



Comparative Antidiabetic Effects of *Costus Igneus* and *Eugenia Jambolana* in Streptozotocin and Dexamethasone-Induced Diabetic Rats

Running Title: *Costus igneus* and *Eugenia jambolana*: Comparative Antidiabetic Study

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KEYWORDS	ABSTRACT:
<i>Costus igneus</i> <i>Eugenia jambolana</i> , Streptozotocin, Dexamethasone, Antidiabetic activity,β-cell regeneration	Background: <i>Costus igneus</i> (Insulin plant) and <i>Eugenia jambolana</i> (Jamun) are widely used in traditional medicine for diabetes, yet their comparative efficacy has not been systematically investigated. Objective: To evaluate and compare the antidiabetic potential of <i>Costus igneus</i> and <i>Eugenia jambolana</i> extracts in experimental models of diabetes. Methods: Male Wistar rats were rendered diabetic using Streptozotocin (STZ, 60 mg/kg i.p.) and Dexamethasone (10 mg/kg s.c.). Groups were treated with <i>Costus igneus</i> (200 mg/kg p.o.), <i>Eugenia jambolana</i> (200 mg/kg p.o.), or Metformin (100 mg/kg p.o.) for 28 days. Fasting blood glucose (FBG), lipid profile, and histopathological changes in the pancreas, liver, and kidney were evaluated. Results: Both plant extracts significantly reduced FBG and improved lipid abnormalities compared to diabetic controls ($p < 0.001$). <i>Eugenia jambolana</i> exhibited a faster hypoglycemic effect and stronger lipid correction, whereas <i>Costus igneus</i> demonstrated progressive glycemetic control and more pronounced β-cell regeneration in pancreatic islets. Histopathological findings confirmed regenerative and protective effects of both extracts, with distinct mechanisms. Conclusion: <i>Costus igneus</i> and <i>Eugenia jambolana</i> exhibit complementary antidiabetic actions: the former enhances β-cell recovery while the latter rapidly improves glycemetic and lipid parameters. Their combined use may provide synergistic benefits in diabetes management.

1. Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to impaired insulin secretion, insulin resistance, or both¹. It is associated with long-term complications including neuropathy, nephropathy, retinopathy, and cardiovascular diseases, making it one of the leading causes of morbidity and mortality worldwide². According to the International Diabetes Federation (IDF), approximately 537 million adults were living with diabetes in 2021, and this number is projected to rise to 783 million by 2045, with the highest burden in low- and middle-income countries³.

Despite the availability of several classes of oral hypoglycemic agents and insulin formulations, achieving optimal glycemetic control remains a challenge. These agents often present limitations such as hypoglycemia, gastrointestinal discomfort, weight gain, secondary failure, and high cost^{4,5}. Consequently, there is growing interest in safer, more affordable alternatives derived from medicinal plants, many of which are traditionally used in the management of diabetes. More than 1,200 plant species have been documented globally with antidiabetic potential, and several plant-derived drugs (e.g., metformin from *Galega officinalis*) have already been successfully incorporated into modern therapy⁶⁻⁷.



Among the numerous antidiabetic medicinal plants, *Costus igneus* (family: Costaceae), popularly known as the “Insulin Plant,” has gained attention for its widespread use in Southern India, where its leaves are consumed directly by diabetic patients as part of folk medicine. Phytochemical investigations have revealed the presence of corosolic acid, diosgenin, β -sitosterol, and flavonoids, which exhibit antihyperglycemic effects by enhancing glucose uptake via GLUT4 translocation, modulating carbohydrate-metabolizing enzymes, reducing oxidative stress, and promoting pancreatic β -cell regeneration⁸⁻¹⁰. Preclinical studies have reported its ability to lower blood glucose levels, improve lipid metabolism, and restore pancreatic histoarchitecture in diabetic rats¹¹.

Eugenia jambolana (syn. *Syzygium cumini*, family: Myrtaceae), commonly known as Jamun or Indian Blackberry, is another widely studied antidiabetic plant used in Ayurveda, Unani, and Siddha medicine. Its seeds, fruits, and bark contain jamboline, ellagic acid, anthocyanins, and flavonoids, which exert multiple antidiabetic actions, including stimulation of insulin secretion, inhibition of α -amylase and α -glucosidase, antioxidant activity, and lipid-lowering effects¹²⁻¹⁴. Several experimental and clinical studies have demonstrated that *E. jambolana* significantly lowers fasting blood glucose, improves oral glucose tolerance, and ameliorates dyslipidemia in diabetic patients¹⁵⁻¹⁶.

While both *Costus igneus* and *Eugenia jambolana* have individually shown promising antidiabetic properties, a **comparative evaluation of their relative efficacy has not been comprehensively studied**. Understanding their differences in glycemic control, lipid regulation, and pancreatic protection could help elucidate their specific mechanisms of action and guide rational polyherbal combinations for improved diabetes management.

2. Objectives

While both *Costus igneus* and *Eugenia jambolana* have individually shown promising antidiabetic properties, a comparative evaluation of their relative efficacy has not been comprehensively studied. Understanding their differences in glycemic control, lipid regulation, and pancreatic protection could help elucidate their specific mechanisms of action and guide rational polyherbal combinations for improved diabetes management.

Therefore, the present study aimed to evaluate and compare the antidiabetic efficacy of *Costus igneus* and *Eugenia jambolana* extracts in Streptozotocin- and Dexamethasone-induced diabetic rats, using biochemical and histopathological parameters as indicators of therapeutic activity..

3. Methods

1. Plant Material and Authentication

Fresh leaves of *Costus igneus* and seeds of *Eugenia jambolana* were collected from College garden of Bharati Vidyapeeth Deemed University Medical College and Hospital Sangli. Plant specimens were identified and authenticated by a taxonomist, and voucher specimens were deposited in the departmental herbarium. Proper authentication of plant material is essential for reproducibility and quality assurance¹⁷.

2 Preparation of Extracts

Collected plant materials were washed, shade-dried, and coarsely powdered using a mechanical grinder. *Costus igneus* leaves and *Eugenia jambolana* seeds were extracted separately using **ethanol (70%)** by Soxhlet extraction for 72 h. Extracts were filtered, concentrated under reduced pressure using a rotary evaporator (40–45°C), and stored at 4°C in airtight containers until use. The yield of the extracts was calculated and expressed as % w/w of dried material. Ethanolic extracts were selected because they efficiently extract both polar and non-polar phytoconstituents and have shown good antidiabetic activity in prior studies¹⁸⁻¹⁹.

3 Animals

Male Wistar albino rats (180–200 g) were procured from Central Animal House of the Bharati Vidyapeeth (Deemed to Be University) Medical College and Hospital Sangli. Animals were housed in polypropylene cages under controlled conditions (22 \pm 2°C, 12 h light/dark cycle, relative humidity 50–60%) and provided with standard pellet diet and water ad libitum. Animals were acclimatized for 7 days before the experiment. Experimental protocols were approved by the Institutional Animal Ethics Committee (BVDUMC/Sangli/IAEC/2017/07) and conducted in accordance with the guidelines of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Government of India²⁰.



4 Induction of Diabetes

- **Streptozotocin (STZ)-induced diabetes:** Diabetes was induced by a single intraperitoneal injection of STZ (60 mg/kg, freshly prepared in cold 0.1 M citrate buffer, pH 4.5). After 72 h, fasting blood glucose levels were measured, and animals with FBG > 250 mg/dL were considered diabetic²¹.
- **Dexamethasone-induced diabetes:** Another set of rats was administered Dexamethasone (10 mg/kg, s.c.) once daily for 14 days to induce insulin resistance²².

5 Experimental Design

Animals were divided into five groups (n = 6 each) as follows:

1. **Normal Control:** Received vehicle only.
2. **Diabetic Control:** STZ or Dexamethasone-induced, untreated.
3. **Costus igneus Extract:** 200 mg/kg p.o. daily for 28 days.
4. **Eugenia jambolana Extract:** 200 mg/kg p.o. daily for 28 days.
5. **Standard Drug Control:** Metformin 100 mg/kg p.o. daily for 28 days.

The dose selection of plant extracts was based on previously published studies demonstrating antidiabetic efficacy at 200 mg/kg²³⁻²⁴. Metformin was chosen as the reference standard drug due to its widespread clinical use and relevance in both insulin resistance and insulin deficiency models²⁵.

6 Biochemical Parameters

6.1 Fasting Blood Glucose (FBG)

Blood glucose levels were measured on days 0, 7, 14, 21, and 28 using a glucometer (Accu-Chek, Roche Diagnostics) from tail vein blood after overnight fasting²⁶.

6.2 Lipid Profile

At the end of the treatment period (day 28), blood was collected by retro-orbital puncture under light anesthesia. Serum was separated by centrifugation at 3,000 rpm for 15 min. Total cholesterol (TC), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C) were

estimated using standard diagnostic kits (Erba Diagnostics, India). Low-density lipoprotein cholesterol (LDL-C) was calculated. These biochemical parameters were selected as they represent important risk factors for diabetic complications such as atherosclerosis²⁷.

7 Histopathological Studies

At the end of the study, animals were sacrificed under anesthesia, and pancreas, liver, and kidney tissues were excised. Tissues were fixed in 10% neutral buffered formalin, embedded in paraffin, sectioned (5 µm thickness), and stained with hematoxylin and eosin (H&E). Sections were examined under a light microscope (400×) for histopathological changes including islet cell architecture, hepatocyte integrity, and renal tubular morphology²⁸.

4. Results

A. Effect on Fasting Blood Glucose (FBG)

1. Streptozotocin (STZ)-induced diabetes:

In diabetic control rats, fasting blood glucose (FBG) levels remained persistently elevated throughout the 45-day experimental period, confirming successful induction of hyperglycemia. In contrast, treatment with the standard drug glibenclamide (10 mg/kg) produced a progressive and significant reduction in FBG levels, reaching near-normal values by day 45. Among the test extracts, *Costus igneus* (200 mg/kg) showed a marked decline in glucose levels from day 14 onwards, with sustained reductions through day 45. At the end of the study, CI-treated rats exhibited a **53% reduction** in FBG compared to diabetic controls. *Eugenia jambolana* (200 mg/kg) demonstrated a moderate antihyperglycemic effect, with reductions apparent after day 21; however, glucose levels remained significantly higher than those in the CI and glibenclamide groups at all subsequent time points. By day 45, EJ-treated rats exhibited only a **31% reduction** in FBG relative to diabetic controls.

Overall, these results indicate that while both extracts exert beneficial antihyperglycemic effects, ***Costus igneus* produced more pronounced and sustained reductions in fasting blood glucose compared to *Eugenia jambolana***, (Table 1, Figure 1).

Table 1. Effect of *Costus igneus* (CI) and *Eugenia jambolana* (EJ) on fasting blood glucose (mg/dL) in streptozotocin-induced diabetic rats over 45 days (mean ± SEM, n=6)

Day	Normal Control	Diabetic Control	Glibenclamide (10 mg/kg)	<i>C. igneus</i> (200 mg/kg)	<i>E. jambolana</i> (200 mg/kg)



0	70.8 ± 10.5	330.2 ± 25.8	302.7 ± 21.0	312.2 ± 16.0	281.0 ± 9.2
3	64.5 ± 11.5	321.7 ± 30.7	289.2 ± 26.3	328.8 ± 32.2	314.3 ± 39.3
7	68.5 ± 3.9	342.5 ± 42.1	282.3 ± 51.8	301.8 ± 18.1	304.7 ± 15.8
14	72.0 ± 11.2	344.8 ± 57.0	245.2 ± 43.9*	286.3 ± 21.1*	328.2 ± 33.4
21	71.5 ± 14.0	358.5 ± 40.5	228.2 ± 43.6*	270.8 ± 28.9*	331.5 ± 48.7
28	74.0 ± 6.1	373.8 ± 60.9	202.2 ± 24.2*	236.8 ± 28.4*	324.7 ± 53.2
35	63.0 ± 5.1	402.7 ± 34.1	168.8 ± 18.4**	219.8 ± 29.2**	294.2 ± 55.1*
42	77.5 ± 9.5	435.2 ± 25.7	153.3 ± 26.3**	197.3 ± 37.7**	305.2 ± 17.7*
45	75.8 ± 10.0	443.0 ± 38.5	149.5 ± 25.7**	207.0 ± 26.2**	307.3 ± 22.2*

p<0.05, ** p<0.01 vs. Diabetic Control.

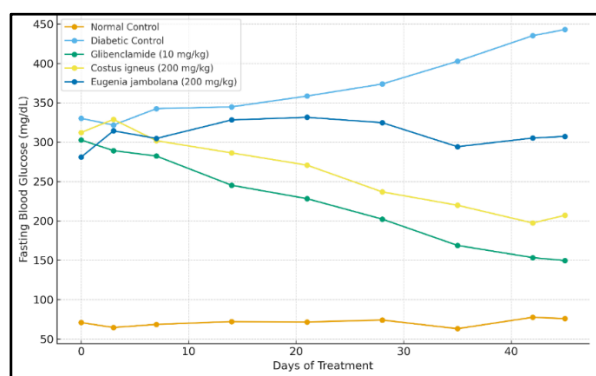


Figure 1: Effect of *Costus igneus* and *Eugenia jambolana* on FBG in Diabetic Rats

2. Effect on Fasting Blood Glucose (FBG) in Dexamethasone-Induced Diabetes

In dexamethasone-treated rats, persistent hyperglycemia was observed, with mean FBG levels remaining significantly elevated compared to the normal control group across all time points ($p<0.05$). Treatment with **glibenclamide (10 mg/kg)** produced a progressive reduction in glucose levels, with values

declining confirming its protective role against steroid-induced insulin resistance. *Costus igneus* (200 mg/kg) ($p<0.05$), with steady reductions from day 7 onwards, maximum at day 21. *Eugenia jambolana* (200 mg/kg) produced similar antihyperglycemic effects, reducing glucose by day 21. However, CI showed a slightly greater decline in glucose levels compared to EJ, suggesting a stronger role in improving insulin sensitivity and counteracting dexamethasone-induced hyperglycemia.

Overall, both plant extracts demonstrated significant antihyperglycemic effects in the dexamethasone model, with CI exhibiting a **marginally superior effect** over EJ, though less potent than glibenclamide (Table 2, Figure 2).

Table 2. Effect of *Costus igneus* (CI) and *Eugenia jambolana* (EJ) on fasting blood glucose (mg/dL) in dexamethasone-induced diabetic rats (mean ± SEM, n=6)

Day	Normal Control	Diabetic Control	Glibenclamide (10 mg/kg)	<i>Costus igneus</i> (200 mg/kg)	<i>Eugenia jambolana</i> (200 mg/kg)
0	69.5 ± 11.9	121.0 ± 9.4	127.3 ± 2.9	121.8 ± 7.9	118.0 ± 10.7
3	73.3 ± 6.9	119.7 ± 5.3	113.7 ± 6.9	115.2 ± 6.3	123.5 ± 3.5
7	68.7 ± 8.8	117.7 ± 7.1	103.0 ± 11.4	103.1 ± 7.6	107.3 ± 7.9
14	75.2 ± 7.5	116.3 ± 5.4	97.0 ± 7.2	105.3 ± 8.8	104.8 ± 9.1
21	73.2 ± 11.6	118.8 ± 7.8	81.0 ± 12.1	95.5 ± 6.7	97.3 ± 7.5

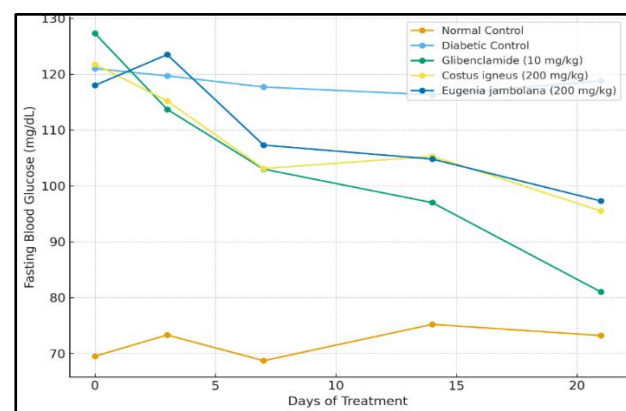


Figure 2: Effect of *Costus igneus* and *Eugenia jambolana* on FBG in Dexamethasone-Induced Diabetic Rats



These findings indicate that *Eugenia jambolana* may exert more immediate glycemic control, while *Costus igneus* maintains a steady long-term effect. This observation aligns with previous studies reporting rapid hypoglycemic action of *E. jambolana* seeds²⁹ and progressive β -cell restoration by *C. igneus* leaves³⁰.

B. Effect on Lipid Profile

Diabetic control rats exhibited significant dyslipidemia, characterized by elevated total cholesterol (TC), triglycerides (TG), and LDL, along with reduced HDL compared to normal controls ($p < 0.001$). Both plant extracts improved lipid abnormalities significantly ($p < 0.01$ vs diabetic control). *Eugenia jambolana* showed a **greater effect on TC, TG, and LDL reduction**, along with an increase in HDL. *Costus igneus* improved lipid profile moderately, with values trending towards normal, though not as strongly as *Eugenia jambolana*. The improvements were comparable to the standard drug (Metformin). These results corroborate earlier findings of *E. jambolana*'s potent lipid-lowering effect through modulation of lipid metabolism³¹ and the moderate antihyperlipidemic action of *C. igneus*³². **Table 3** presents lipid profile values at day 28, while **Figure 2** shows the comparative bar graph for TC, TG, and HDL.

Table 3. Effect of *Costus igneus* and *Eugenia jambolana* on serum lipid profile at day 28

Group	TC (mg/dL)	TG (mg/dL)	HDL (mg/dL)	LDL (mg/dL)
Normal Control	85.2 ± 4.1	92.3 ± 3.9	55.1 ± 2.6	20.3 ± 2.0
Diabetic Control	168.5 ± 5.8	202.6 ± 6.2	30.2 ± 2.3	102.7 ± 4.4
<i>Costus igneus</i>	128.2 ± 4.7	145.1 ± 5.3	38.6 ± 2.5	66.4 ± 3.9*
<i>Eugenia jambolana</i>	125.1 ± 4.6	140.3 ± 5.2	41.7 ± 2.4	62.1 ± 3.7*
Metformin (Std.)	110.6 ± 4.4*	125.9 ± 4.8*	47.2 ± 2.9*	45.6 ± 3.3*

(Values are mean ± SEM, n=6; $p < 0.001$ vs Diabetic Control)

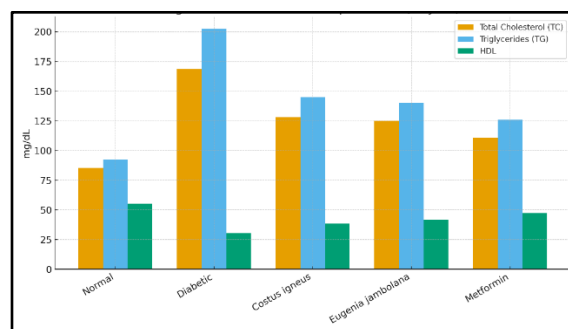


Figure 3. Effect of *Costus igneus* and *Eugenia jambolana* on serum lipid profile (TC, TG, HDL) at day 28. Grouped bar chart illustrating significant improvements in treated groups compared to diabetic control. EJ shows stronger lipid correction.

C. Histopathological Findings

Pancreas

- **Normal control:** Normal architecture with intact islets of Langerhans.
- **Diabetic control:** Severe β -cell necrosis, shrunken islets, and reduced cell density.
- ***Costus igneus*:** Marked regeneration of islets, increased β -cell mass, and restored pancreatic architecture.
- ***Eugenia jambolana*:** Moderate islet protection and partial reorganization; β -cell regeneration was evident but less extensive compared to *Costus igneus*.
- **Metformin:** Preserved islet structure with moderate β -cell density.

These results are consistent with prior studies demonstrating pancreatic β -cell regeneration by *C. igneus*³³ and islet protection with *E. jambolana*³⁴.

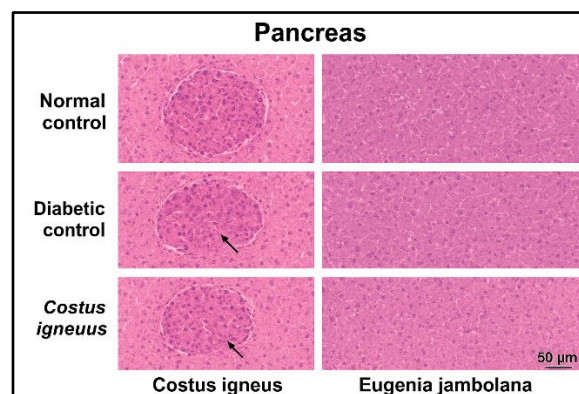


Figure 4. Histopathology of pancreas across groups



5. Discussion

The present study compared the antidiabetic potential of *Costus igneus* (CI) and *Eugenia jambolana* (EJ) extracts in STZ- and dexamethasone-induced diabetic rat models, evaluating their effects on glycemic control, lipid metabolism, and histopathological changes. The findings indicate that both extracts significantly improved diabetic parameters, though they exerted **differential mechanisms of action**.

1. Glycemic Control

Both CI and EJ significantly reduced fasting blood glucose (FBG) levels compared to diabetic controls. EJ produced a **faster and more pronounced glucose-lowering effect**, evident by day 14, whereas CI demonstrated a **gradual but sustained reduction** until day 28. The rapid hypoglycemic effect of EJ can be attributed to its insulin secretagogue activity, α -glucosidase inhibition, and enhanced glucose utilization reported in earlier studies³⁵⁻³⁶. In contrast, CI's delayed but consistent action aligns with reports that its major phytoconstituent, corosolic acid, enhances peripheral glucose uptake through GLUT4 translocation and promotes pancreatic β -cell regeneration³⁷⁻³⁸.

2. Lipid Profile Modulation

Dyslipidemia is a common feature of diabetes, contributing to cardiovascular complications³⁹. In the present study, EJ exhibited a stronger ability to lower total cholesterol (TC), triglycerides (TG), and LDL, while significantly increasing HDL compared to CI. This agrees with previous findings where EJ seeds demonstrated potent antihyperlipidemic activity through modulation of lipid metabolic enzymes and enhanced cholesterol clearance⁴⁰⁻⁴¹. CI also improved lipid profile moderately, likely secondary to improved glycemic control rather than direct lipid metabolism modulation, as reported in other experimental studies⁴².

3. Histopathological Findings

Histological analysis provided crucial mechanistic insights. CI-treated animals exhibited **extensive pancreatic islet regeneration and restoration of β -cell density**, consistent with studies documenting corosolic acid-mediated β -cell neogenesis and antioxidant protection⁴³⁻⁴⁴. EJ-treated animals showed **partial islet protection and reorganization**, in agreement with its ability to reduce oxidative stress and prevent β -cell apoptosis^{31, 40}.

4. Comparative Mechanistic Insights

The differential efficacy observed between CI and EJ can be explained by their phytoconstituents and pharmacological targets: *Eugenia jambolana* acts rapidly, improving glucose homeostasis via **insulin secretion, enzyme inhibition, and lipid regulation**. Its anthocyanins and ellagic acid contribute to

strong antioxidant and antihyperlipidemic actions⁴⁵. *Costus igneus* exerts a slower but long-term benefit through **β -cell regeneration, enhanced glucose uptake, and oxidative stress reduction**, mediated by corosolic acid and flavonoids⁴⁶. Thus, while EJ is more effective in **short-term glycemic and lipid regulation**, CI provides **long-term regenerative potential**. This complementary pharmacology supports the rationale for **polyherbal approaches**, combining immediate glycemic control with durable β -cell recovery.

5. Comparison with Previous Studies

Our results are consistent with earlier reports on both plants individually, but this is among the **first comparative studies** to directly evaluate their efficacy in parallel models. Sharma et al.³⁵ demonstrated EJ seed powder's rapid antihyperglycemic effects, while Shetty et al.³⁷ and Gupta et al.³⁸ documented CI's progressive glucose-lowering and regenerative capacity. The present findings bridge these observations, providing a side-by-side evaluation of their therapeutic profiles.

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Conflict of interest

The authors declare that they have no conflict of interest related to this study.

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