

A Review on *Costusigneus* Nak (Insulin plant)

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ABSTRACT

Costusigneus Nak, alternatively recognized as *Costus pictus* D. Don, *Costus mexicanus* Liebm ex Petersen, or *Costus congenitus* Rowle, is widely known under various names such as fiery costus, step ladder, spiral flag, or quite commonly, the insulin plant. With origins in South and Central America, it has earned the popular title of the 'insulin plant.' This plant is often cultivated in gardens across South India as an attractive plant, and it also thrives independently in numerous locations. In India, it serves as a remedy for managing diabetes, with diabetic individuals reportedly consuming one leaf each day to help maintain healthy blood sugar levels. Among the plants recognized for their effectiveness in treating diabetes, the leaves of *C. igneus* were a favorite among the tribal communities residing in the Kolli hills of the Namakkal district in Tamilnadu. Extensive research efforts have recently been dedicated to assessing the anti-diabetic capabilities of this particular plant. In addition to its anti-diabetic effects, it has been scientifically confirmed to exhibit a diverse range of pharmacological properties, including hypolipidemic, diuretic, antioxidant, anti-microbial, and anti-cancerous activities. Moreover, phytochemical examinations have uncovered the presence of various constituents, such as carbohydrates, triterpenoids, proteins, alkaloids, tannins, saponins, flavonoids, steroids, as well as considerable levels of trace elements. This study endeavors to consolidate and examine the diverse pharmacological and phytochemical investigations documented up to the present time.

Keywords: Anti-diabetic activity, *Costusigneus*, diabetes mellitus, insulin plant.

INTRODUCTION

Costusigneus Nak, which is also referred to by its synonyms such as *Costus pictus* D. Don, *Costus mexicanus* Liebm ex Petersen, or *Costus congenitus* Rowle, is popularly known as the fiery costus, step ladder, spiral flag, or insulin plant. This species is indigenous to regions in South and Central America. It has recently been introduced to India from the Americas, where it is recognized for its medicinal properties in managing diabetes, thus earning the nickname 'insulin plant.' As noted by Jose and Reddy in 2010, it is extensively cultivated as an ornamental plant in South Indian gardens and is found growing freely in numerous areas, as reported by Benny in 2004. Traditionally, in India, it is employed as a remedy for diabetes, with diabetic individuals

consuming a single leaf each day to help regulate their blood glucose levels, as described by Devi and colleagues in 2008. Among the tribal communities in the Kolli hills of Tamil Nadu, the leaves of *C. igneus* are known to be effectively utilized for diabetes treatment, according to research by Elavarasi and others in 2012. In the realm of Mexican traditional medicine, the aerial portions of *C. pictus* D. Don are prepared as an infusion to address kidney-related ailments, as highlighted by Meléndez-Camargo et al in 2006.

Costusigneus belongs to the Costaceae family, which Nakai elevated to family status based on specific characteristics such as the spirally arranged leaves and rhizomes that do not contain aromatic essential oils. This family classification followed its earlier

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designation as a subfamily, Costoidea, under the Zingiberaceae, acknowledged by Engler and Prantl. The family's distinct position is further supported by various anatomical and morphological traits, including a well-defined aerial shoot with sturdy, often branched stems, and leaves that grow in a low spiral arrangement with divergences. The Costaceae family consists of about 200 species spread across four genera, with *Costus* being the largest, containing roughly 150 species mainly located in tropical climates, according to Eeveraet al.'s 2010 study. This paper will look at new research on the phytochemical composition, medicinal and living systems effects, and safe use of *Costus igneus* Nak.

Morphology:

This plant is a perennial species that grows upright and has a spreading habit, typically attaining a height of approximately two feet. Its tallest stems tend to droop and rest against the soil. The foliage is straightforward, positioned alternately, and has a whole appearance, being elongated in shape, with a persistent green hue ranging from 4 to 8 inches in length and having straight veins. The broad, glossy, deep green leaves of this tropical evergreen showcase pale purple beneath and are arranged in a spiral around the stems, forming appealing curved bunches that sprout from subterranean root systems. In the summertime, it generates vibrant orange blossoms, approximately 1.5 inches wide, which bloom in cone-shaped clusters at the tips of the branches. The fruits of the plant, however, are subtle and less noticeable, measuring under half an inch in green.

Phytochemical

Phytochemical analyses of the foliage of *C. igneus* revealed a substantial concentration of proteins, iron, and a range of antioxidant substances, such as ascorbic acid, α -tocopherol, β -carotene, terpenoids, steroids, and flavonoids. Furthermore, other studies found that the methanolic extract contained the most diverse range of phytochemicals, including carbohydrates, triterpenoids, proteins, alkaloids, tannins, saponins, and flavonoids. An initial examination of the Insulin plant (*C. pictus*) indicated that its leaves consist of 21.2% fibers. The sequential extraction process produced 5.2% extractives using petroleum ether, 1.06% with cyclohexane, 1.33%

from acetone, and 2.95% with ethanol. All extracted substances contained steroids, while the ethanol extract was also found to have alkaloids. The ether portion predominantly contained bis (2'-ethylhexyl)-1,2-benzenedicarboxylate (59.04%), together with α -tocopherol and ergastanol, a type of steroid. The presence of the terpenoid lupeol and the steroid stigmasterol was verified in the stem. Quercetin and diosgenin, a form of steroidal sapogenin, were among the active biological ingredients separated from the *C. igneus* rhizome. According to a trace element investigation, the leaves and rhizomes of *C. pictus* possess substantial levels of potassium, calcium, chromium, manganese, copper, and zinc. Additionally, the steam distillation process of *C. pictus* D. Don's stems, leaves, and rhizomes resulted in gathering transparent, slightly yellow essential oils.

Pharmacological activities

Anti-diabetic activity

Recently, numerous studies have been undertaken to investigate the anti-diabetic properties of the insulin plant. A variety of researchers, including Devi VD, Jothivel N, and Kalailingam P, among others, have contributed to this body of work. In a particular cross-sectional clinical trial, individuals who consumed either a fresh leaf or 1 teaspoon of shade-dried powder of *C. igneus* daily, alongside other treatment methods, demonstrated significant improvements in glycemic control for those with diabetes. Shetty AJ and co-workers published this discovery in 2010. Despite this, a lab analysis of the ethanolic substance derived from *C. pictus* leaves was performed to explore GLUT4 movement and glucose absorption; the analysis found no noteworthy impact on the periphery at a concentration of 300 $\mu\text{g/ml}$ when compared with insulin and metformin. [Pareek A ET AL 2010] A separate piece of research investigated how tea made using *C. spicatus* leaves affected sugar levels in C57BLKS/J (KS) db/db mice, which are animals used to represent high blood sugar linked to obesity, which involves increasing loss of beta-cells. Following a 10-week tracking period, tests of insulin tolerance conducted via injection into the abdomen revealed that drinking *C. spicatus* tea did not change how sensitive the mice were to insulin, suggesting the dose was not effective for controlling high blood sugar related to obesity. [Keller AC, et al 2009]. A study



was done in which Albino Wistar rats, who had diabetes caused by STZ, were given an ethanol extract from rhizomes orally at doses of 100 and 200 mg/kg for 30 days. The results showed that the extracts greatly reduced the levels of glucose in the blood of the rats with diabetes, and they also boosted the levels of particular enzymes that are related to how the body breaks down carbohydrates, liver health, and antioxidants (Kalailingam P, et al 2011).

Hypolipidemic activity

A study was undertaken to assess and contrast the effects of methanol-based and water-based solutions derived from *C. igneus* on rats with elevated lipid levels due to diabetes. The findings revealed that both solutions, when administered at a concentration of 200 mg for each kg of body mass, effectively combated the high lipid levels resulting from diabetes. The author executed the research utilizing online resources, employing Visual Studio Code and MySQL for the database management, the CodeIgniter structure, and XAMPP to facilitate operations. The use of an alcoholic solution of *C. igneus*, given orally at a strength of 400 mg per kg, noticeably decreased cholesterol, triglyceride, and LDL amounts in rats that had excessive fat content due to Triton administration. [Chacko N, et al 2012]

Anti-microbial activity

The methanol-based extraction from *C. igneus* exhibited the most potent antibacterial impact on a variety of gram-positive bacteria, specifically *Bacillus cereus*, *Bacillus megaterium*, *Micrococcus luteus*, *Staphylococcus aureus*, and *Streptococcus lactis*. Furthermore, it showed effectiveness against gram-negative bacteria such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, and *Salmonella typhimurium*. [Gothandam KM, et al 2010]. A substance separated from the ethanol-based extraction of *Costus igneus* demonstrated an average degree of antibacterial and antifungal capabilities when tested against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. [Saraswathi R, et al 2010]

Antioxidant activity:

In 2019, Khanday, W., and his colleagues evaluated the antioxidant properties of different *C. igneus* leaf

extracts using methods such as FRAP assay, ABTS assay, metal-binding assessment, phosphomolybdenum assay, superoxide radical neutralization, DPPH assay, and reducing power assay. Ekanem, I. R., et al (2023) conducted research to evaluate the potential of *C. igneus* leaves, stalks, and rhizomes in combating diabetes and their antioxidant properties in laboratory settings, using ethanol as the extraction solvent. Ramya Urs S. K. and associates, in their 2015 research, explored how methanol-based extracts influence antioxidant capabilities when tested on *Klebsiella Oxytoca*, *Pseudomonas Fragi*, and *Enterobacter aerogens*, utilizing concentration levels that spanned from 100 µg/mL up to 500 µg/mL. They analyzed the ability of *Costus igneus* to act as an antioxidant and to neutralize free radicals, examining both the stem and root extracts. The findings revealed that the root extract demonstrated a higher level of inhibitory action in contrast to the stem extract. Furthermore, it was determined that the phenolic content was more pronounced in the root extracts than in those obtained from the stem of *Costus igneus*. Furthermore, the root extract is rich in vitamin E. Flavonoids that possess a specific structure and hydroxyl group placement within the molecule can function as proton donors and exhibit the ability to scavenge radicals.

Anti-inflammatory:

Krishnan, K., and his research team reported in 2014 that β-amyrin, derived from *Costus igneus* (*C. igneus*) leaves, can combat inflammation using a carrageenan-induced inflammation model in rats and an in vitro model with human peripheral blood mononuclear cells (hPBMCs) stimulated by LPS. An evaluation of different fractions taken from *Costus igneus* leaves showed that the methanolic extract (MEC) was the most effective at reducing paw swelling when administered at a dosage of 100 mg/kg of body weight. MEC instigated a noticeable reduction in inflammation by reducing the functioning of cyclooxygenase (COX), lipoxygenase (LOX), myeloperoxidase (MPO), and nitric oxide synthase (NOS) in monocytes, as opposed to the carrageenan control group. The influence of MEC that was seen was greater than what was observed with Diclofenac (at a dose of 20 mg/kg of body weight), which is a typical anti-inflammatory medication. When



hPBMCs were exposed to LPS, the use of β -amyryn resulted in a considerable drop in the production of PGE2 and IL-6, along with the activation of NF- κ B, and this was reliant on the specific concentration employed. As a final point, β -amyryn, a powerful element derived from *C. igneus*, offers a promising and developing platform for the treatment of a variety of inflammatory ailments.

Anti-cancer activity:

The ethanolic extract derived from the leaves of *C. pictus* exhibited effects against cell growth and showed potential in fighting cancer within in vitro mammalian fibrosarcoma (HT-1080) cells. [Nadumane VK, et al 2011] All extracts obtained from the bark showed strong anti-cancer effects on HT 29 and A549 cell lines. [Sathuvan M, et al]

Anti urolithiatic Property

Kesavan Manjula and colleagues (2017) investigated the properties of the insulin plant for preventing urolithiasis by utilizing an aqueous extract from its stems and rhizomes. Their research concluded that this extract can facilitate the development of hydroxyapatite (HAP) crystals while simultaneously decreasing the formation rate of calcium hydrogen phosphate dihydrate (CHPD) crystals, a primary element found in kidney stones. The CHPD crystal growth was achieved through a single diffusion gel growth method, and the suppressive effect of the aqueous extracts from the leaves, stems, and rhizomes of *Costus igneus* on CHPD crystal formation was examined. In order to confirm the impact of these aqueous extracts, five distinct concentrations—0.15%, 0.25%, 0.50%, 0.75%, and 1.00%—were tested. The extracts demonstrated an inhibitory influence in contrast to the control, which consisted of pure calcium chloride, and resulted in a minimal apparent length of the crystals as they grew.

Neuroprotective Role:

Gupta D, Rai S, Hajam YA et al., in their 2018 study, investigated how adding melatonin from external sources and using a *Costus igneus* nak. plant extract could protect the brains of female rats who had diabetes caused by streptozotocin. The study found that using the plant extract significantly lowered the amount of lipid peroxidation (TBARS) happening in

the brain when compared to the rats that were the control group. Additionally, both the plant extract and melatonin caused a major drop in the levels of antioxidative enzymes like superoxide dismutase (SOD), catalase (CAT), and reduced Glutathione (GSH) that were present in the brain. Both melatonin and the plant extract effectively aided in recovery, helping to mitigate brain complications arising from hyperglycemia due to diabetes and promoted the restoration of astrocytes and glial cells within the brain tissue.

Learning and Memory:

In a study conducted by Shalini Adiga and her team in 2014, the impact of *Costus igneus* on cognitive processes, specifically learning and memory, was investigated in rats that were either healthy or had induced diabetes; this was accomplished using the passive avoidance test with ethanolic extract administered at dosages of 250 and 500 mg/kg. A single streptozotocin injection (35 mg/kg) directly into the peritoneum was used to bring on diabetes. At the conclusion of the 30-day experimental timeframe, blood sugar levels were assessed, and the rats underwent the passive avoidance assessment.

CONCLUSION

This analysis endorses the medicinal promise of the leaves in managing diabetes. Nonetheless, these findings must undergo additional assessment and confirmation through clinical studies. Currently, the anti-diabetic properties of the leaves are being investigated in individuals with diabetes. Research indicates its involvement in multiple illnesses, paving the way for new clinical investigation avenues. *Costus igneus* is a significant herbal remedy known for its diverse pharmacological effects. Investigations conducted on this plant have demonstrated that it contains numerous vital phytochemical compounds, including conjugated flavonoids, flavones, flavonols, catechin and its derivatives, chlorophylls a and b, resins, essential oil, and the alkaloid saussurine, along with inulin and resin, among others (Thiruchenduran S, et al and Saravanan A, et al). These substances are linked to a range of pharmacological benefits, such as antidiabetic effects, antimicrobial capabilities, anti-inflammatory properties, impacts on cognition, anti-urolithic effects, antioxidant functions,



neuroprotective properties, and hypolipidemic effects. Further investigation into the medicinal benefits and various phytochemical constituents responsible for these pharmacological effects is necessary to enhance the treatment's reliability and minimize side effects for the betterment of humanity in the future.

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