PHYTOCHEMICAL AND PHARMACOLOGICAL INVESTIGATION OF *COSTUS SPECIES*: A REVIEW

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ABSTRACT

Costus plants are known for their attractive flowers with different colours and are also known as Spiral flags. In this review, we choose three of the Costus plants with different activities. The plant is from South and Central America, new to India, and having attractive flowers. The Leaves from the costus plant are used as a dietary supplement in the treatment of diabetes mellitus in southern India. Additionally, it is demonstrated to have several pharmacological properties, including hypolipidemic, diuretic, antioxidant, anti-microbial, and anti-cancer properties. Phytochemical tests have shown that this plant contains carbohydrates, triterpenoids, proteins, alkaloids, tannins, saponins, flavonoids, steroids, and significant levels of trace elements. This work is an effort to gather and examine the various phytochemical research and pharmacological that have been reported up to this point.

Keywords: *Costus Igneus*, Insulin plant, Anti-diabetic activity, Diabetes mellitus.

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INTRODUCTION

The Costus plant, which belongs to the Costaceae family, produces leaves that help the body produce more insulin as a result of the adverse effects oral hypoglycemic medications have on the body. The demand for herbal treatments to treat diabetes mellitus is growing. The insulin plant is a well-known traditional plant that is currently used extensively in Ayurvedic medicine. People with diabetes who consume the leaves of this plant are said to experience a fall in blood glucose levels (1). One of the

alternatives that is being considered for the treatment of numerous disorders, including diabetes mellitus, is herbal therapy. It has been found that the cherry tree (*Muntingia calabura*) and the insulin plant (*Costus pictus*) both have substances that can aid in the treatment of diabetes (2). Drugs against different diseases are made specifically with the help of medicinal plants. Certain compounds found in the insulin plant (*Costus igneus*) are beneficial for diabetic individuals. The fiery costus, typically referred to as the spiral, belongs to the Costaceae family (3). A deficiency in insulin action and/or secretion causes diabetes, a chronic condition, to have abnormally high blood sugar levels (4). Diabetes mellitus (DM), frequently referred to as diabetes, is characterized by hyperglycemia, a medically abnormal state marked by persistently high blood glucose levels. A complex metabolic disease, DM. An abnormality in insulin secretion, action, or both can lead to a sustainable and varied range of metabolic dysfunctions affecting protein, lipid, and carbohydrate metabolism. The origin of diabetes is obscure, it progresses slowly over time, and it may demonstrate in a variety of distinct ways (5). The symptoms of diabetes mellitus appear when the body is unable to control the amount of glucose (a type of sugar) in the blood and when the kidneys produce an excessive quantity of urine. When the body cannot produce enough insulin or uses it inappropriately, diabetes mellitus develops (6). One of the top five causes of death worldwide is known metabolic ailment diabetes mellitus, which is characterized by hyperglycemia. In the next 20 years, the number of those who suffer will quadruple from the more than 150 million who do so now (7). Diabetes mellitus is a syndrome marked by aberrant metabolism and unjustified hyperglycemia that can be caused by either a lack of insulin secretion or by a concurrent combination of insulin resistance and insufficient insulin secretion to make up for it. Diabetes mellitus exists in two varieties: Type 1 and Type 2. Because their pancreatic islet B cells have been primarily killed by an autoimmune process, patients with type 1 diabetes are more vulnerable to ketoacidosis. Type 2 diabetes, however, is more common, is triggered by insulin resistance and the inability to secrete sufficient insulin to make up for it (8). Numerous chronic illnesses, including diabetes mellitus, cancer, and cardiovascular disorders, are the result of changes in modern lifestyle. These disorders are commonly treated with herbal plants because of their healing characteristics. Approximately 80% of native people still rely on medicinal plants to relieve their pain and suffering (9). According to the World Health Organisation (WHO), over the next ten years, the number of deaths related to diabetes would rise by 80% in some regions of the world. Approximately 35 million people, or 8% of the adult population, are affected, India has the largest diabetes population in the world. According to the WHO, about 200 million people worldwide today suffer from diabetes. Only 5% of diabetes cases worldwide are type 1 (IDDM). 90% of the remainder is type 2 (NIDDM) (10,11). Drugs for the treatment of DM that are currently on the market have a number of drawbacks, including side effects and a high rate of secondary failure (Koski, 2004). Traditional plants may be a potential source of new hypoglycemic chemicals, as there is an increasing tendency towards using natural medicines as supplements to conventional therapy (12).

TAXONOMY OF *COSTUS* PLANT:

Table No.1: Taxonomy of *Costus* plant

TAXONOMY OF *COSTUS* PLANT	
Domain	Eukaryota
Kingdom	Plantae
Phylum	Tracheophyta
Class	Liliopsida
Order	Zingiberales
Family	Costaceae
Genus	*Costus*
Species	*C. afer, C. pictus, C. igneus, C. speciosus,*

Fig.1: *Costus* plant

VARIOUS SPECIES OF CLOTUS PLANT:

Costus afer

Bush cane, spiral ginger, and ginger lily are other names for the plant Costus afer (C. afer). Numerous studies on the plant to obtain scientific evidence have been conducted in response to these alleged ethnomedicinal applications. It is allegedly used in traditional medical practise to treatment and manage a variety of illnesses including arthritis, gout, gastrointestinal pain and diabetes mellitus. Its traditional usage of nutritional composition toxicological effect and pharmacological activity are all covered in the systematic review, which attempts to give an extensive update on it (13).

Costus pictus

From ancient times to the present, medicinal plants have played a significant part in curative care. The "insulin plant", or *Costus pictus*, has a wide range of worthy bioactivities, including antioxidant, anti-cancer, anti-inflammatory, hepatoprotective, and anti-diabetic properties. The rich phytochemicals, primarily flavonoids and phenolic substances, are what give the plant its many

unique characteristics. The current article is focused on figuring out the therapeutic potential of *C. pictus* and the mechanism of action behind these promising advantages (14).

Costus igneus

The medicinal plant *Costus igneus*, which is classified as part of the Costaceae family, is referred to as the "insulin plant" as well because it stimulates the production of insulin in the body through its leaves (15). The term "insulin plant" is widely used to refer to this plant, this is a herb intended to treat diabetes that was just brought from America to India. In many parts of South India, it grows untamed and is extensively grown as a decorative plant in gardens. It is used to control diabetes in India, and it is well known that diabetics take one leaf daily to sustain low blood sugar levels. The tribal inhabitants of the Kolli Hills in Namakkal District, Tamil Nadu, and Ahmednagar District, Maharashtra, were among those who employed plants, including the leaves of *C. igneus*, to treat diabetes (16). With over 20 million diabetics, India is currently the most important country in the world for the disease, and by 2025, that figure is predicted to rise to 57 million (17). Traditional herbal diabetes treatment involves chewing plant leaves for at least a month to get a stabilised blood glucose level (15). The species of *Costus* are frequently used in homeopathic, ayurveda, and traditional medicine (18). A traditional diabetic remedy in India is called *Costus igneus*, also known as spiral flag and fiery costus and is high in iron (40 mg), protein (18%), and antioxidants (19). It is a prostate-developing plant with a root system that spreads widely. The leaves are lance-shaped and slender, with serrated, scalloped, or lobbed margins that are tinted scarlet pink above and a deeper pink below. Throughout the year, the small flora grows sporadically. This plant has an undetermined spread and a 6-inch top (20).

Costus speciosus

The perennial rhizomatous herb *Costus speciosus*, also known as spiral ginger, pancake ginger, or insulin plant, has a variety of medicinally significant bioactive phytochemicals that have strong pharmacological effects because of their antioxidant, antimicrobial, insecticidal, and anti-cancer effects. This plant is quite common in India and has a wide variety of ethnobotanical applications. As a result the of a wide range of bioactive phytochemicals, the spiral ginger plant exhibits a variety of pharmacological effects. However, compounds with extremely specific anti-diabetic, anti-cancerous, and antioxidative activities include diosgenins, costunolides, eremanthin, and arbuscular. As a result, *C. speciosus* can be used as a sustainable economic source for medications that are effective against lethal conditions like cancer and diabetes and have few to no side effects. However, further research is required to fully understand the complexity of its biological activity in human trials (21). People often refer to *C. speciosus* as "Crepe ginger." Its rhizomes are aphrodisiac, expectorant, bitter, astringent, and astringent. The phytochemical analysis of *C. speciosus* revealed the presence of beta-carotene, alkaloids, glycosides, steroids, phenolics, flavonoids, and polyphenols. The following compounds were isolated from *C. speciosus*: diosgenin, sitosterol, furostanol saponins, costusosides, D-glucoside, prosapogenins, dioscin, gracillin, dihydrophytylplastoquinone, and tocopherol quinone. Each of these compounds has a distinct biological function that will be covered below. The anticancer properties of amyrin, camphene, costunolide, diosgenin, humulene, lupeol, and zerumbone were later discovered (19,20).

Chilocostous Specious

The Costaceae (Zingiberaceae) family includes *Cheilocostus speciosus*. Due to the presence of sesquiterpene, it is claimed that the plant has a variety of biological properties which, includes anti-

inflammatory, antiangiogenic, antioxidant, antibacterial, and antifungal properties. It also has antihyperglycemic properties by inhibiting glucosidase and glycation, anticholinesterase, antipyretic, anti-inflammatory, and analgesic properties. Additionally, it exhibits larvicidal, anti-stress, estrogenic, astringent, aphrodisiac, purgative, anthelminthic, and expectorant properties. Additionally, it has anabolic and anti-fertility effects. The plant is being exploited so extensively that its extinction is imminent (24)**.** *Costus speciosus* is a low-growing to tall herb with spiro monostichous phyllotaxy, a cone-like inflorescence, a prominent labellum, and a three-locular ovary. Because of its therapeutic qualities, the plant is indigenous to Southeast Asia's Malay peninsula (25). This essential Asian herb can be found all over India (26). The rhizomes are bitter and possess expectorant, anthelmintic, hepatoprotective, astringent, and anti-diabetic effects. They are also useful in the treatment of burning sensation, constipation, leprosy, bronchitis, and asthma. This significant medicinal herb served as a suitable substitute for diosgenin and provided relief from anemia and fever (27).

PHYTOCHEMICAL CONSTITUENTS

The insulin plant, fiery costus and spiral flag all members of the Costaceae family, are traditional treatments for diabetes in India. It is rich source of antioxidants such as alkaloids, ascorbic acid, glutathione, phenols, a-tocopherol, b-carotene, steroids, terpenoids and flavonoids as well as iron (40mg), protein (18%) and other minerals (28–30). A medicinal plant called *Costus igneus* may have a miraculous treatment for diabetes. As a result of its ability to increase pancreatic beta cells in the human body, this herbal plant's leaf is commonly referred to as an "insulin plant" in India. In the current study's qualitative examination of the leaf extract of *Costus igenus,* the presence of phytosterol, flavonoids, protein, phenolic compound, glucosides and alkaloids was screened (31,32).

Table No.2: List of chemical constituents found in parts of the *Costus* Plant.

SL.NO.	PART	CHEMICAL CONSTITUENTS	REFERENCE
1	Leaves	Zinc oxide	(7)
2	Leaves	Flavonoids	(9)
3	Leaves	Alloxan	(11)
4	Leaves	Beta-Sitosterol	(15)
5	Leaves, root, stem, and Rhizomes	Triterpenoids	(15)
6	Leaves	Glibenclamide	(17)
7	Rhizome and leaves	Diosgenin	(18)
8	Flower	Alkaloids	(29)
9	Fruit and herb	Catechin	(33)
10	Leaves, rhizomes, roots, and stems	Terpenoids	(34)
11	Leaves	Phenols	(35)
12	Leaves	Ascorbic acid	(36)
13	Leaves	Alpha-tocopherol	(36)
14	Leaves	Beta-carotene	(36)
15	Leaves	Steroids	(37)

PHARMACOLOGICAL ACTIVITY

As an alternative to synthetic preservatives that endanger human health, Costus has a wide variety of antibacterial properties (38). The insulin plant, a natural herb from Southeast Asia, has been used medicinally for generations. The plant, which was very recently introduced to the nation, is grown in South India as a decorative plant. The plant that produces insulin is made up of a phytochemical elements, such as glycosides, alkaloids, saponins, flavonoids, steroids and triterpene. Its leaves are acts as a food supplement to control diabetes mellitus. The slogan about advertising of plant's is "A leaf a day keep diabetes away". Numerous pharmacological activities include anti-inflammatory, anti-bacterial, anti-urolithiasis, anti-proliferative potential, anti-diabetic effect, anti-oxidant activity, neuroprotective function and hyperlipidaemic action (39).

Antidiabetes Activity

In south Indian gardens, Costus igneus is a typical attractive and traditionally used in medicinal plant. The crucial component that produces a strong anti-diabetic effect is the leaves. It lowers blood glucose levels both during fasting and after meals. However, the precise mechanism of action behind the antidiabetic effect is still unknown. Insulin plant not only has anti-diabetic effects but also enhances histopathological analysis, lowers the amount of glycosylated haemoglobin, regulates renal and hepatic parameters, raises body weight, improves lipid profile and insulin levels and lessens complications related to diabetes (39). The leaves of *Costus pictus*, also referred to as the "insulin plant," contain proteins, phenols, flavanoids, alkaloids, cardiac glycosides, saponins, cumarins, terpinoids, and triterpenes. The kidney can operate better thanks to the Costus pictus leaves hypoglycemic, anti-inflammatory, potent anti-oxidant properties. The leaves were discovered to contain flavonoids such as phenolic acids as well as kaempferol and 3',4'- di Me-quercetin, melilotic acid, coumaric acid and p-hydroxybenzoic acid (40).

Hypolipidemic Activity

The leaves of Costus pictus, also referred to as the "insulin plant," contain proteins, phenols, flavanoids, alkaloids, cardiac glycosides, saponins, cumarins, terpinoids, and triterpenes. The kidney can operate more efficiently due to the Costus pictus leaves anti-inflammatory, hypoglycemic and anti-oxidant properties. The were discovered to contain flavonoids such as melilotic acids, p-hydroxybenzoic acids kaempferol and coumaric acids (41).

Antimicrobial Activity

Utilising the antibacterial characteristics of Costus igneus' 100 mg of powdered root. Gram-negative In the study Klebsiella pneumonia, Pseudomonas aeruginosa, Salmonella spp. and Proteus vulgaris (*P. vulgaris*) bacterial cultures were used to test the antibacterial activity of root extracts of *Costus igneus* produced in vitro. A Soxhlet extraction was performed using 5ml of acetone, chloroform, and methanol on about 10 grammes of root material that was obtained from Indole butyric acid and Indole 3-acetic acid (IAA). The MS (Murashige and Skoog) medium was supplemented with the two growth regulators IAA and IBA in combination for direct root induction in the study. When acetone was used as the solvent, it was discovered that Klebsiella pneumonia was most vulnerable to both IBA and IAA derived roots(42).

Anticancer activity

A sustainable green synthetic process was established to produce magnesium oxide nanoparticles using leaf extract from the Costus pictus D. Don species as a reducing agent. Comprehensive

characterisation techniques provided proof that magnesium oxide nanoparticles were successfully formed. Proteins and metal oxides were discovered by studying Fourier transform infrared (FT-IR) spectrum data. X-ray diffraction (XRD) was used to find how to make pure cubic MgO crystalline nanoparticles. Scanning electron microscopy (SEM) observations revealed hexagonal-shaped MgO crystallites on the surface of the MgO particles. MgO nanoparticles made through biosynthesis had an average size of roughly 50 nm, according to TEM examination. This study proposed a potential mechanism for the synthesis of MgO nanoparticles. The biosynthesized magnesium oxide particles demonstrated effective anticancer activity and had a maximal inhibition rate for MgO nanoparticles at 200 g (43).

Anti-Proliferative Potential

Effects of the *Costus igneus* dried powdered leaves methanolic extract on the in vitro Michigan Cancer Foundation-7(MCF 7) breast cancer cell line with regard to apoptotic activities and antiproliferative. The extract reduced the cancer without harming the healthy cells. The MTT (3- (4, 5-dimethyl thiazol-2-yl)-2, 5-diphenyl tetrazolium bromide) test was used to examine the extract's cytotoxicity and cell viability in L6 (a rat skeletal muscle cell line). A 2000 g/ml extract was the IC 50 Value that was displayed. Only at very high concentrations did the extract exhibit cytotoxicity consistent with the normal cell lines, but it did not cause apoptosis in the normal cell linesThe extract displayed strong anticancer activity, or 97.460.74 % cytotoxicity, at the highest dose of 2000 g/ml. The MCF-7 cell line was sensitive to the extract's cytotoxicity in a dose-dependent manner (44). Chemicals found in *Costus* plant, having antidiabetic, anti-inflammatory, antioxidant, anticancer activity.

Table No.3: List of biological activity of *Costus* plant species chemical constituents.

SL.NO.	CONSTITUENT RESPONSIBLE	BIOLOGICAL ACTIVITY	REFERENCE
1	Ascorbic acid	Anti-oxidants activity	(10)
2	Stigmasterol and Lupeol	Putative activity	(11)
3	22,23-dihydrospinasterone, dehydrodihydro*costus* lactone, dehydro*costus* lactone, stigmasterol,	Anti-inflammatory activity	(22)
4	Arbusculin A, santamarine, and reynosin		(22)
5	Hexamethyl-(cyclic hydrocarbon)	Anti-oxidant	(34)
6	Cyclotrisiloxane	Anti-microbial activity	(34)
7	Diosgenin	Anti-diabetics activity	(45,46)
8	Ascorbic acid (Vitamin C), α-tocopherol (Vitamin E),	Anti-oxidants activity	(47)
9	Glutathione (GSH), and β-carotene	Anti-oxidants activity	(47)
10	Costunolide	Anti-cancer activity	(48)
14	Quercetin	Anti-diabetics	(49)

15	Quercetin	Anti-cancer activity	(49)
16	Quercetin	Anti-allergic	(49)
17	Quercetin	Anti-inflammatory	(49)
15	Beta-amyrin	Anti-inflammatory	(50)
16	Diphenyl 1-2 picryl Hydrazyl	Anti-oxidant	(51)
17	Diosgenin	Anti-diabetics	(52)
18	Diosgenin	Antitumor activity, estrogenic effects	(53)
19	Palmitic acid	Larvicidal activity	(54)

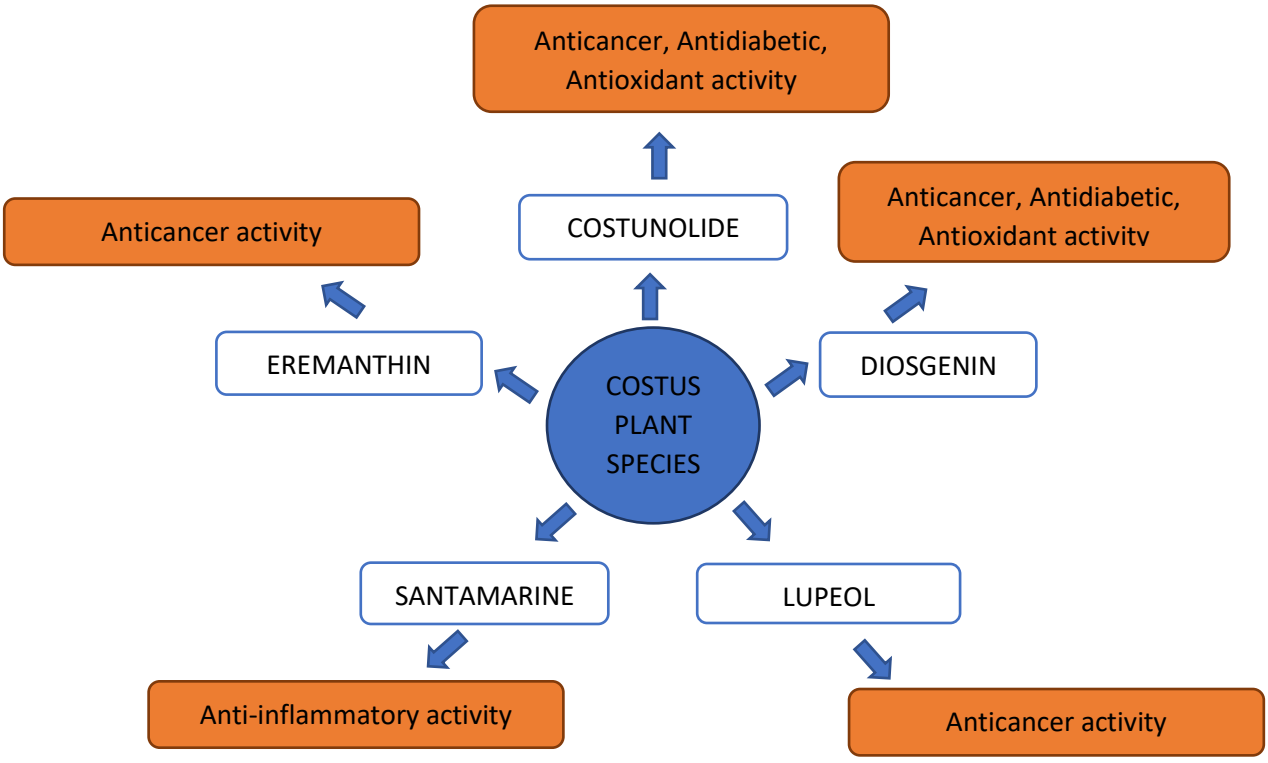

Fig No.2: Biological activity of *Costus* plant

CONCLUSION:

By this review we found the therapeutic potential of the leaves and various parts of *costus* plant used in diabetes, cancer, inflammation and so on. The mentioned effect of *costus* plant is reviewed by authors and it shows the effectful results. It unlocks the various new clinical research areas for the

different pharmacological activities. Furthermore, it also helps in the understanding of number of mechanism of actions in various common diseases for global use.

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CONFLICT OF INTEREST:
The authors declare no conflict of interest, financial or other-wise.

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