucose into the blood. The β-carotene and flavonoids in kepok bananas also act as antioxidants, increasing cell sensitivity to insulin and reducing insulin resistance. Furthermore, the flavonoid compounds in bananas can activate the insulin receptor tyrosine kinase, which is important for blood sugar control (11).

Meanwhile, butterfly pea flowers (Clitoria ternatea L.) contain anthocyanins, which function as natural antioxidants, enhance insulin action, and inhibit the enzyme α-glucosidase, thus slowing the breakdown of carbohydrates into glucose in the digestive tract. This effect helps reduce spikes in blood sugar levels after meals. Furthermore, the flavonoid and phenolic content in butterfly pea flowers also contributes to reducing oxidative stress, which often occurs in people with type II diabetes mellitus (12).

The mechanism of blood sugar reduction in the treatment group can be explained by the nutritional content of the food bar. Kepok bananas are rich in fiber, particularly resistant starch, which is not easily digested in the small intestine, thus slowing the release of glucose into the blood. Fiber also plays a role in increasing satiety, which can help with dietary management in people with diabetes (11). Furthermore, butterfly pea flowers contain flavonoids, which function as antioxidants and anti-inflammatories, supporting pancreatic health and optimal insulin production (12).

These results are also in line with research by Marbun et al. (2023) which showed that providing a high-fiber food bar for 7 days was able to significantly reduce blood glucose levels by 51.53 mg/dL in the treatment group, greater than the control group which only experienced a decrease of 17.17 mg/dL. This research is also supported by Ruhdiana & Sandi (2023) who revealed that kepok bananas contain dietary fiber that plays a role in slowing glucose absorption thereby helping control spikes in blood sugar

levels. In addition, butterfly pea flowers contain anthocyanin compounds which are proven to have a hypoglycemic effect by increasing insulin sensitivity and inhibiting the α-glucosidase enzyme which is responsible for breaking down carbohydrates into glucose.

Compared to the control group, the reduction in blood sugar levels in the treatment group was more significant. This suggests that functional food-based interventions, such as food bars, can be a non-pharmacological approach to supporting the management of type II diabetes mellitus (5). Although pharmacological therapy remains the primary option, consuming foods with a low glycemic index, such as food bars made from banana flour and butterfly pea flowers, can be an effective additional strategy in maintaining stable blood sugar levels (13).

Therefore, it can be concluded that administering food bars made from banana flour and butterfly pea flowers has a significant effect on lowering blood sugar levels in patients with type II diabetes mellitus. This product has the potential to be a healthy snack alternative that supports non-pharmacological diabetes management, especially in local communities with access to these local foods. Implementing food bars in the daily diet can be a promising strategy in diabetes management, especially when combined with a healthy lifestyle and regular physical activity (14).

CONCLUSION

Providing food bars containing banana flour and butterfly pea flowers has a significant effect on stabilizing blood sugar levels in individuals with type II diabetes mellitus. However, as participants continued their pharmacological therapy during the study, the observed changes cannot be attributed solely to the food bar intervention.

The use of random blood glucose measurements may introduce variability related to recent food intake and daily activities, limiting the precision of the results. Additionally, limitations such as the limited control over meal timing and the potential for measurement bias must be considered. It is important to note that HbA1c would be a more reliable indicator for assessing long-term glucose control.

This study was conducted with adherence to ethical standards, ensuring informed consent was obtained from all participants, and the study was approved by the relevant ethics committee.

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