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Effect of Cinnamon Powder on Random Blood Glucose Among Type 2 Diabetes Patients: A Nonequivalent Control Group Quasi-Experimental Study

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Abstract:
Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistently elevated blood glucose due to insulin resistance and impaired pancreatic β-cell function. Cinnamon (Cinnamomum sp.), which contains polyphenols and cinnamaldehyde, has been suggested to influence biological pathways related to glucose regulation. This study aimed to assess the short-term effect of cinnamon powder supplementation on random blood glucose levels in adults with type 2 diabetes mellitus. A quasi-experimental study with a non-randomized, nonequivalent control group design was conducted among 32 participants. The intervention group consumed Cinnamos sp. daily for three consecutive days. The control group continued usual diabetes management without additional supplementation. Two-hour postprandial (random) blood glucose was measured at baseline and on each of the three study days using a digital glucometer. Blood glucose levels declined significantly over time in both the intervention and control groups during the three-day observation period ($p < 0.001$). On day 3, mean blood glucose was 193.31 mg/dL in the intervention group and 167.31 mg/dL in the control group, yielding a mean difference of 26.00 mg/dL ($p < 0.05$). These findings suggest that short-term cinnamon powder administration is associated with changes in random blood glucose relative to standard therapy alone, although the direction of effect between groups was not consistent with an added benefit. Causal inference should be made cautiously given the non-randomized design, brief exposure period, and baseline imbalances between groups, and larger randomized controlled trials are warranted.

Keywords: *blood glucose, Cinnamon, herbal therapy, type 2 diabetes mellitus*
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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a long-standing metabolic disorder in which blood glucose levels remain chronically elevated due to disturbances in insulin secretion and insulin action (Galicia-Garcia et al., 2020). Sustained hyperglycemia gradually affects multiple organs and leads to cardiovascular, neurological, and renal complications (Roy, 2025). Recent global estimates show that the prevalence of T2DM continues to increase. The report showed that the number of cases is expected to reach approximately 578 million by 2030 (Sebastian et al., 2023). The growing magnitude of this condition, combined with its substantial clinical and economic consequences, underscores its significance as a pressing public health concern (Hossain et al., 2024).

Type 2 diabetes mellitus accounts for the majority of diabetes cases in Indonesia (Muharram et al., 2025). National data reports that estimate a prevalence of 10.6%, indicating a substantial disease burden compared with many other countries (Soeatmadji et al., 2023) (Młynarska et al., 2025).

Subnational data further illustrate this burden in West Java, where reported cases increased from over 800,000 in 2019 to more than one million in 2020 (Ahmad et al., 2024). A similar upward trend has been observed in Cimahi, where records from the Cigugur Tengah Community Health Center show an increase in the number of patients with diabetes between 2020 and 2021. The persistence of these trends underscores the need to identify management strategies that are safe and feasible for routine primary care (Ahmad et al., 2024).

Uncontrolled diabetes carries the risk of serious complications, including coronary heart disease, stroke, neuropathy, and chronic kidney failure (Mohd et al., 2025). The management of type 2 diabetes generally combines pharmacological therapies such as metformin and other oral hypoglycemic drugs (Antar et al., 2023). Non-pharmacological interventions include diet management, physical activity, weight management, and lifestyle modifications. Pharmacological treatment is effective in lowering blood glucose levels. Still, side effects of the drugs, such as digestive disorders, hypoglycemia, and drug interactions, have sparked interest in complementary therapies based on natural ingredients that are considered safer and more widely accessible (Padhi et al., 2020).

Several medicinal plants and spices are being studied as hypoglycemic agents, such as turmeric, red ginger, cloves, and cinnamon (Debnath et al., 2025). Cinnamon (*Cinnamomum sp*.) is known to lower blood glucose levels through several mechanisms, including increased insulin sensitivity, stimulation of insulin receptors, inhibition of gluconeogenesis enzymes, and decreased peripheral insulin resistance (Azimi et al., 2015). The active compounds in cinnamon are polyphenols and cinnamaldehyde, which are thought to regulate glucose and lipid metabolism (Kizilaslan & Erdem, 2019). Cinnamon powder is relatively easy to obtain and inexpensive. It can be consumed as an addition to food or beverages, making it a safe and straightforward, natural-based strategy for blood glucose control (Debnath et al., 2025). Several previous studies have reported blood glucose-lowering effects after cinnamon administration in people with type 2 diabetes. Numerous studies exhibit drawbacks, like small sample sizes, brief intervention durations, or non-randomized designs, which restrict the capacity to infer causal findings (Kizilaslan & Erdem, 2019) (Shang et al., 2021). Data on the use of cinnamon as a complementary therapy in Indonesia is still limited, despite the country's potential as a source of herbal resources.

This study evaluated the effect of cinnamon powder consumption on blood glucose levels among adults with T2DM. In addition, the study explored the feasibility of cinnamon as a complementary therapy with an acceptable safety profile. The findings are intended to provide preliminary evidence to inform future randomized controlled trials. Longer intervention periods and to contribute to discussions on the potential role of herbal-based approaches in diabetes management within clinical and public health settings.

METHODS

The study employed a quasi-experimental design with a nonequivalent control group. In May and June of 2025, data were collected in the operational area of the Cigugur Tengah Community Health Center in Cimahi City, Indonesia.

The study population consisted of adults who were registered at the health center and diagnosed with T2DM. The eligibility criteria for this study were subjects with fasting or two-hour postprandial blood glucose levels above 200 mg/dL at baseline, measured with a 500 mg/day dose of metformin. Patients who experienced acute complications or made changes to their antidiabetic drug regimen during the study period were excluded. Consecutive sampling was used to select respondents in the order in which patients who met the requirements arrived. The division into intervention and control groups was done sequentially by arrival order, so that the two groups were not formed through randomization. A formula for comparing two independent means was used to determine the sample size, assuming a mean difference of 1.64 mg/dL and a standard deviation of 8 mg/dL, based on previous studies. This study was designed as an exploratory study and was not intended to have sufficient power to definitively detect differences between groups. The sample size calculation was designed to obtain preliminary data that could serve as the basis for subsequent studies. The sample size calculation is as follows:

$$N_1 = N_2 = 2\left(\frac{(Z_\alpha - Z_\beta)S}{X_1 - X_2}\right)^2$$

The total number of participants in this study was 32, divided into two groups: non-treatment and treatment. An overview of the recruitment process, group division, follow-up, and data analysis is presented in Figure 1.

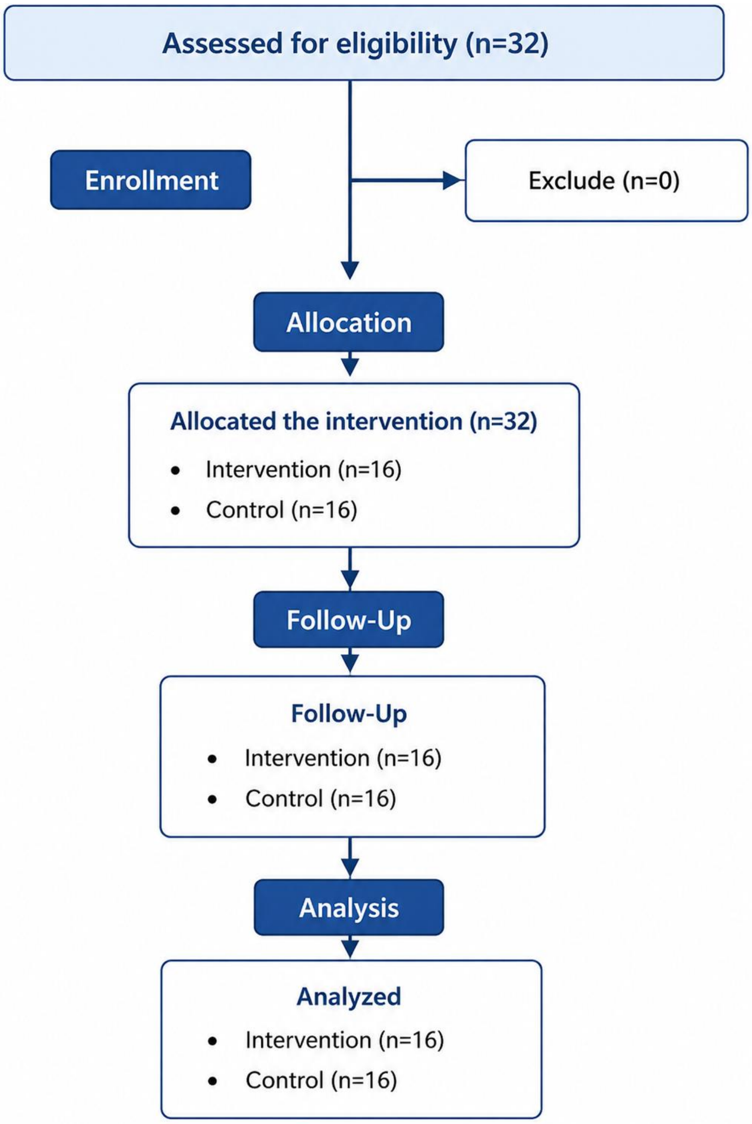

Figure 1. Flow diagram of participant from enrollment to final analysis

Ethical Clearance has been obtained from the FITKes–Unjani Research Ethics Committee (No. 017/KEPK/FITKes Unjani/V/2025), and the protocol has been prospectively registered with the Indonesia Clinical Research Registry (INA CRR; No. INA 103080E). All respondents signed a written consent form before participating in the study, and data confidentiality was strictly maintained throughout the research process.

Intervention

Participants assigned to the intervention group consumed cinnamon powder derived from *Cinnamomum cassia* obtained from local commercial sources. The research team processed the raw material into a fine powder and packaged it into uniform, pre-measured portions to ensure consistent dosing. Each participant consumed three grams of cinnamon powder dissolved in one cup of hot water once daily. Approximately two hours after a meal for three consecutive days. The selected dosage was based on amounts commonly reported in previous clinical studies assessing the glycemic effects of cinnamon. Trained health personnel supervised the intake of the preparation to support adherence and proper administration. Participants in the control group continued routine management for type 2 diabetes mellitus, including stable metformin therapy, without receiving any additional herbal supplementation.

Data Analysis

The primary analysis of this study was the 2-hour postprandial blood glucose level. Measurements were obtained using a digital glucometer (Gold AQ Glucose Monitoring System; Sinocare Inc., China). Blood glucose was assessed at baseline prior to the intervention and subsequently measured on Days 1, 2, and 3 following the intervention period. Trained healthcare personnel conducted all measurements using the same device throughout the study to maintain procedural consistency.

RESULTS

This analysis compared changes in blood glucose levels between adults with type 2 diabetes mellitus who received cinnamon powder as an adjuvant to standard therapy and those who received standard therapy alone. Random blood glucose was assessed in both groups at baseline and subsequently measured over three consecutive follow-up days (Days 1–3). Each measurement was obtained two hours after treatment administration.

Baseline Characteristic

Participant characteristics at baseline are outlined in Tables 1 and 2. Both groups had comparable age distributions, with mean ages of 60.44 ± 8.51 years in the intervention group and 59.38 ± 10.63 years in the control group. Most participants were women, had lower to middle educational attainment, and were engaged in household work.

Table 1. Age distribution of participants

VariabLE	control (n=16)	Intervention (n=16)
Age		
Mean ± SD	59.38 ± 10.63	60.44 ± 8.51
Median	56	60
Min-Max	47-85	50-74

Table 2. Characteristics of participants

Variable	Goups			
	Control		Intervention	
	F	%	F	%
Gender				
Male	3	18.8	2	12.5
Female	13	81.2	14	87.5
Education				
No formal education	0	0	1	6.3
Primary school	7	43.8	8	50
Junior high school	5	31.3	5	31.3
Senior high school	4	25	2	12.5
Occupation				
Unemployed	0	0	1	6.3
Housewife	13	81.3	14	87.5
Private employee	3	18.7	0	0
Civil servant	0	0	1	6.3

Table 3. Comparison of Random Blood Glucose Levels Before and After Cinnamon Powder Supplementation Between Intervention and Control Groups

Groups	N	Time	Blood Glucose (Mean ± SD)	p-value
Control	16	Pre-treatment	275.81±15.901	< 0.001*
		Day-1	243.19 ± 36.772	
		Day-2	203.88 ± 29.212	
		day-3	167.31 ± 26.396	
Intervention	16	Pre-treatment	239.69 ± 23.866	< 0.001*
		Day-1	218.38 ± 31.249	
		Day-2	210.56 ± 29.164	
		day-3	193.31 ± 33.611	

***Note**: Data was analyzed with on Repeated Measures ANOVA at a 95% confidence level; * Significane different*

As shown in Table 3, mean random blood glucose levels in the control group decreased steadily over the three-day observation period. The baseline value of 275.81 ± 15.90 mg/dL declined to 243.19 ± 36.77 mg/dL on Day 1, followed by further reductions to 203.88 ± 29.21 mg/dL on Day 2 and 167.31 ± 26.40 mg/dL on Day 3.. In the intervention group, mean random blood glucose decreased from 239.69 ± 23.87 mg/dL at baseline to 218.38 ± 31.25 mg/dL on Day 1, 210.56 ± 29.16 mg/dL on Day 2, and 193.31 ± 33.61 mg/dL on Day 3. Within-group analysis using repeated measures ANOVA indicated a statistically significant reduction in random blood glucose over time in both groups ($p < 0.001$).

Table 4. Between-Group Comparison on Day 3

Group	n	Mean ± SD (mg/dL)	Mean Difference	95% CI	Cohen's d	p-value
Control	16	167.31 ± 26.40	26.00	4.22 – 47.78	0.86	0.021*
Intervention	16	193.31 ± 33.61				

Note: Independent t-test; CI = confidence interval.

Table 4 showed a significant difference in random blood glucose between the groups on Day 3 ($p = 0.021$). The tretament group had a higher mean random blood glucose level than the non-treatment group at this time point. The estimated mean difference was 26.00 mg/dL, with a 95% confidence interval of 4.22 to 47.78 mg/dL. This finding show that participants in the intervention and non-treatment groups had significantly different Day 3 glucose values, with a large effect size (Cohen's d = 0.86).

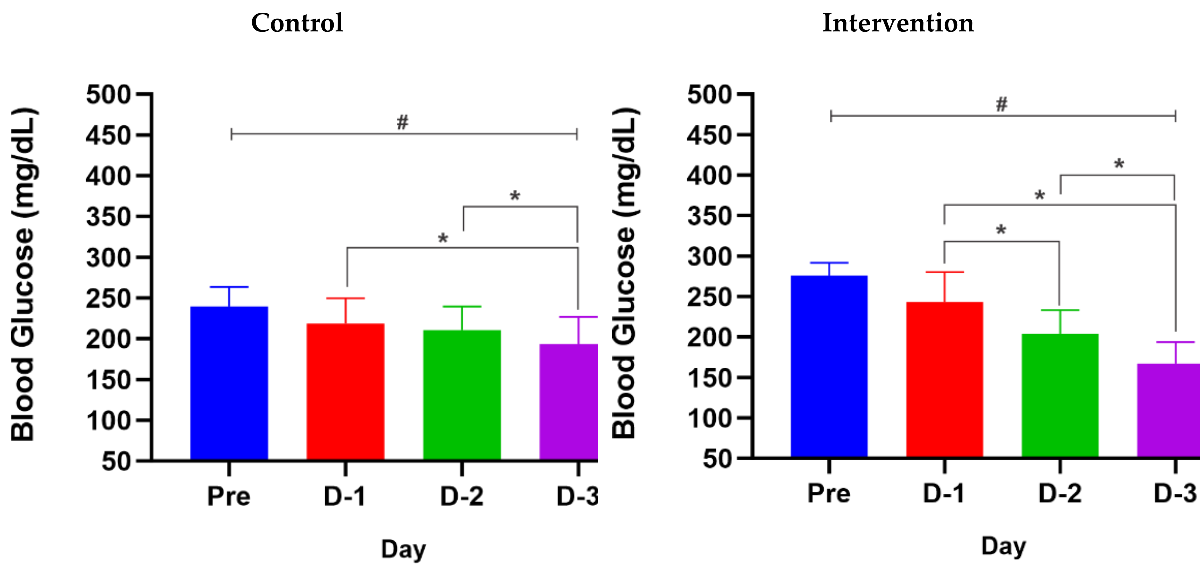

Figure 2. Illustrates of mean random blood glucose concentrations from baseline to Day 3 in both study groups. Across the three observation days, glucose values declined in the control arm as well as in participants who received cinnamon supplementation. Within each group, several time-point comparisons showed statistically significant reductions relative to baseline (repeated-measures ANOVA and post hoc tests, $p < 0.05$)

According to Figure 2, the magnitude of within-group change differed between groups. Over the three-day period, the control group experienced a decline of approximately 108.5 mg/dL, whereas the reduction in the intervention group was about 46.4 mg/dL.

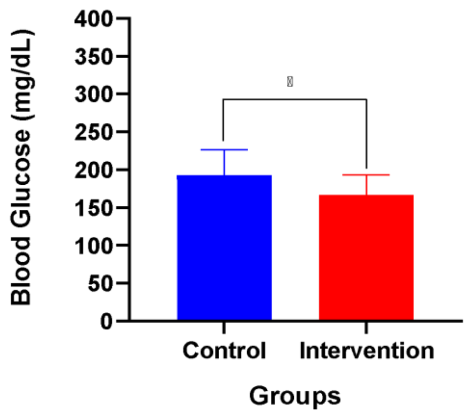

Figure 3. The mean random blood glucose concentrations on Day 3 for participants in the control and cinnamon groups. At this final measurement, glucose levels were significantly different between the two arms ($p < 0.05$). Results are shown as mean values with corresponding standard deviations, and * indicate statistical significance at the 95% confidence level.

The average Day-3 random blood glucose in the control group was 167.31 ± 26.40 mg/dL, whereas the cinnamon group showed a higher mean value of 193.31 ± 33.61 mg/dL. The resulting between-group difference of 26.0 mg/dL occurred despite overall declines in blood glucose across the study period in both groups, and should be interpreted while considering concurrent lifestyle and pharmacological interventions

DISCUSSION

This study aimed to evaluate short-term changes in random blood glucose among adults with type 2 diabetes mellitus who received cinnamon powder in addition to standard therapy. After three days of observation demonstrated that the both groups has statistically significant reduction in blood glucose level. Suggesting early improvement in glycemic control under routine diabetes management.

Blood glucose levels declined over time in both study groups, including participants who received cinnamon supplementation and those who continued standard care alone. This observation indicates that early improvements in glycemic control were not exclusive to the intervention group. Previous research by Novendy et al., (2020) reported that a rapid decrease in blood glucose following cinnamon intake. The present findings differ in terms of dosage, preparation, and exposure duration. In this study, caution is required when interpreting the magnitude and timing of glucose changes (Novendy et al., 2020). Short-term glycemic fluctuations observed in this study are likely shaped by ongoing standard therapy, initial glycemic conditions, and individual differences in metabolic response (Bailey, 2024). These findings suggest that cinnamon may have a supportive role in short-term glucose regulation, although confirmation through randomized controlled trials with larger sample sizes and longer intervention periods remains necessary..

Diabetes mellitus is commonly defined as a metabolic disease marked by chronic hyperglycemia brought on by insufficient insulin production and reduced tissue sensitivity to insulin (Adeleke et al., 2023). This study also showed a decrease in random blood glucose levels in control group participants who did not receive cinnamon. This result likely reflects their consistent involvement in standard diabetes management, including structured physical activity programs such as Prolanis and the continued use of oral hypoglycemic medications (Alkaff et al., 2021). The results of this study illustrate the critical role of lifestyle modifications, combined with pharmacological therapy, in achieving effective glycemic control (Rahu et al., 2025).

All respondents in this study received metformin, which is generally recommended as the initial pharmacological agent for the management of type 2 diabetes mellitus (Indarto et al., 2023) (Bailey, 2024). The antihyperglycemic effect of metformin primarily occurs through mechanisms of increased insulin sensitivity, decreased hepatic glucose synthesis and elevated peripheral tissue glucose absorption (Riwu et al., 2015). The study's two groups declining blood glucose levels was likely influenced by ongoing metformin therapy, making it challenging to attribute glycemic changes exclusively to the cinnamon intervention. The difference in baseline glucose levels between groups increases the likelihood of regression to the mean and short-term clinical variability, which may contribute to the significant decreases observed, including decreases of more than 100 mg/dL in three days.

Cinnamon supplementation has been proven in earlier research to enhance glycemic outcomes when used as an adjunct to standard management (Allen & Coleman, 2013). Vonikartika & Hutapea (2024) reported that participants who received cinnamon supplementation had greater reductions in blood glucose levels than those who received only education. Qurrohman et al., (2023) emphasized the potential role of herbal therapy in supporting the four pillars of diabetes management, namely pharmacological treatment, education, diet, and physical activity. Most randomized clinical trials and meta-analyses reported a more moderate decrease in blood glucose after cinnamon supplementation, which was observed after several weeks to months of intervention. Results from several studies in a meta-analysis of randomized clinical trials involving 543 individuals with type 2 diabetes mellitus indicate that cinnamon supplementation is linked to a decrease in fasting plasma glucose levels of roughly 24.6 mg/dL with daily dosages ranging from 120 mg to 6 g during 4 to 18 weeks (Allen & Coleman, 2013). The study's findings also show that there are lipid alterations, such as a rise in HDL cholesterol and a drop in total cholesterol, LDL cholesterol, and triglycerides, in addition to glycemic effects. Despite metabolic improvements, consistent effects on HbA1c levels were not proven. The high heterogeneity between studies limits the direct application of these findings in everyday clinical practice. The results of this previous study indicate that the hypoglycemic effects of cinnamon, although statistically significant, are typically moderate and require a longer duration of use to be clinically apparent (Allen & Coleman, 2013).

Findings from triple-blind, placebo-controlled randomized trials by Zare et al., 2019) and Yu et al., (2023) showed that cinnamon bark powder at a dose of 500 mg twice daily for three months produced improvements in body composition and lipid profiles, together with reductions in fasting plasma glucose, 2-hour postprandial glucose, and HbA1c, particularly among participants with higher body mass index. These studies support cinnamon as a potential adjunct to improve glycemic and metabolic control, but the magnitude of glucose lowering observed typically reductions of several tens of mg/dL over weeks to months remains much smaller than the rapid, large decreases reported in short-term quasi-experimental designs such as the present study, so caution is needed when extrapolating short-term findings to long-term clinical effectiveness. The metabolic benefits were more pronounced among participants with higher body mass index (BMI). These trials support the role of cinnamon as a potential adjunct to enhance glycemic and metabolic control. The extent of glucose lowering reported in rigorously controlled clinical settings, generally amounting to reductions of several tens of mg/dL. Substantially lower than the rapid and marked decreases observed in short-term quasi-experimental designs, including the present study. This discrepancy highlights the importance of cautious interpretation when extrapolating findings derived from brief intervention periods.

The glucose-modulating properties of cinnamon are mainly due to its bioactive molecules, including cinnamaldehyde, cinnamic acid, and various polyphenols (Bindawa et al., 2025) (Williamson & Sheedy, 2020). According to experimental research, these substances increase glucose absorption in peripheral tissues by promoting GLUT4 translocation to the cell membrane and enhancing insulin signaling via pathways such IRS1/PI3K/Akt (Senevirathne et al., 2022). Cinnamon has also been reported to inhibit the enzymes α-glucosidase and α-amylase. The mechanism that has the potential to suppress postprandial blood glucose elevation (Lakshmi et al., 2009) (Naz et al., 2023).

Several limitations of this study should be acknowledged. The non-randomized design with nonequivalent control groups increases the risk of selection bias and baseline differences between the intervention and control arms, which may affect the internal validity of the findings. The short intervention period limits inferences regarding sustained glycemic effects, and the lack of blinding among outcome assessors may have introduced measurement bias. In addition, key lifestyle-related factors, such as diet, physical activity, and medication adherence, were not quantitatively assessed. Within these limitations, the findings suggest that cinnamon powder supplementation, when administered alongside standard care, may contribute to short-term reductions in random blood glucose levels among individuals with type 2 diabetes mellitus. These observations should be interpreted as preliminary and exploratory. Further studies using randomized controlled trial designs, larger sample sizes, longer intervention periods, standardized cinnamon formulations, and rigorous control of potential confounders are required to clarify the clinical relevance of cinnamon as an adjunctive therapy.

CONCLUSION

The results of this study indicate that administering cinnamon powder as an adjunct to standard pharmacological therapy reduced blood glucose levels in the short term in both the intervention and no-intervention groups. The results also indicate that routine diabetes management can control blood sugar levels. Further research is expected to utilize a longer-term randomized clinical trial design, a standardized cinnamon formulation, and a larger sample size to confirm efficacy and safety.

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AUTHOR CONTRIBUTION

Dedi Supriadi contributed to the conception of the study idea, data collection, data analysis, and manuscript preparation. Ismafiaty contributed to the study design, data analysis, and manuscript review. Yusuf Cahyana contributed to data collection and manuscript preparation.

ETHICAL CONSIDERATIONS

This study was approved by the FITKes–Unjani Research Ethics Committee, General Achmad Yani University (No. 017/KEPK/FITKes Unjani/V/2025). The objectives and procedures of the study were explained to all participants, who voluntarily agreed to take part and signed written informed consent prior to participation.

FUNDING

This study received no external funding.

CONFLICT OF INTEREST

All the authors declare that they have no conflicts of interest

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

PROTOCOL REGISTRATION

This study was prospectively registered with the Indonesian Clinical Research Registry (INA CRR; No. INA 103080E).

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