Research Article

The Impact of Strawberry-Flaxseed Soymilk Intake on Fasting Blood Glucose Levels in Patients with Type 2 Diabetes Mellitus

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Abstract

Type 2 diabetes mellitus is a metabolic disease characterized by increased blood glucose levels caused by impaired insulin secretion and insulin resistance. This study was intended to determine the effect of providing soymilk with strawberry and flaxseed as a healthy snack in helping reduce fasting blood glucose levels in patients with type 2 diabetes mellitus. The research design used was a quasi-experimental study using a Two Pretest-Post-test Design. The sample consisted of 29 people in the working area of Puskesmas Banjaran Kota. The data collected included sample characteristics such as age, gender, level of education, occupation, and risk factors for diabetes mellitus such as nutritional status, family history of diabetes mellitus, dietary intake, physical activity such as exercise, and nutrient intake (carbohydrates and fiber).
Data on changes in fasting blood glucose levels before and after the intervention were analyzed using the Wilcoxon test with a significance level of 0.05. The results showed that the treatment group experienced a decrease in blood glucose levels of 12.93 mg/dl with a p-value = 0.008, while the control group experienced an increase in blood glucose levels of 3.2 mg/dl with a p-value = 0.548. To determine the differences in changes in fasting blood glucose levels, a statistical test using the independent t-test was conducted with a significance level of 0.05. The results showed a p-value = 0.0023, indicating that there was a difference in changes in fasting blood glucose levels between the treatment group and the control group.

Key words: Diabetes mellitus, Soymilk, Strawberry, Flaxseed

1. Introduction

Diabetes mellitus (DM) is a metabolic disorder characterized by hyperglycemia resulting from insufficient insulin production or impaired insulin action due to insulin resistance (1). Type 2 diabetes mellitus (T2DM) develops as a result of impaired insulin secretion and insulin resistance, which are associated with obesity and unhealthy lifestyle behaviours, such as excessive consumption of carbohydrate-rich foods and insufficient physical activity (2). According to the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia), the prevalence of DM based on physician-diagnosed cases in West Java was 1.7%, with approximately half of the cases classified as T2DM. Bandung Regency was reported as one of the areas with the highest number of DM cases in West Java, recording 20,941 patients in 2024. Furthermore, within the service area of Banjaran Kota Public Health Center, the number of patients with DM increased from 579 in 2021 to 1,150 in 2024, while the coverage of healthcare services for patients with DM reached only 74% of the total number of registered patients.

The management of T2DM involves controlling blood glucose levels, blood pressure, body weight, and lipid profiles (3). This requires medical nutrition therapy through a high-fiber, low-glycemic-index diet, complemented by the consumption of antioxidant-rich foods to help improve insulin resistance and prevent chronic complications (4). Soybeans are a plant-based food source with a low glycemic index (GI of 15) and contain isoflavones that may contribute to improving glucose metabolism and protecting pancreatic beta cells (5). Flaxseed (Linum usitatissimum)

is a seed with a high dietary fiber content (27.3 g/100 g) and contains the lignan secoisolariciresinol diglucoside (SDG), which has potential antidiabetic properties (6). Furthermore, strawberries are rich in vitamin C and anthocyanins, which act as antioxidants and may help reduce oxidative stress (7).

Considering the potential health benefits of these three food ingredients, this study aimed to analyze the effect of strawberry-flaxseed soymilk administration as a functional food on fasting blood glucose levels in patients with type 2 diabetes mellitus.

2. Method

Study Design and Setting

This study employed a quasi-experimental design with a pre-test and post-test two-group design. The intervention was conducted over 14 consecutive days in April 2026 in the service area of Banjaran Kota Public Health Center, Bandung Regency, Indonesia. The study population consisted of patients with type 2 diabetes mellitus (T2DM) whose fasting blood glucose (FBG) levels ranged from 100 to 300 mg/dL. A total of 29 respondents aged 45–70 years were selected using proportional random sampling from five integrated health service posts (Posyandu).

The inclusion criteria were a physician-confirmed diagnosis of T2DM, current use of oral antidiabetic drugs (OADs) without injectable insulin therapy, and residence within the catchment area of the public health center. The exclusion criteria included the presence of comorbidities, pregnancy or breastfeeding, and the use of injectable insulin. The sample size was calculated using the formula for testing differences between two independent means, yielding an initial requirement of 15 participants per group, with an additional allowance for potential dropouts.

Intervention Procedures

The respondents were divided into two groups. The intervention group (n = 14) received 250 mL of strawberry-flaxseed soymilk daily as a morning snack for 14 consecutive days. The control group (n = 15) received diabetes diet education through a poster-based educational session lasting 30 minutes.

The strawberry-flaxseed soymilk was prepared using 50 g of soybeans, 100 g of fresh strawberries, and 15 g of flaxseed, combined with 200 mL of water, without added sugar.

Fasting blood glucose levels were measured using a glucometer before and after the intervention. Respondent characteristics were obtained through interviews and measurements, including diabetes history, physical activity, nutritional status, and dietary intake of carbohydrates and dietary fiber assessed using a Semi-Quantitative Food Frequency Questionnaire (SQFFQ).

Statistical Analysis

Data normality was assessed using the Shapiro–Wilk test. Pre- and post-intervention FBG levels within each group were analyzed using a paired-samples t-test if the data were normally distributed or the Wilcoxon signed-rank test if the data were not normally distributed.

Differences in changes in FBG levels between the two groups were analyzed using an independent-samples t-test for normally distributed data or the Mann–Whitney U test for non-normally distributed data. All statistical analyses were performed at a 95% confidence level, with a significance threshold of $\alpha = 0.05$. Data were analyzed using SPSS Statistics version 20.

3. Results

Sample Characteristics

Table 1 presents the characteristics of participants in the intervention and control groups. All participants (100%) in both groups were taking oral antidiabetic drugs. Insufficient physical activity was observed in 73.3% of participants in the control group and 64.3% in the intervention group. Regarding nutritional status, obesity (Class I and II) was more prevalent in the intervention group (71.4%) than in the control group (20.0%). Similarly, inadequate dietary fiber intake was more common in the intervention group (57.1%) than in the control group (46.7%). These findings indicate differences in several baseline characteristics between the two groups, particularly in nutritional status and physical activity, which should be considered when interpreting the intervention outcomes.

Table 1. Characteristics of Study Participants

Participant characteristics

Characteristic	**Intervention group (n = 14/%)**	**Control group (n = 15/%)**
Age (years)	45–70	45–70
Use of oral antidiabetic drugs, n (%)	14 (100.0)	15 (100.0)
Insufficient physical activity, n (%)	9 (64.3)	11 (73.3)
Obesity Class I–II, n (%)	10 (71.4)	3 (20.0)
Inadequate dietary fiber intake, n (%)	8 (57.1)	7 (46.7)

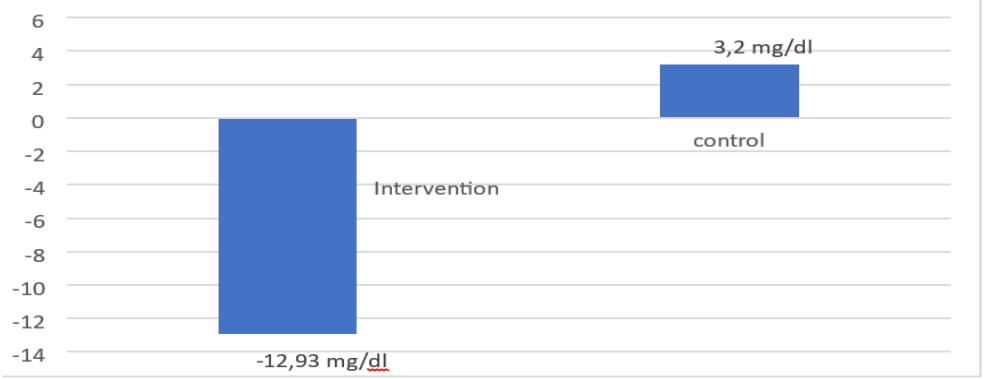
Fasting Blood Glucose Levels Before and After the Intervention

The Shapiro–Wilk normality test indicated that fasting blood glucose levels before and after the intervention were normally distributed in both groups ($p > 0.05$). The measurement results and statistical analyses are presented in Table 1.

Variable	**Intervention group (n = 14)**	**Control group (n = 15)**	**p-value**
Fasting blood glucose before intervention (mg/dL), mean	192.5	131.67	—
Fasting blood glucose after intervention (mg/dL), mean	179.57	134.87	—
Change in fasting blood glucose (mg/dL)	−12.93	+3.20	—
Within-group pre–post comparison (paired-samples t-test)	0.008	0.548	—
Between-group comparison of changes (independent-samples t-test)	—	—	0.0023

In the intervention group, the mean fasting blood glucose (FBG) level decreased from 192.5 mg/dL at baseline to 179.57 mg/dL after 14 days of product administration. This represented a mean reduction of 12.93 mg/dL, which was statistically significant ($p = 0.008$). In contrast, the control group, which received dietary education, showed an increase in mean FBG levels of 3.20 mg/dL, from 131.67 mg/dL at baseline to 134.87 mg/dL after the intervention. This change was not statistically significant ($p = 0.548$).

The independent-samples t-test revealed a statistically significant difference in the changes in FBG levels between the two groups ($p = 0.0023$), with a between-group difference in mean changes of 16.13 mg/dL.



Grafik 1. Comparison of Changes in Fasting Blood Glucose Levels

This chart compares the change in a measured value (in mg/dl) between an intervention group and a control group. The intervention group showed a substantial decrease of 12.93 mg/dl, while the control group showed a slight increase of 3.2 mg/dl. This gives a difference of roughly 16 mg/dl between the two groups, suggesting the intervention was effective in lowering the measured parameter. However, statistical significance and sample sizes are not shown, so firm conclusions cannot be drawn from the chart alone.

4. Discussion

The reduction in fasting blood glucose (FBG) levels observed in the intervention group may have been influenced by the dietary fiber, isoflavones, vitamin C, and anthocyanins contained in the strawberry-flaxseed soymilk. Dietary fiber helps absorb water and bind glucose, thereby potentially slowing gastric emptying and glucose absorption in the intestine (8). Consequently, it may help attenuate postprandial blood glucose elevations (9). In addition, isoflavones in soybeans may contribute to improving insulin sensitivity, enhancing glucose metabolism, and protecting pancreatic beta cells. Meanwhile, vitamin C from strawberries acts as an antioxidant that may help reduce oxidative stress by inhibiting the polyol pathway and non-enzymatic glycation reactions (10).

These findings are consistent with a study conducted by Febriyanto and Prihatin (2016), which reported that consuming 25 g of soybeans twice daily for seven days reduced blood glucose levels by 13.9 mg/dL (11). Similarly, a study by Lopez-Toledo et al. (2025) reported a change in fasting blood glucose levels of 20.5 mg/dL following the consumption of 15 g of flaxseed daily for three months (12). Furthermore, a study by Yuliwati and Nugroho (2021) demonstrated a change in fasting blood glucose levels of 30.18 mg/dL after consuming 200 g of strawberries daily for 14 consecutive days (13). In addition, the reduction in participants' fasting blood glucose levels may also have been influenced by adherence to the product consumption regimen and the adoption of healthy lifestyle practices, including adequate carbohydrate and dietary fiber intake. Conversely, it is important to address liability, as this is a key factor in ensuring that functional foods can be consumed (14).

In the control group, the non-significant increase in fasting blood glucose levels suggests that poster-based dietary education alone may not be sufficient to produce meaningful changes in participants' eating habits and physical activity over a short period (15). This finding is supported by the fact that 73.3% of participants in the control group had insufficient physical activity, while 46.7% had inadequate dietary fiber intake.

5. Conclusion

The administration of strawberry-flaxseed soymilk for 14 days in the intervention group had a statistically significant effect on reducing fasting blood glucose levels in patients with type 2 diabetes mellitus, with a mean reduction of 12.93 mg/dL ($p = 0.008$). In contrast, the control group, which received poster-based dietary education, experienced an increase in fasting blood glucose levels of 3.20 mg/dL, although this change was not statistically significant ($p =$

0.548). A statistically significant difference in fasting blood glucose changes was observed between the two groups ($p = 0.0023$).

Strawberry-flaxseed soymilk has the potential to be developed as a functional beverage for individuals with type 2 diabetes mellitus. However, its consumption should be accompanied by a healthy dietary pattern, regular physical activity, and adherence to oral antidiabetic medication.

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