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A MEDICINAL POTENCY OF ANTI DIABETIC INSULIN PLANT (*COSTUS IGNEUS*)

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ABSTRACT:

For many years, people have employed medicinal plants as an alternative to modern medications. The Costaceae family includes *Costus igneus*, often known as the spiral flag or insulin plant, which is cultivated as a decorative plant. Since the pancreatic beta cells in the human body are strengthened by the leaf of this plant, it is commonly referred to as the "insulin plant" in India. This plant is a recent arrival from South and Central America in India. It is a perennial, erect, spreading plant that grows to a height of about two feet. It has spiral-shaped leaves and lovely flowers. The herb is becoming more popular as a medicine in the current decade. It has been applied to treat many disorders. We have demonstrated the effectiveness of *Costus igneus* as a remedy in this review.

Keywords: *Costus igneus* , spreading plant, Insulin plant, β -cells of pancreas

INTRODUCTION:

Nature has provided a complete store house of remedies to cure all ailments of mankind [1]. As man began to acquire the closure acquaintance with his environment, he began to know more about the plants as

these were the only curative agents he had [2]. India has a rich heritage of using medicinal plants. Plants have played an important role as various medicinal agents since ages. The use of plants to treat illness is

found throughout human culture [3]. Medicinal plants have curative properties due to the presence of various complex chemical substance of different composition, which are found as secondary metabolites of the plants [4]. Due to they have lesser side effects than synthetic drugs in recent times there has been a tremendous increase in the use of plant based health products in developing as well as developed countries, resulting in an exponential growth of herbal products globally [5].

Insulin plant was first found by the scientists NEES and MART. The plant – *Costus igneus* belongs to family Costaceae. It grows wild but ornamental development is also there. It grows up to two feet and has a remarkable spiral arrangement of leaves – the identification landmark of the family

Costaceae, which was first raised to the rank of family by Nakai on the basis of spirally arranged leaves & rhizome being free from aromatic essential oils. This family consists of four genera & approximately 200 species. The genus *costus* is the largest family because it is having 150 specie [6-7].

Insulin plant is one such traditional plant which is getting global acceptance nowadays and is now widely used as an ayurvedic medicinal herb. Consumption of the leaves are believed to lower blood glucose levels, and cholesterol. Diabetics who consumed the leaves of this plant said to have a fall in their blood glucose levels. Insulin plant is native to Southeast Asia, especially on the Greater Sunda Islands in Indonesia [8].



Figure 1: Leaves



Figure 2: Flowers

Description:

Leaves:

Leaves are simple, alternate, entire, oblong, evergreen, 4-8 inches in length with

parallel venation. The large, smooth, dark green leaves of this tropical evergreen have light purple undersides and are spirally arranged around stems.

Flowers:

Orange flowers are produced in the warm months, appearing on cone-like heads at the tips of branches.

Fruits:

Fruits are inconspicuous, not showy, less than 0.5 inch, and green-colored.

Propagation:

Propagation is by division of the clumps, Seed germination, cuttings, or by separating the offsets or plantlets that form below the flower heads. Mites and nematodes can be a problem, especially on light, sandy soil.

Synonyms: *Costus cuspidatus*, *Costus igneus*, *Globba cuspidatus* and *Costus pictus*.

Regional names:

English – Banaba.

Telugu – Peddavesiga, Yeangesha

Hindi- Banda, Bija-sal, Peisar, Keukand

Tamil – Neyccarikamaram, Venkai-c-ciray, Kostam

Bengali – Piasal

Kannada – Kempu honne

Malayalam – Honne, Karintakara, Vengai, Venna-maram

Marathi – Honi, Pushkarmula

Odisha – Vengis

Sanskrit – Asana, Bandhukapushpa

Urdu- Bijasar, Bam al akhwain

Gujarati – Pakarmula [9]

Classification:

Kingdom: Plantae

Phylum: Tracheophyta

Class: Liliopsida

Order: Zingiberales

Family: Costaceae

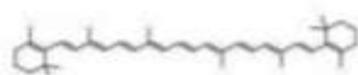
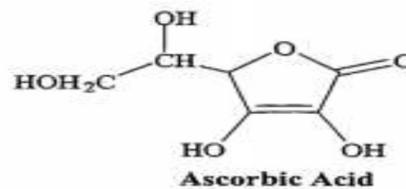
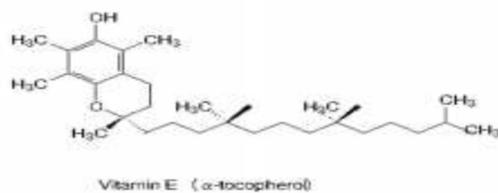
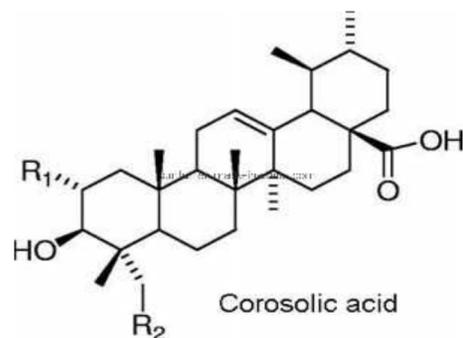
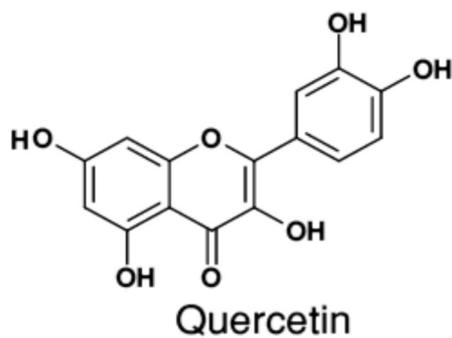
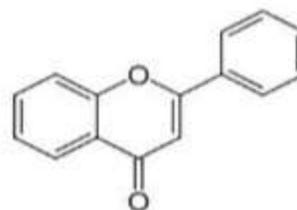
Genus: Costus

Specific: Igneus

Binomial name: *Costus igneus* N.E.Br

PHYTOCHEMICALS: (Anti-Diabetic):

Costus igneus contains various phytochemicals like flavonoids, alkaloids, terpenoids and it was traditionally used in India to control diabetes. The bio-components are present in various plant parts like in leaves, stems, rhizomes, etc. In leaves, corosolic acid, Ascorbic acid, Carbohydrates, triterpenoids, proteins, alkaloids, tannins, saponins, and flavonoids, β -carotene and alpha-tocopherol etc. are present. Besides these, steroids and carbohydrate like roseoside, fatty acids like hexadecanoic acid, tetradecanoic acid, ethyl oleate, oleic acid, squalene are also present in leaves. In Stem, terpenoid compound lupeol and steroid compound stigmasterol are present. In Rhizome, Quercetin, diosgenin, a steroidal sapogenin etc. are available. In root, terpenoid, alkaloids, tannins etc. are available.

 **β -carotene****Flavonoids****PHYTOCHEMICALS OF ESSENTIAL OILS: [10]**

Plant parts	Essential oils
Leaf	Hexadecanoic acid, 2-pentanol, Dodecanoic acid, β -ionone, Famesyl acetone, A-ionone
Stem	Hexadecanoic acid, 9,12-octadecadienoic acid, Dodecanoic acid, Linalyl propanoate, Tetradecanoic acid, A-eudesmol, γ -eudesmol 4-ethoxy phenol
Rhizome	Hexadecanoic acid, 9,12-octadecadienoic acid, Dodecanoic acid, Tetradecanoic acid, Linalool, α -tetrpineol

STUDIES CARRIED OUT TO EVALUATE ANTI-DIABETIC EFFECT: [11]

Author, year	Model	Part/extract used	Results
S P Dhanabal, 2007	Normoglycemic rats and Hyperglycemic rats	200, 400 mg/kg b.w of ethanolic leaf extract	Both the doses did not significantly reduce the blood glucose levels in Normoglycemic rats. 400 mg/kg b.w of extract led to significant blood glucose-lowering effect in hyperglycemia rats
Nandhakumar Jothivel, 2007	Alloxan induced in Male Wistar Albino rats	120 mg/kg b.w of methanolic leaf extract, p.o. single dose/day for 21 days	The methanolic extract significantly decreased serum glucose level and increase in liver glycogen, which shows its anti-diabetic effect. It also showed increase in plasma insulin level and improvement in lipid profile (cholesterol, triglyceride, HDL, LDL, VLDL, and phospholipids), which indicates it is useful in hyperlipidemia consequent upon diabetes mellitus
Gireesh 2007	STZ induced in Male Albino Wistar rats	250 mg/kg b.w of crude aqueous extract, orally for 14 days	<i>C. pictus</i> leaf extract significantly reduced the blood glucose to near the control in diabetic rats. <i>In vitro</i> studies showed <i>C. pictus</i> leaf extract induced glucose-stimulated insulin secretion in pancreatic islets. <i>C. pictus</i> extracts have a regulatory role in the secretion and glucose homeostasis through muscarinic receptors. It was evident that the aqueous solution of <i>C. pictus</i> leaves was effective in maintaining the blood glucose levels in normal and STZ-induced diabetic rats. Morphometric analysis of <i>C. pictus</i> -treated rat pancreatic islets showed a significant increase in the number and area of islets. Preliminary data of this study indicates that leaf powder is effective in lowering blood glucose
M A Jayasri, S Gunasekaran, 2008	STZ induced in Albino Wistar rats	2 gm/kg b.w of aqueous solution, orally for 28 days	It significantly increased the plasma insulin level to near control in diabetic rats. <i>In vitro</i> insulin secretion study using rat islet culture revealed that aqueous extract of <i>C. pictus</i> enhanced insulin secretion. Extract at both doses produced significant reduction in blood glucose and lipid peroxidation (LPO)
V Devi, Asna Urooj, 2008	STZ induced in Male Albino Wistar rats	500 mg/kg b.w of crude leaf powder, orally for 15 days	The extract significantly decreased glucose level in diabetic rats
Gireesh G, Santhosh K, 2009	STZ induced in Male Albino Wistar rats	250 mg/kg b.w of crude aqueous extract, orally for 14 days	Among these extracts, methanolic extract at 200 mg/kg b.w was found to be almost significant as the standard drug (Glibenclamide-0.5 mg/kg) in lowering blood glucose level when compared to aqueous extracts
P P Sethumathui, J Nandakumar, 2009	Alloxan induced in Male albino Wistar rats	120 mg/kg and 180 mg/kg b.w of methanolic leaf extract, p.o. single dose/day for 21 days	<i>In vitro</i> observations suggest that one mode of action of <i>C. pictus</i> is through stimulating insulin secretion, which may be mediated, in part, by the ability of the plant extract to increase $[Ca^{2+}]$ levels through voltage-gated Ca^{2+} -channel (VGCC)
Bhat Vishnu, Asuti Naveen, 2010	Alloxan induced in Male albino Wistar rats	500 mg ethanolic leaf extract, orally for 7 days	250, 500 mg/kg leaf powder reduced the fasting and post-prandial blood sugar levels, bringing them to normal.
Pangal Mani, 2010	Alloxan induced in Male Albino Wistar rats	50, 100, 200 mg/kg b.w of methanolic and aqueous leaf extract, intra peritoneally for 30 days	Supplementation of <i>C. pictus</i> powder resulted in a consistent and gradual decrease in blood glucose levels
Altaf Al- Romaiyan, 2010	<i>In vitro</i> study in Mouse and Human Islets of Langerhans	Methanolic leaf extract	Of the three extracts, methanolic extract at 100 mg/kg b.w showed optimum benefits by eliciting pronounced hypoglycemia and antioxidant activities
Akhila J Shetty, 2010	Dexamethasone in Male Albino Wistar rats	100, 250, 500 mg/kg b.w leaf powder, orally for 7 days	Study showed that the extracts significantly reduced blood glucose levels in diabetic rats and also reversed levels of carbohydrate metabolic, hepatoproduective, and antioxidant enzymes
V Devi, Asna Urooj, 2011	STZ Induced in Male Albino Wistar rats	500 mg/kg b.w of leaf powder for 45 days	Both are highly effective in lowering the blood glucose levels; however, hypoglycemic activity of <i>C. pictus</i> was found to be higher than <i>C. pictus</i>
Kripa Krishnan, 2011	STZ induced in Male Albino Sprague- Dawley	100 mg/kg b.w of aqueous, methanolic, and ethanolic leaf extract, orally for 30 days	Results showed that fasting blood glucose, lipid profile levels were significantly decreased, and hence <i>C. igneus</i> rhizome showed potent anti-diabetic and hypolipidemic effect
Pazhanichamy Kalaiilingam, 2011	STZ induced in Albino Wistar rats	100, 200 mg/kg b.w of ethanol rhizome extract, orally for 30 days	Significantly reduced the levels of blood glucose, lipid profile, lipid peroxidation, liver marker enzymes, liver marker enzymes, urea, creatinine and increased the antioxidant enzymes
Stabitha T Issac, 2011	STZ induced in Male albino rats	500 mg/kg b.w of aqueous leaf extract of <i>C. pictus</i> and <i>C. pictus</i> , orally for 15 days	500 mg/kg b.w of both aqueous and ethanolic extracts showed significant reduction in blood glucose level and lipid profile. However, anti-diabetic activity of 500 mg/kg b.w of ethanolic extract was more significant than the aqueous extract
Pazhanichamy Kalaiilingam, 2011	STZ induced in Albino Wistar rats	100, 200 mg/kg b.w of methanolic rhizome extract, orally for 30 days	Results show significant decrease in blood glucose level and lipid profiles
S Suganya, 2012	Alloxan induced in Female Albino Wistar rats	200 mg/kg b.w of aqueous extract, orally for 30 days	
M V Kumudhavalli, 2012	STZ Induced in Male Albino Wistar rats	250, 500 mg/kg b.w each of aqueous and ethanolic leaf extract, orally for 15 days	
R Remya, M Daniel, 2012	Alloxan induced in Male Sprague Dawley rats	200, 400 mg/kg b.w of fresh leaf extract, orally for 60 days	

FOLKLORIC USES:

Philippines- increased as ant diabetic herbal medicine. Tribal of Kolli hills of Tamilnadu used for diabetes Decoction of leaves, and roots used to reduce blood sugar in Mizoram, India. In Mexico, infusion of aerial parts used for treatment of renal disorders. Leaves used for treatment of diabetes, skin diseases, asthma, bronchitis, fever and intestinal worm disease in west Sikkim, India. In Sidda- leaves chewed twice daily or in dried powder leaves taken 1/2 to 1 g twice daily used for diabetes treatment.

MEDICINAL USES:

C. cuspidatus is known as Insulin plant. As it is having the virtue of the promoting insulin by human body. Aqueous extract of this plant would prevent the formation of calcium kidney stones by the inhibitory effect on plant growth of calcium oxalate. The dry leaves of this plant show significant control over blood sugar level in laboratory rats. This plant is used for the reduction of post prandial blood sugar levels during fasting. It is now accepted and widely used as an Ayurvedic medicinal herb. It is possible to consume the leaves by drying and grinding the powder of the leaves.

PHARMACOLOGICAL ACTIVITIES:**Anti-diabetic activity:**

Of late, a lot of research work has been conducted to evaluate the anti-diabetic effect of insulin plant. In a cross-sectional clinical study, patients consuming either one fresh leaf or 1 teaspoon of shade-dried powder/day of *Costus igneus* in conjunction with other modalities of treatment had effectively produced glycemic control in diabetics.

Hypolipidemic activity:

A study was carried out to comparatively evaluate the methanolic and aqueous extracts of *Costus igneus* in diabetes-induced hyperlipidemia in rats. The study revealed that methanolic and aqueous extracts at a dose of 200 mg/kg body weight reversed the diabetes-induced hyperlipidemia. Alcoholic extract of *Costus igneus* at the dose of 400 mg/kg (p.o) had significantly decreased the levels of serum cholesterol, triglycerides, LDL in Triton-induced hyperlipidemic rats.

Diuretic effect:

A study was carried out to measure the diuretic effect of an aqueous extract of *Costus pictus* D. Don at doses of 100 and 200 mg/kg body weight and to compare it with the one induced by furosemide at 4 mg/kg. The results revealed that *Costus pictus* induced a natriuretic effect similar to furosemide. The aqueous extract induced an

increment in sodium and potassium clearance similar to the one obtained with furosemide, suggesting that it represents significant diuresis.

Antioxidant activity:

An *in vitro* study of alcoholic extract of leaves of *Costus mexicanus* showed moderate antioxidant activity. The antioxidant activities of leaves and rhizomes in methanol, aqueous, ethanol, and ethyl acetate extracts were assessed using different models like DPPH, β -carotene, Deoxyribose, superoxide anion, reducing power, and metal chelating assay at different concentrations. Leaves and rhizomes of *Costus pictus* showed good antioxidant activity of about 89.5% and 90.0% when compared with standard BHT (Butylated Hydroxy Toulene) (85%) at a concentration of 400 $\mu\text{g}/\text{ml}$.

Ameliorative effect:

A study was conducted to evaluate the ameliorative effect of ethanolic extract (50 mg/kg b.wt, orally) of rhizome on mitochondrial enzymes in alcohol-induced free radical toxicity in male albino rats. After 21 days of treatment, mitochondrial enzymes were restored to normal levels, which showed that *Costus pictus* improved mitochondrial activities during alcohol-induced free radical stress.

Anti-microbial activity:

Arun Nagarajan *et al.*, in 2017 investigated the antimicrobial activity of *Costus igneus* using its 100mg of root powder. Gram-negative Bacterial cultures like *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Salmonella* species, *Proteus vulgaris* were used in the study to determine the antibacterial activity.

Anti-cancer effect:

The ethanolic extract of leaves of *Costus pictus* was found to have anti-proliferative and anti-cancer potential *in vitro* mammalian fibrosarcoma (HT-1080) cells. All the extracts of bark had potent anti-cancer properties against HT 29 and A549 cells.

Putative activity:

Aqueous extract of *Costus* stem and isolated compounds lupeol, and stigmasterol had an inhibitory effect on calcium oxalate urolithiasis, and its putative activity was confirmed by the promotion of formation of calcium oxalate dehydrate (COD) crystals and may possibly treat urinary stones by inhibiting the formation of calcium oxalate monohydrate (COM) crystals.

Anti-urolithiatic Property:

Kesavan studied the antiurolithiatic property of insulin plant using its aqueous extract of stem and rhizome and through the work found out that the plant extract was

able to promote the formation of hydroxyapatite (HAP) crystals and reduce the nucleation rate of CHPD crystals, a major component of calcium urinary stone. The growth of Calcium hydrogen phosphate dihydrate (CHPD) crystals has done by the single diffusion gel growth technique and the inhibitory effect of aqueous extracts of leaves, stems, and rhizome of *Costus igneus* on the growth of CHPD crystals has been investigated.

Anti-Inflammatory:

Kripa Krishnan *et al.*, in 2014 studied the anti-inflammatory potential of β -amyrin isolated from the leaves of *Costus igneus* using rat model along with LPS-induced human peripheral blood mononuclear cells (hPBMCs) in vitro model. The differential fractionation methanolic extract (MEC) of *Costus igneus* leaves indicated a maximum percentage inhibition of paw edema at a given dose of 100 mg/kg body weight. The fractionation of MEC had been performed using various solvents such as chloroform, hexane, ethyl acetate, and butanol. The maximum beneficial effect was shown by chloroform extract (CEC) of MEC at a dose of 50 mg/kg bw.

Effect of *Costus igneus* on Memory:

Shalini Adiga *et al.*, in 2014 has evaluated the effect of *Costus igneus* on

learning and memory in normal and diabetic-induced rats using passive avoidance test at doses of 250 & 500mg/kg ethanolic extract. For the induction of diabetes, a single dose of streptozotocin was injected (35 mg/kg) intraperitoneally. After a study period of 30 days, blood glucose level measured and rats were subjected to a passive avoidance test. The treatment with *Costus igneus* significantly reduced the blood glucose level in a dose-dependent manner (75.70% reduction for 500mg) in diabetic treated groups when compared to the diabetic control group. As summarizing the ethanolic extract of *Costus igneus* was able to produce a significant effect on learning and memory in diabetic rats when treated with at a dose of 500mg.

Neuroprotective Role:

Gupta D *et al.*, in 2018, investigated the neuroprotective role of exogenous melatonin and insulin plant extract on the brain in streptozotocin-induced female diabetic rats. The extract showed a significant decrease of lipid peroxidation (TBARS) in brain tissue compared to the control group of rats. Melatonin as well as plant extract showed significant recovery to restore the brain complication induced by hyperglycemic effect caused by the diabetic condition and rescued the brain tissue by

restoring the number of astrocytes and glial cells [12-13].

Acute Oral Toxicity Study:

Acute oral toxicity studies of CIF fraction of chloroform extract showed no abnormal or toxic symptoms in mice treated with 5, 50, 500, 2000 mg/kg. LD 50 value is above 2 g/kg.

Anti-Proliferative / Apoptotic / Leaves:

Study evaluated the anti-proliferative and apoptotic potential of ME of *Costus igneus* on in vitro MCF-7 Breast cancer cell line. Results showed reduction of tumor size without affecting the normal cells.

Silver Nanoparticles / Antidiabetic:

Study reports on the simple and cost-effective synthesis of silver nanoparticles using *C. igneus* extract. The *C. igneus* mediated nanoparticles showed high antidiabetic activity and maximum amylase inhibition concentration of 87% at 100 µg. The Ag NPs showed good antidiabetic activity than the plant extracts.

Hepatoprotective / Paracetamol Induced Liver Damage:

Study evaluated the hepatoprotective activity of *C. igneus* in paracetamol induced hepatic damage. Administration of *C. igneus* extract prior to acetaminophen effectively ($p < 0.05$) prevented the induction of damage by acetaminophen. The 400 mg/kg dose of *C.*

igneus was comparable to the standard drug silymarin.

Gold Nanoparticles / Antidiabetic / Leaves:

Study reports on the green synthesis of gold nanoparticles using insulin plant *Chamaecostus cuspidatus* leaf powder extract. The gold nanoparticles exhibited 50% inhibition of free radicals. Treatment of diabetic mice with the gold nanoparticles restored blood glucose, glycogen, and insulin level.

Toxicity Studies:

Acute oral toxicity studies of aqueous extract of *C. pictus* at various doses from 5, 10, 20, and 40 g/kg body weight. None of the extract doses produced mortality or any behavioral disorders. Administration of 1 g/kbw per day for 30 days, likewise, produced no mortality or behavioral effects. An ethanolic extract of leaves from 50 mg/kbw up to 5000 mg/kbw showed no mortality or significant toxicity.

Antifungal / Saponins / Rhizomes:

Study evaluated the antifungal activity of crude ethanol extracts of leaves, stems, and rhizomes of *Chamaecostus cuspidatus* against *Candida* and *Trichophyton* species. Only the rhizomes showed antifungal activity and had no activity against bacteria (*S. aureus* and *E.*

coli). The hexane fraction from the rhizome extract showed the best antifungal effect. Three known saponins were isolated from the fraction, of which two (dioscin and aferoside A) showed good antifungal activity. Fungicidal activity caused significant changes in the morphology of the fungal cells and showed anti-Candida albicans biofilm activity.

Silver Nanoparticles / Antimicrobial / Leaves:

Study reports on the synthesis of antibacterial nanoparticles using a leaf broth of *Costus igneus*. The silver nanoparticles showed enhanced antibacterial activity against well known pathogenic strains viz. *Streptococcus sp.*, *Pseudomonas aeruginosa*, *Staphylococcus sp.*, *Proteus sp.*, as well as fungi *Penicillium sp.*, *Mucor sp.*, *Candida albicans*, *Aspergillus sp.*

Antiangiogenic / Non-Teratogenic / Leaves:

Study evaluated the anti-angiogenic potential of crude ethanolic extract of *Costus igneus* through chorioallantoic membrane (CAM) vascularity and teratogenicity assays in mallard duck (*Anas platyrhynchos*). Teratogenicity assay showed statistically insignificant gross morphological abnormalities. The extracted crude ethanolic substance did not contain components that

can significantly inhibit angiogenesis. Also, results reveal insulin plant has no teratogenic effect.

Flavonoids / Hypoglycemic Impact / Rhizome:

Study isolated and quantified flavonoids from ethanol extract of *Costus igneus* rhizome and the impact of CiREE on hypoglycemic effect in STZ-induced diabetic rats. Quercetin (Rf-0.72, 0.794%) and kaempferol (Rf-0.35, 4.2%) were quantified by HPTLC. Results showed that treatment with CiREE pf rats with pretreatment abnormalities (increased elevated blood glucose, serum TC, TG, LDL, VLDL and decreased HDL, glycogen and insulin levels) resulted in reversal back to normal. Histopathological and electron microscopy study of the pancreas showed increase in number of β -cells and insulin granules. Results showed the CiREE has potent antidiabetic effect comparable to that of standard reference drug glibenclamide [9].

WARNING: This leaf is not recommended for pregnant or lactating women.

CONCLUSION:

More investigations are needed to analyze the mechanism of action of the compounds and standardization of herbal drugs using models and this in turn would be useful to provide many links to develop

various kinds of ant diabetic drugs in low costs. We concluded that *Costus igneus* is a potential herbal in the world.

CONFLICT OF INTEREST:

We declare that we have no conflict of interest.

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