



Case Study

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The Effect of Cinnamon Consumption on Reducing Blood Sugar Levels in Diabetes Mellitus Patients: An Experimental Study



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Abstract

Background: Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia. Complementary therapy using natural substances such as cinnamon (*Cinnamomum verum*) has been widely studied due to its bioactive compounds that can improve insulin sensitivity and reduce blood glucose levels.

Objective: To analyze the effect of cinnamon consumption on reducing blood sugar levels in patients with type 2 diabetes mellitus.

Methods: This study was a pre-post experimental design with a single group. A total of 310 patients with type 2 diabetes mellitus from three healthcare facilities in South Sulawesi were sampled. The intervention consisted of consuming 1.5 grams of cinnamon capsules daily for 40 days. Fasting blood glucose levels were measured before and after the intervention using the enzymatic spectrophotometric method (GOD-PAP).

Results: There was a significant decrease in fasting blood glucose levels after cinnamon consumption (mean before: 186.3mg/dL; after: 142.7mg/dL; $p < 0.001$). Seventy-two percent of respondents experienced a reduction of ≥ 30 mg/dL.

Conclusion: Regular consumption of cinnamon can significantly reduce fasting blood glucose levels in patients with type 2 diabetes mellitus. Cinnamon has potential as a complementary therapy in diabetes management.

Keywords: Cinnamon; *Cinnamomum verum*; Diabetes mellitus; Blood glucose; Herbal therapy

Introduction

Diabetes Mellitus (DM) is a global health problem characterized by chronic hyperglycemia and associated with dangerous systemic complications. Pharmacological therapies, while essential, often have limitations due to side effects and their inability to optimally control blood glucose levels. This has led to increased interest in complementary and adjuvant therapies using natural substances such as cinnamon (*Cinnamomum verum*), which may offer safer and effective alternatives in diabetes management [1,2].

Cinnamon contains several bioactive compounds including cinnamaldehyde, cinnamic acid, procyanidins, eugenol, and coumarin, which contribute to its antidiabetic properties. Cinnamaldehyde, the primary aromatic aldehyde, enhances insulin receptor activity by promoting phosphorylation of insulin signaling molecules, resulting in increased glucose uptake in muscle and adipose tissues [3-5]. Cinnamic acid inhibits digestive enzymes such as α -glucosidase and α -amylase, slowing carbohydrate digestion and glucose absorption, which helps reduce postprandial glucose

spikes [6-8]. Meanwhile, procyanidins and other polyphenols exert antioxidant effects protecting pancreatic β -cells from oxidative stress and improve insulin sensitivity through activation of AMP-activated protein kinase (AMPK) pathways [9-12]. Additionally, eugenol and coumarin contribute anti-inflammatory and antioxidant effects that further support glucose metabolism, although caution is warranted with coumarin due to potential hepatotoxicity at high doses [13,14].

These combined effects of cinnamon's chemical constituents work synergistically to improve insulin sensitivity, modulate hepatic glucose metabolism, inhibit carbohydrate digestion, and reduce oxidative stress and inflammation, which are key factors in the pathogenesis of type 2 diabetes [5,7,9,12]. As such, cinnamon has the potential to serve as a complementary therapy to improve glycemic control in patients with type 2 diabetes mellitus.

This study aims to experimentally evaluate the effect of cinnamon consumption on fasting blood glucose levels in patients with type 2 diabetes mellitus, contributing to evidence-based validation of cinnamon as an adjuvant therapeutic option.

Methods

Study design

This study employed a pre-experimental one-group pre-test-posttest design to evaluate the effect of cinnamon consumption on fasting blood glucose levels in patients with type 2 diabetes mellitus [18,19]. This design allows for the assessment of changes within the same subjects before and after the intervention without a control group, suitable for preliminary efficacy evaluation.

Population and sample

The study population consisted of 310 patients diagnosed with type 2 diabetes mellitus who met the following inclusion criteria: aged between 30 and 65 years, not currently undergoing insulin therapy, no known allergy to cinnamon, and willing to comply with the intervention protocol for 40 consecutive days. Recruitment was conducted through purposive sampling to ensure participants met the clinical and demographic criteria relevant to the study's objectives [20,21].

Study setting

The research was conducted across three primary health care centers (Puskesmas) and one diabetes specialty clinic located in South Sulawesi province, Indonesia, specifically in the cities/regencies of Makassar, Gowa, and Bone. These settings were selected for their accessibility to the target population and existing infrastructure to support clinical monitoring [22].

Intervention

Participants were administered cinnamon capsules at a dose of 500mg three times daily, totaling 1.5 grams per day, over a 40-day intervention period. The cinnamon used was standardized *Cinnamomum verum* extract, ensuring consistency in bioactive compound content across all capsules [23]. The dosage and duration were based on previous clinical trials indicating efficacy and safety within this range [6,16].

Measurement of outcomes

Fasting blood glucose levels (FBG) were measured at baseline (pre-intervention) and immediately after the 40-day intervention (post-intervention). Blood samples were analyzed using the glucose oxidase-peroxidase enzymatic method (GOD-PAP), a widely accepted and reliable biochemical assay for plasma glucose quantification [24,25]. All blood samples were collected under fasting conditions (minimum 8 hours fasting) to standardize measurements.

Data analysis

Statistical analysis was performed using paired t-tests to compare the mean fasting blood glucose levels before and after cinnamon consumption, with a significance threshold set at $\alpha=0.05$ (95% confidence level). Prior to parametric testing, data normality was assessed with the Shapiro-Wilk test to validate the assumptions for the t-test [26,27]. Analyses were conducted using

statistical software packages commonly employed in biomedical research (e.g., SPSS, R).

Results

Participant characteristics

A total of 310 patients with type 2 diabetes mellitus participated in the study. The average age of respondents was 53.1 years (SD not reported). Female participants accounted for 60% (n=186), while males made up 40% (n=124). The mean duration of diabetes diagnosis among participants was 5.4 years. These demographic characteristics reflect a middle-aged population with a relatively moderate duration of diabetes.

Fasting blood glucose measurements

Fasting blood glucose (FBG) levels were measured before and after the 40-day cinnamon intervention. The mean FBG at baseline was 186.3mg/dL (SD 42.7), which decreased significantly to 142.7mg/dL (SD 35.1) following cinnamon consumption ($p < 0.001$). This statistically significant reduction demonstrates the potential efficacy of cinnamon as an adjunct therapy to lower blood glucose levels in type 2 diabetes patients.

Furthermore, 223 out of 310 participants (72%) experienced a clinically meaningful reduction in fasting blood glucose of at least 30mg/dL. Importantly, no serious adverse effects were reported throughout the intervention period, indicating that cinnamon supplementation was well tolerated.

Table 1 presents the demographic profile of the 310 participants involved in the study, highlighting key characteristics such as age, gender distribution, and duration of diabetes mellitus (DM). These factors are critical for understanding the baseline context of the study population and interpreting the study outcomes appropriately.

Table 1: Demographic Characteristics of Respondents (n=310).

Characteristic	Value
Age (mean $\pm$ SD)	53.1 $\pm$ — years
Gender	
Female	186 (60%)
Male	124 (40%)
Duration of DM (mean $\pm$ SD)	5.4 $\pm$ — years

Age

The mean age of respondents was 53.1 years, which aligns with the typical age range for type 2 diabetes onset and prevalence. Diabetes mellitus type 2 is predominantly a disease of middle-aged and older adults, as age-related insulin resistance and pancreatic beta-cell dysfunction contribute significantly to its pathogenesis. The selected age range (30-65 years) ensured inclusion of a representative adult population who are most likely to benefit from lifestyle and complementary interventions like cinnamon supplementation. The relatively middle-aged cohort also

reduces confounding effects of age-related comorbidities common in elderly patients, such as cardiovascular diseases, which could influence glucose metabolism independently.

Gender distribution

The study cohort consisted of 60% females and 40% males, which may reflect the demographic distribution of diabetes patients attending the selected healthcare facilities. Some epidemiological data suggest a slightly higher prevalence of type 2 diabetes in women, potentially due to differences in fat distribution, hormonal influences, and healthcare-seeking behavior. Gender differences can affect the response to interventions; for example, insulin sensitivity and metabolism may vary between males and females, influenced by sex hormones such as estrogen and testosterone. Therefore, including a gender-diverse sample enhances the generalizability of the findings and allows for potential subgroup analyses in future studies.

Duration of diabetes mellitus

Participants had been diagnosed with type 2 diabetes for an average duration of 5.4 years. This relatively moderate disease duration is relevant for evaluating the effectiveness of adjunct therapies such as cinnamon because long-standing diabetes often leads to progressive beta-cell dysfunction and increased complications, which may limit treatment responsiveness. Patients with shorter to moderate duration of diabetes are more likely to have residual beta-cell function and retain insulin sensitivity, making them ideal candidates for interventions aimed at improving glycemic control through enhanced insulin activity. Additionally, disease duration can correlate with the likelihood of existing pharmacological treatment regimens, dietary habits, and comorbidities, all of which impact glucose regulation.

Clinical relevance

Understanding the demographic profile is essential for interpreting the outcomes of cinnamon supplementation. For example, age and duration of diabetes may influence baseline glycemic control, while gender distribution can affect metabolic responses. These baseline characteristics also inform future clinical recommendations, as they highlight the patient populations most likely to benefit from cinnamon as an adjuvant therapy. Moreover, the absence of extreme age groups (very elderly or adolescents) focuses the applicability of results on the most prevalent adult diabetic population.

Potential confounding factors and study strengths

The relatively homogenous age range and balanced gender ratio reduce the risk of confounding variables affecting the intervention outcome. However, future studies should consider stratifying results by age groups and gender to further elucidate differential responses. Additionally, including patients with a broad duration of diabetes increases external validity but also necessitates careful interpretation regarding the progressive nature of the disease.

Table 2 summarizes the fasting blood glucose (FBG) levels

measured before and after the 40-day cinnamon supplementation intervention in 310 patients with type 2 diabetes mellitus (T2DM). The data show a significant reduction in FBG, highlighting the potential efficacy of cinnamon as an adjuvant therapy in glycemic control.

Table 2: Fasting Blood Glucose Levels Before and After Cinnamon Intervention.

Variable	Mean $\pm$ SD (mg/dL)	p-value
Before Intervention	186.3 $\pm$ 42.7	
After Intervention	142.7 $\pm$ 35.1	<0.001

Baseline fasting blood glucose

Before the intervention, the mean fasting blood glucose level was 186.3mg/dL with a standard deviation of 42.7mg/dL. This value reflects poor glycemic control consistent with the diagnostic criteria for diabetes, where fasting glucose levels above 126mg/dL are considered diagnostic for diabetes mellitus. The relatively large standard deviation indicates variability in glucose levels across participants, which is typical in diabetic populations due to differences in disease duration, treatment regimens, lifestyle, and metabolic status.

Post-intervention fasting blood glucose

After 40 days of daily cinnamon capsule intake (1.5 grams total), the mean FBG significantly decreased to 142.7mg/dL (SD 35.1mg/dL). This reduction represents a mean decrease of approximately 43.6mg/dL, which is clinically meaningful. Although the post-intervention average glucose level is still above the optimal target (typically <126mg/dL fasting), the improvement demonstrates a positive trend toward better glycemic control. This magnitude of reduction could translate into a lower risk of microvascular and macrovascular complications associated with chronic hyperglycemia.

Statistical significance

The paired t-test revealed a p-value of less than 0.001, indicating that the reduction in fasting glucose after cinnamon consumption is highly statistically significant. The use of paired analysis is appropriate as it accounts for within-subject variability, thus enhancing the validity of the findings. Normality of data distribution was confirmed using the Shapiro-Wilk test, justifying the parametric test choice.

Clinical implications

The observed decrease in fasting blood glucose suggests that cinnamon may have a beneficial effect on glucose metabolism in T2DM patients. This is consistent with cinnamon's bioactive compounds, such as cinnamaldehyde and procyanidins, which have been shown to enhance insulin receptor signaling, increase glucose uptake in peripheral tissues, and inhibit intestinal carbohydrate digestion enzymes. Consequently, cinnamon can help reduce glucose excursions after fasting and potentially improve overall glycemic control when used alongside conventional treatments.

Comparison with previous studies

The findings align with previous clinical trials that reported significant reductions in fasting glucose and HbA1c following cinnamon supplementation. However, some meta-analyses highlight variability in the effect size, possibly due to differences in cinnamon type, dosage, duration, and study populations. Our study contributes robust evidence with a relatively large sample size and standardized dosage over an extended period.

Safety profile

Importantly, no serious adverse effects were reported during the intervention period, supporting cinnamon's safety as a complementary therapy. This is crucial given the chronic nature of diabetes and the need for long-term management strategies with minimal side effects.

Table 3 highlights a critical clinical outcome of this experimental study — the proportion of participants who achieved a reduction of at least 30 mg/dL in fasting blood glucose (FBG) after 40 days of cinnamon supplementation. This threshold was selected as it represents a clinically meaningful decrease, often associated with improved glycemic control and reduced risk of diabetes-related complications.

Table 3: Fasting Blood Glucose Levels Before and After Cinnamon Intervention.

Outcome	Frequency (n)	Percentage (%)
Respondents with FBG reduction ≥ 30 mg/dL	223	72
Respondents without ≥ 30 mg/dL reduction	87	28
Serious adverse effects reported	0	0

Key findings

Out of 310 participants, 223 (72%) experienced a reduction in fasting blood glucose of 30mg/dL or more. This substantial proportion indicates a robust hypoglycemic effect of cinnamon consumption in the studied cohort. The magnitude and prevalence of this response underscore cinnamon's potential as an effective adjunct therapy in managing hyperglycemia in type 2 diabetes mellitus (T2DM).

Clinical significance

A reduction of ≥ 30 mg/dL in fasting glucose is significant because even modest improvements in blood glucose levels can reduce the risk of microvascular and macrovascular complications associated with diabetes, such as retinopathy, nephropathy, neuropathy, and cardiovascular diseases. Maintaining lower fasting glucose levels contributes to better overall metabolic control and can reduce the burden of pharmacological therapy or delay its intensification.

Variability in response

The fact that nearly three-quarters of the participants re-

sponded with clinically significant glucose reductions suggests that cinnamon's bioactive compounds effectively modulate glucose metabolism for most, but not all, patients. The 28% who did not reach this threshold may have had more advanced disease, differences in adherence, variations in metabolism, or other comorbid conditions influencing glucose control. This heterogeneity in response is common in nutritional and herbal interventions and highlights the need for personalized approaches in diabetes management.

Mechanistic insights

The observed glucose-lowering effect aligns with cinnamon's multiple mechanisms of action, including enhancement of insulin receptor signaling, increased glucose uptake via GLUT4 translocation, inhibition of carbohydrate-digesting enzymes in the gut, and anti-inflammatory properties that reduce insulin resistance [30–33]. These mechanisms synergistically improve fasting blood glucose by both peripheral glucose utilization and reduction of postprandial glucose absorption.

Safety profile

Importantly, no serious adverse effects were reported during the intervention period, suggesting that cinnamon at a dosage of 1.5 grams daily is safe and well-tolerated among middle-aged adults with T2DM. This safety profile, combined with the hypoglycemic efficacy, supports the inclusion of cinnamon as a complementary therapy in clinical practice, especially for patients seeking natural treatment options or those with mild to moderate hyperglycemia not yet requiring insulin.

Implications for future research

While the results are promising, further randomized controlled trials with placebo groups and longer follow-up are warranted to confirm cinnamon's long-term efficacy and safety. Additionally, studies exploring optimal dosing, standardized cinnamon extracts, and subgroup analyses by age, gender, disease duration, and concurrent medications will help tailor interventions more precisely.

Public health and clinical relevance

Given the increasing global prevalence of T2DM and the challenges in achieving optimal glycemic control with pharmacotherapy alone, affordable and accessible adjuvant therapies like cinnamon could have a significant public health impact. In low-resource settings, where access to medications may be limited, cinnamon supplementation could be a practical approach to improve patient outcomes and reduce the burden of diabetes complications.

Discussion

This study demonstrated a significant reduction in fasting blood glucose levels following 40 days of cinnamon supplementation in patients with type 2 diabetes mellitus. These findings are consistent with previous research that has reported the hypoglycemic effects of cinnamon in both animal models and clinical trials.

Several mechanisms have been proposed to explain cinnamon's glucose-lowering properties. First, cinnamaldehyde, one of the primary bioactive compounds in cinnamon, has been shown to enhance insulin receptor expression and improve insulin signal transduction, particularly through upregulation of glucose transporter type 4 (GLUT4) in muscle cells. This facilitates increased glucose uptake by peripheral tissues, thereby reducing circulating glucose levels [28,29]. Second, procyanidins, a class of polyphenolic compounds found in cinnamon, improve insulin sensitivity by modulating intracellular pathways that reduce insulin resistance. This action helps restore the normal metabolic response to insulin in insulin-resistant individuals [30]. Third, cinnamon inhibits digestive enzymes such as α -glucosidase in the small intestine, delaying carbohydrate digestion and glucose absorption. This contributes to lower postprandial glucose spikes and improved overall glycemic control [31].

The clinical implications of these mechanisms suggest that cinnamon can serve as a cost-effective and relatively safe adjuvant therapy for type 2 diabetes patients, especially those who have not yet required insulin treatment. The natural origin of cinnamon and its minimal side effect profile make it attractive for long-term use in community and primary care settings. Importantly, this study reported no serious adverse effects, reinforcing the safety profile of cinnamon at the administered dose.

However, the efficacy of cinnamon may vary depending on several factors including dosage, duration of use, and cinnamon species. Previous meta-analyses have shown mixed results, with some studies indicating significant glycemic improvements while others report modest or non-significant changes [32,33]. Therefore, further large-scale randomized controlled trials are warranted to standardize dosage regimens, identify optimal treatment durations, and explore the long-term effects of cinnamon supplementation on diabetic complications.

Limitations of the current study include its single-group pre-post design, which may introduce confounding variables and lacks a control group for comparison. Future studies should incorporate placebo-controlled designs to strengthen the evidence base. Additionally, the biochemical markers used in this study focused only on fasting glucose; inclusion of HbA1c and insulin resistance markers (e.g., HOMA-IR) could provide a more comprehensive picture of metabolic improvements.

In conclusion, this study supports the growing body of evidence that cinnamon supplementation can effectively reduce fasting blood glucose levels in type 2 diabetes patients. Its multifaceted biochemical actions targeting insulin sensitivity, glucose transport, and carbohydrate digestion position cinnamon as a promising complementary therapy in diabetes management.

Summary

This experimental study investigated the effect of cinnamon consumption on fasting blood glucose levels in patients with type 2 diabetes mellitus (T2DM). A total of 310 participants aged 30-65

years, who were not on insulin therapy and had no known allergy to cinnamon, received 1.5 grams of cinnamon daily in capsule form for 40 days. The study employed a one-group pretest-posttest design, with fasting blood glucose measured before and after the intervention using the GOD-PAP enzymatic method.

The results revealed a statistically significant reduction in fasting blood glucose levels, with the average decreasing from 186.3 ± 42.7 mg/dL to 142.7 ± 35.1 mg/dL ($p < 0.001$). Notably, 72% of the participants (223 individuals) experienced a reduction of at least 30 mg/dL, indicating a clinically meaningful improvement. No serious side effects were reported during the intervention period.

The hypoglycemic effect of cinnamon is attributed to its active compounds — particularly cinnamaldehyde, cinnamic acid, and procyanidins — which enhance insulin sensitivity, improve insulin receptor function, and inhibit carbohydrate-digesting enzymes. These mechanisms support cinnamon's role as a safe, affordable, and accessible adjuvant therapy for managing blood glucose levels in T2DM patients.

The findings suggest that cinnamon supplementation may be a valuable complementary approach in diabetes care, especially in low-resource settings or for patients seeking non-pharmacological alternatives. Further randomized controlled trials are recommended to validate these findings, explore long-term effects, and determine the optimal dosage for clinical use.

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Disclosure

The authors declare that they have no conflicts of interest related to the design, execution, analysis, or publication of this study. This research was conducted independently without any financial support or sponsorship from pharmaceutical companies, herbal supplement manufacturers, or other commercial entities.

All authors have reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Limitation of the Study

This study has several limitations that should be acknowledged. First, the use of a one-group pretest-posttest design without a control group limits the ability to attribute causality exclusively to the cinnamon intervention, as external factors may have influenced blood glucose levels. Second, the study was conducted in selected health facilities within South Sulawesi, which may limit the generalizability of the findings to broader populations with different demographic or lifestyle characteristics.

Third, the duration of the intervention was relatively short (40 days), and long-term effects of cinnamon consumption on glyce-mic control remain unclear. Fourth, dietary habits, physical activity, and adherence to the intervention were self-reported and not tightly controlled, which may introduce bias. Lastly, the study did not measure HbA1c levels, which could have provided additional insight into long-term glucose regulation.

Future studies with randomized controlled designs, longer follow-up periods, and broader outcome measures are needed to confirm and expand upon these findings.

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