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## NUTRITIONAL AND PHARMACOLOGICAL IMPORTANCES OF GENUS *COSTUS*: A REVIEW

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**ABSTRACT:** The Genus *Costus* (Linn.) is an important medicinal plant belonging to the family Costaceae. The Genus as a whole is often called Spiral Ginger. The genus is represented by about 175 species distributed throughout the world. The aerial parts of the plant and the rhizomes are edible, the rhizome being good source of carbohydrate, starch, amylase, protein and lipid. Moreover the rhizome is an alternative source of diosgenin and generally used to control diabetes. Rhizome of *Costus* is also used for curing many other ailments. In Ayurveda, the rhizomes are ascribed to be astringent, acrid, cooling, aphrodisiac, purgative, anthelmintic, depurative and expectorant. The present study focuses on the nutritional and pharmacological importances of *Costus* species.

**INTRODUCTION:** In India, the sacred Vedas provide many references on the utilities and importances of medicinal plants<sup>1</sup>. Plant materials are of wide use in traditional systems of medicine, particularly in rural and tribal communities of the developing world. Medicinal plants are the native heritage of many distinctive geographical area and they bear significant global importances<sup>2</sup>. Wild edible tuber species are important sources of food in India and they play significant role in the dietary habits of small and marginal families and forest-dwelling communities, most often during periods of food scarcity<sup>3</sup>. Wild edible tubers refer to species that are neither cultivated nor domesticated, but available from their natural habitat and used as sources of food<sup>4</sup>.

Tubers rhizomes and wild edible plants are collected and consumed from time to time by rural and tribal people over a period of 4-5 months a year from May- June to September- October to meet their food needs during periods of food shortage<sup>5</sup>. Edible tubers/ rhizomes not only enrich the diet of the people but also possess medicinal properties. The use of plant based drugs and chemicals for curing various ailments and diseases are as old as human civilization<sup>6</sup>. They are the only resources available for the treatment of different microbial infections among many rural and tribal communities even today<sup>7</sup>.

In Odisha, several tribal communities like Kharia, Kolho, Santhal, Mankirdia, etc. depend on wild food plants and use their fruits, flowers, leaves, bulbils, tubers etc. as food either for their daily requirement or to fulfill the need during the periods of food shortage and famine<sup>8</sup>. Many of the forests are rich in wild tubers that are used both for food and medicinal purposes<sup>9</sup>. Many tropical tuber species are used in the preparation of stimulants, tonics, carminatives and expectorants<sup>10</sup>. The tuber

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crops like *Ipomoea* spp., *Colocasia* spp. *Manihot* spp., *Dioscorea* spp., *Amorphophallus* spp. and other rhizomatous crops like *Curcuma* spp., *Costus* spp., *Zingiber* spp. etc. are profoundly used by the tribal communities of the state as food and medicines<sup>5</sup>. The genus *Costus* belonging to the family Costaceae, has species like *Costus igneus*, *Costus afer*, *Costus pictus*, *Costus arabicus*, *Costus dubius*, *Costus speciosus*, etc. Among these species, *Costus speciosus* is profusely distributed in the forests of Odisha. It is locally known as Kakaiya, Keu, Keukand, etc. *C. speciosus* is used as therapeutic both in traditional and folk medicines<sup>11</sup>. It is not only used as therapeutic medicines but for other socio-cultural purposes, such as wrapping of indigenous food items, mat making, treatment of evil repellants<sup>12</sup>. The rhizome of the *C. speciosus* is used as an antifertility agent as it is rich in diosgenin, a suitable component for the synthesis of corticosteroids and oral contraceptives<sup>13</sup>. The rural and tribal people use the leaves against ear infections, diarrhoea, cold, catarrhal fever, cough, dyspepsia and rhizomes for skin diseases and snake bites<sup>14</sup>. It possesses antibacterial activity due to the presence of bioactive compounds like alkaloids, terpenoids, tannins, glycosides, saponins, etc.<sup>15</sup>.

Botanically, the genus have long fleshy stems with tuberous rootstock. The leaves are spirally arranged

with silky pubescent beneath. Flowers are densely arranged which are terminal or spikes. The calyx is like short tube, funnel-shaped with ovate teeth. corolla tube is short, the segments are large and sub equal. Stamens with broad filament, forming oblong petaloid process with the connective. The ovary is generally 3- celled, style is filiform and stigma with a semilunar ciliated depression. Ovules are many and superposed. Capsule globose or ovoid. Seeds are subglobose or obovoid with short aril<sup>16</sup>. Flowering time of the plant is from August to October<sup>17</sup>. With respect to the Genus, *C. speciosus* plant is straight with long leafy stem that grows about 0.6 to 1.8 height.

The root stock is tuberous. The leaves are sessile, oblong, spirally arranged with silky pubescent beneath. Calyx is short tube, funnel- shaped with ovate teeth. The bracts are ovate, mucronate, bright red, corolla tube is short. The flowers are white in colour and present in very dense spikes. Fruit is capsule, globosely trigonus and red in colour. The seeds are black with white aril. The ovary is generally 3- celled, style is filiform and stigma generally with a semilunar ciliated depression. Ovules are many and superposed. Capsule generally globose or ovoid, finally dehiscent on one side between the ribs. Seeds are subglobose or obovoid with short aril<sup>18</sup>.



PLATE 1: VEGETATIVE PARTS OF *C. SPECIOSUS* A) AERIAL PARTS B) RHIZOME

**Distribution:**

The genus *Costus* comprises of 175 species distributed in the humid tropics of both hemispheres. Different species are found in Indo-China, Malaysia to New Guinea, Taiwan and more or less throughout India<sup>18</sup>. The plant is generally found in roadside ditches and low lying areas in the forests. It occurs throughout the foot hills of Himalayas from Himachal Pradesh to Assam, Vindhya Satpura hills in Central India, Eastern Ghats of Andhra Pradesh and Western Ghats of Maharashtra, Karnataka, Tamil Nadu and Kerala up to an altitude of 1220 ft<sup>19</sup>. *Costus speciosus* is the only species of family *Costaceae* found in Odisha. *C. speciosus* is distributed in different parts of the state like Papadahandi, Gandhamardan, Jagatsinghpur, Cuttack, Rayagarh, Khurda etc.<sup>18</sup>.

**Traditional food system:****Nutritional Values of Different *Costus* spp.**

Rhizome of *Costus* spp. is rich in macronutrients like carbohydrate, starch, amylose, protein, lipid etc. and is also good source of micronutrients like Vitamin A<sup>19</sup>. Besides it is rich in antioxidant components like  $\beta$ - carotene, ascorbic acid (Vitamin C), tocoferol (Vitamin E), that can prevent coronary disorder and cancer (Nedunchezhiyan et al., 2012). Singh (2011)<sup>20</sup> reported that the rhizome of *C. speciosus* is consumed raw or as cooked vegetable and it is highly nutritious with high content of carbohydrate, starch, amylase, protein and lipid/oil. The stem of *C. afer* is reported to contain good amount of moisture, crude fat, crude protein, carbohydrate, crude fibre and ash which indicates its nutritional values<sup>21</sup>. Vishalakshi and Urooj (2010)<sup>22</sup> reported that the leaves of *C. speciosus* and *C. igneus* are rich with protein, iron, ascorbic acid,  $\beta$ - carotene,  $\alpha$ - tocopherol, glutathione and flavonoids. Karthikeyan et al., (2012)<sup>23</sup> highlighted the protein and phenolic content of *C. speciosus* qualitatively and quantitatively and found high amount of phenolic content in the mature leaves of the plant.

**Anti- Nutritional factors in *Costus* spp:**

Anti nutritional components are natural or synthetic compounds that interfere with the absorption of nutrients. Protease inhibitors, lipase, amylase, phytic acid, oxalic acid etc. are some of the anti-nutritional components. Ukana et al., (2012)<sup>21</sup>

reported the anti-nutritional compounds such as saponins, total oxalate, cyanide, and tannins in the stem of *C. afer*. The anti- nutritional compounds like saponins, oxalate, tannin, etc. with low toxicity level are beneficial to plants (Singh et al., 2010)<sup>22</sup>. The saponins collected from *C. speciosus* observed to impair the digestion of protein and the uptake of vitamins and minerals in the gut of animals (Francis et al., 2002)<sup>23</sup>.

**Trace Elements in *Costus* spp:**

Trace elements are the dietary elements that are needed in minute quantities for the proper growth. Singh (2011)<sup>20</sup> reported that the tubers of *C. speciosus* are rich in trace elements and contains 3.14% nitrogen, 1.72% calcium, 1.42% potassium, 0.28% sodium, 0.19% magnesium and 0.06% phosphorus. Ukana et al., (2012)<sup>21</sup> evaluated the trace elements in the stem of *C. afer* and concluded that it has rich content of potassium, sodium, calcium, magnesium and phosphorus.

**Ethnobotanical Importances of *Costus* spp:**

Plants provide food, medicine, shelter, dyes, fibers, oils, resins, gums, soaps, waxes, latex, tannins and even contribute to provide clean air we breathe<sup>3</sup>. Ethnobotany deals with the study of ethnic beliefs, concepts, knowledge and practices among the tribal communities for curing different diseases using different plants (Ignacimiuthu et al., 2006)<sup>26</sup>. *Costus speciosus* has diverse ethnomedicinal values as per literature survey report (Table 1).

The aboriginals of tribal Odisha use the rhizome of *Costus speciosus* as expectorant, for curing asthma, fever, bronchitis (Duraipandiyam and Ignacimuthu 2011)<sup>27</sup> leprosy (Omukhua, 2011)<sup>28</sup>, skin diseases (Kumar et al. 2012)<sup>8</sup>, etc.

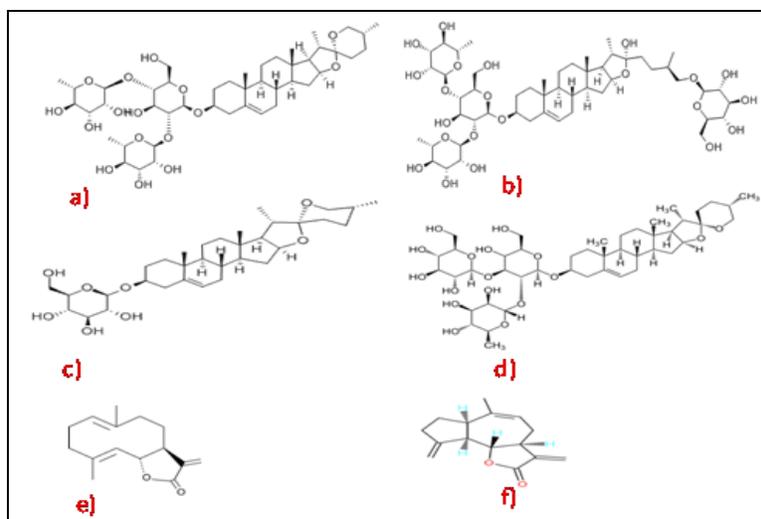
**Bio- Active Compounds Present in *Costus* spp:**

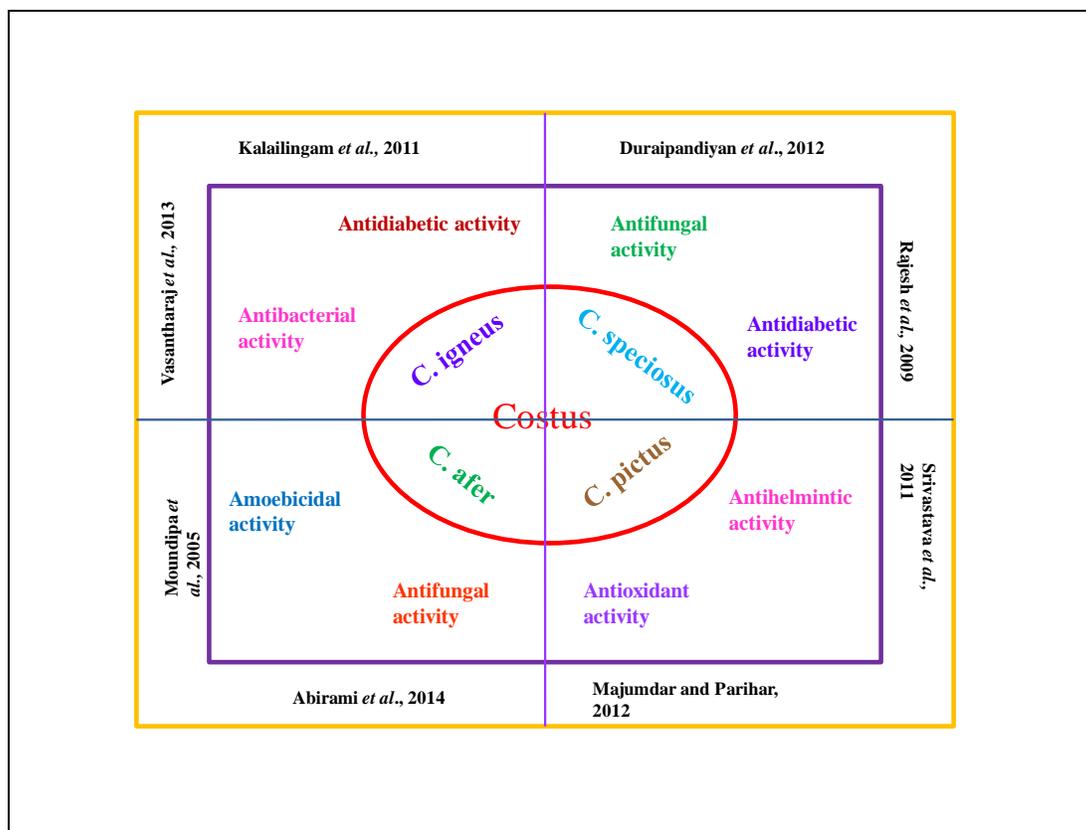
Bioactive compounds are the compounds or the secondary metabolites capable of eliciting pharmacological or toxicological effects. The rhizome of genus *Costus* is rich in diosgenin (Gupta et al., 2008a.)<sup>28</sup>. The rhizome is also rich in prosapogenin B of dioscin, diosgenone, cycloartenol, 25 cycloartenol, octacosanoic acid, spirostanol glycoside, (steroidal saponin) and furostanol glycoside 26-O- $\beta$ - glucosidase<sup>29, 30</sup>. The rhizome of *Costus* spp. contain 5 $\alpha$ - stigmasten-3b-ol, sitosterol- $\beta$ -D-glucoside, dioscin, prosapogenins

A and B of dioscin, gracillin and quines<sup>31</sup>. Duraipandiyar *et al.* (2012)<sup>32</sup> isolated two sesquiterpene lactones- costunolide and eremanthin from hexane extract of *C. speciosus* which inhibited the tested pathogens at lowest concentrations.

**TABLE 1: ETHNOBOTANICAL VALUES OF COSTUS Spp.**

Plant Name	Plant Parts	Against	Uses	Source(S)
<i>Costus speciosus</i>	Rhizome	Diarrhoea and Dysentery	Juice is taken orally.	Vasantharaj <i>et al.</i> (2013) Saraf, (2010)
		Skin Diseases	The paste is effective against scabies, ringworms, eczema, etc	Vasantharaj <i>et al.</i> (2013) Kumar <i>et al.</i> (2012) Duraipandiyar and Ignacimuthu (2011) Saraf (2010)
		Diabetes	Two spoon juice is taken orally daily.	Duraipandiyar and Ignacimuthu (2011) Rajesh <i>et al.</i> (2009) Vishalaxmi and Urooj (2009)
	Stem	Inflammation	Decoction is applied externally	Binny K. <i>et al.</i> (2010)
		Helmintic infection	Decoction is taken orally	Srivastava <i>et al.</i> (2011)
Leaves	Asthma and Bronchitis	5- 6 leaves is grinded and juice is taken	Duraipandiyar and Ignacimuthu (2011) Omakhua (2011)	
<i>Costus igneus</i>	Leaves	Urinary infections Food Poisoning	Juice is taken orally Juice is used	Vasantharaj <i>et al.</i> (2013) Sulakshana <i>et al.</i> (2013) <sup>50</sup>
<i>Costus afer</i>	Leaves	Dysentery	Leaf juice is taken orally	Moundipa <i>et al.</i> (2005)
		Fever and Malaria	The leaves are boiled with leaf of <i>Carica papaya</i> , citrus species(orange) and bark of <i>Mangifera indica</i> (mango)	Omukhua (2011).
<i>Costus pictus</i>	Stem	Cough and Bronchitis	The stem juice is taken	Omukhua (2011).
	Leaf (essential oil)	Microbial infections	As antiseptic and applied externally	Reddy and Jose, (2010) <sup>49</sup>
	Stem and Root	Skin infection	Juice is applied	Majumdar and Parihar (2012)

**PLATE 2: STRUCTURE OF BIOACTIVE COMPOUNDS PRESENT IN *COSTUS* Spp. a) DIOSCIN, b) PROTODIOSCIN, c) DIOSGENIN, d) GRACILLIN, e) COSTUNOLIDE, f) EREMANTHIN**

**Pharmacological Values:****PLATE 3: PHARMACOLOGICAL VALUES OF *COSTUS* SPP.**

Saraf (2010)<sup>11</sup> reported the *in vitro* antibacterial activity of the rhizome of *C. speciosus*. The plants have shown efficient results against the bacterial strains like *Escherchia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. The mature leaves of *C. igneus* have proven to be effective against bacterial pathogens like *Bacillus subtilis*, *Proteus mirabilis*, *E. coli*, *P. aeruginosa*. The methanol extract showed maximum zone of inhibition against *E. coli* whereas least zone of inhibition against *P. mirabilis* (Vasantharaj et al., 2013)<sup>15</sup>. Rhizome extract of *C. speciosus* was found to be effective against *Staphylococcus epidermidis* and *Salmonella typhimurium*, and hence used as a potential bacteriocidal agent (Ariharan et al., 2012)<sup>14</sup>. The antibacterial activity of the different parts (leaf, flower, stem and root) of *C. pictus* exhibited pronounced inhibitory activity against *Shigella flexneri*, *K. pneumoniae*, *B. subtilis* and *E. coli*. (Majumdar and Parihar, 2012)<sup>33</sup>.

Duraipandiyan et al. (2012)<sup>32</sup> isolated two sesquiterpene lactones- costunolide and eremanthin

from hexane extract of *C. speciosus* which showed significant antifungal activity against *Trichophyton mentagrophytes*, *Trichophyton simii*, *Trichophyton rubrum*, *Epidermophyton floccosum*, *Scopulariopsis* spp., *Aspergillus niger*, *Curvularia lunata* and *Magnaporthe grisea*. The ethyl acetate extract of *C. speciosus* rhizome and leaves have shown promising antifungal activity against fungal strains like *T. rubrum*, *T. mengagrophytes*, *T. simii*, *E. floccosum*, *A. nizer*, *Botrytis cinerea*, *C. lunata* and *Candida albicans* (Duraipandiyan and Ignacimuthu, 2011)<sup>32</sup>.

The methanol extract of *C. speciosus* leaves was inhibitory against fungal strains like *Penicillium* spp. and *Mucor* spp. Thus, the plant possesses effective antifungal activity<sup>15</sup>. The extracts of different parts of two species of *C. speciosus* and *C. pictus* were found to be effective against fungus *Pythium aphanidermatum* whereas the extracts were not effective against the fungi *Colletotrichum capsici* and *Sclerotium rolfsii*<sup>34</sup>. The leaves of *C. afer* exhibited efficient amoebicidal activity. The extract was tested for antiamoebic activity *in vitro*

using polyxenic culture of *Entamoeba histolytica* (Moundipa et al., 2005)<sup>35</sup>.

Helminthes are known as parasitic or intestinal worms those reside in human intestine and feed on living host. Medicinal plants can be natural and effective therapeutics against helminthes (Kanthal et al 2012)<sup>36</sup>. Srivastava et al., 2011 reported that the aerial parts of *C. speciosus* can be used as promising anthelmintic agent. The extracts of the aerial parts was evaluated using *Pheritima posthuma* as experimental worms, which showed significant effect on paralyzing the worms.

Antioxidant has the ability to trap highly reactive free radicals and oxygen species. These free radicals may oxidize nucleic acids, proteins, lipids or DNA and can initiate degenerative disease. Vishalakshi and Urooj (2010) reported that antioxidants like phenolic acids, polyphenols and flavonoids scavenge free radicals such as peroxide, hydroperoxide or lipid peroxy and thus inhibit the oxidative mechanisms that lead to degenerative diseases. Nahak, (2009)<sup>37</sup> showed free radical scavenging activity of ethanolic extract of *C. speciosus* rhizome through DPPH (2, 2- diphenyl-1- picrylhydrazyl) assay. The result showed maximum level of free radical scavenging activity with  $71.61 \pm 0.02\%$  with  $IC_{50}$  value  $25 \mu\text{g/ml}$ . The methanol and aqueous extracts of *C. pictus* was tested for antioxidant activity using DPPH radical scavenging assay. The methanol extract of *C. pictus* showed highest antioxidant activity. (Majumdar and Parihar, 2012)<sup>33</sup>.

Chang et al., (2005)<sup>38</sup> reported that *C. speciosus* rhizome extract showed moderate anti-cancerous activity in adenocarcinomic human alveolar basal epithelial cells- A549, SK-OV-3, human melanoma cell line- SK-MEL-2 and colo-carcinoma- HCT15 cells. The rhizome extract induced apoptosis via reactive oxygen species (ROS) and B-cell lymphoma2 (Bcl-2) dependent mitochondrial permeability transitions and ROS-mediated JNK activation in human leukemia cells (Nahak, 2009)<sup>37</sup>.

The rhizome extracts of *Costus* spp. is also used against inflammation and anaphylactic shocks. The ethanolic extract of the rhizome of *C. speciosus*

possesses anti- inflammatory and anti- pyretic properties. Significant anti- inflammatory effect was found against carrageenan- induced edema formation in rats at a dose of 800mg/kg and against cotton pellet granuloma formation in rats at doses of 400mg/kg and 800mg/kg (Binny et al., 2010)<sup>39</sup>.

This plant is also known for its hepatoprotective activity. An experimental investigation was carried out to explore the use of this plant as hepatoprotective agent. The ethanolic extract registered a significant fall in the levels of serum glutamyl oxalacetic acid transaminase (SGOT), serum glutamyl pyruvate transaminase (SGPT), alkaline phosphatase (ALKP), serum bilirubin (SBLN) and liver inflammation, thus, exhibiting a significant hepatoprotective activity (Verma and Khosa, 2009)<sup>40</sup>.

Diabetes mellitus is a chronic metabolic disorder affecting approximately 4% population worldwide and is expected to increase to 5.4% in 2025 (Ignacimuthu 2008)<sup>41</sup>. The disease is characterized by high blood glucose levels due to absolute or relative deficiency of circulating insulin levels (Vishalakshi and Urooj 2008). Eliza et al. (2009)<sup>42</sup> extracted costunolide from crude extract of *Costus speciosus* and administered to streptozotocin (STZ)-induced diabetic male wistar rats at different doses and found plasma glucose to be significantly reduced in a dose-dependent manner when compared to the control.

It has been shown that costunolide inhibited the expression of nitric oxide synthase and thus helped in correcting the secretary defects in diabetes (Gupta et al., 2008 b)<sup>43</sup>. The aqueous and methanolic extracts of *C. speciosus* were highly effective in bringing down the blood glucose level (Rajesh et al., 2009)<sup>44</sup>. Daisy et al. (2008)<sup>45</sup> investigated biochemical parameters in Streptozotocin (STZ)- induced male diabetic wistar rats using *C. speciosus* rhizome extracts. STZ treatment (50 mg/kg) caused a hyperglycemic state that led to various physiologic and biochemical alterations where as hexane, ethyl acetate and methanol extracts administered to STZ resulted reduced and normal glyceic rats. Kalailingam et al., (2011)<sup>46</sup> investigated antihyperglycemic and hypolipidemic activities of methanol extract of *C.*

*igneus* rhizome in Streptozotocin (STZ) induced diabetic albino rats. The results showed that fasting blood glucose, serum TC, TG, LDL, VLDL levels were significantly decreased, whereas serum HDL level was significantly increased in the diabetic rats. Bavara et al. (2008)<sup>47</sup> evaluated the antihyperglycemic, antihyperlipemic and antioxidant potency of ethanol extract of *C. speciosus* root in alloxan-induced diabetic male rats. *C. speciosus* is known to possess anti-diabetic properties and used in local health traditions in India (Rajesh et al., 2009).

The methanol extract of *C. pictus* leaves when administered as single dose per day to diabetes-induced rats for 21 days elicited significant reductions of blood glucose, thus *C. pictus* leaves seem to be good anti-diabetic agent (Jothivel et al., 2007)<sup>48</sup>.

#### CONCLUSION AND FUTURE PROSPECTS:

From the detailed study of the available literature on *Costus* spp. it is clearly shown that the rhizome is rich in carbohydrate, starch, amylase, protein and lipid. Thus, can be a great source of food alternative. They are important sources of many medicinally efficient chemicals- like diosgenin, steroidal saponins such as prosapogenin,  $\alpha$  &  $\beta$  dioscin, furostanol saponins like costunolide, octasanoic acid, cycloartenol and various other constituents. Many different pharmacological activities are attributed to these compounds such as antidiabetic, hepatoprotective, antifertility, antioxidant, antibacterial and antifungal activity. Many other pharmacological importances are still unknown. Further research can establish these plants as suitable sources of nutrient and herbal medicine as well.

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