International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Website: https://ijmpr.in/

Research Article

Experimental Evaluation of Hypoglycemic Effect of Ethanolic Bark Extract of Cinnamomum verum in Streptozotocin-Induced Diabetic Rats

Hari Kumar K[1], Sam Pavan Kumar G[2], Sai Srujan Kumar Gadiparthi[3]

[1]*Clinical Team Manager, Thermofisher, Mason, Ohio, USA*
[2]*Professor, Department of Pharmacology, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, Telangana, India, 505001*
[3]*Sai Srujan Kumar Gadiparthi, 171 Canyon Gap Way, Raleigh North Carolina, 27610, USA*

OPEN ACCESS

Corresponding Author:

Sai Srujan Kumar Gadiparthi
Sai Srujan Kumar Gadiparthi, 171 Canyon Gap Way, Raleigh North Carolina, 27610, USA.

Received: 20-03-2026
Accepted: 28-04-2026
Published: 23-05-2026

Copyright© *International Journal of Medical and Pharmaceutical Research*

ABSTRACT

Background: Diabetes mellitus is a chronic metabolic illness that affects millions of people around the world. Despite the widespread availability of synthetic antidiabetic drugs, their high cost and undesirable impact profile demand the search for viable herbal alternatives. Cinnamon (*Cinnamomum verum*) has been used in traditional medicine to manage blood glucose levels, although scientific evidence in controlled animal models is sparse

Objective: To assess the hypoglycemic effect of an ethanolic bark extract of Cinnamon at dosages of 50, 100, and 200 mg/kg body weight in streptozotocin (STZ)-induced diabetic rats, and to compare the results to the standard medication glibenclamide (0.5 mg/kg).

Materials and methods: A single intraperitoneal dose of STZ (45 mg/kg) produced diabetes in male Wistar albino rats weighing 150-200 g. Animals having fasting blood glucose levels ≥250 mg/dl on Day 3 were enrolled. Thirty-six rats were randomly assigned to six groups (n=6): normal control, diabetic control, glibenclamide-treated, and three cinnamon extract-treated groups (50, 100, and 200 mg/kg p.o.Daily for 15 days). On days 0, 5, 10, and 15, blood glucose was monitored with a glucometer. Body weights were measured at baseline and on Day 15. Statistical analysis was performed using the student's t-test; values are expressed as Mean ± SD.

Results: The diabetes control group had chronically increased blood glucose levels (332→379 mg/dl). On Day 15, glibenclamide reduced blood glucose by 73.14% (269.16±22.95 to 101.83±9.43 mg/dl; $p<0.0001$). Cinnamon extract at 50, 100, and 200 mg/kg resulted in significant, dose-dependent decreases of 44.22%, 51.87%, and 53.76% by Day 15 (all $p<0.0001$ vs. Diabetes control). All treated groups gained significant body weight compared to the diabetes control group, which lost 25% of its body weight over the research period.

Conclusion: In STZ-induced diabetic rats, ethanolic bark extract of cinnamon showed considerable, dose-dependent hypoglycemic efficacy. The 200 mg/kg dose had the most effective effect. These findings lend credence to its traditional usage as an antidiabetic medication and call for additional mechanistic and clinical studies.

Keywords*: Cinnamon; Cinnamomum verum; streptozotocin; diabetes mellitus; hypoglycemic; herbal medicine; glibenclamide; rat model.*

INTRODUCTION

Diabetes mellitus (dm) is one of the most common chronic metabolic illnesses worldwide, marked by persistent hyperglycemia caused by abnormalities in insulin production, insulin action, or both. According to the world health organization (who), the number of individuals living with diabetes increased from 108 million in 1980 to 422 million in 2014, with global adult prevalence rising from 4.7% to 8.5% during the same period [1]. Diabetes was responsible for an estimated 1.5 million fatalities in 2012, with high blood glucose accounting for an additional 2.2 million [1]. Diabetes is projected by the world health organization to be the seventh largest cause of mortality by 2030 [2]. India suffers a disproportionate burden of this disease, with around 61.3 million people infected as of 2011 and forecasts of over 100

million by 2030 [3]. The condition has tremendous economic and social consequences, especially in low- and middle-income areas where the majority of sufferers live.

Insulin, sulfonylureas, biguanides, thiazolidinediones, alpha-glucosidase inhibitors, and incretin-based treatments are all now used in pharmacotherapy. While effective, these agents carry significant adverse effects — including hypoglycaemia, hepatotoxicity, nephrotoxicity and weight gain — and remain economically inaccessible to large segments of the diabetic population in developing countries [4]. This highlights the ongoing need for innovative, cost-effective antidiabetic medicines with good safety profiles.

Plant-derived medicines have traditionally made major contributions to medication discovery. Cinnamon (*Cinnamomum verum* J. Presl., Lauraceae) is a well-known spice that has long been used in South Asian traditional medicine to treat hyperglycemia. Cinnamaldehyde, cinnamic acid, cinnamate, and polyphenolic polymers have been shown to have insulin-mimetic and insulin-sensitizing properties by increasing the expression of glucose transporter GLUT4, insulin receptor β-subunit (irβ), and tristetraprolin (TTP) [5, 6].

Previous clinical investigations have shown that cinnamon supplements reduce fasting blood glucose and hba1c levels in type 2 diabetic patients [7, 8]. However, there are few well-controlled preclinical studies examining dose-response correlations, notably in the often used STZ-induced rat model. The current study was conducted to assess the antidiabetic effect of ethanolic bark extract of cinnamon at three dose levels in STZ-induced diabetic rats, with glibenclamide serving as a reference standard.

MATERIALS AND METHODS

Ethical Approval: The study was approved by the Institutional Animal Ethics Committee (IAEC) of the Chalmeda Anand Rao Institute of Medical Sciences in Karimnagar, Telangana, India. All animal experiments followed the rules of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA).

Animals: M/S Sainath Agencies in Hyderabad, India supplied laboratory-bred male Wistar albino rats weighing 150-200 g. The animals were housed in conventional laboratory circumstances (12-hour light/dark cycle, temperature 22±2°C, relative humidity 50-60%), with free access to standard rat pellet diet and water ad libitum. Animals were acclimatised for one week before to the trial.

Plant Material and Extraction: Cinnamon bark (*Cinnamomum verum*) was obtained from a local market in Karimnagar, Telangana, India, and validated by the Department of Botany, Government Junior College of Sciences, Karimnagar. The bark was crushed into a coarse powder and extracted using a Soxhlet equipment with 50% ethanol as the solvent. The resultant extract was concentrated and kept at 4°C until use.

Chemicals and Drugs: Streptozotocin (STZ) was obtained from Sisco Research Laboratories Pvt. Ltd. In Maharashtra, India. Glibenclamide (Daonil®, Aventis Pharma, India) was used as the standard antidiabetic medication. STZ was freshly dissolved in sterile normal saline just before use and kept at 4-8°C. The blood glucose was tested with a One Touch Horizon glucometer (lifescanScotland Ltd., UK).

Acute Toxicity Study

The acute oral toxicity of cinnamon bark extract was tested in seven groups of two rats each, with dosages of 10, 50, 100, 500, 1000, 5000, and 10,000 mg/kg body weight orally. The animals were monitored for 24 hours for behavioural changes, adverse effects, and mortality.

Dose Determination: The extract's effective dose (ED50) was obtained in preliminary investigations utilising logarithmically graded dose increments (0.5 log units). A quantifiable antidiabetic effect was first found at 50 mg/kg and plateaued after 500 mg/kg. The primary trial included doses of 50, 100, and 200 mg/kg. For STZ, an initial dose of 60 mg/kg resulted in 50% mortality; a dose of 45 mg/kg successfully produced diabetes in all surviving animals with zero mortality, and was thus chosen.

Induction of Diabetes: Before receiving STZ, the animals were fasted overnight. Diabetes was caused by a single intraperitoneal injection of STZ at 45 mg/kg body weight, freshly dissolved in sterile normal saline. On the third day after injection, blood glucose levels were measured. The study comprised rats with fasting blood glucose levels of 250 mg/dl or above, indicating diabetes.

Experimental Design

Thirty-six male albino rats were randomly assigned to six groups (n=6 each):
Group I (Normal Control): Non-diabetic rats were given distilled water orally daily for 15 days.
Group II (Diabetic Control): STZ-induced diabetic rats were given distilled water orally daily for 15 days.

Group III (Standard): STZ-induced diabetic rats were given 0.5 mg/kg glibenclamide orally every day for 15 days.
Group IV (Test 1): STZ-induced diabetic rats were given 50 mg/kg cinnamon bark extract orally every day for 15 days.

Group V (Test 2): STZ-induced diabetic rats were given 100 mg/kg cinnamon bark extract orally every day for 15 days.

Group VI (Test 3): STZ-induced diabetic rats were given 200 mg/kg cinnamon bark extract orally every day for 15 days.

All medications and extracts were delivered orally using a feeding tube. Blood samples were taken from the tail vein on days 0, 5, 10, and 15. Body weight was taken on days 0 and 15.

Statistical Analysis

All values are shown as Mean ± Standard Deviation (SD). The standard error of mean (SEM) and percent reduction in blood glucose levels were calculated. Statistical significance was determined using the Student's t-test. A p-value < 0.001 was judged statistically significant.

RESULTS

Acute Toxicity

No death or serious adverse effects were detected at any of the tested doses (10-10,000 mg/kg p.o). Higher dosages resulted in a temporary reduction in locomotor activity. The extract was consequently deemed safe for use in the current study.

Effect on Blood Glucose Levels

summarises the blood glucose concentrations (Mean ± SD) for all groups across the study period.

Table 1. Blood glucose levels (mg/dl, Mean ± SD) and percentage reduction across all groups

Group	Treatment	Day 0 (mg/dl)	Day 5 (mg/dl)	Day 10 (mg/dl)	Day 15 (mg/dl)	% Reduction (Day 0→15)
I	Normal control (Distilled water)	100.16±9.84	102.16±10.22	101.83±13.11	102.17±10.32	—
II	Diabetic control (Distilled water)	332±41.82	377.83±45.36	390.16±60.04	379.16±33.43	—
III	Glibenclamide 0.5 mg/kg	269.16±22.95	239±22.46	141.16±16.37	101.83±9.43	73.14%**
IV	Cinnamon extract 50 mg/kg	347.33±36.10	306.33±30.11	260.5±34.80	211.5±17.75	44.22%*
V	Cinnamon extract 100 mg/kg	328.83±11.06	293±22.37	242.5±35.01	182.5±24.23	51.87%**
VI	Cinnamon extract 200 mg/kg	342.16±34.85	286.16±23.69	234.66±41.28	175.33±44.07	53.76%**

*Values are Mean ± SD (n=6 per group). *p<0.001; **p<0.0001 vs. Diabetic control (Student's t-test). % reduction calculated relative to Day 0 value of respective group.*

Group I (Normal Control): Blood glucose levels remained steady after 15 days (100.16±9.84 to 102.17±10.32 mg/dl), indicating normal glycaemic homeostasis.

Group II (Diabetic Control): Untreated STZ-diabetic rats had continuously high blood glucose levels throughout the research, rising from 332±41.82 mg/dl on Day 0 to 379.16±33.43 mg/dl on Day 15, indicating stable diabetes induction with no spontaneous recovery.

In Group III (Glibenclamide 0.5 mg/kg), the standard medicine significantly reduced blood glucose levels from 269.16±22.95 mg/dl on Day 0 to 101.83±9.43 mg/dl on Day 15, resulting in a 73.14% reduction (p<0.0001 compared to diabetes control). By day 15, near-normoglycemia had been reached.

Group IV (50 mg/kg cinnamon extract) showed a 44.22% decrease in blood glucose from 347.33±36.10 mg/dl to 211.5±17.75 mg/dl on Day 15 (p<0.0001 vs. Diabetes control). On Day 5, a statistically significant decline was seen (p<0.001).

In Group V (100 mg/kg cinnamon extract), blood glucose levels decreased by 51.87% by Day 15 compared to diabetes control (328.83±11.06 mg/dl vs. 182.5±24.23 mg/dl, p<0.0001).

In Group VI (Cinnamon extract 200 mg/kg), the highest dose resulted in the biggest reduction in the cinnamon-treated groups, from 342.16±34.85 mg/dl to 175.33±44.07 mg/dl — a 53.76% reduction by Day 15 ($p<0.0001$ vs diabetes control). A clear dose-response association was seen in Groups IV, V, and VI.

Effect on Body Weight

presents the changes in body weight over the study period

Table 2. Body weight (g, Mean ± SD) on Day 0 and Day 15 across all groups

Group	Treatment	Body Weight Day 0 (g)	Body Weight Day 15 (g)	Change
I	Normal control (Distilled water)	200.33±17.50	207.00±20.38	↑ 3.3%
II	Diabetic control (Distilled water)	188.66±6.37	141.50±3.44	↓ 25.0%
III	Glibenclamide 0.5 mg/kg	152.50±4.54	197.33±7.06	↑ 29.4%
IV	Cinnamon extract 50 mg/kg	154.33±2.58	189.00±5.11	↑ 22.5%
V	Cinnamon extract 100 mg/kg	156.00±2.52	190.00±5.37	↑ 21.8%
VI	Cinnamon extract 200 mg/kg	150.00±2.60	192.66±5.13	↑ 28.4%

Values are Mean ± SD (n=6 per group).

After 15 days, the diabetic control group (Group II) lost almost 25% of their body weight, from 188.66±6.37 g to 141.50±3.44 g. In contrast, the normal control group gained about 3.3% of its body weight. All treatment groups (Groups III-VI) gained weight gradually throughout the course of the research, with the glibenclamide group gaining the most (29.4%), followed by the 200 mg/kg cinnamon group (28.4%), 50 mg/kg (22.5%), and 100 mg/kg (21.8%).

DISCUSSION

the current work shows that the ethanolic bark extract of cinnamon (cinnamomum verum) has considerable, dose-dependent hypoglycemic effect in stz-induced diabetic wistar rats. Stz, a glucosamine-nitrosourea compound selectively transported into pancreatic β-cells via glut2 transporters, causes β-cell destruction through dna alkylation, nitric oxide generation, and reactive oxygen species-mediated mitochondrial dysfunction [9,10]. It is a widely validated and reproducible animal model of type 1 diabetes.

In our work, a dose of 45 mg/kg stz (i.p.) Consistently generated sustained hyperglycemia (≥250 mg/dl) in all treated animals without mortality, which is consistent with previously reported effective dose ranges [11]. The diabetic control group maintained increased blood glucose levels throughout without spontaneous recovery, confirming the experimental model.

Glibenclamide, a reference standard at 0.5 mg/kg, reduced blood glucose by 73.14% over 15 days. This is consistent with its well-established method of increasing insulin secretion via KATP channel blockage in pancreatic β-cells [12]. This result indicates that even in the STZ model, residual β-cell function was sustained at the specified STZ dose, similar with the 45 mg/kg regimen.
All three doses of cinnamon bark extract (50, 100, and 200 mg/kg) resulted in statistically significant and progressive blood glucose decreases beginning on Day 5. The 200 mg/kg dose resulted in the highest reduction (53.76%), followed by 100 mg/kg (51.87%) and 50 mg/kg (44.22%), indicating a clear dose-response association. While these decreases were significant, they did not achieve the near-normoglycemic levels attained by glibenclamide, indicating that the extract may have additional mechanisms beyond direct insulin secretagogue activity.

The potential mechanisms for cinnamon's antidiabetic action are complex. Preclinical and clinical investigations have linked its glucose-lowering benefits to insulin-mimetic and insulin-sensitizing features, such as increased insulin receptor β-subunit (irβ), GLUT4 glucose transporter expression, and tristetraprolin (TTP) levels [5]. Cinnamon's polyphenolic polymers are considered to stimulate insulin signalling cascades, increasing glucose absorption in peripheral tissues while not directly stimulating insulin secretion [6]. Cinnamaldehyde, a key component of essential oils, has been shown to block α-glucosidase enzymes, potentially lowering postprandial glucose absorption [13].

Significant body weight preservation and recovery were found in all therapy groups when compared to the diabetes control group, indicating metabolic improvement. Untreated diabetic rats lost weight gradually due to increased catabolism, glycosuria, and muscle wasting, all of which are common features of uncontrolled diabetes in the STZ model [14]. All therapy groups reversed this trend, with weight gain proportional to glycaemic control.

These results are consistent with earlier research. Khan et al. Found significant reductions in fasting blood glucose (18-29%) in type 2 diabetes people who consumed 1-6 g cinnamon daily for 40 days [7]. Sahib found that 12 weeks of adjuvant therapy with 1 g cinnamon reduced fasting blood glucose and hba1c in poorly managed type 2 diabetic patients,

while also improving oxidative stress markers [8]. Howard and White summarised evidence from several animal models demonstrating cinnamon's insulin-mimetic and sensitising actions [15].

The current study adds to this evidence base by establishing strong dosage-dependent effects in a standardised STZ rodent model, with statistically significant activity observed at the lowest tested dose (50 mg/kg) and gradually increasing efficacy at higher doses. The 15-day treatment period, while adequate to demonstrate antidiabetic activity, is relatively short; longer-term studies with measurement of additional metabolic parameters (hba1c, lipid profile, insulin levels, histopathological assessment of pancreatic islets) would strengthen these findings.

Several restrictions should be noted. First, the study employed a male-only cohort, and sex differences in STZ-induced diabetes and herbal medication responses were identified. Second, the exact phytochemical fingerprint and standardisation of the extract were not determined; standardising to cinnamaldehyde level might increase reproducibility. Third, the mechanistic foundation was not explicitly addressed in this study, necessitating additional investigation using molecular assays. Fourth, blood glucose was measured using a glucometer rather than established enzymatic methods, however the One Touch Horizon glucometer offers enough accuracy for such research.

CONCLUSION

In stz-induced diabetic rats, ethanolic bark extract of cinnamon (*cinnamomum verum*) showed considerable, dose-dependent hypoglycemic efficacy. At the maximum studied dose of 200 mg/kg, the extract reduced blood glucose by 53.76% over 15 days, compared to 73.14% with glibenclamide. Cinnamon treatment resulted in significant reductions ($p<0.0001$) and reversal of diabetes-related weight loss. The extract was well tolerated, with no toxicity detected up to 10,000 mg/kg orally.

These preclinical findings back up the traditional usage of cinnamon as an antidiabetic treatment and provide scientific justification for future investigation. Future research should look into the molecular mechanisms of action, standardise the extract, evaluate long-term metabolic and histopathological effects, and eventually lead to clinical trials in diabetes patients.

CONFLICT OF INTEREST: The authors declare no conflict of interest

FUNDING: This study received no external support. It was carried out as part of the Doctor of Medicine (M.D.) dissertation requirements at the Department of Pharmacology, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, Telangana, India. 505001.

REFERENCES

1. World Health Organization. Global Report on Diabetes. Geneva: WHO; 2016.
2. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. Plos Med. 2006;3(11):e442.
3. Sicree R, Shaw J, Zimmet P. Diabetes and impaired glucose tolerance. In: Gan D, ed. Diabetes Atlas. 5th ed. Brussels: International Diabetes Federation; 2011:1-103.
4. Park K. Diabetes mellitus. In: Park's Textbook of Preventive and Social Medicine. 21st ed. Jabalpur: Bhanot Publishers; 2011:362-364.
5. Jakhetia V, Patel R, Khatri P, et al. Cinnamon: a pharmacological review. J Adv Sci Res. 2010;1(2):19-23.
6. Cao H, Graves DJ, Anderson RA. Cinnamon extract and polyphenols affect the expression of tristetraprolin, insulin receptor, and glucose transporter 4 in mouse 3T3-L1 adipocytes. Arch BiochemBiophys. 2010;496(1):49-55.
7. Khan A, Safdar M, Ali Khan MM, Khattak KN, Anderson RA. Cinnamon improves glucose and lipids of people with type 2 diabetes. Diabetes Care. 2003;26(12):3215-3218.
8. Sahib AS. Anti-diabetic and antioxidant effect of cinnamon in poorly controlled type-2 diabetic Iraqi patients: a randomized, placebo-controlled clinical trial. J IntercultEthnopharmacol. 2016;5(2):108-113.
9. Lenzen S. The mechanisms of alloxan- and streptozotocin-induced diabetes. Diabetologia. 2008;51(2):216-226.
10. Szkudelski T. The mechanism of alloxan and streptozotocin action in B cells of the rat pancreas. Physiol Res. 2001;50(6):536-546.
11. Arulmozhi DK, Veeranjaneyulu A, Bodhankar SL. Neonatal streptozotocin-induced rat model of type 2 diabetes mellitus: a review. Indian J Pharmacol. 2004;36(4):217-221.
12. Ashcroft FM. Mechanisms of the glycaemic effects of sulfonylureas. Horm Metab Res. 1996;28(9):456-463.
13. Rao PV, Gan SH. Cinnamon: a multifaceted medicinal plant. Evid Based Complement Alternat Med. 2014;2014:642942.
14. Srinivasan K, Ramarao P. Animal models in type 2 diabetes research: an overview. Indian J Med Res. 2007;125(3):451-472.
15. Howard MN, White ND. Cinnamon in the management of type 2 diabetes. Am J Lifestyle Med. 2013;7(1):23-26.
16. Powers AC. Diabetes mellitus. In: Longo DL, Fauci AS, Kasper DL, et al., eds. Harrison's Principles of Internal Medicine. 18th ed. New York: mcgraw-Hill; 2012:2968-3003.

17. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. Indian J Med Res. 2007;125(3):217-230.
18. Schnedl WJ, Ferber S, Johnson JH, Newgard CB. STZ transport and cytotoxicity: specific enhancement in GLUT2-expressing cells. Diabetes. 1994;43(11):1326-1333.
19. Pieper AA, Brat DJ, Krug DK, et al. Poly(ADP-ribose) polymerase-deficient mice are protected from streptozotocin-induced diabetes. Proc Natl Acad Sci USA. 1999;96(6):3059-3064.
20. American Diabetes Association. Standards of medical care in diabetes — 2012. Diabetes Care. 2012;35(Suppl 1):S11-S63.