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Costus speciosus: An Important Medicinal Plant

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Abstract: ***Costus speciosus is an important medicinal and ornamental plant used to cure different diseases. The plant has been found to possess many pharmacological activities such as antibacterial, antifungal, anticholineesterase, antioxidant, antihyperglycemic, antiinflammatory, analgesic, antipyretic, antidiuretic, larvicidal, antistress and estrogenic activity. The rhizomes of Costus speciosus are bitter, astringent, acrid, cooling, aphrodisiac, purgative, anthelminthic, depurative, febrifuge, expectorant, tonic, improve digestion, and is a stimulant herb that clears toxins. It also has anti-fertility, anabolic properties. Rhizomes are also given in diseases as pneumonia, rheumatism, dropsy, urinary diseases, jaundice, and leaves are given in mental disorders. Due to its excess use and ill effective conventional method of propagation, it becomes one of the rare, threatened plants which are on danger of extinction. Therefore there is need to conserve genetic pool of this plant species. Biotechnological approaches as tissue culture can help in conservation of this valuable plant. The present review reveals information about distribution, morphology, chemical constituents, traditional, pharmacological and medicinal uses of Costus speciosus, need for its conservation and different conservation methods using biotechnological approaches.***

Keywords: Chemical constituents, conservation, *Costus speciosus*, medicinal uses, pharmacological activities.

1. Introduction

Medicinal plants have been of great importance in human culture to meet the primary health care needs. Many people in developing countries use medicinal plants as traditional drugs. According to World Health Organization, up to 80% of the world's population relies on traditional medicinal system for some aspect of primary health care [1]. Medicinal plants produce a variety of compounds having known therapeutic properties [2]. From the last few decades, there is an increasing interest in formation of the drugs derived from plant which helps to control diseases. Also the herbal products are safer than synthetic products which may be harmful and unsafe to the human and environment [3]. India is rich in indigenous herbal resources consist of near about 20,000 plant species, of which about 2,500 are of medicinal value. Considering rich diversity and traditional knowledge, world is looking towards India for developing new natural, safe, herbal drugs to cure different diseases [4]. Due to the medicinal, pharmacological properties and safety issues there is increasing demand for natural products in the market. Hence there is need to investigate more natural products with therapeutic importance. Among various plants studied, *Costus speciosus* is traditionally, medicinally and pharmacologically important one.

2. Classification

Costus speciosus, an important medicinal and ornamental plant cultivated in India belongs to family Costaceae (Zingiberaceae) [5] - [7]. *Zingiberaceae* is a family of about fifty two genera and more than 1,300 species distributed throughout tropical Africa, Asia, and the Americas [3]. Within the Zingiberales, costaceae is easily recognized and distinguished from other families by well-developed and sometimes branched aerial shots that have a characteristic monistichous (one-sided) spiral phyllotaxy [8]. Formerly Costaceae was placed as a subfamily within the larger Zingiberaceae family due to broad similarities of inflorescence and floral characters [9]. The genus *Costus* is made up of 175 species [6]. Among the different genera, *Costus* is widely studied due to its medicinal and pharmacological properties.

Table 1: Taxonomic Classification [10]

Kingdom	Plantae
Subkingdom	Tracheobinota
Super division	Spermatophyta
Division	Mangoliophyta
Class	Liliopsida
Sub class	Zingiberidae
Order	Zingiberales
Family	Coastaceae
Genus	Costus
Species	speciosus

Costus speciosus is popularly known as kemuka, Kushta, Kashmira, Shura, Katar katar in Sanskrit [11], pushpamoola in Kannada, kashmeeramu in Telugu [12], keukand, Keu in Hindi and Bengali, Chengalva Koshta' in Telegu and Kannada, 'Kottam' or 'Koshtam' in Tamil and 'Penava' or 'Pushkarmula' in Marathi [13], Jom lakhuti in Assamese, Crepe ginger in English [14].

3. Distribution

Costus speciosus occurs in the moist and wet evergreen areas of the Indo-Malayan region and Sri Lanka [3]. Within India, *C. speciosus* occurs throughout the foot hills of Himalayas from Himachal Pradesh to Assam, Vindhya Satpura hills in Central India, Eastern Ghats of Andra Pradesh and Western Ghats of Maharashtra, Karnataka, Tamil Nadu and Kerala [15]. These plant species are also distributed in the Kalsubai-Harishchandragad wild life sanctuary, Ahmednagar [16].

4. Cultivation

It is mainly cultivated in rainy seasons [17]. It grows well on rich moist soil or clayey loam soil in shady area under mixed

deciduous forests of South India [18]. It grows well in the climate with high humidity and low temperature. *Costus speciosus* is propagated by different methods such as vegetative methods using rhizome pieces [5], division of culms, stem cuttings [19] or via seeds dispersed by birds [14].

5. Conservation

Due to low multiplication rate, poor seed viability, low percentage of seed germination and scanty delayed rooting of vegetative cuttings there is need for alternative propagation methods of these plants [7]. Different plant biotechnological approaches such as micropropagation, germplasm preservation and various tissue culture techniques which results in large scale production of uniform planting material can be used for commercial cultivation and preservation of this species.

6. Morphology

Costus speciosus is a succulent, erect, perennial, ornamental, herbaceous plant, root stock tuberous stem, sub-woody at the base, thick creeping rhizomes (120-300 cm height) [20] growing up to 2-2.7 m height with long lanceolate leaves and white fragrant flowers in terminal clusters [14], [4]. It is tall and dramatic landscape plant with large dark green, sub-sessile, elliptic or obovate leaves arranged on the stalk in spiral form. It can grow up to 3.1 m height in frost free areas but usually grows to about 1.8 m tall in cooler areas where its roots get harden but dies back in winter [11]. The plant flowers during the months of July and August, the aerial parts withering away during the winter season [21], [12]. The flowers look like crepe paper, thus the common name is "Crepe ginger". The flowers are 5-6 cm long with a cup-shaped labellum and crest yellow stamens. Fruit is red *in* color whereas seeds are black, five in number with a white fleshy aril [22].

7. Traditional uses

This plant is used as food and medicine by the Kannikars, the primitive hill tribes of South India [23]. Recently it is used in drug industry as a natural source of diosgenin which is a steroidal sapogenin used for synthesis of sex hormones, cortisone and oral contraceptives [15], [24], [44]. Diosgenin content up to 3.37% has been reported in rhizome of *Costus speciosus* [25]. The plant parts has many medicinal uses, juice of rhizome is applied to head for cooling and relief from head-ache, bruised leaves are applied in fever, decoction of stem is used in fever and dysentery, patients with high fever mostly utilize leaf infusion or decoction as a sudorific or in a bath, sap from leaves, young stems are used against diarrhea [10] cough, cuts, wounds, scabies, antidote for snake bite, jaundice, arthritis [6], burning sensation, constipation, leprosy, skin diseases, asthma, bronchitis, inflammations, anemia [1], [26] , intestinal warms, worm infection, rash, nose pain, to stop vomiting [4] spermatorrhoea [2] used as antivermin and for abortion [5]. The rhizomes of *Costus speciosus* are bitter, astringent, acrid, cooling, aphrodisiac, purgative, anthelminthic, depurative, febrifuge, expectorant, tonic [27], improve digestion [28], and is a stimulant herb that clears toxins. The rhizomes have anti-fertility, anabolic properties [29]. The rhizomes are generally consumed in the form of decoction. An alkaloid extract from rhizomes had papaverine like smooth muscle relaxant and enhances antispamodic activities. Rhizomes are also given in pneumonia, rheumatism, dropsy, urinary diseases, jaundice, and leaves are given in mental disorders. *C. speciosus* rhizomes' extract stimulate the uterine contraction due to non-estrogenic effects [30]. The plant is also used for eye and ear infections. Rhizomes have also been seen to exhibit cardiotonic, hydrochloretic, diuretic and CNS depressant activities, formerly used in Malaysia for small pox [31]. It is used as an ingredient in a cosmetic to be used on eyelashes to increase sexual attractiveness, as mentioned in Kama Sutra [14].

8. Pharmacological Activities

8.1 Antibacterial and Antifungal Activity

Antibacterial activity was studied by Ariharan *et al*., 2012, where high antibacterial activity of rhizome extract was seen against Gram positive (*Staphylococcus aureus, Staphylococcus epidermidis)* and Gram negative bacteria (*Escherchia coli, Pseudomonas aeruginosa, Salmonella typhimurium*) which may be due to the presence of diosgenin, a precursor for the synthesis of steroidal hormones. This shows that the plant has disease resistance ability, which may be due to presence of phenolics and alkaloid substances [6].

Antibacterial and antifungal activity were observed by Duraipandiyan *et al*., 2012 in hexane, chloroform, ethyl acetate and methanol extracts. Among the tested extracts the hexane extract showed good activity against only Gram-positive bacteria (*Staphylococcus aureus, Staphylococcus epidermidis, and Bacillus subtilis*) and tested fungi (*T.mentagrophytes, E. floccosum, T. rubrum and M. grisea*). The isolated compounds, costunolide and eremanthin, significantly inhibited the tested pathogenic fungi at lowest concentrations, which indicates its antifungal and antibacterial activity [2].

N.O. Al-Ameri and Z. Azeez also studied effect of alcoholic extract of *C. speciosus* against *Aspergillus sp*. isolated from pulmonary infections. They also supported to the antifungal activity of the extract [41].

8.2 Anticholineesterase Activity

Bhattacharya *et al*., 1972 have reported that the total alkaloids isolated from the rhizome of *Costus speciosus* potentiated the pharmacological actions of acetylcholine both in vitro and in vivo. Anticholineesterase activity was shown by observation on frog rectus muscle and dog blood pressure. The use of the plant in eye diseases and as a depurative may be due to the anticholinesterase activity of the plant alkaloids [39].

8.3 Antihelmentic Activity

Srivastava *et al*., 2011 has evaluated and compared the anthelmintic activity of the methanolic and aqueous extracts of the aerial parts of *Costus speciosus* in Indian adult earthworms (*Pheretima posthuma*). It was observed that aqueous and methanolic extracts of *C. speciosus* showed excellent anthelmintic activity at all the concentrations when compared with the conventional drugs. Helminthiasis or worm infestation is one of the most prevalent and most serious public health problems in the world. As *Costus speciosus* showed significant anthelmintic activity in the experimental study, it can be used as a promising anthelmintic agent [5].

8.4 Antioxidant Activity

Nehete *et al*., 2010 has tried to evaluate in vitro antioxidant activity of different extracts of this plant by DPPH radical scavenging activity, total antioxidant capacity, nitric oxide scavenging activity, ion chelating activity, hydroxyl radical scavenging activity and its correlation with total phenolic content. Among all the extracts analyzed, a significant phenolic content and antioxidant activity were found for benzene extract which predicted that the antioxidant activity may be due to the total phenolic content in the plant. Scientific evidences suggest that antioxidants reduce risk for chronic diseases including cancer and heart disease [21]. *C. speciosus* has an antioxidant activity which may be due to plant-derived antioxidants such as tannins, lignans, stilbenes, cou-marins, quinones, xanthones, phenolic acids, flavones, flavonols, catechins, anthocyanins and proanthocyanins that could delay or provide protection for living organisms from damage caused by uncontrolled production of reactive oxygen species and the concomitant lipid peroxidation, protein damage, and DNA strand breaking [32].

8.5 Antiinflammatory, Analgesic and Antipyretic Activity

Srivastava S *et al*., 2013 used methanolic extracts of *Costus speciosus* Koen, aerial parts to assess antiinflamatory, analgesic and antipyretic activities in experimental animals [37]. The anti-inflammatory activity of methanol extract of *Costus speciosus* was evaluated using carrageenan-induced paw oedema test. Analgesic effect was evaluated using acetic acid induced writhing and Eddy's hot plate models and antipyretic was assessed by Brewer's yeast-induced pyrexia in rats. Results revealed that methanol extracts of *Costus speciosus* has significant anti-inflammatory, analgesic and antipyretic activities. K. Binny *et al*., 2010, reported that rhizome of *Costus speciosus* has been traditionally used for treating inflammatory and painful conditions. The ethanolic extract of the rhizome of *Costus speciosus* possesses anti-inflammatory and antipyretic properties [38].

8.6 Antihyperglycemic Activity

Diabetes mellitus is a chronic disease which is characterized by high blood glucose levels due to deficiency of circulating insulin levels. Diabetes mellitus is a chronic metabolic disorder affecting population worldwide. Epidemiologic studies and clinical trials strongly support that hyperglycemia is the main cause leading to complications such as coronary artery disease, cerebrovascular disease, renal failure, blindness, limb amputation, neurological complications and premature death [5].

M.S.Rajesh *et al*., 2009 has evaluated the antihyperglycemic activity of petroleum ether, chloroform, methanolic, and aqueous extracts of *C. speciosus* rhizomes on overnight fasted, Streptozotocin (STZ) induced diabetic rats. Blood glucose level (BGL) was monitored at regular intervals 0, 30, 60, 120 and 240 minutes suggested that all extracts of *C. speciosus* resulted in reduction of BGL significantly except that of petroleum ether. Aqueous and methanolic extracts were far superior to other extracts in bringing down the BGL from very high levels to acceptable levels within 240 minutes and the same was verified for its reproducibility of results in long duration multiple dose studies [12].

8.7 Antistress Activity

Stress is a daily phenomenon faced by every human and the normal functioning of every individual is dependent on optimum levels of stress. Stress induces alteration in the metabolism and function of neurotransmitters in the CNS as well as Peripheral Nervous system. Cold immobilization stress causes depletion of norepinephrine and dopamine levels in the brain [33]. So there is need to control the stress and normal functioning is not hampered due to excess stress.

Nitin Verma *et al*., 2009 has studied the effect of alcoholic extract of *Costus speciosus* rhizomes on stress induced changes in brain neurotransmitters and enzyme monoamine oxidase levels in albino rats. The extracts 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 enzyme monoamine oxidase (MAO), which provided biochemical evidence for antistress activity of the tested extracts [40].

8.8 Larvicidal activity

Mosquito borne diseases are one of the world's most health hazardous problems causing various diseases. Mosquitoes are the major vector for the transmission of various diseases such as malaria, dengue fever, yellow fever, filariasis, schistosomiasis and Japanese encephalitis.

Surendra Kumar Muniyandi *et al*., 2013 has studied the larvicidal activity using *Costus speciosus* Koen aqueous extracts**.** Larvicidal potential of stem, leaf and rhizomes of *Costus speciosus* aqueous extracts were evaluated against third and fourth instar larvae *(Aedes aegypti).* Maximum larvicidal potential or percentage mortality was seen with extracts from leaves as compared with rhizomes and stem [17]. Larviciding is a successful way of reducing mosquito densities in their breeding places before they emerge into adults [17], [42].

8.9 Diuretic Activity

Drug induced increased urine flow is diuretics which is used to adjust the volume and composition of body fluid in variety of disorder including hypertension, nephritic syndrome, cirrhosis, renal failure, heart failure, and pregnancy toxaemia [34]. Administration of diuretic drugs has many adverse side-effects. Hence there is need for new diuretic agent with therapeutic efficacy.

Dubey S *et al*., 2010 has evaluated the effect of aqueous and alcoholic extract of rhizomes of *Costus speciosus* in albino rats of and the effect was compared with furesemide as standard drug in diuretic activity. He found that both the extracts significantly increased the urine output as well as urinary electrolyte concentration, which concluded *Costus speciosus* having diuretic activity [20].

8.10 Estrogenic Activity

This plant is widely studied for fertility control in women by the people of Assam. Choudhury Najma *et al*., 2012 has investigated the effect of methanolic rhizome extract on ovary and uterus of Gonado-intact female adult mice. The extract showed significant decrease in ovarian weight and increase in uterine weight in comparison with normal control. This might be due to inhibition of release of tropic pituitary gonadotropins due to negative feedback mechanism and also indicated that the plant had endocrine active estrogenic activity which leads to increase in uterine weight [14]. The plant have also been reported to posses many useful properties for human health, including enzyme inhibition, antiallergic, vascular, cytotoxic antitumor activity, anti fertility and hepatoprotective activity [4].

9. Chemical Constituents

The rhizomes of *Costus speciosus* are a good source of saponin like diosgenin, sapogenin, tigogenin, steroids and alkaloids [17], [20]. It contains diosgenin, 5α-stigmast-9(11)-en-3β-ol, sitosterol-β-D-glucoside, dioscin, prosapogenins A and B of dioscin, gracillin, quinones, α-tocopherol, tricontanoic acids, curcumin and tricontanol [1], [3]. It also contains aliphatic hydroxyl ketones, triterpenes, starch mucilage, oxa-acids, fatty acids, abscisic acid and corticosteroids [12] tigogenin and diosgenin have been isolated from rhizomes and stems. Also α-amyrin stearate, β-amyrin and lupeol have been isolated from rhizomes and palmitates from leaves. The seed fat contains palmitic acid, stearic acid, oleic acid, linoleic acid, arachidic acid, gadoleic acid and behenic acid. Defatted seeds contained diosgenin, glucose, galactose and rhamnose [35]. Two new quinones dihyrophytilplastoquinone and its methyl derivatives including α-tocopherolquinone are isolated from seeds. Also there is report on isolation of diosgenone, prosapogenins B of dioscin, cycloartanol, 25-en-cycloartenol and octacosanoic acid along with diosgenin from rhizome [29]. Costunolide is a sesquiterpene compound isolated from *C.speciosus* exhibiting preventive effects on intestinal carcinogenesis [2]. Five compounds have been reported from the rhizomes of C. speciosus namely tetradecyl 13-methylpentadecanoate, tetradecyl -11-methyltridecanoatc, 14-oxotricosanoic acid, 14-oxoheptacosanoic acid and 15-oxooctacosanoic acid [36]. Flavonoids, a subclass of polyphenols, further divided into several subclasses including flavones, flavonols, isoflavones, anthocyanins, flavanols, proanthocyanidins and other plant phenolics are especially common in leaves, flowering tissues and woody parts such as the stem and bark [21], [43].

10. Conclusion

India is rich in various herbal, medicinal plants which can be used for treating various diseases. *Costus speciosus* is one of them which serve as an important source of many therapeutically efficient compounds possessing many traditional and pharmacological activities. This plant is on the verge of extinction because of its propagation problems and excessive use. So there is need for alternative propagation methods as tissue culture techniques (micropropagation) and different biotechnological aspects which will result in large scale production of these plants to make it easily available to farmers, nurseries and pharmaceutical industries at affordable prices.

References

[1] S. Hasan, M. Qari, “DNA –RAPD Fingerprinting and Cytogenetic Screening of Genotoxic and Antigenotoxic Effects of Aqueous Extracts of *Costus speciosus* (Koen.),” JKAU: Sci, 22(1), pp. 133-152, 2010.

[2] V. Duraipandiyan, N. A. Al-Harbi, S. Ignacimuthu and C. Muthukumar, "Antimicrobial activity of sesquiterpene lactones isolated from traditional medicinal plant, *Costus speciosus* (Koenex. Retz.) Sm.," BMC Complementary and Alternative Medicine, 12(13), pp. 2-6, 2012.

[3] A. H. EL - far, and I. I. Abou - Ghanema, Biochemical and hematological evaluation of *Costus speciosus* as a dietary supplement to Egyptian buffaloes,” African Journal of Pharmacy and Pharmacology, 7(42), pp. 2774-2779, 2013.

[4] J. Karthikeyan, V. Reka and R. V. Giftson, Characterization of bioactive compounds in *Costus speciosus* (Koen.) by reverse phase HPLC,” International Journal of Pharmaceutical Sciences and Research, 3(5), pp. 1461-1465, 2012.

[5] S. Srivastava, P. Singh, K. K. Jha, G. Mishra, S. Srivastava, R. L. Khosa, "Anthelmintic activity of aerial parts of *Costus speciosus,"* International Journal of Green Pharmacy, 5, pp. 325-328, 2011.

[6] V. N. Ariharan, V. N. Meena Devi, M. Rajakokhila and P. N. Prasad, "Antibacterial activity of *Costu sspeciosus* rhizome extract on some pathogenic bacteria," International Journal of Advanced Life Sciences, 4, pp. 24-27, 2012.

[7] J. P. Robinson, S. J. Britto and V. Balakrishnsn “Micropropagation of *Costus speciosus* (Koem, ex. retz) Sm., an Antidiabetic plant by using Explants of Pseudostems,” Botany Research International, 2(3), pp. 182-185, 2009.

[8] B. K. Kirchoff and R. Rutishauser, "The Phyllotaxy of *Costus* (Costaceae),” Bot. Gaz, 151, pp. 88-105, 1990.

[9] C. D. Specht and Dennis Wm. Stevenson, "A new phylogeny-based generic classification of Costaceae (Zingiberales)," Taxon, 55(1), pp. 153-163, 2006.
[10] S. Srivastava, P. Singh, G. Mishra, K. K. Jha, R. L. Khosa, "*Costus speciosus* (Keukand): A review," Der Pharmacia Sinica, 2 (1), pp. 118-128, 2011.
[11] V. Devi D and A. Urooj, "Nutrient Profile and Antioxidant components of *Costus speciosus* Sm. And *Costus igneus* Nak.," Indian Journal of Natural Products and Resources, 1(1), pp. 116-118, 2010.
[12] M. S. Rajesh, M. S. Harish, R. J. Sathyaprakash, A. R. Shetty, T. N. Shivananda, "Antihyperglycemic activity of the various extracts of *Costus speciosus* rhizomes," Journal of Natural Remedies, 9(2), pp. 235-241, 2009.
[13] G.V. Satyavathi, "Medicinal plants of India," ICMR. New Delhi, Vol. 1, 1976.
[14] N. Choudhury, K. J. Chandra and H. Ansarul "Effect of *Costus speciosus* Koen on reproductive organs of female albino mice," International Research Journal of Pharmacy, 3(4), pp. 200-202, 2012.
[15] Y. K. Sarin, K. L. Bedi, and C. K. Atal, "*Costus speciosus* rhizome as a source of Diosgenin," Current Science, 43(18), pp. 569-570, 1974.
[16] A. S. Wabale, M. N. Kharde, K. J. Salunke and A. S. Petkar, "*Costus speciosus* (Koeing.) J. E. Sm., *Lobelia nicotianaefolia* Roth. And *Urginea indica* Kunth- the important Ethnomedicinal Plants from the Western Ghats," Asian J. Exp. Biol. Sci., 2(1), 169-170, 2011.
[17] S. K. Muniyandi, A. T. Nandanan, S. C. Veeti, A. Narayanan, B. Ganesan, "Studies on *Costu s speciosus* Koen Alcoholic Extract for Larvicidal Activity," International Journal of Pharmacognosy and Phytochemical Research, 5(4), pp. 328-329, 2013.
[18] P. N. Prasad, "Studies on *Costus speciosus* (Koen) sm. and *C. malortieanus* H Wendl. Ph.D. Thesis, University of Madras, Tamil Nadu, India, 1982.
[19] A. S. Rani, G. Sulakshana and S. Patnaik, "*Costus speciosus,* an antidiabetic plant-review," FS J Pharma Res, 1(3), pp. 52-53, 2012.
[20] S. Dubey, V. K. Verma, A. K. Sahu., A. K. Jain, A. Tiwari, "Evaluation of Diuretic activity of Aqueous and Alcoholic Rhizomes extracts of *Costus speciosus* Linn in Wister Albino mice," IJRAP, 1(2), pp. 648-652, 2010.
[21] J. Nehete, M. Bhatia and M. Narkhede, "*In-vitro* Evaluation of Antioxidant Activity and Phenolic Content of *Costus speciosus* (Koen) J. E. Sm.," Iranian Journal of Pharmaceutical Research, 9(3), pp. 271-277, 2010.
[22] Stone and C. Benjamin, The flora of Guam, Micronescia, 6, pp. 1-659, 1970.
[23] J. Ammal, E. K. and N. Prasad, "Ethnobotanical finding on *Costus speciosus* (Koen) sm. Among the Kannikkars of Tamil Nadu," J. Econ. Tax. Bot, 5(1), pp. 129 – 133, 1984.
[24] S. Kumar, R. S. Shukla, K. P. Singh, J. D. Paxton and A. Husain, "Glyceollin : A Phytoalexin in Life Blight of *Costus speciosus,"* Phytopathology, 74, pp. 1349-1352, 1984.
[25] I. Singh, Y. Gautam and Y. Vimala, "Detection and Isolation of Diosgenin from *Costus speciosus* Callus Raised from Non-Germinal Seeds," Int. J. Chem. and Life Sciences, 2(10), pp. 1240-1242, 2013.
[26] K. Punyarani, G. J. Sharma, "Micropropagation of *Costus speciosus* (Koen.) Sm. Using Nodal Segment Culture'" Sci Biol, 2(1), pp. 58-62, 2010.
[27] J. H. Bavarva and A. V. Narasimhacharya, Antihyperglycemic and Hypolipidemic Effects of *Costus speciosus* in Alloxan Induced Diabetic Rats," Phytotherapy Research, 22(5), pp. 620-626, 2008.
[28] B. Deni, Encyclopedia of Herbs. The Royal Horticulture Society. London: Dorling Kindersley, p. 181, 2008.
[29] S. Bhattacharya, U. Nagaich, "Assessment of Anti-nociceptive Efficacy of *Costus speciosus* Rhizome in Swiss Albino mice," Journal of Advanced Pharmaceutical Technology and Research, 1(1), pp. 34-40, 2010.
[30] L. Wanwisa, K. Pakanit, C. Nuannoi, W. Susan, K. Sajeera, "The Effects of Wild Ginger, *Costus speciosus* (Koen Smith) Rhizome Extract and Diosgenin on Rat Uterine Contractions," Reprod. Sci., 18 (6), pp. 516-524, 2011.
[31] C. P. Khare, Indian medicinal plants, India: Springer (India) Private Limited, pp. 181-2, 2007.
[32] M. K. Jha, M. B. Alam, M. S. Hossain, A. Islam, "In *vitro* antioxidant and cytotoxic potential of *Costus speciosus* (Koen.) Smith rhizome," Int. J. Pharm. Sci. Res, 1(10), pp. 138-144, 2010.
[33] J. Tache, H. Selye, J.G. Spielberger, Sarason. (Eds.), "Stress and Anxiety," John Wiley and Sons, New York, pp.2, 1978.
[34] A. Agunu, E. M. Abdurahman, G. O. Andrew, Z. Muhammed, "Diuretic activity of the stem bark extracts of *Steganotaenia araliaceahoehst,* " J. Etthnopharmcol, 96, pp. 471-5, 2005.
[35] R. P. Rastogi, B. N. Mehrotra, Compendium of Indian Medicinal plants, Central Drug Research Institute, Lucknow and National Institute of Science Communication and Information Resources, New Delhi, 4, pp. 224-225, 2004.
[36] M. M. Gupta, R. K. Verma, A. Akhila, "Oxo acids and branched fatty acid esters from rhizomes of *Costus speciosus*," Phytochemistry, 25, pp. 1899-1902, 1986.
[37] S. Srivastava, P. Singh, K. K. Jha, G. Mishra, S. Srivastava, R. L. Khosa, "Anti-inflammatory, Analgesic and Antipyretic Activities of Aerial parts of *Costus speciosus* Koen.," Indian Journal of Pharmaceutical Sciences, 75 (1), pp. 83-88, 2013.
[38] K. Binny, Sunil Kumar G, D. Thomas, Journal of Basic and Clinical Pharmacy, 2010.
[39] S. K. Bhattacharya, A. K. Parikh, P. K. Debnath, V. B. Pandey and N. C. Neogy, "Anticholinesterase activity of *Costus speciosus* alkaloids," Ind. J. Pharmac, 4 (3), pp. 178-179, 1972.
[40] N. Verma and R. L. Khosa, "Effect of *Costus speciosus* and *Wedelia chinensis* on Brain Neurotransmitters and Enzyme Monoamine Oxidase following Cold Immobilization Stress," Journal of Pharmaceutical Sciences and Research, 1(2), pp. 22-25, 2009.
[41] N. O. AL-Ameri, Z. F. Azeez, "Morphological effects of alcoholic extract of *Costus speciosus* Koen. on *Aspergillus sp*. that causing pulmonary infections (III),"

Journal of Natural Sciences Research, 4(3), pp. 98-101, 2014.

[42] S. Kanakkanath, A. Narayanan and B. Ganesan "Evaluation of *Costus speciosus* Koen aqueous extract for larvicidal activity," Der Pharmacia Lettre 5(4), pp. 283-285, 2013.

[43] Y. Q. Chang, S. N. Tan, J. W. H. Yong and L. Ge, "Determination of Flavonoids in *Costus speciosus* and *Etlingera elatior* by Liquid Chromatography –Mass Spectrometry," Analytical Letters, 45, pp. 345-355, 2012.

[44] A. K. Sharma and S. Chattopadhyay, "Relative Amounts of Nuclear DNA in populations of *Costus speciosus* (Koen.) Sm.," Current Science, 52(14), pp. 653-658, 1983.

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