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Review Article

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Chemical and medico biological applications of the genus *Costus* (Gingers)

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ABSTRACT

Many herbal remedies individually or in combination have been recommended in various medical treatises for the cure of different diseases. Medicinal plants have served as nature's gift to make disease free healthy life.The genus Costus Linn. Belongs to family Costaceae, which has been separated from family Zingiberaceae on the basis of the presence of spirally arranged leaves and rhizomes being free from aromatic essential oils. This family includes 4 genera and 100 species. In south India Costaceae is represented by one genus and four species, including three exotic ornamentals. The diverse phytoconstituents and various medicobiological uses of the plants belonging to this genus are reviewed here.

Keywords: *Costus*, Costaceae, Chemistry, Pharmacology, Review

INTRODUCTION

Medicinal plants have been of great importance to the health care needs of individuals and their communities. The use of herbal preparations made from medicinal plants is widespread in developing countries.[1] The healing powers of traditional herbal medicines have been realized since antiquities. About 65% of the world populations have access to local medicinal plant knowledge system. India is sitting on a gold mine of well-recorded and traditionally well practiced knowledge of herbal medicine. India has an officially recorded list of 45,000 plant species and estimation put the list of 7500 species of medicinal plants growing in its 16 agro climatic zones under 63.7 million hectares of forest coverage.[2] With an ever-increasing global inclination towards herbal medicine, there is an obligatory demand for a huge raw material of medicinal plants.[3] Medicinal herbs are moving from fringe to mainstream use with a greater number of people seeking remedies and health approaches free from side effects caused by synthetic chemicals.[4]

Costus is the wonderful world of spiral ginger. Its foliage spirals around bamboo like stalks, know for this species. Some varieties have a velvety soft texture on the backs of its leaves, while others maybe smooth with purple undersides. Its bracts and flowers can range from a cone like bract, pineapple shaped or soft crepe like flowers emerging from green cones. Very easy to grow, they do well in partial sun in mild climates and partial shade in hot climates. They love a rich well draining soil kept on the moist side. They make beautiful garden specimens or container plants for the garden or patio.

Costaceae or the *Costus* Family is a family of pantropical monocots. They belong to the order Zingiberales, which contains other horticulturally and economically important plants such as the banana (Musaceae), bird-of-paradise (Strelitziaceae), and edible ginger (Zingiberaceae). The seven genera contain about 100 species (1 in *Monocostus*, 2 in *Dimerocostus*, 16 in *Tapeinochilos*, 2 in *Paracostus*, *ca.* 8 in *Chamaecostus*, *ca.* 4 in *Cheilocostus*, *ca.* 80 in *Costus*) and are found in tropical climates of Asia, Africa, and Central/South America. Costaceae are unique from other members of Zingiberales in that its species have 5 fused staminodes, rather than 2, and Costaceae contain no aromatic oils. The fused infertile stamen forms a large petalloid labellum that often

functions to attract pollinators. The flowers are generally solitary or aggregated in inflorescences. Inflorescences are arranged in a terminal head or spike, except for *Monocostus*. The simple leaves are entire and spirally arranged, with those toward base of the stem usually bladeless. Leaf bases have a closed sheath with a ligule, or projection at the top of the sheath. Fruit is a berry or capsule. The rhizome is fleshy with tuberous roots.

Costus speciosus

Chemistry and therapeutic applications:

Diosgenin was the major constituent isolated from *Costus speciosus.*[16] The maximum quantity of diosgenin reported in the stem was 0.65%, in the leaves 0.37% and in the flowers 1.21%.The saponins from seeds yielded three genins and glucose on acid hydrolysis, major genin was diosgenin. Two new furostanol saponins – costusosides I and J were characterized as 3-O-[β-D-glucopyranosyl(1→4)-β-D-glucopyranosyl]-26-O-(β-Dglucopyranosyl-22α-methoxy (25R) furost-5-en-3β,26-diol and its 22-hydroxy derivatives respectively [17-18]. β-sitosterol-β-D-glucoside, prosapogenins A and B of dioscin, dioscin, gracillin, 3-O-[α-L-rhamnopyranosyl(1→2)-β-D-glucopyranosyl]-26-O-[β-D-glucopyranosyl]- 22α-methoxy-(25R) furost-5-en-3β,26-diol,protodioscin and methyl protodioscin were isolated from seeds.[17-19] Two new quinones –dihydrophytylplastoquinone and its 6- methyl derivative[16] – along with α-tocopherolquinone and 5α-stigmast-9(11) en-3β-ol were isolated from seeds and their structures elucidated; methyl hexadecanoate, methyl octadecanoate and tetracosanyl octadecanoate were isolated from seeds.[21] A tocopherol was isolated from seeds and identified as G2-tocopherol. Defatted seeds contained Diosgenin, glucose, galactose and rhamnose[22]. Few constituent were isolated from roots were 24-hydroxytriacontan-26-one and 24-hydroxytriacontan-27-one[19] together with methyl triacontanoate, diosgenin, sitosterol [3, 21], 8-hydroxy triacontane-25-one and methyl triacontanoate[21], 5α-stigmast-9(11)-en-3β-ol was also characterized[7, 22-24]. The roots of this plant also contained β-sitosterol-β-D-glucoside, prosapogenins A and B of dioscin, dioscin, gracillin[26], 3-O-[α-L-rhamnopyranosyl(1→2)-β-D-glucopyranosyl]-26-O-[βDglucopyranosyl]-22α-methoxy-(25R)furost-5-en-3β,26diol, protodioscin and methylprotodioscin. Other components identified were 31-norcycloartanone, cyloartanol, cycloartenol and cycloalaudenol.[7,22] Methanolic extracts of underground parts reported the presence of steroidal glycosides: prosapogenin B of dioscin, dioscin, gracillin, methyl protodioscin, methylprotogracillin, protogracillin, 26-O-β- D-glucopyranosyl-(25R)-furost-5-ene-3β,22ζ,26-triol, diosgenin 3-O- β-Dglucopyranosyl(1→3)-β-D-glucopyranoside.[32-33]

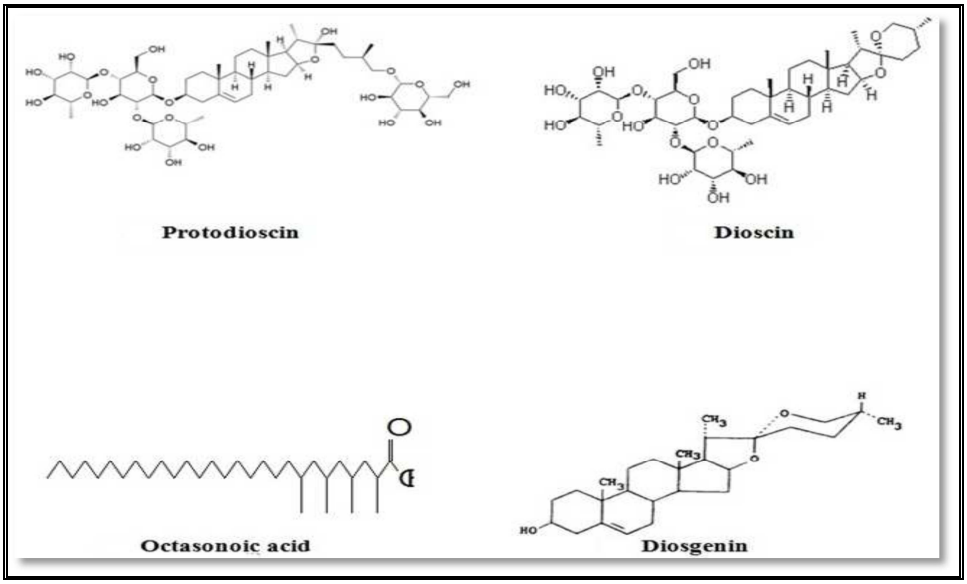

Fig .1 Structures of some phytoconstituents isolated from *Costus speciosus*

From the petroleum ether extracts of the stems and roots of *C. speciosus*, diosgenin and sitosterol were isolated and identified with authentic samples by comparison of spectroscopic data.[27] The rhizomes yielded five new compounds (Oxo acids and branched fatty acids esters) – tetradecyl 13-methylpentadecanoate, tetra 11-methyltriadecanoate, 4-oxotriaconsanoic acid, 14 – oxoheptacosanoic acid and 15-oxooctacosnoic acid.[28] Methyl 3-(4-hydroxyphenyl)-2E-propenoate was also isolated from the rhizomes.[7,22] The rhizomes also contained saponins diosgenin[29], dioscin, gracillin and betasitosterol-beta-D-glucoside.[12, 30] The rhizomes yielded an essential oil which constituted of spinocarveol (59.9%), cadinene (22.6%), cineol (10.7%), p-methoxybenzophenone (3.3%) and cavacrol (1.3%) [7]. Bis(2-ethylhexyl)phthalate was also isolated from the rhizomes of *C. speciosus*.[31]

Hexane, ethyl acetate and methanol crude extracts of *Costus speciosus* (Koen.) Sm. administered at the dose of 250 mg/kg, 400 mg/kg and 400 mg/kg respectively for 60 days to STZ(50 mg/kg, *i.p.*) induced hypoglycemic and normo-glycemic rats. The hexane crude extract of *C. specious* rhizome was effective in decreasing the serum glucose level and normalizing other biochemical parameters in diabetic rats.[35-37] Aqueous extract and methanolic extracts of *C. speciosus* were highly effective in bringing down the blood glucose level.[38] The antihyperglycemic, antihyperlipedemic and antioxidant potency of an ethanol extract of *Costus speciosus* root in alloxan-induced diabetic male (Charles Foster) rats were carried and shoed good activity.[39]

C. specious alkaloids have been shown to possess anticholinesterase activity in both *invitro* and *invivo* methods, explaining the earlier observed potentiation of acetylcholine responses on frog rectus muscle and dog blood pressure. Isolation and selective screening of the individual alkaloids is warranted in order to pinpoint the specific alkaloid or alkaloids responsible for this activity. The use of the plant in eye diseases and as a depurative may be due to the anticholinesterase activity of the plant alkaloids.[40-41]

The hepatoprotective activity of the ethanolic extract of the rhizomes of *Costus speciosus* (Koenig) Sm. was studied on carbon tetrachloride treated rats. The extract registered a significant fall in the levels of serum glutamyl oxaloacetic acid transaminase (SGOT), serum glutamyl pyruvate transaminase (SGPT), alkaline phosphatise (ALKP), serum bilirubin (SBLN) and liver inflammation supported by histopathological studies on liver, thus exhibited a significant hepatoprotective activity.[42] The ethanolic extracts provide significant protection against the toxic effects of CCL4 on liver.[43] It was seen that the Chloroform extract of *Costus speciosus* had strong antioxidant activity.[44,45] The alcoholic extracts of *Costus speciosus* rhizomes were found to possess normalizing activity against cold immobilization stress induced changes in norepinephrine (NE), dopamine (DA), 5 hydroxy tryptamine (5-HT), 5-hydroxy indole acetic acid (5- HIAA), and enzymemonoamine oxidase (MAO). The results obtained provide biochemical evidence for antistress activity of the tested extracts.[46] Leaf and rhizome extracts of *C. Speciosus* showed good *in vitro* antibacterial activities whereas no antibacterial activity was recorded with water extracts. The disc-diffusion method showed significant zone of lysis against all the pathogens studied.[47] A mixture of saponins isolated from the rhizomes of *Costus speciosus* effectively protected against pregnancy in rats, when fed at 5-500 µg/100 g body wt. for 15 days.[50] Saponins showed oestrogenic activity in sprayed rats, significantly increased uterine weight and uterine glycogen concentration and produced proliferative changes in uterus.[51-52] The estrogenic activity of 1600 µg diosgenin (I) [512-04-9] isolated from *C. speciosus* was approx. equal to that of 150 µg neoclinestrol.[53] *Costus speciosus* exhibited a moderate degree of non-specific spasmolytic activity when tested on guinea pig ileum, although the activity was weak compared with that of papaverine.[14,55] The ethanolic extract of the rhizome of *Costus speciosus* have shown to possess significant anti-inflammatory effect against carrageenan induced oedema formation in rats at a dose of 800 mg/kg and against cotton pellet granuloma formation in rats at doses of 400 mg/kg and 800 mg/kg. The antipyretic effect was only minimal and was observed only at 800 mg/kg dose.[56]

Traditionally,the rhizomes and roots are used as bitter astringent[9-13], acrid,cooling, aphrodisiac[7-13], purgative [9-12], anthelmintic[7-13], depurative[7-13],febrifuge, expectorant, tonic[7- 9], digestive[10] and stimulant[9-13] herb that clears toxins. Bruised leaves are applied in fever while decoction of stem is used in fever and dysentery.[7] Rhizome juice is given with sugar internally to treat leprosy, used as antivermin[12] and for abortion.[7, 15] The plant is also used in gout rheumatism and bronchial asthma.[12] The plant is used internally for eye and ear infections, diarrhoea (sap from leaves, young stems), cold, catarrhal fever, cough, dyspepsia, skin diseases (rhizome) and snake bites.[7, 10-13] Tubers are cooked and made into syrup or preserved which is very wholesome.[13]

Costus pictus

Chemistry and therapeutic applications:

The essential oils of the stems, leaves and rhizomes of *Costus pictus* from southern India were investigated by GC-MS. The essential oil of stem was found to be rich in hexadecanoic acid (28.3%), 9,12-octadecadienoic acid (18.33%), linalyl propanoate (6.03%), dodecanoic acid (5.62%), tetradecanoic acid (4.82%), α-eudesmol (3.55%), γ-eudesmol (3.21%) and 4-ethoxy phenol (3.06%). The leaf essential oil contained hexadecanoic acid (24.51%), 2-pentanol (22.48%), β-ionone (8.69%), α-ionone (8.01%), farnesyl acetone (7.04%) and dodecanoic acid (3.96%). Hexadecanoic acid (25.26%), dodecanoic acid (16.56%), tetradecanoic acid (10.20%), linalool (8.48%), 9, 12-octadecadienoic acid (7.74%), and α-terpineol (4.44%) were the main constituents of the rhizome. Hexadecanoic acid (palmitic acid), the chief constituent of *Costus pictus* leaf oil, has been recognized as the precursor for the development of coronary heart diseases and therefore the constant use of *Costus pictus* leaves for the diabetic treatment by the people in Kerala, South India cause serious health hazards and it must be avoided [58].The essential oil of *costus pictus* d. Don showed good anti bacterial activity.[59] Antihyperglycemic and insulin secretory activity of an aqueous extract of *Costus pictus* in streptozotocin induced diabetic rats and antidiabetic activity of methanol extract of *Costus pictus* in alloxan –induced diabetic rats were carried out and the results showed *Costus pictus* had

prominent antidiabetic activity.[60-62] Anti oxidant activity of leaves and rhizomes in *Costus pictus* D Don were carried out and the showed both have effective activity.[63] The anti-proliferative and apoptotic potential of *Costus pictus* D. Don on fibrosarcoma HT-1080 cell line, and also evaluating its safety to normal human lymphocytes were carried out and confirmed the pro-apoptotic and anticancer potential of *C. pictus* D. DON ethanol extract. [64]

Costus spiralis

The aqueous fraction from *Costus spiralis* (Jacq.) Roscoe leaf reduced contractility by impairing the calcium inward current in the mammalian myocardium.[65] The extract of *Costus spiralis* were evaluated to have good antiurolithiatic activity in rats.[66] Flavonol glycosides were isolated from leaves of *Costus spiralis.*[67]

Costus spicatus

Costus spicatus Sw. (Costaceae) is a prominent medicinal herb used by Dominicans in the Dominican Republic and the United States for the treatment of diabetes, a growing epidemic in the Hispanic community. An ethnobotanical survey of the Dominican community in New York City revealed the popular use of a tea from the insulina plant to treat hyperglycemia. Insulina was identified as *Costus spicatus.* The plant had promising antinociceptive and anti-inflammatory effect.[69] The leaves of *Costus spicatus* were found to alter glucose homeostasis in C57BLKS/J (KS) db/db mice, a model of obesity-induced hyperglycemia with progressive beta cell depletion.[70] Two flavonol diglycosides, tamarixetin 3-O-neohesperidoside, kaempferide 3-O-neohesperidoside and the known quercetin 3-O-neohesperidoside, together with six other known flavonoids were isolated from the leaves of *Costus spicatus.* The flavonol diglycosides were evaluated for inhibitory activity of nitric oxide production by activated macrophages.[71]

Costus Curvibracteatus

The anti neoplastic activity of *Costus Curvibracteatus* extracts against Enrlich ascites carcinoma (eac) cells in swiss albino mine carried out and results showed prominent activity.[72]

Costus Scaber

The plant is traditionally used in Trinidad and Tobago for Urinary problems and Diabetes mellitus.[73]

CONCLUSION

Medicinal plants have attracted considerable global interest in recent years. In last two to three decades, it has been observed that number of phytochemical, pharmacological study are being performed to find out the different therapeutic properties of a herbal medicines. All the therapeutic properties mentioned in Ayurvedic and other classical medicines are being tested and if they are found correct they are accepted otherwise discarded. Investigation of traditional medicine is very important for the welfare of rural and tribal communities for the treatment of conventional illness. The main goal of the present comprehensive review was to present the research carried out with species of the *Costus* genus, widely spread in world, in order to organize the data produced. As Costaceae has been successfully used in many health problems since a long time it provides a wide area of interest for the research purposes in development of newer drug molecules. The therapeutic potential should also be seen in combination with other medicinal agents.

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