ORIGINAL ARTICLE

Dragon fruit versus soybean: impact on blood glucose of diabetic patients

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ABSTRACT

Introduction: *Diabetes Mellitus (DM) is a severe problem with a rapidly increasing incidence rate. DM can affect almost all segments of society worldwide. The number of individuals with DM continues to rise yearly due to the sedentary lifestyle and unhealthy eating habits prevalent in contemporary society.* ***Objectives:*** *This study aims to compare the effects of soymilk and red dragon fruit consumption on fasting blood glucose levels in individuals with type 2 diabetes mellitus.* ***Methods:*** *The research design employed in this study is quasi-experimental with a pre-test-post-test approach involving two treatment groups. The study subjects were 54 individuals with type 2 diabetes mellitus from Bukittinggi. The participants were divided into three groups: an intervention group of 18 individuals who consumed red dragon fruit daily for seven days, a second intervention group of 18 individuals who consumed soymilk daily, and a control group of 18. Comparison analysis is done using the ANOVA test.* ***Results:*** *The research findings indicate that the p-value is 0.035, and the calculated t-value (2.198) is greater than the tabulated t-value (2.110. Furthermore, the consumption of red dragon fruit impacted fasting blood glucose levels and blood pressure, as evidenced by a p-value of 0.018 for fasting blood glucose and a calculated t-value of 2.198, which exceeds the tabulated t-value of 2.110. The ANOVA results indicate that the effectiveness of red dragon fruit consumption is superior, with an average decrease in blood glucose levels of 32.56, compared to the effectiveness of soymilk consumption, which resulted in an average decrease of 22.50.* ***Conclusions:*** *Red dragon fruit is more effective in reducing blood glucose and blood pressure levels in patients with type 2 diabetes mellitus.*

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1. Introduction

Type 2 Diabetes Mellitus (DM) is the most prevalent disease characterized by increased sugar blood levels due to abnormalities in insulin secretion, function, or both. According to WHO Data in 2021, diabetes mellitus is one of the top 10 leading causes of death worldwide (Srywahyuni et al., 2021). The International Diabetes Federation (2021) reports that China and India rank first and second in the world, with 140,9 million (9.98%) and 74.2 million (5.26%) diabetes patients, respectively. The number is predicted to continue increasing to 578 million in 2030 and 700 million in 2045 (IDF, 2021).

Indonesia is the fifth country with the highest number of diabetes patients globally. The International Diabetes Federation reports that 19.5 million Indonesians aged 20-79 had the disease in 2021 (IDF, 2021). Among the 33 provinces in Indonesia, three provinces have the highest prevalence of diabetes, namely Jakarta, Yogyakarta, and East Kalimantan. In contrast, East Nusa Tenggara has the lowest prevalence of patients in Indonesia. The results show that the number of diabetes patients in West Sumatra is 1.64 % (2.533.200), with the highest number in the city of Padang, 461.367 patients, and Agam 235.134 patients. Meanwhile, the lowest number is Sawalunto, with 30.241 patients. Seen from the age group, the highest percentage is in the 55-

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64 years old group (4.23%) and 65-74 years old group (4.87%). Based on the sexes, females are more dominant, with 2.13% and 1.14% percentages.

Blood glucose control can be achieved through the four pillars of type 2 DM management, including education, dietary regulation, physical exercise, and pharmacological/ nonpharmacological treatment (Putri & Isfandiari 2013). Several studies have shown that many patients with type 2 DM are non-compliant with the recommended treatment, leading to increased blood glucose levels and worsening of the condition, resulting in increased complications (Putri & Isfandiari 2013). Treatment of type 2 DM is not limited to pharmacological treatment alone but also includes herbal treatment (nonpharmacological). Nonpharmacological treatments are derived from natural ingredients, cause no side effects, are readily available in the environment, and are affordable (Pramono et al., 2020).

Nonpharmacological treatment for controlling blood glucose levels in patients with type 2 DM includes dragon fruit, avocado, mahkota dewa (Phaleria Macrocarpa), iler (coleus scutellariodies), starfruit, noni, ciplukan (Physalis), Spanish Cherry, corn, broccoli, bitter melon, garlic, apple, cinnamon, and soymilk (Apriyanti, 2012; Arisandi, Y & Andriani, 2011). Consuming soymilk has a protective effect on type 2 DM. Its high protein, isoflavone, fiber, and lecithin content benefit body health, especially for metabolic balance. Therefore, many experts believe soymilk plays a positive role in blood glucose control (Mukaromah & Chanif, 2021; Ningrum et al., 2018).

A literature review found that the administration of one sachet of soymilk powder mixed with 200 ml of warm water twice a day for five consecutive days can reduce blood glucose levels by 60.16 mg/dL (p=0.011) or a decrease of approximately 19.5% (Pramono et al., 2020). Another study similar to the one mentioned above stated that the administration of 50 grams of soymilk powder mixed with 250 ml (one glass) of warm water once a day for five days can reduce blood glucose levels (p=0.01) (Chang et al., 2018).

A study by Hosea et al. in 2022 stated that after the administration of 280 ml/day of soymilk for 14 days, soymilk affected reduced blood glucose levels in type 2 DM patients by 10.68 mg/dL (p=0.045) (Hosea et al., 2022). A study by Sinaga in 2012 also found that after the administration of 280 ml/day of soymilk for 14 days as a morning snack or between breakfast and lunch, soymilk affected reduced fasting blood glucose levels in prediabetic women by 26.31 (Sinaga & Wirawanni, 2012).

Nonpharmacological treatment by consuming red dragon fruit is also an option for controlling blood sugar levels in patients with type 2 diabetes mellitus (DM). Based on previous research conducted by Salsabila and Lanongbuka in 2022 and Setyani in 2019, red dragon fruit (Hylocereus Polyrhizus) significantly lowers blood sugar levels. This indicates that consuming red dragon fruit (Hylocereus Polyrhizus) can reduce blood sugar levels. Red dragon fruit (Hylocereus Polyrhizus) can help balance blood sugar levels because it contains various antioxidants such as flavonoids, vitamin E, vitamin C, and potassium, which can reduce oxidative stress and decrease ROS (Reactive et al.), thus providing a protective effect on pancreatic beta cells and improving insulin sensitivity (Lanongbuka et al., 2022; Salsabila et al., 2022; Setyani et al., 2019).

Consuming 200 grams of red dragon fruit for seven consecutive days can decrease blood sugar levels by approximately 79.1 mg. red dragon fruit is more effective because it does not require a long duration like broccoli or bitter melon, which need to be consumed for 28 days; apples, which need to be consumed for two weeks; or aloe vera, which needs to be consumed twice a day to see a decrease in blood sugar levels. Meanwhile, red dragon fruit is consumed at 200 grams daily for a week (Ayuni, 2020).

Based on the preliminary survey results at Guguk Panjang Primary Health Center in Bukittinggi, there were 243 visits from patients with type 2 diabetes mellitus. The interview with healthcare workers and some patients at the Primary Health Center found that some patients had chronic books and were registered in the chronic disease management program. In this program, the patients have yet to consume dragon fruit and soymilk for blood sugar control. Researchers were interested in conducting a study to compare the effectiveness of dragon fruit consumption with soymilk consumption to determine the more effective intervention in blood sugar control.

2. Methods

This study was quasi-experimental with a pre-test-post-test design involving two intervention groups and a control group. This design compares the research results between the intervention and control groups. The first intervention group was measured before and after consuming soymilk. Blood sugar measurements in the first intervention group were conducted before the administration of soymilk, and the second measurement was taken on the seventh day after the administration of soymilk. The administration involved 50 grams of soymilk powder mixed with 250 ml of warm water for seven days. The second intervention group was measured before and after dragon fruit; 200 grams of red dragon fruit was consumed for seven days, and blood sugar levels were measured before and after consumption. At the same time, the control group is measured at the beginning and end of the study. The control group underwent blood sugar control intervention programmed by the health center without administering soymilk or red dragon fruit.

The population in this study consists of all type 2 DM patients in the working area of Guguk Panjang Primary Health Center in Bukittinggi, totaling 243 individuals. The sample size is 54 individuals determined using G Power software, with an effect size of d=0.8, α error probability of 0.05, and power (1-β error probability) of 0.8, resulting in a sample size of 18 individuals for each intervention group (soymilk intervention group 1, dragon fruit intervention group 2), and 18 individuals for the control group. The sampling method used is purposive sampling. The inclusion criteria for this study are type 2 DM patients with fasting blood sugar levels ≥100 mg/dl, patients taking pharmacological drugs, and good communication ability. The exclusion criteria are type 2 DM patients with complications such as gangrene. Bivariate analysis is performed using paired-sample t-test and independent sample t-test, while comparison analysis is done using the ANOVA test.

3. Results and Discussion

The study was conducted in the working area of Guguk Panjang Primary Health Center in Bukittinggi. The sample comprises 54 respondents divided into three groups, each with 18 respondents. Group 1 received a soymilk intervention, Group 2 received a red dragon fruit intervention, and the control group had 18 respondents. Soymilk and red dragon fruit were administered for seven consecutive days in the intervention groups. The research findings were presented as tables and descriptive based on univariate and bivariate analysis using paired-sample t-tests and independent sample t-tests.

Table 1. Respondents' Characteristics

Respondents' Characteristics		Group					
		Intervention 1		Intervention 2		Control	
		F	%	f	%	f	%
Sexes							
-	Male	5	27.8	4	22.2	4	22.2
-	Female	13	72.2	14	77.8	14	77.8
Age							
-	45 – 59 years old	16	88.9	12	66.7	12	66.7
-	60 – 74 years old	2	11.1	6	33.3	6	33.3

Based on Table 1, it can be observed that most respondents in Group 1 were female (72.2%), and most were aged between 45 and 59 years old (88.9%). The characteristics of Group 2 and the control group were also predominantly female (77.8%), with more than half of them aged between 45 and 59 (66.7%).

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3.1 Blood Glucose Levels

Table 2. Average fasting blood glucose in Group 1, Group 2, and the control group of Type 2 DM Patients.

Variable	Intervention Group 1				Intervention Group 2				Control Group			
	F	Mean	Std Deviation	Min-max	F	Mean	Std Deviation	Min-max	F	mean	Std Deviation	Min-max
Pre-test	18	168.3	38.24	109-243	18	196.17	59.07	125-358	18	149.89	34.91	106-214
Post-test	18	145.8	29.32	102-197	18	163.61	43.03	89-248	18	138.11	30.35	97-200

Based on Table 2, the average fasting blood glucose level of the 18 respondents in Group 1 before consuming soymilk was 168.33 mg/dL, with the lowest level recorded at 109 mg/dL and the highest level at 243 mg/dL. After consuming soymilk, the average fasting blood glucose level was 145.83 mg/dL. The average fasting blood glucose level of the 18 respondents in Group 2 before consuming red dragon fruit was 196.17 mg/dL. The initial average fasting blood glucose level of the 18 respondents in the control group was 149.89 mg/dL, with the lowest level at 106 mg/dL and the highest level at 214 mg/dL. The final average fasting blood glucose level in the control group was 138.11 mg/dL, with the lowest level at 97 mg/dL and the highest at 200 mg/dL.

The findings were consistent with a study conducted by (Chang et al., 2018), which found that the average blood glucose level after soymilk intervention in the treatment group was 167.11 mg/dL, while the average blood glucose level after intervention in the control group was 166.10 mg/dL. In a study by Sinaga 2012, the average fasting blood glucose level after soymilk intervention in the treatment group was 84.31 mg/dL (Sinaga & Wirawanni, 2012). These results are influenced by other factors that affect blood sugar, known as confounding factors. These confounding factors include poor dietary habits, lack of physical activity, obesity, and significant stress. This aligns with the present study's findings, where two respondents with increased fasting blood glucose levels had poor dietary habits, consuming more than 1,200 calories per day (the recommended limit for females). Both respondents who experienced increased fasting blood glucose levels did not engage in physical activity (≤3 times a week for ≤30 minutes), with one respondent having no physical activity and the other engaging in physical activity only once a week. Additionally, one of the respondents with increased blood glucose levels was obese, and both respondents experienced moderate to severe stress.

In Group 2, the research findings showed a decrease in blood glucose levels in 14 respondents due to their adherence to consuming 200 grams of red dragon fruit daily for seven consecutive days and their ability to follow the prescribed lifestyle modifications. The four respondents who experienced an increase in blood glucose levels in the intervention group might be attributed to their lack of effort in controlling their fasting blood glucose levels, such as maintaining a proper diet, engaging in physical activity, struggling to control their body weight, and experiencing significant mental stress, which hindered their ability to lower their fasting blood glucose levels. Nonpharmacological interventions, such as consuming red dragon fruit, can effectively lower blood glucose levels in patients with type 2 diabetes mellitus. It is due to the active components of red dragon fruit, such as flavonoids, which act as antioxidants, and its high fiber content, along with other beneficial components that can lower blood glucose levels (Setyani et al., 2019).

Furthermore, in the control group, the research findings indicated that out of the 18 respondents, 16 experienced a decrease in fasting blood glucose levels, while two respondents experienced an increase. Although the control group did not receive interventions such as soymilk or red dragon fruit, 16 respondents still experienced decreased fasting blood glucose levels. It can be attributed to confounding factors, including maintaining a healthy diet, engaging in physical activity, not being obese, and experiencing normal or mild stress levels. Both pharmacological and nonpharmacological treatments are essential in reducing blood glucose levels in patients with type 2 diabetes mellitus. However, nonpharmacological treatments are more effective than

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pharmacological treatments since they do not have side effects, are easily accessible in the surrounding environment, and are affordable (Arisandi, Y & Andriani, 2011).

3.2 Differences in Fasting Blood Glucose Levels Before and After Administration of Soymilk and Red Dragon Fruit in Patients with Type 2 Diabetes Mellitus

Table 3. Distribution of differences in fasting blood glucose level in Intervention Group 1, Intervention Group 2, and the Control Group

Fasting Blood Glucose Level	N	Mean	Df	t	Standard deviation	P-Value
FBGL Before and After Intervention Group 1 (Soymilk)	18	22.5	17	5.195	18.376	0.001
FBGL Before and After Intervention Group 2 (Red et al.)	18	32.55	17	3.006	10.83	0.008
FBGL Initial and Final Control Group	18	11.77	17	5.248	9.521	0.001

Based on Table 3 above, it is known that among the 18 respondents in Intervention Group 1, the mean difference in fasting blood glucose levels before and after consuming soymilk was 22.5 mg/dL. Based on the statistical test results using paired sample t-test, the p-value was found to be <0.05 (p=0.001), and the calculated t-value (5.195) ≥ t-table (2.110), indicating statistical significance in the fasting blood glucose levels before and after the intervention in Intervention Group 1. The mean difference in fasting blood glucose levels before and after consuming red dragon fruit was 32.55 mg/dL, with a p-value of 0.008, indicating a significant difference between the fasting blood glucose levels before and after consuming red dragon fruit. In the Control Group, the mean difference was 11.778 mg/dL, with a p-value of 0.001, indicating statistical significance.

Moreover, from 18 respondents in the control group, it is known that the difference in the average fasting blood glucose levels before and after in the control group was 11.778 mg/dL. Based on the results of the statistical test using paired sample t-test, the p-value was found to be <0.05 (p=0.001), and the calculated t-value (5.248) ≥ tabulated t-value (2.110), indicating that the statistical test for fasting blood glucose levels before and after in the control group was significant.

These findings are consistent with a study (Hosea et al., 2022) on the effects of soymilk on fasting blood glucose levels in prediabetic women, which showed the effect of soymilk in reducing fasting blood glucose levels in patients with type 2 diabetes mellitus (p=0.001). The decrease in blood glucose levels is also supported by a study conducted by Oleh (Ningrum et al., 2018), which showed the effects of soymilk on blood glucose levels in patients with type 2 diabetes mellitus (p-value=0.045). The high content of soymilk in protein, isoflavones, fiber, and lecithin can improve the metabolic balance of the body, effectively reducing blood glucose levels in patients with diabetes mellitus. The reduction in blood glucose levels by soymilk can be explained through two main mechanisms: intra-pancreatic and extra-pancreatic. The intra-pancreatic mechare generates damaged pancreatic beta cells, while the extra-pancreatic mechaprotectscts beta cells from further damage. The main content of soymilk, lecithin, carries out these mechanisms. Lecithin is an antioxidant that inhibits oxidative stress on beta-pancreatic cells, thus protecting them from damage and promoting quick repair and restoration of their function. Additionally, lecithin stimulates insulin production, allowing for maximum insulin secretion.

Based on the above research results, there is an influence of red dragon fruit in reducing fasting blood glucose levels. Red dragon fruit has the advantage of lowering fasting blood glucose levels. A literature review study demonstrated that consuming red dragon fruit has significant potential and benefits in controlling blood glucose levels and lipid profiles in patients with type 2 diabetes mellitus, with a reduction of approximately 37.14%. Studies by (Ayuni, 2020;

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Lanongbuka et al., 2022) have also shown that red dragon fruit (Hylocereus Polyrhizus) significantly reduces blood glucose levels. This indicates that consuming red dragon fruit (Hylocereus Polyrhizus) can lower blood glucose levels.

3.3 Comparison of the Effects of Soymilk and Red Dragon Fruit on Fasting Blood Glucose Levels in Patients with Type 2 Diabetes Mellitus

To determine the comparison of the effects of soymilk and red dragon fruit on fasting blood glucose levels in patients with type 2 diabetes mellitus, an ANOVA test was conducted, and the results are presented in the table below.

Table 4. Comparison of the Effects of Soymilk and Red Dragon Fruit Levels in Patients with Type 2 Diabetes Mellitus.

Variable	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Dragon fruit	18	32.56	45.947	10.830	9.71	55.40	-68	120
Soymilk	18	22.50	18.376	4.331	13.36	31.64	-13	50
comparison	18	11.78	9.521	2.244	7.04	16.51	-7	28
Total	54	22.28	29.797	4.055	14.14	30.41	-68	120

Nonpharmacological treatments such as consuming red dragon fruit can lower blood glucose levels because it can reduce oxidative stress and reactive oxygen species (ROS) due to its active component flavonoids. It also acts as a potent glucose transporter (GLUT2) inhibitor in the intestinal mucosa. This leads to a decrease in glucose and fructose absorption from the intestines, decreasing blood glucose levels. The reduction in fasting blood glucose levels occurs because red dragon fruit contains beneficial antioxidants for diabetic patients. The fiber content of red dragon fruit, especially in the form of pectin, can slow down glucose absorption by increasing the viscosity of intestinal contents, potentially reducing the diffusion rate and lowering blood glucose levels. Additionally, the phytochemicals in red dragon fruit, acting as antioxidants, can maintain blood vessel elasticity and cell permeability. Increased cell permeability automatically enhances insulin sensitivity, resulting in increased uptake of blood glucose by insulin into cells for metabolism, leading to a decrease in blood glucose levels. The administration of red dragon fruit agar-agar (Hylocereus polarizes) for eight days at a dose of 250 grams is considered safe, as the respondents reported no physical or clinical complaints during the treatment. Similar findings were reported, where the administration of red dragon fruit at a dose of >100 grams for one month did not have any negative impact on the liver and kidneys, as evidenced by normal liver and kidney function values.

Various studies have shown that Vitamin C and E to lower blood glucose levels. The research indicated a significant relationship between vitamin C intake and blood glucose levels in patients with type 2 diabetes, as vitamin C can improve insulin sensitivity and lower blood glucose levels. Vitamin C reduces glucose toxicity, prevents beta cell mass decline, and increases insulin levels. Regarding the role of lowering blood glucose levels, vitamin C modulates insulin action in patients with diabetes mellitus, especially in non-oxidative glucose metabolism. Vitamin E is an antioxidant and can inhibit increased blood glucose levels by suppressing oxidative stress.

4. Conclusion

Based on the research conducted on the effect of soymilk on blood glucose levels in patients with type 2 diabetes mellitus, the following conclusions can be drawn. The average fasting blood glucose milk in the intervention before administering the soymilk group was 168.33. After administering soymilk in the intervention, the average fasting blood glucose level was 145.83 mg/dL. The average initial fasting blood glucose level in the control group was 149.89 mg/dL, and the average final fasting blood glucose level in the control group was 138.11 mg/dL. There was a significant difference in fasting blood glucose levels before and after administering soymilk in patients with type 2 diabetes mellitus (p=0.035). After consuming red dragon fruit, the

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average fasting blood glucose level was 163.61 mg/dL, with the highest value being 248 mg/dL and the lowest being 89 mg/dL. There was a significant effect on fasting blood glucose and blood pressure in patients with type 2 diabetes mellitus and hypertension after administering red dragon fruit in 200 grams, with a p-value <0.05. The test results showed a more significant effect on fasting blood glucose levels in the administration of red dragon fruit, with an average decrease of 32.56, compared to the administration of soymilk, with an average decrease of 22.50.

Ethics approval and consent to participate

This research has obtained ethical approval from the Research Ethics Committee of the Faculty of Nursing, UNISSULA, Semarang. To protect the rights, dignity, and well-being of the research subjects, a certificate of ethical approval for this research was obtained with the number 245/A.1-KEPK/FIK-SA/III/2023

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