

Effect of *Costus igneus* Leaf Powder on Oxidative Stress Biomarkers in Diabetic Rats

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ABSTRACT

Background: Diabetes mellitus is associated with oxidative imbalance, increased lipid peroxidation and altered antioxidant defenses. *Costus igneus* is traditionally studied for antidiabetic and antioxidant potential. **Objective:** The present study was designed to investigate the effect of directly obtained leaf powder of *C. igneus* on selected oxidative stress markers in streptozotocin-nicotinamide (STZ-NA)-induced diabetic rats. **Materials and Methods:** Adult male Wistar rats were divided into normal control, STZ-NA diabetic control and STZ-NA + *C. igneus* leaf powder groups with six animals in each group. Diabetes was induced by intraperitoneal injection of nicotinamide (120 mg/kg) followed 15 min later by intraperitoneal injection of streptozotocin (65 mg/kg). *C. igneus* leaf powder (1 mL/kg body weight vehicle volume) was freshly suspended in distilled water and orally administered at 200 mg/kg/day every morning. SOD, CAT, GPx, GSH and LPO were determined. **Results:** The overall group differences were statistically significant for CAT, GSH and LPO for the available observations, while SOD and GPx were not statistically significant. LPO was higher in STZ-NA animals and lower after administration of *C. igneus*. CAT also showed a significant group effect. The *C. igneus* group had lower GSH levels than the diabetic untreated animals. **Conclusion:** The leaf powder of *C. igneus* showed selective modulation of oxidative-stress biomarkers, with the most evident treatment-related modification being in lipid peroxidation.

Keywords: *Costus igneus*, oxidative stress, streptozotocin, nicotinamide, diabetes mellitus

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INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder that is characterized by persistent alterations in glucose homeostasis and progressive metabolic derangements. Experimental diabetes is linked to hyperglycemia and increased production of reactive oxygen species, leading to oxidative stress in tissues. It may therefore be involved in cellular injury and progression of diabetic complications.¹⁻³

The streptozotocin-nicotinamide (STZ-NA) model is a commonly utilized model for experimental studies of type 2 diabetes. Nicotinamide provides partial protection from streptozotocin-induced destruction of beta cells and produces a diabetic phenotype suitable for evaluation of pharmacological and phytotherapeutic interventions.²⁻⁶

The assessment of oxidative stress is strengthened by studying both oxidative damage and antioxidant

defence. Lipid peroxidation (LPO) is a marker of oxidative damage to membrane lipids, whereas the enzymes superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx) are important antioxidant systems. Reduced glutathione (GSH) is a major non-enzymatic component of the cellular redox defense.²⁻⁶

Costus igneus is commonly known as the insulin plant and has been studied for its antidiabetic and antioxidant effects.⁷⁻⁹ It has been experimentally studied for its effects on glucose metabolism, antioxidant enzymes and lipid peroxidation in diabetic animals.⁴⁻⁶

C. igneus rhizome extract was evaluated for SOD, CAT, GPx, GSH and LPO and improvement in several oxidative parameters following oral administration was observed.¹⁰⁻¹⁷

More recent experimental work has examined the use of *C. igneus* leaf extract in diabetic rats, including its effects on lipid peroxidation, GSH, SOD, CAT and GPx.⁶ Diosgenin from *C. igneus* was further explored for its antioxidant and metabolic effects in streptozotocin-induced diabetes.^{13–17}

Hence, the present study was planned to evaluate the effect of *C. igneus* leaf powder at a dose of 200 mg/kg/day, administered orally every morning, on SOD, CAT, GPx, GSH and LPO in STZ–NA-induced diabetic rats.^{10–20}

MATERIALS AND METHODS

ANIMALS FOR EXPERIMENTATION

Adult male Wistar rats (150–200 g) were housed in standard laboratory conditions with proper ventilation, 12-h light/dark cycle, standard laboratory pellet diet and ad libitum drinking water. The experimental groups consisted of six animals each.¹⁸

ETHICAL APPROVAL

The animal experiment was approved by Institutional Animal Ethical Committee, KMCH College of Pharmacy, Coimbatore.

INDUCTION OF EXPERIMENTAL DIABETES MELLITUS

Animals were fasted overnight. Nicotinamide was administered intraperitoneally at a dose of 120 mg/kg body weight. After 15 min, streptozotocin was injected intraperitoneally at a dose of 65 mg/kg body weight. Streptozotocin was dissolved in citrate buffer and injected immediately, while nicotinamide was dissolved in physiological saline. Diabetes was confirmed when the fasting blood glucose (from tail vein) was >250 mg/dl.^{1–3}

The STZ–NA induction approach is supported by established experimental diabetes models in which nicotinamide is used to partially protect pancreatic β -cells before streptozotocin administration.^{1–3}

TREATMENT WITH *COSTUS IGNEUS* LEAF POWDER

The leaf powder of *C. igneus* was collected and stored in a clean, dry and airtight container under prescribed conditions until administered. The required dose was freshly suspended in distilled water at a vehicle volume of 1 mL/kg body weight and administered orally at 200 mg/kg/day every morning during the treatment period.^{12,16}

PARAMETERS OF OXIDATIVE STRESS

Superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), reduced glutathione (GSH) and lipid peroxidation (LPO) levels were determined.^{8,9}

STATISTICAL ANALYSIS

Data were presented as mean $\pm$ SEM. A one-way analysis of variance was performed to assess overall differences among the three groups, followed by

Tukey's multiple comparison test. Statistical significance was set at $p < 0.05$ for two-sided testing.¹⁸

Group	Designation	n
I	Normal control	6
II	STZ–NA diabetic control	6
III	STZ–NA + <i>Costus igneus</i>	6

Table 1. Experimental Groups

RESULTS

There was a statistically significant overall difference in CAT scores ($F=57.496$, $p < 0.001$). The *C. igneus* group had a lower CAT value than the STZ–NA group and higher than the control mean.

There was no statistically significant difference in GPx overall ($F=3.720$, $p=0.089$). There was a statistically significant overall difference for GSH ($F=29.434$, $p < 0.001$). The *C. igneus* group had lower GSH than the STZ–NA untreated group.

LPO showed a statistically significant overall difference ($F=16.611$; $p=0.004$). The *C. igneus* group had a lower LPO value than the untreated STZ–NA group. No significant overall difference was observed for SOD ($F=3.006$, $p=0.125$).

Parameter	Control	STZ–NA	STZ–NA + <i>C. igneus</i> leaf powder	ANOVA p
SOD	0.4130 $\pm$ 0.0046	0.409 $\pm$ 0.045 3	0.3320 $\pm$ 0.0046	0.125

CAT	0.2263 ± 0.0026	0.270 5 ± 0.000 9	0.2415 ± 0.0043	<0.001
GPx	0.2670 ± 0.0064	0.280 0 ± 0.001 2	0.2795 ± 0.0014	0.089
GSH	0.1723 ± 0.0026	0.202 0 ± 0.005 8	0.1603 ± 0.0026	<0.001
LPO	0.0540 ± 0.0179	0.144 0 ± 0.006 9	0.0823 ± 0.0038	0.004

Table 2. Summary of Oxidative Stress Parameters

The present investigation was designed to evaluate the oxidative-stress profile of STZ-NA-induced diabetic rats following administration of *C. igneus* leaf powder. Results showed that the treatment-related response was parameter specific with the most prominent change in lipid peroxidation.⁴⁻⁷

LPO was significantly increased in the STZ-NA group compared with controls, indicating increased oxidative lipid damage. The mean LPO value was 0.1440 and it reduced to 0.0823 after the administration of *C. igneus*. This agrees with earlier experimental studies on the effect of *C. igneus* preparations on lipid peroxidation and antioxidant defense systems.^{5,6,10,13-17,8,9,14}

There was also a large overall group difference for CAT. The CAT value was increased in the diabetic group as compared to controls and was brought down to the control range on treatment with *C. igneus* leaf powder. The result is better described as partial normalization because CAT did not return completely to the control value. The GSH level was higher in the

STZ-NA group compared to the control group, but it was reduced after treatment with *C. igneus* leaf powder. The group effect was statistically significant, but this result does not support the claim that *C. igneus* increased or restored GSH. This points to the fact that individual oxidative stress biomarkers should be examined together, and one should not assume that each antioxidant marker will change in the same direction.^{14,16}

No significant differences were found among the groups for SOD and GPx. Therefore, the current dataset does not support a significant treatment effect on these two enzymes. Previous studies on *C. igneus* have reported changes in SOD, CAT, GPx and GSH under different experimental conditions, but differences in plant material, extract composition, diabetic model, treatment duration and assay methodology may account for variation between studies.^{5-7,10-17}

The most important finding of the present investigation is the decrease of LPO. This demonstrates that *C. igneus* may affect the oxidative damage of lipids in STZ-NA-induced diabetes. This finding is biologically plausible in light of the reported antioxidant constituents and activities of *C. igneus* preparations.^{4-7,14,16}

CONCLUSION

Costus igneus leaf powder (200 mg/kg/day) was administered orally every morning and significantly modulated the selected oxidative-stress biomarkers in STZ-NA-induced diabetic rats. The most notable observation was the reduction of lipid peroxidation and a significant change in catalase. SOD and GPx were not significantly changed, while GSH was significantly decreased in the *C. igneus* group. Therefore, the results indicate a selective modulation of oxidative stress rather than a uniform normalization of antioxidant defenses. The antioxidant effects of *C. igneus* will be strengthened by future histopathological and molecular studies.

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Nil.

CONFLICT OF INTEREST

The authors have no conflict of interest.

ETHICAL APPROVAL

The animal experimental procedures were approved by Institutional Animal Ethical Committee, KMCH College of Pharmacy, Coimbatore.

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