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PHARMACOGNOSTIC STUDY AND PHARMACOLOGICAL POTENTIALS OF *COSTUS IGNEUS* PLANT – REVIEW

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ABSTRACT: The Plant *Costus igneus* is a member of the Costaceae family. The family Costaceae has about 200 species, of which genus Costus being largest comprises about 104 species. *Costus igneus* is indigenous to South-East Asia. *Costus igneus* is often called as 'Insulin plant' as it helps to elevate the insulin levels in the body and hence, works as a hypoglycemic agent. The phytochemical analysis of the leaves of *Costus igneus* revealed that it has higher compositions of iron, protein, and antioxidant substances such as ascorbic acid, α-tocopherol, β-carotene, terpenoids, steroids, and flavonoids. The traditional utilization of this plant included promoting healthy life and age, treating rashes, asthma, and bronchitis, reducing fever and eliminating intestinal worms. This article aims to review the pharmacognostic study of *Costus igneus* and explore its pharmacological activities such as antidiabetic activity, antiproliferative activity, antimicrobial activity, antiurolithiatic activity, its effects on learning and memory, antioxidant activity, hepatoprotective activity, *etc*.

INTRODUCTION: The advent of contemporary living resulted in a multitude of diseases such as diabetes mellitus, malignancy, cardiovascular diseases, *etc*. It is evident that herbal plants are treating these ailments efficiently, which leads the majority of people to depend on them. The world market for herbal products has a notable rise and estimated US$ 60 billion approaches. The admix of modern methods and ancient practices, keeping in view of scientific procedures helps ingeneration of newer medications from natural sources to tackle lifestyle diseases [1].

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Nature is a storehouse of remedies to treat all ailments of mankind. The extensive knowledge of medicinal agents results from man's curiosity towards nature. Hence, we hold much effective alternatives while ensuring the health care needs [2]. Plant parts contain many important chemical constituents which possess beneficial Pharmacological activities. There is rapid growth in the need for medicinally important natural products both nationally and internationally.

The recent demands for plant-based products in medicine and industry led to the expansive investigations of the plants for potential agent shaving therapeutic activities [3]. The Pharma-cognostic study marks the identity of the plant, develops the standardization. Parameters to exclude adulterants and thus help in authentication of plants. It provides reproducible quality of herbal products that render safe and efficacious natural

products [4]. *Costus igneus* Nakhas synonyms such as Costuspictus D. Don, *Costus congenitus* Rowle or *Costus mexicanus* Liebmex Petersen. It is commonly referred to as fiery Costus or step ladder or spiral flag or insulin plant [5].

The plant *C. igneus* belongs to the Costaceae family. The Costaceae was first hiked to the rank of the family by Nakaion based on spiral phyllotaxy having alternate leaves arranged spirally and rhizomes devoid of aromatics sential oils. Earlier Engler and Prantl regarded Costoideal as a subfamily under Zingiberaceae. However, with investigations of anatomical and morphological features such as aerial shoots with rigid and differential branches, spiral leaves with divergences. The family Costaceae has 4 genera and about 200 species, with genus Costus being largest possessing 150 species [6]. More than100 species of the Costus are available, which vary in colour of flowers. Some flowers and bracts appear like compact cones, while remaining sculpts like Pineappleors of crepe emerge out of green cones. Few leaves appear pubescent on Abaxial surface, while the remaining are lustrous and purplish. In India, about 7 species belonging to genus Costus Linn observed are *C. barbatus, C. chartaceus, C. Cuspidatus, C. Giganteus, C. Igneus, C. Spectabilis, C. pictus* [7].

This review aims to conduct a pharmacognostic study on the *Costus igneus*, a medicinally promising plant, and explore its pharmacological activities. *Costus igneus* is usually referred to as an insulin plant by Indians sit helps to elevate the Insulin in the body. The insulin plant is indigenous to Southeast Asia. In India, it has found its use as a nornamental plant that adorns the beauty of the environment [8]. The leaves of *C. Igneus* were used in the treatment of diabetes by the tribes of Kolli hills, belonging to the Namakkal district of Tamil Nadu [9]. As per the Mexican traditions, The aerial part of *C. pictus D. donis* being used to treat renal disorders [10].

TABLE 1: VERNACULAR NAMES [11]

Language	Names
English	Spiral Ginger, Spotted Spiral Ginger, Painted Spiral Ginger
Telugu	Peddavesiga, Yeangesha
Urdu	Bijasar, Dam alakhwain
Bengali	Piasal
Hindi	Banda, Bija-sal, Peisar, JARUL, Keukand
Kannada	Kempuhonne
Malayalam	Honne, Karintakara, Vengai, Venna-maram
Marathi	Honi, Pushkarmula
Odisha	Vengis
Sanskrit	Asana, Bandhukapushpa
Tamil	Neyccarikamaram, Venkai-c-ciray, Kostam
Gujarati	Pakarmul

TABLE 2: TAXONOMY [12]

Botanical name	*Costus igneus* N. E. Br
Domain	Eukaryota
Kingdom	Plantae
Subkingdom	Viridaeplantae
Phylum	Tracheophyta
Subphylum	Euphyllophytina
Infraphylum	Radiatopses
Class	Liliopsida
Subclass	Commelinidae
Superorder	Zingiberanae
Order	Zingiberales
Family	Costaceae
Subfamily	Asteroideae
Tribe	Coreopsideae
Genus	Costus
Specificepithet	Igneus

Plant Description: It is a perennial and upright growing plant that spreads about of extends sets down onto the ground. The leaves are simple, alternate, oblong, and evergreen, which acquires about 4-8 inches of length and possesses parallel venation. This tropical evergreen plant has smooth, large, and spirally arranged dark green leaves with light purple undersides that appear attractive and arching clumps from underground rootstocks. It produces 1.5 inches beautiful, orange flowers in the warm months and appears as cone-like heads arising from the tip of branches [13]. The plant is a rhizomatous shrub and penetrates through the tuberous rhizome underground.

The rhizome is soft, cylindrical, and fleshy with a smooth pale brown surface ranging from about 30-40 C min. It is pleasantly aromatic [14]. It is indigenous to eastern Brazil (states of Bahia and Espiritu Santo) and South America. It is also observed in Tropical Africa, North America, Asia, and Australia. It was introduced into India from America as an herbal cure for diabetes. In India, Costus is mainly found in Kashmir and South India regions [15].

The spiral flag can grow either in full sun or partial shade. It requires fertile soil and sufficient moisture and is often planted near an adequate water source. The propagation mode is by division of the clumps, cuttings or by separating the offsets or plantlets that form below the flower heads. Mites and nematodes can often menace, especially on light sandy soil. Currently, there are no diseases majorly affecting plant growth [13].

FIG. 1: INSULIN PLANT

FIG. 2: STEM OF *COSTUS IGNEUS* PLANT

FIG. 3: LEAF OF *COSTUS IGNEUS* PLANT

FIG. 4: RHIZOMES OF *COSTUS IGNEUS* PLANT

Microscopy: The transverse section (T.S) of *C. igneus* leaf showed upper and lower epidermis. It contains wide mesophyll tissue having a huge proportion of large parenchymal cells. They are seenem bedding the continuous strands of fibrovascular bundles. The upper epidermis cells are comparatively smaller than the lower epidermal cells. The lower epidermis is embedded with stomata, often beaded with the epidermal cells. The vascular bundles are found to be embedded in then broken strands of chlorenchyma, with their cells being either elongated or spherical.

The vascular bundles contained large vessels at the center, which is surrounded by phloem tissue. The bundles are found to be fibrous with parenchyma present adjacent to them and are loaded with rosette-shaped calcium oxalate crystals. Fibers are thin-walled, making two arc-like patches that protect the vascular tissue on either side. The extravascular bundles present in the mid-rib possess 'U' shaped fibrous heath on the lower side. T. S through the lamina shows same anatomical feature slacking extra-vascular bundles.

The plant *Costus igneus* exhibits a set of diagnostic characteristics like epidermis having anomocytic stomata and calcium oxalate crystals which will help for identification [16].

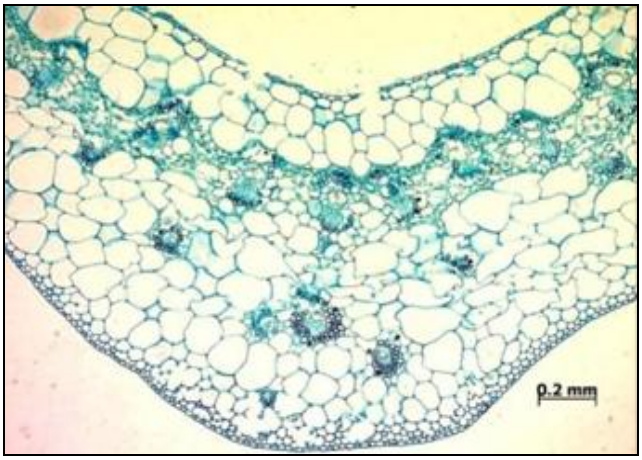

FIG. 5: DETAILED TS OF LEAF PASSING THROUGH LAMINA

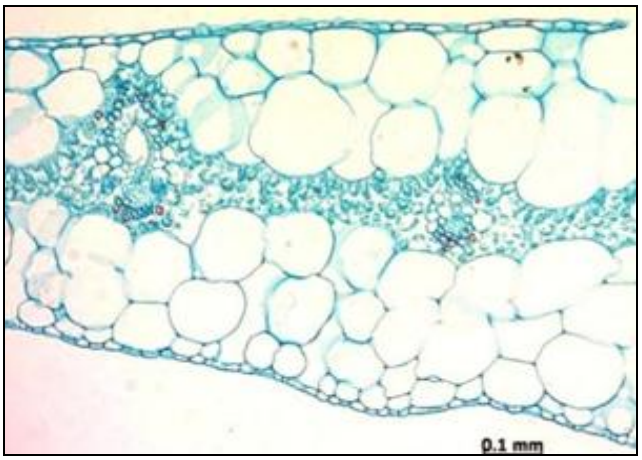

FIG. 6: DETAILED OF LEAF PASSING THROUGH MIDRIB

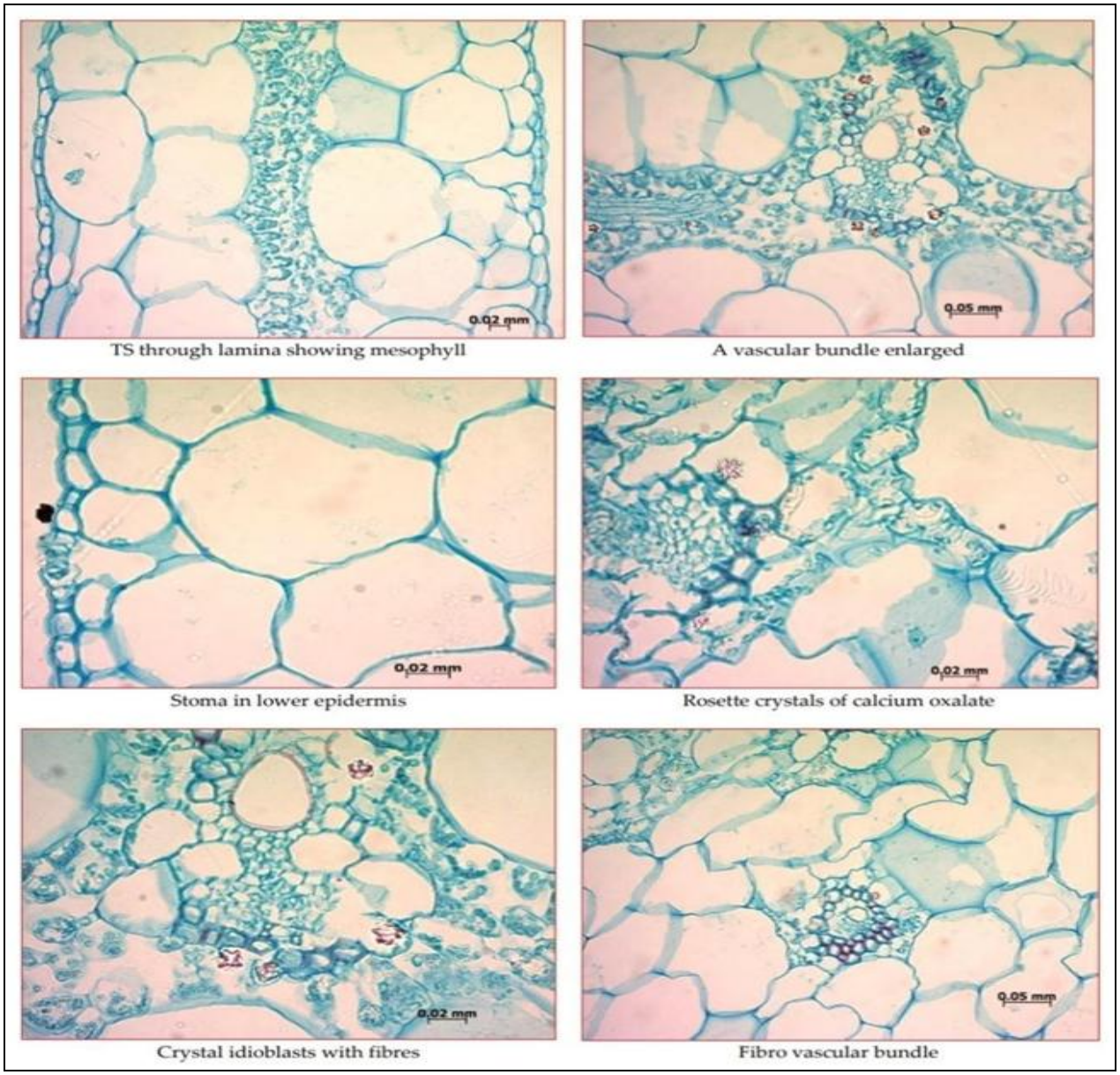

FIG. 7: DETAILED MICROSCOPIC FEATURES OF LEAF OF *COSTUS IGNEUS* PLANT

Phytochemical Constituents: Various phytochemicals such as flavonoids, terpenoids, and alkaloids are observed in *Costus igneus*. These bio-active components are present in plants like leaves, stems, rhizomes, *etc*.

Leaves: Carbohydrates, triterpenoids, proteins, alkaloids, tannins, saponins, and flavonoids, *etc*., are found [17]. In addition, carbohydrates such as rose side, steroids, fatty acids such as oleic acid, tetradecanoic acid, hexadecanoic acid 9, 12-octadecanoic acid, ethyl oleate, squalene are also present in leaves.

Stem: Terpenoid compound (lupeol) and steroid compound (stigma sterol) are available in stem [18].

Rhizome: Quercetin, diosgenin, asteroidal sapogenin *etc* are found in rhizome [19, 20].

Root: Terpenoid, alkaloids, Tannins, *etc*., are available in root portion [14]. The phytochemical screening of *C. igneus* leaves displayed high concentrations of iron, protein, various antioxidants (ascorbic acid, α-tocopherol, β-carotene), steroids, terpenoids, and flavonoids [21, 22].

TABLE 3: MAJOR CONSTITUENTS OF ESSENTIAL OIL [26]

Stem oil (%)	Lea foil (%)	Rhizome oil (%)
Hexadecanoic acid (28.3)	Hexadecanoic acid (24.51)	Hexadecanoic acid (25.26)
9,12-octadecadienoic acid (18.33)	2-pentanol (22.48)	9,12-octadecadienoic acid (7.74)
Dodecanoic acid (5.62)	Dodecanoic acid (3.96)	Dodecanoic acid (16.56)
Linalylpropanoate (6.03)	ß-ionone (8.69)	Tetradecanoic acid (10.20)
Tetradecanoic acid (4.82)	Farnesyl Acetone (7.04)	Linalool (8.48)
A-eudesmol (3.55)	A-ionone (8.01)	α-terpineol (4.44)
γ-eudesmol (3.21)		
4-ethoxyphenol (3.06)		

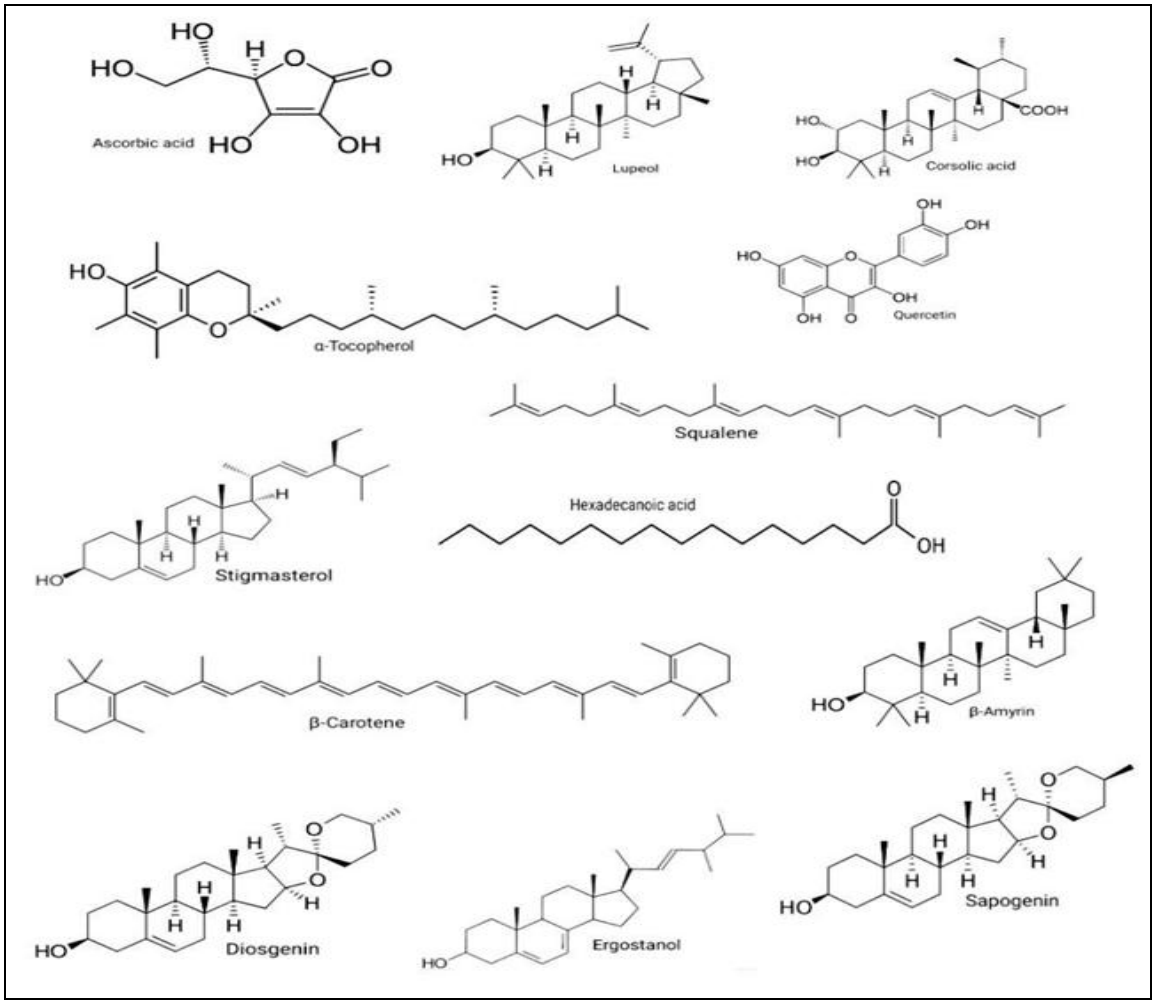

FIG. 8: PHYTOCONSTITUENTS OF *COSTUS IGNEUS* PLANT

A study conducted on methanolic extract of *Costus igneus* revealed to possess the highest number of phytochemicals such as carbohydrates, proteins, proteins, alkaloids, triterpenoids, tannins, saponins, etc flavonoids [23]. The preliminary phytochemical evaluation of *C. igneus* plant reported that the leaves contain 21.2% fibers. The subsequent extractions showed 5.2% of the extractives in petroleum ether, 1.06% in cyclohexane, 1.33% in acetone, and 2.95% in ethanol portions. The evaluation of these successive extracts revealed the presence of steroids in all the extracts. Additionally, alkaloids were also found in the ethanol extract. In the ether fraction, the major component was bis (2'-ethylhexyl) - 1, 2-benzene dicarboxylate (59.04%) in addition to α-tocopherol and asteroid namely, ergostanol [24]. The analysis for trace elements showed that the leaves and rhizomes of *C. pictus* contains considerate amounts of the element such as potassium, calcium, chromium, manganese, copperandzinc [25]. The steam distillation of stem, leaves, and rhizomes of *C. pictus* D. Don produced yellow and translucent essential oils. The major constituents present in the essential oil are enlisted in the below table [26].

Traditional uses:

Leaves: According to Ayurveda, patients with diabetes were instructed to chew the Insulin plant leaves for one month. Here the patients were prescribed consumption of 4 leaves in a day (2 in the morning and 2 in the evening) for a week. They were cautioned to chew the leaf well before swallowing it. After that, it was reduced to 2 leaves in a day. They were advised to consume 1 leaf in the morning and 1 in the evening. It was continued up to 30 days. It was evident in restoring the blood sugar levels back to the controlled limits. The traditional uses of these leaves included the promotion of healthy life and age, treatment of rashes, asthma and bronchitis, reduction of fever, and in removal of intestinal worms [28].

Rhizome: The rhizome of the insulin plant has found its uses as an astringent, acrid, bitter, cooling, aphrodisiac, anthelmintic, purgative, febrifuge, depurative, and expectorant. It is also useful in burning sensation, constipation, leprosy, worm infection, skin diseases, fever, asthma, bronchitis, inflammations, and anemia [21].

Pharmacological Activities: The *C. igneus* plant has been found to possess several activities, while amongst them, some are yet to be confirmed. The parts of this plant that displayed various beneficial activities included leaves, stem, roots, rhizome, and whole plant, respectively. The Leaves have high hypoglycemic potential. The stem has shown anti-urolithiatic activity. Both the stem and the root has reported considerable antioxidant activity.

Anti-Diabetic Effects: The leaves of *Costus igneus* plant are the most vital part of the plant, which produces prominent antidiabetic activity. It lowers both fasting and post pyramidal blood sugar levels in dexamethasone-administered hyperglycemic rats. The reduction in the fasting blood glucose levels and the postprandial blood-glucose levels by the *Costus igneus* leaves was found equivalent to that observed with Glibenclamide 500µg/kg against 250 mg/kg/day and 500 mg/kg/day of the powdered leaves of the *Costus igneus*. However, the actual mechanism of action for this antidiabetic activity is not yet discovered [28]. A study was conducted by administering100 and 200 mg/kg body weight of ethanol rhizome extract orally for 30 days to STZ induced diabetes in Albino Wistar rats. It revealed that the extracts significantly reduced blood glucose levels in diabetic rats and also reversed levels of carbohydrate metabolic, hepatoprotective, and antioxidant enzymes [36]. Various bio-components present from Costus igneus plant show anti-diabetic activities. Some of them are relisted in the table below:

TABLE 4: MAJOR ISOLATED COMPOUNDS FROM *COSTUS IGNEUS* PLANT INDICATING ANTIDIABETIC EFFECTS [29]

Name of the compound	Activities
Triterpenoid (Corsolicacid)	Glucose uptake activity
Steroid (Diosgenin)	Hypoglycemic property
Steroid (beta-sitosterol)	ıcreases plasma insulin level and a lsoincreases glucose uptake activity
Flavonoid (Quercetin)	Increases insulin-mediated glucose up taking and activity of antioxidant enzymes
Phenol (catechin)	ibitαglucosidase activity and antioxidant activity
Insulin-like protein	Hypoglycemic activity
Fatty acid (Oleic acid)	Hypoglycemic activity

Anti-Proliferative Potential: Prof. S. Dhanasekaran *et al.,* (2014) investigated the anti-proliferative or anticancer activity of methanolic extract of the *Costus igneus* powdered leaves (MECiL) on an *in-vitro* Michigan Cancer Foundation-7(MCF7) Breast cancer cellline.

This extract reported potential cell toxicity against the MCF-7 cell line only. With 2000 µg/ml dose, the extract showed potential anticancer activity. It showed 97.46±0.74 percent of cytotoxicity at the maximum dose. Thus, the MECiL was found to have dose-dependent cytotoxic activity on MCF-7 cell lines. Additionally, it was evaluated for the cell viability and cytotoxicity of the extract (15-2000µg/ml) on the L6 cell line (Rat skeletal muscle cell line) using the MTT [3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide assay.

The extract showed no-cytotoxicity on the normal L6 cell lines. It showed IC_{50} value for the 2000 µg/ml concentration. Although at high doses, it also aligned the cytotoxicity on normal call lines but was not detrimental [30].

Antimicrobial Activity: Arun Nagarajan *et al.,* (2011) evaluated the antimicrobial activity by utilizing 100mg of *Costus igneus* root powder. The use of cultures of Gram-negative bacteria like *Pseudomonas aeruginosa* (*P. aeruginosa*), *Klebsiella pneumonia* (*K. pneumonia*), *Salmonella sps*, *Proteus vulgaris* (*P. vulgaris*) helped to ascertain the antibacterial activity. About 10 grams of the IBA (Indolebutyric acid) and IAA (Indole3-acetic acid) derived root materials were subjected to extraction using Soxhlet apparatus using 5ml of acetone, chloroform, and methanol. In the study, two growth regulators IAA and IBA in combinations were added to Murashige and Skoog (MS) culture medium for direct induction of the root. For *Pseudomonas aeruginosa*, the best result was observed in root extracted with chloroform with the maximum inhibition zone about 17 mm (IBA derived root). The zone of clear an ceinpositive control was found to be 25mm.

With acetone as a solvent, Klebsiella pneumonia cultures were affected to both the IBA and the IAA-derived roots. Its clearance zone was found to be 25 mm, which was nearly the same as that obtained antibiotic gentamycin.

For *Proteus vulgaris*, the maximum result was recorded by extracting roots that were initiated on IBA and IAA with acetone as solvent. The inhibition zone was found to be about25mm.

The acetone-derived plant extract of both IBA and IAA-derived roots recorded the best of about 20mm zone of inhibition, while antibiotics didn't show any effect on *Salmonella sps* [31].

Antiurolithiatic Property: Kesavan Manjula *et al.,* (2017) analyzed the antiurolithiatic activity by using the aqueous extract of stem and rhizome of *Costus igneus* plant. They found that the plant extract promoted the hydroxylapatite (HAP) crystals formation and reduced the growth of CHPD crystals, which is an important component of urinary calcium stones.

Calcium hydrogen phosphate dihydrate (CHPD) crystals were grown by the single diffusion gel growth method. Later the activity of aqueous sex tracts of leaves, stem, and rhizome of *Costus igneus* plant on CHPD crystal growth was determined. Here five different concentrations (0.15, 0.25, 0.50, 0.75 and 1.00%) of these plant extracts were selected. The plant extracts produced an inhibitory effect with minimal apparent crystals length compared to control (pure calcium chloride). On increasing the aqueous extract concentration of *Costus igneus* from 0.15% (w/v) to 1.00% (w/v), there was a gradual decrease in the formed crystals weight from 2.03g to 0.03g (stem) 0.05g (rhizome), 0.06g leaves [32].

Anti-Inflammatory Potential Kripa Krishnan *et al.,* (2014) studied the anti-inflammatory activity of β-amyrin isolated from the leaves of *Costus igneus* using carrageen an-induced rat model and *in-vitro* model of LPS-induced human peripheral blood mononuclear cells (hPBMCs).

At a given dose of 100 mg/kg body weight, the differential fractionation methanolic extract (MEC) of *Costus igneus* leaves reported a maximum percentage reduction in paw oedema. The methanolic extract was fractionated using various solvents like chloroform, hexane, ethyl acetate, and butanol. The maximum effect was shown by chloroform extract (CEC) of ME Cgivenata dose of 50mg/kg body weight.

Treatment of carrageen an-administered rats with CEC significantly reduced the COX (cyclooxygenase), LOX (lipoxygenase), MPO (myeloperoxidase), and NOS (nitric oxide synthase) activities when compared to carrageenan-induced rats. β-amyrin isolated from it showed a dose-reliant reduction in paw edema with a 97 % decrease in carrageenan-induced pawed main rats for a dose of 100µg [33].

Effect of *Costus igneus* on Learning and Memory: Shalini Adiga *et al.,* (2014) have investigated the effect of *Costus igneus* on learning and memory in normal and diabetic-induced rats using the passive avoidance test at doses of 250 & 500mg/kg ethanolic extract. Diabetes was induced by administering a single dose of streptozotocin (35mg/kg) intraperitoneally. On completion of 30 days study period, the blood glucose level was measured, and rats were subjected to a passive avoidance test.

The treatment with *Costus igneus* significantly decreased the blood glucose level in dose reliant manner (75.70% reduction for 500mg) in diabetic-treated groups compared to the diabetic control group. Yet, there was no considerable responseonnon-diabetic rats and had similar normal values. Rats were subjected to three acquisition trials. The *Costus igneus*- treated diabetic rats showed lesser duration to move into the dark compartment predicting that their innatebehavior was maintained and also showed improvement in tendency of learning, while the non-treated diabetic rats show edimpairment in the passive avoidance test. Also, the treatment with *Costus igneus* extract in their post-shock retention testing conducted after 24 and 48 h, showed daconsiderable rise in the movement towards the entrance and reduced in the duration of time spentin the darkroom. Hence, it can be concluded that the thanolic extract of *Costus igneus* plant efficiently produces a significant effect on learning and memory in diabetic rats [34].

Antioxidant Activity: Ramya Urs S. K* *et al.,* (2015) studied the effect of methanolic extraction antioxidant activity against *Klebsiella oxytoca*, *Pseudomonas fragi*, *Enterobacter aerogens* using various concentrations ranging from100µg/mL-500µg/mL.

The antioxidant and radical scavenging activities of *Costus igneus* were evaluated for both root extract and stem extract. Root extract showed a significantly higher inhibition rate compared to the stem extract. Root extract showed a high amount of vitamin E. Also, the total phenolic contents were found to be greater for roots extracts compared to the stem.

Flavonoids bearing a hydroxyl (-OH) position in the molecular structure can function as a sport on the donator and thus shows radical scavenging activity. The study shows that the polyphenols and antioxidants scavenge off the free radicals and inhibit the generation of the free radical [35].

Neuroprotective Role: Gupta D, Rai S, HajamYA *et al.,* (2018) investigated the neuroprotective role of exogenous melatonin and insulin plant extract on the brain of streptozotocin-induced female diabetic rats. The extract showed a significant lowering of lipid peroxidation (TBARS) in brain tissue compared to the control group of rats. Also, the plant extract and the melatonin produced a significant reduction in antioxidative enzyme *viz*. SOD (superoxide dismutase), CAT (catalase), reduced Glutathione (GSH) of the brain. It was found that both Melatonin and the plant extract showed significant potential to restore the brain complication induced by hyperglycemic effect due to the diabetic condition and protected the brain tissue by restoring the number of astrocytes and glialcells [12].

Hypolipidemic Activity: Pazhanichamy Kalailingam *et al.,* (2011) investigated the hypoglycemic and hypolipidemic activities of the methanol extract of *Costus igneus* rhizome (MECiR) in streptozotocin (STZ) induced diabetic albino rats. The MECiR was administered at 100 and 200 mg/kg dose orally o.i.d to diabetes-induced rats for 30 days.

The results indicated that fasting blood glucose levels, total serum cholesterol (TC) levels, triglycerides (TG) levels, low-density lipoprotein (LDL) levels, very-low-density lipoprotein (VLDL) levels were significantly ($p<0.05$) decreased, while serum high-density lipoprotein (HDL) level significantly ($p<0.05$) increased in the diabetic rats. Better results were obtained with 200mg/kg. The

antidiabetic and hypolipidemic effects in STZ induced diabetic albino rats were comparable to standard reference drug glibenclamide (5mg /kg/ bw) [36].

Hepatoprotective Activity: Nimmy Chacko *et al.,* (2012) investigated the Hepatoprotective activity of *Costus igneus* plant against the paracetamol-induced hepatic damage in rats.

In this experiment, paracetamol in a dose of 300mg/kg orally induced hepatic damage. The alcoholic extract of the leaves of *Costus igneus* was used, and the drug Silymarin was used as references and ardina dose of 100mg/kg. The liver damage was established by elevated serum enzyme levels and was confirmed by the histopathological picture showing zonal focal necrosis. Administration of *Costus igneus* extracts prior to the administration of paracetamol ($P<0.05$) effectively prevented the induction of damage by paracetamol. It was validated by the normal levels of the enzymes and the absence of necrotic changes in the to pathological studies.

It was observed that 400mg/kg of *Costus igneus* produced an effect comparable to that of the standard drug silymarin. In histopathological studies, the paracetamol-treated group showed severe inflammation with focal necrosis, while the rats previously treated with *Costus igneus* showed almost normal hepatocytes.

Thus, the alcoholic extract of *Costus igneus* was able to reverse the hepatotoxicity used by paracetamol [37].

FIG. 9: COSTUS *IGNEUS JUICE* (NETHRA ORGANIC FARM)

FIG. 10: *COSTUS IGNEUS* CAPSULES (PANACEA HERBALS)

FIG. 11: *COSTUS IGNEUS* TEA (NETHRA ORGANIC FARM)

FIG. 12: *COSTUS IGNEUS* POWDER (AYURA ORIGINS)

CONCLUSION: *Costus igneus* is a traditionally used potent medicinal plant. The present review article confirms that *Costus igneus* plant possesses high therapeutic value. The presence of major phytochemical constituents such as diosgenin, corsolic acid, beta-sitosterol, beta-amyrin, quercetin, *etc.*, and their Pharmacological activities proved that the plant has

a leading capacity for the development of novel efficacious drugs in future.

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