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THE EFFECT OF NIRA BEVERAGE CONSUMPTION ON BLOOD GLUCOSE LEVELS AND GLYCEMIC INDEX IN PATIENTS WITH DIABETES MELLITUS: AN EXPERIMENTAL STUDY

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ABSTRACT
Diabetes mellitus (DM) is a major public health problem with a continuously increasing prevalence. Dietary regulation is a key pillar in glycemic control for DM management. Palm sap (nira aren) is a traditional beverage reported to have a low glycemic index; however, public concerns regarding its potential alcohol content have raised controversy about its consumption among individuals with DM. This study aimed to determine the effect of nira beverage consumption on blood glucose levels and glycemic index in patients with diabetes mellitus. This study employed a quasi-experimental pretest–posttest control group design involving 28 patients with diabetes mellitus. Data were collected through direct measurement of blood glucose levels using a glucometer before and after the intervention, while glycemic index was calculated based on standardized glycemic response procedures. Statistical analysis was performed using the paired t-test. The findings showed a statistically significant difference in blood glucose levels before and after nira beverage consumption in the intervention group (p = 0.000). In addition, glycemic index analysis demonstrated a significant difference (p = 0.001). Nira beverage consumption has a significant effect on blood glucose levels and glycemic index among patients with diabetes mellitus.

Keywords: blood glucose levels; diabetes mellitus; glycemic index; palm sap

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INTRODUCTION

Diabetes Mellitus (DM) is a chronic metabolic disease with a rapidly increasing global prevalence. Type 2 diabetes mellitus (T2DM) is characterized by persistent hyperglycemia resulting from impaired insulin secretion and insulin resistance. Poorly controlled DM significantly increases the risk of cardiovascular complications, including hypertension, myocardial infarction, heart failure, and stroke, making effective diabetes management essential to improve quality of life and reduce mortality (Rajput et al., 2022; Lestari et al., 2021). According to the World Health Organization, approximately 422 million people worldwide were living with diabetes in 2022, and the disease is projected to become one of the top ten leading causes of death globally. Indonesia ranks seventh among countries with the highest number of diabetes cases, with a prevalence of 10.5% in 2021. Data from the 2023 Indonesian Health Survey (SKI) indicate a continued increase in DM prevalence, with Gorontalo City reporting the highest proportion in the province (Fauzan et al., 2025). These data highlight the urgent need for effective and context-specific diabetes management strategies.

Effective diabetes management focuses on maintaining glycemic control through a combination of healthy dietary patterns, regular physical activity, and pharmacological interventions. Glycemic control is commonly assessed using fasting plasma glucose (FPG), glycated hemoglobin (HbA1c), and dietary approaches such as the glycemic index (GI). Foods and beverages with a low GI are associated with slower increases in blood glucose levels and are therefore recommended for individuals with DM (Abdullah et al., 2020; Solang et al., 2020).

Nira (palm sap) is a traditional Indonesian beverage composed primarily of water and natural sugars. Palm sap (nira aren) has a low glycemic index (GI = 35.56), suggesting potential benefits in maintaining blood glucose stability. However, fermentation of nira into tuak results in varying alcohol levels depending on storage time, which may influence metabolic responses in patients with DM. Despite its widespread consumption, scientific evidence regarding the effects of nira consumption on blood glucose levels and glycemic index in patients with diabetes mellitus remains limited in Indonesia. Therefore, this study aims to examine the effect of nira beverage consumption on blood glucose levels and glycemic index among patients with diabetes mellitus in Molosipat W Subdistrict, West Kota District, Gorontalo City. The findings are expected to provide scientific evidence on the metabolic response to nira consumption and contribute to the development of culturally relevant dietary recommendations for diabetes management.

METHOD

This study employed a quantitative research approach using a quasi-experimental design with a pre–post test intervention involving the consumption of a nira beverage. The study was conducted in the service area of West Kota Public Health Center (the health center with the highest number of diabetes patients) over a one-month period, from October to November 2025. A total of 28 participants were selected using purposive sampling based on the following inclusion criteria: willingness to participate until the completion of the study; a confirmed diagnosis of Diabetes Mellitus; residency in Molosipat W Subdistrict, West Kota District, Gorontalo City; no known allergy to nira beverages; not pregnant or breastfeeding; consumption limited to prescribed blood glucose–lowering medications; and restriction from consuming sweet snacks (such as cakes, cookies, dodol, and similar foods) that could increase blood glucose levels during the study period.
Data collection included respondent characteristics, blood glucose levels, and glycemic index measurements. Data analysis was performed using a paired t-test for normally distributed data and the Wilcoxon signed-rank test for non-normally distributed data.

RESULT

Characteristics of Respondents

Table 1.
Characteristics of Respondents

	Min-max	Mean±SD
Age	35-65	52,50±7,48
Duration of Diabetes Mellitus (years)	1-15	4,93±4,2
Body Weight (kg)	45-94	62,43±12,68
Height (cm)	147-163	153±4,61
Body Mass Index (kg/m²)	21-39	26,94±4,41
Fasting Blood Glucose Before Nira Consumption	185-359	257,5±52,19
Random Blood Glucose 2 Hours After Nira Consumption	108-247	182,29±40,39
Fasting Blood Glucose Before Sugar Water Consumption	211-342	265±43,23
Blood Glucose 2 Hours After Nira Consumption	96-355	175,43±75,81

Table 1 presents the baseline characteristics of the respondents as well as changes in fasting blood glucose (FBG) and blood glucose levels 2 hours after the intervention. The respondents' ages ranged from 35 to 65 years, with a mean of 52.50 ± 7.48 years, indicating that most participants were in the middle-aged group, which epidemiologically carries a higher risk of metabolic disorders, including diabetes mellitus. The duration of diabetes mellitus varied from 1 to 15 years, with an average of 4.93 ± 4.20 years, reflecting heterogeneity in disease duration and potential differences in metabolic control among participants. Anthropometric parameters showed that body weight ranged from 45 to 94 kg, with a mean of 62.43 ± 12.68 kg, while height ranged from 147 to 163 cm, with a mean of 153.00 ± 4.61 cm. The respondents' Body Mass Index (BMI) ranged from 21 to 39 kg/m², with an average value of 26.94 ± 4.41 kg/m², indicating that the majority of participants were classified as overweight to obese, a condition known to contribute to reduced insulin sensitivity.

Regarding blood glucose measurements, fasting blood glucose levels before nira consumption ranged from 185 to 359 mg/dL, with a mean of 257.50 ± 52.19 mg/dL, indicating that respondents were in a hyperglycemic state prior to the intervention. Two hours after nira consumption, postprandial blood glucose levels decreased to a range of 108–247 mg/dL, with a mean of 182.29 ± 40.39 mg/dL. This reduction suggests that nira consumption may have a potential postprandial glucose-lowering effect among the respondents. In contrast, fasting blood glucose levels before sugar water consumption ranged from 211 to 342 mg/dL, with a mean of 265.00 ± 43.23 mg/dL. These values were slightly higher than fasting glucose levels prior to nira consumption, reflecting baseline glycemic status before the comparator intervention. Two hours after sugar water consumption, blood glucose levels ranged from 96 to 355 mg/dL, with a mean of 175.43 ± 75.81 mg/dL. The wider variability in response, as indicated by the higher standard deviation (SD = 75.81), may be attributed to individual differences in glucose tolerance.

Differences in Blood Sugar Levels Before and After Giving Sap to Patients with Diabetes Mellitus

Table 2.
Differences in Blood Sugar Levels Before and After Giving Nira to Patients with Diabetes Mellitus

Consuming		n	mean	SD	SE mean	P value
Nira	Before	14	257,5	52,2	13,9	0,000*
	After	14	182,3	40,4	10,7	
Sugar Water	Before	14	265,6	43,2	11,6	0,000*
	After	14	175,4	75,8	20,3	

**Paired sample t test*

Table 2 presents the results of the analysis comparing differences in blood glucose levels among patients with diabetes mellitus who received two types of interventions: nira beverage consumption and sugar water solution. Measurements were conducted before and after the intervention, with 14 respondents in each group. In the nira beverage group, the mean blood glucose level before the intervention was 257.5 mg/dL with a standard deviation of 52.2 mg/dL. Two hours after nira consumption, the mean blood glucose level decreased to 182.3 mg/dL with a standard deviation of 40.4 mg/dL. A p-value of 0.000 indicates that this reduction was highly statistically significant, suggesting that nira consumption had a meaningful postprandial glucose-lowering effect among the respondents.

In the sugar water group, the baseline blood glucose level was 265.6 mg/dL with a standard deviation of 43.2 mg/dL. Two hours after consumption, blood glucose levels decreased to a mean of 175.4 mg/dL with a standard deviation of 75.8 mg/dL. The greater variability in response, as reflected by the substantially higher post-intervention standard deviation (SD = 75.8), indicates differences in individual glucose tolerance within this group. Nevertheless, a p-value of 0.000 demonstrates that the reduction in blood glucose levels following sugar water consumption was also statistically significant.

Analysis of the effect of giving 25 g of sugar water on glycemic index (blood sugar levels 0, 30, 60, 90 and 120 minutes) in patients with diabetes mellitus

Table 3 illustrates changes in the mean blood glucose levels of patients with diabetes mellitus following sugar water administration, observed at multiple time intervals. At minute 0, prior to the intervention, the mean blood glucose level was recorded at 265.6 mg/dL. After sugar water consumption, blood glucose levels increased and reached a peak at 30 minutes, with a mean value of 289.3 mg/dL. This increase reflects the body's initial glycemic response to the intake of simple carbohydrates contained in sugar water.

Table 3.
Table of the effect of 25 g of sugar water on the glycemic index of people with diabetes mellitus

Sugar water administration	Average	F	P value
Minute 0	265,6	5,461	0,001*
Minute 30	289,3		
Minute 60	258,1		
Minute 90	224,4		
Minute 120	175,4		

******one way anova*

Subsequently, blood glucose levels exhibited a gradual downward trend as the observation time progressed. At 60 minutes, the mean blood glucose level decreased to 258.1 mg/dL, followed by a further reduction at 90 minutes to 224.4 mg/dL, and reached the lowest value at 120 minutes, at 175.4 mg/dL. This pattern suggests the activation of physiological blood glucose regulatory mechanisms; however, clinically, glucose levels remained above normal ranges.

Statistical analysis using one-way ANOVA revealed an F value of 5.461 with a p-value of 0.001 ($p < 0.05$), indicating a statistically significant difference in mean blood glucose levels across the measurement time points at 0, 30, 60, 90, and 120 minutes. Therefore, it can be concluded that sugar water administration had a significant effect on changes in blood glucose levels among patients with diabetes mellitus, characterized by an initial post-consumption increase followed by a gradual decline over time.

Analysis of the effect of giving palm sap drink on the glycemic index (blood sugar levels at 0, 30, 60, 90 and 120 minutes) in diabetes mellitus sufferers.

Table 4.
The Effect of Nira Beverage Administration on the Glycemic Index in Patients with Diabetes Mellitus

Nira Beverage Administration	Average	F	P value
Minute 0	257,6	5,539	0,001*
Minute 30	217,5		
Minute 60	223,9		
Minute 90	190,4		
Minute 120	182,3		

******one way anova*

Table 4 presents the results of the analysis on the effect of nira beverage administration on changes in the glycemic index among patients with diabetes mellitus, observed at several time intervals. At minute 0 (before nira beverage administration), the mean blood glucose level of the respondents was 257.6 mg/dL, indicating a hyperglycemic condition in most participants prior to the intervention. Following nira beverage consumption, the mean blood glucose level decreased to 217.5 mg/dL at 30 minutes. This finding indicates that nira consumption did not induce a sharp early postprandial glucose spike, in contrast to the glycemic response commonly observed after simple sugar intake. At 60 minutes, the mean blood glucose level slightly increased to 223.9 mg/dL; however, this value remained lower than the baseline blood glucose level. This mild fluctuation may be attributed to individual variations in metabolic responses to glucose absorption and utilization.

Subsequently, at 90 minutes, a more pronounced reduction in blood glucose levels was observed, with a mean value of 190.4 mg/dL, followed by a further decrease at 120 minutes to 182.3 mg/dL. This gradual downward pattern suggests a relatively stable blood glucose regulation process after nira consumption, which may be associated with the natural sugar content of nira with a lower glycemic index and the possible presence of bioactive compounds that slow glucose absorption. Statistical analysis using one-way ANOVA revealed an F value of 5.539 with a p-value of 0.001 ($p < 0.05$), indicating statistically significant differences in mean blood glucose levels across the measurement time points. Therefore, it can be concluded that nira beverage consumption has a significant effect on changes in the glycemic index among patients with diabetes mellitus, as evidenced by a consistent decline in blood glucose levels over the two-hour observation period.

DISCUSSION

Diabetes mellitus is characterized by impaired insulin secretion resulting from damage to pancreatic β-cells, which is largely mediated by immunological mechanisms and typically leads to absolute insulin deficiency (Klin et al., 2023). It is a common metabolic disorder worldwide, and its progression is driven by the interaction of two primary factors: impaired insulin secretion from pancreatic β-cells and reduced insulin sensitivity in peripheral tissues (Suardi et al., 2021). Additional risk factors include the rising prevalence of obesity and unhealthy dietary patterns (Sindi et al., 2024). A significant increase in diabetes incidence occurs in late adulthood and early old age, continuing up to ≤65 years. At this stage, glucose intolerance is common due to the declining capacity of pancreatic β-cells to produce insulin, resulting in elevated blood glucose levels (Soviana & Pawestri, 2020).

Consumption of foods with a high glycemic index (GI) may exacerbate the progressive development of diabetes. Therefore, one non-pharmacological approach is dietary regulation through the selection of low-GI foods. The glycemic index is used as an indicator to assess the potential risk of foods in the development or worsening of diabetes mellitus. However, GI assessment should be complemented by the calculation of glycemic load (GL), which considers not only the type but also the quantity of carbohydrates consumed. Glycemic load more comprehensively reflects the impact of carbohydrate intake on postprandial blood glucose levels and thus serves as an important complementary parameter to GI in evaluating carbohydrate quality and quantity. Consequently, dietary planning for low-sugar diets should consider both GI and GL values of carbohydrate-containing foods (Sunani, 2023).

Low-GI foods are digested and absorbed more slowly, resulting in gradual gastric emptying and intestinal glucose absorption, thereby promoting more stable blood glucose fluctuations. As a result, consumption of low-GI foods is beneficial for maintaining glycemic and lipid stability in both individuals with type 2 diabetes mellitus and healthy individuals. In contrast, high-GI foods are digested and absorbed rapidly, leading to greater glycemic and insulin responses and wider fluctuations in blood glucose levels (Sunani, 2023). Since GI does not account for the amount of carbohydrate consumed, it does not fully reflect blood glucose elevation. Therefore, glycemic load provides a more accurate representation by linking GI values with carbohydrate quantity. Foods with a high GL are associated with increased insulin production and elevated fasting and 2-hour postprandial blood glucose levels (Sunani, 2023).

Low-glycemic-load foods slow gastric emptying, thereby delaying digestion and glucose absorption in the small intestine. This mechanism helps stabilize insulin levels and prevent sharp increases in blood glucose (Soviana & Pawestri, 2020). The glycemic index ranges from 1 to 100 and is categorized as low (≤55), moderate (56–69), or high (≥70). Information on GI values can guide consumers in food selection for diabetes management, prevention, and overall health maintenance (Simping Yuliatun, 2023).

Palm sugar is a carbohydrate source with a relatively low glycemic index. Crystalline palm sugar has a GI of 43.61, while molded palm sugar falls into the moderate GI category with a value of 62.47. Palm sugar is derived from palm sap (nira aren), a sugar-rich liquid that can be processed into sugar or fermented into ethanol. In addition to carbohydrates, palm sap contains protein, energy, fiber, and vitamins. Fresh palm sap contains approximately 13.9–14.9% sucrose, with ash and fat contents of 0.04% and 0.02%, respectively. Although present in small amounts, protein contributes to glucose metabolism and accounts for approximately 0.78% of the total dry matter (Solang et al., 2020).

Palm sap (nira aren) is obtained from the sap of palm tree inflorescences (Borassus flabellifer) and is widely found in regions such as East Nusa Tenggara, East Java, and South Sulawesi, Indonesia. It has a naturally sweet taste and high nutritional value, including vitamin A, calcium, protein, iron, and magnesium. Palm sap exhibits hypoglycemic and antihyperlipidemic effects. Methanolic extracts of male palm flowers and the major saponin compound, dioscin, have been shown to reduce serum glucose levels in diabetic rat models. In addition, bioactive compounds such as tannins, flavonoids, saponins, alkaloids, and terpenes contribute to blood glucose reduction in experimental diabetes models (Ida Leida et al., 2020). According to Solang et al. (2020), palm sap has a low glycemic index (GI = 35.56), making it a healthier alternative compared to other sugars. Low-GI foods are digested and converted into glucose gradually, producing a lower and shorter glycemic peak, suggesting that palm sap may serve as an alternative beverage for maintaining blood glucose levels.

The results of this study showed that following nira beverage consumption, the mean blood glucose level decreased to 217.5 mg/dL at 30 minutes. This finding indicates that nira consumption did not induce a sharp early postprandial glucose spike, in contrast to the typical glycemic response observed after simple sugar intake. At 60 minutes, mean blood glucose levels slightly increased to 223.9 mg/dL but remained lower than baseline values. These findings are supported by previous research demonstrating a significant reduction in blood glucose levels in groups receiving palm sap intervention compared with control groups (Ida Leida et al., 2020). Follow-up observations revealed weekly reductions in blood glucose levels in both intervention and control groups; however, the reduction was greater in the palm sap intervention group. Administration of palm sap for three weeks at a dose of 200 mL twice daily (morning and evening after meals) was shown to be effective in reducing blood glucose levels in individuals with prediabetes.

One limitation of this study is the relatively small sample size, which may limit the generalizability of the findings to broader populations. Individual variability in glycemic response and carbohydrate metabolism may also have influenced the results, requiring cautious interpretation. A second limitation is the short duration of the intervention, which ranged from several hours for postprandial measurements to only a few weeks overall. This limited timeframe restricts the ability to assess the long-term effects of palm sap, sugar, or honey consumption on blood glucose levels, insulin dynamics, and lipid profiles.

Another limitation relates to the control of external factors, such as dietary intake, physical activity, and individual health conditions, which could not be fully standardized. These factors may contribute to fluctuations in blood glucose levels and affect the internal validity of the study. Therefore, future research employing more rigorous designs and stricter control of confounding variables is recommended to strengthen the conclusions.

CONCLUSION

Based on the study results, it can be concluded that consumption of nira beverage has a significant effect on blood glucose levels. A statistically significant difference was observed between blood glucose levels before and after nira consumption in the intervention group ($p = 0.000$). In addition, glycemic index analysis also demonstrated a significant difference ($p = 0.001$). These findings indicate that nira beverage exerts a measurable effect on the body's glycemic response and therefore should be carefully considered in dietary regulation, particularly among individuals at risk of impaired glucose metabolism.

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