IJPSR (2019), Volume 10, Issue 7 (Review Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 16 November 2018; received in revised form, 11 June 2019; accepted, 14 June 2019; published 01 July 2019

# A COMPREHENSIVE REVIEW ON *COSTUS PICTUS* D. DON

G. M. Radha Devi

Department of Botany, Jnanabharathi Campus, Bangalore University, Bangalore - 560056, Karnataka, India.

**Keywords:**

Anti-diabetic, Anti-bacterial, Anti-microbial, *Costus pictus*, Insulin plant

**Correspondence to Author:**
**G. M. Radha Devi**

Research Scholar,
Department of Botany,
Jnanabharathi Campus,
Bangalore University, Bangalore - 560056, Karnataka, India.

**E-mail:** radha.kle@gmail.com

**ABSTRACT:** *Costus pictus* is rhizomatous medicinal herb, commonly known as "Insulin plant," well known for its therapeutic properties. Many important and beneficial aspects of *C. pictus* are reported, which includes anti-diabetic, anti-microbial, anti-cancer, anti-oxidant, anti-fertility, anti-helminthic, diuretic, anti-inflammatory properties. The present review focus on the literature survey based on their occurrence, nature of plant, distribution, pharmacologically important bio-active compounds, utilized in the treatment of diabetes and related disorders. Along with micropropagation of C*ostus pictus* under the aspectic condition and molecular approaches towards the treatment of disorders and different pathways involved. This summarized review focus on the future scope of research and development for synthesis of much effective dose and dosage period to formulate the therapeutic potential of C*ostus pictus* and their phytoconstituents.

**INTRODUCTION:** Medicinal plants being an herbal remedy in both developing and developed countries in the management of health care, globally 80% of the population relies on traditional medicine, since ancient times as major source of medicine in treating many diseases, Ayurveda, Unani, homeopathy, naturopathy. Natural products derived from plants on a large scale and attracted by many researchers due to less or no side effects. *Costus pictus* is commonly known as fiery *Costus*, step ladder or spiral flag or Insulin plant native to south and Central America and recently introduced in India for its valuable medicinal properties, oral consumption of leaf daily to cure diabetes and most widely spread across Kerala as an ornamental and daily culinary purpose [1].

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.10(7).3187-95

The article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.10(7).3187-95

It's used as folk medicine by tribal people of kolli hills of Namakkal district Tamil Nadu [2]. The field survey in Paithan Tehsil Aurangabad district found *C. pictus* new flora in Maharashtra [3] and similarly found in Odisha [4].

The first published record of *Costus* as taxa was found in Hortus malabaricus by Hendrick Andariaan Van Rheede (1678-1693) in Kerala. The family Zingiberaceae consists of nearly 53 genera largest family of the order Zingiberales over 1000 species and found abundant in South East Asia distributed mainly in tropics and subtropics of central distribution in Indo-Malayan region also extending through tropical Africa to central and South America [5]. The family Costaceae consists of 4 genera and over 200 species. *Costus* is native of tropical areas of Asia, Africa, Australia, and the America [7]. *Costus* under family Zingiberaceae, Costaceae is classified as Costideae by Engler & Prantl; sub family or as a tribe (Costeae) within Zingiberaceae. Thus genus *Costus* along with genera *Dimerocostus* (2 species), *Monocostus* (1

species) and *Tapeinochilus* (20 species) was separated from family Zingiberaceae to the family Costaceae due to fused staminode [7]. Their molecular dating of cladogenic events combined with phylogeny-based bio-geographic analysis, Dispersal Variance Analysis (DIVA) and Chloroplast DNA data trnsL-F and transK. It has been separated from Zingiberaceae for its the significant arrangement of leaves, spiral phyllotaxy showy labellum unique character along with easily differentiable characters like essential oils and distichous arrangement of the leaves [1].

The phylogenetic relationship, bio-geographic and pollination history of *Costus* sub genus by ITS and ETS regions, the sequence data of nuclear ribosomal DNA (18s-26s) shows monophyletic neotropical species radiations, having large, showy flowers visited by a euglossine bee or hummingbird [8]. Costaceae has been mono-phylogenetic in origin when compared with the different taxonomic groups, by studying 65 taxa by their geographical and morphological diversity of the family [13] found their molecular characters in 3 major clades American, Asian, African, neo-tropical by comparing 5898 characters of 5827 molecular and 71 morphological characters of 67 taxa. It is a pantropical monocot family Costaceae (Zingiberaceae) approximately 120 species, it also shows recognizable differentiation from families including bananas (Musaceae) and ginger (Zingiberaceae) by it's well developed and sometimes branched aerial shoot with characteristic spiral monistichous (one-sided phyllotaxy) of leaves [10] belonging neotropical radiation bee pollinated ancestors.

*C. pictus* consists of various therapeutic properties, anti-diabetic mainly along with anti-bacterial, anti-cancerous, diuretic, anti-helminthic, anti-oxidant, anti-fertility, anti-glycation, *etc.* [11] Along with these the methanol and ethanolic extract of *C. pictus* leaves known to exhibit significant enzymatic action on pepsin, α amylase, effect on mitochondrial enzymes, carbohydrate hydrolyzing enzymes; induce insulin production. The phytochemical investigation reveals the presence of major bioactive methyl tetracosonoate as a precursor for bixin production acts as an anti-diabetic property for leaves. The rhizome, stem, and flowers are rich in primary and secondary metabolites presence secondary metabolites like alkaloids, flavonoids, phenolics, saponins, terpenoids, tannins, steroids, etc along with trace elements. *C. pictus* now world widely accepted as an anti-diabetic plant as clinically trails on animal cells line *in-vitro* and *in-vivo* studies, and Pharmacoepidemiological survey suggests that consumption of one leaf daily known to reduce blood glucose level (Biospectrum 2013). Thus exploitation of this plant is increasing day by day, hence *in-vitro* propagation and production in mass have been carried out.

**Pharmacological Properties:** *C. pictus* used a folk medicine treating various chronic diseases due to the presence of major and minor phytochemical constituents as primary and secondary metabolites identification characterization of the chemical and bioactive components is carried out by many researchers. It has been reported that the saponified extract of leaf analysis by GC-MS revealed 18 major chemical compounds **Table 1** major component in the ether fraction is bis(2'-ethyl hexyl)-1,2 benzene dicarboxylate. Presence of α-tocopherol as a cause of the anti-oxidant property of the leaf extracts [12].

Different solvent extract of leaves stem and rhizome methanol extract exhibited maximum and pronounced anti-diabetic activity consists of β-L-Arabionopyranose methyl glycoside as a reference compound [13]. The leaf of *C. pictus* shows the anti-diabetic property when treated on alloxan induced rats by the presence of various secondary metabolites in specific flavonoids compounds. **Table 1** constitute for anti-diabetic and anti-oxidant activities [14]. The leaf of *C. pictus* consists of calcium oxalate crystals as minute particles along with carbohydrates, triterpenoids, proteins, alkaloids, tannins, saponins, flavonoids sterols volatile oils. Powder microscopic study of leaf showed fragments of unicellular trichomes, hexacytic stomata, abaxial solitary bundle [15], and appearance of cuboidal solid crystals in all parts of *C. pictus* plant [16].

The LC-MS analysis of *C. pictus* extract found 4 major flavonoids along with 6 phenolic compounds **Table 1** [17]. The macro and microscopic study of *C. igneus* leaves found epidermis with anomocytic stomata, mesophyll cells with calcium oxalate

crystals and fibers associated with parenchyma cells [18]. The report on physicochemical and phytochemical screening of aqueous and ethanolic extract of *C. pictus* carried out as per the WHO guidelines found to contain many primary and secondary metabolites [19].

**TABLE 1: LIST OF BIO-ACTIVE COMPOUNDS FOUND IN LEAF AND RHIZOME EXTRACT OF *C. PICTUS***

| Author and year | Part used | Compound identified | Methodology involved |
|---|---|---|---|
| George *et al.,* 2007 | leaf | Phytol, Xanthene-3-one, Bis(2'ethyl hexyl)1-2-benzene di carboxylate, octacosane, α-ergastanol, tetradeconic acid, pentadeconic acid, hexadecanoic acid, heptadeconic acid, heptadecene, carbonic acid, octadecanoic acid(stearic acid), 4,8,12,16 tetramethyl-heptadecane 4olide, 7 tridecanone, Decosanoic acid(Behenic acid), 9-Octadecenoic acid (oleic acid) | GC-MS |
| Beena and Joji Reddy 2010 | Leaf | Hexadecanoic acid, 2-pentanol, β-ionone, α-ionone, farnesyl acetone, dodecanoic acid. | |
| | Rhizome | Hexadeconic acid, dodecanoic acid, tetra decaonoic acid, linalool, 9,12-octadecadienoic acid,α-terpineol | |
| Shiny *et al.,* 2013 | leaf | B-arabinopyranose methyl glycoside | TLC, HPLC, GC-MS |
| Ramya *et al.,* 2013 | leaf | Flavonoids( Kaempferol, 3-4di-O-Me-Quercetin, 4'-O-Me-Kaempferol). Phenolics (gentistic, 2,5-dihydroxy benzoic acid, O-coumaric, meliotic, α-resorcyclic, 3-5, di hydroxyl benzoic acid, p-hydroxy benzoic acid, cis &trans p-coumaric acid) | Phyto-chemical studies |
| Ashwini *et al.,* 2015 | leaf | Flavonoids (Iso-quercetin, Astragarin, Kaempferol, quercetin) Phenolics (Iso vitexin naringenin, galangin, genistin, licochalcone A, onion | LC-MS |
| Vijayan *et al.,* 2016 | Leaf | Geranyl geraniol, Isophytol, phytol, β-sitosterol acetate, tetradecene, Dodecanoic acid, tetradecanoic acid, pentadecanoic acid, n-hexadecanoic acid, Eicosanoic acid, Octasane, tritetracontane, penta tri-a contane, hexatricontane, 2-aminonona decane, dotricontane, hexadecane, hexa decyloxira-ne,2-hexyl-1-decanol,z-5,17 octadecadiene-1-ol-acetate, 1,pentacantanol, pentatriacontane | |
| | Flower | Thymol, β-caryophyllene, trans-Z-α-bis-abolene epoxide, α-farnesene, δ-nerolidol, homopiperazine, n-decanoic acid, tetradecane, Dodocanoic acid, tetra decanoic acid, E-7-octadecene, pentadecanoic acid, 5-methyl heneicosane, heptacosanoic acid methyl ester, n-hexadecanoic acid, Elicosanoic acid, 1-octadecyne, octasane, tritetracontane,9-12-octadeca-dienoic acid, octadecanoic acid, 17-penta-tri-acontene, hexacosane, hexatriacontane, 1-octacosanol, tetra contane, 1-hexaicosanol, 1-decasene, 1-tetracosane. | |
| | Root | Kaur 16 ene, thumbergol, tetradecanoic acid, n-hexasecanoic acid, eicosanoic acid, 1-octa decyne, octacosane, hexatriacontane, tetra tetra contane, dotricontane, hexadecane, henecoane, heptacosane, 11-tridecen-1-ol, 1,2-heptadecenol, hexadecenol, octadecanol, tetradecanol, 9-octadecenol | |
| | Stem | Phytol, n-hexadecanoic acid, eicosanoic acid, octasane, tritetracontane,17,pentatri-acontene, hexatriacontane, 2 aminonona-decane, hexadecylria-ne, n-butyl myristate,2-methyl octadecane, 9-12 tetra decadicene-1-ol, 1-hexacosene | |
| | Rhizome | Thymol, β-myrcene, tetradecane, dodecanoic acid, tetra decanoic acid, octacosane,9-12-octadeca-dienoic acid, hexatricontane, tetracosane, dotricontane, 14-hepta-decenol, octadecanol, heneicosanol, oleic acid, heptadecanoic acid, 9.17 octa decadienol, heptacosanol | |
| Manjula K. *et al.,* 2016 | leaf | Lupeol and stigmasterol | HPLC |
| Ashwini *et al.,* 2017 | leaf | Pentacyclic triterpenes α and β amyrins | LC-MS |

It is also reported that aqueous and ethanolic extracts of *C. igneus* stem with calcium oxalate crystals and isolated compounds like lupeol and stigmasterol [20], also calcium oxalate monohydrate crystal growth was reduced and morphology of the crystals changed from hexagonal to bi-pyramidal form due to the inhibitory action of extracts. A bioactive compound like diosgenin a steroidal

saponin has been isolated and quantified by HPLC method [21], isolated diosgenin was characterized by various parameters such as color, odor, pH, physical appearance solubility was reported by [22]. The leaves are sour due to the presence of oxalic acid in the leaves and determination of oxalate oxidizes activity [23].

**Anti-diabetic Property:** The leaves of *C. pictus* is medicinally important in treating hyperglycemic activity, the ethanolic and methanolic extracts when induced to streptozotocin and alloxan induced rats [24, 25, 26, 27, 14] showed a significant reduction in the blood sugar level. Along with the identification of trace elements like K, Ca, Cr, Mn, Cu, and Zn [28] stimulates the antidiabetic property. The aqueous extract also reported that antidiabetic property on streptozotocin-induced diabetic rats and *in-vitro* pancreatic islet culture, oral administration of 250 mg/kg of *C. pictus* [29]. Effect of Carbohydrates hydrolyzing enzymes like α amylase and α glucosidase in aqueous extract showed the highest inhibitory effect at 100 mg/ml [30, 31]. *In-vitro* studies carried out on M1N6 monolayer, and M1N6 membrane integrity showed a concentration-dependent increase in insulin secretion and showed a direct effect on islets of β cells to stimulate insulin secretion [32].

Genomic analysis of *C. pictus* leaves shows solid molecular transcripts for bixin, ABA and geraniol and geraniol biosynthesis by Next-generation sequences base approach in contribution towards therapeutic properties and presence of a precursor to bixin a putative product of nor-bixin methyltransferases as anti-diabetic property [33]. The ethanolic extract of a leaf found to be anti-proliferative and cytotoxic at lower concentration and induced cell death in MOLT-4 cells [34]. The extract at a dose of 500mg/kg b/w shows the highest percentage of glucose lowering of blood glucose level compared with the reference compound β-L-arabinopyranose methyl glycoside [13].

**Anti-microbial Activity:** The essential oil obtained from *C. pictus* leaf showed anti-bacterial activity against gram +ve and gram –ve bacteria strains of *Bacillus cerenus, Enterobacter facealis, Salmonella paratyphi, Escherichia coli, Protus vulgaris, Pseudomonas aeuroginosa, Serratic marcescens, Staphylococcus aureus, Staphylococcus faccalis, Klebisella pneumonia* [35]. Similarly, rhizome extract when treated in different concentration *Bacillus subtilis, Staphylococcus aureus* and *Escherichia coli* and *Pseudomonas aeurginosa* showed significant anti-bacterial activity [36] and *Solmonella typhimrium* [37]. As per the observation, *Aspergillus nigar* and *Claviceps purpea* fungal members had no significant with rhizome methanolic extract of *C. pictus*. The ethanolic leaf extract showed concentration-dependent activity on bacterial colonies along with identification of bioactive compound experimentally proved as antibacterial property.

**Anticancer Property:** The methanolic extract of *C. pictus* can induce apoptosis of bone cancer on MCF7 Breast cell and proved cytotoxic [38]. The ethanolic extract of *C. pictus* of leaves found to be anti-proliferative and cytotoxic at lower concentration and induce cell death in HT1080 fibrosarcoma cells [21]. The bark extract of *C. pictus* has potential natural anti-oxidant activity against HT 29 and A549 cells [39].

**Anti-oxidant Activity:** The leaf and rhizome extracts of *C. pictus* show the good anti-oxidant activity of about 89.5% and 90% at a concentration of 400µg/ml [24] estimated by DPPH, β carotene, Deoxyribose superoxide anion, reducing power and metal chelating assay at different concentration. The chloroform extract of *C. pictus* leaf extract showed a high percentage of inhibition of lipid peroxidation radical scavenging activity on *in-vitro* goat liver and RBC ghost and identification of steroidal compound acts as a defense system on enzymes and radical scavengers [40].

Leaf extracts show significant anti-oxidant and free radical scavenging activity were clinically tested against pre-oxidative damaged albino rats; it resulted that ethanolic leaf extracts significant reversal of reduction of GSH, SOD, and CAT and reduced significantly the levels of MDA. A biomarker for lipid peroxidation as dose-dependent acting as a defense system against anti-oxidative injury [41]. The root and stem extract of *C. igneus* showed high anti-oxidant activity [14] also reported that methanolic extract has high bioactive components and active anti-oxidant property [42, 43].

**Anti-fertility:** Ethanolic extract of *C. pictus* rhizome when treated to female rats at a dose of 200 and 400 mg/kg for 19 days, later studied with various parameters like percentage of pregnant female animals in each group, Mean live foetal number/pregnant female, mean foetal crown-rump length. Mean corpus luteum number/pregnant female and fertility index showed a decrease when compared to control. The rhizome extract has an active biomarker diosgenin a naturally occurring steroid saponin that acts as an anti-fertile index [44].

**Anti-helminthic:** A comparative *in-vitro* evaluation of anthelmintic property of leaves and rhizome of *C. pictus* against albendazole standard drug, methanolic and aqueous extract of leaves and rhizome showed the significant anti-helminthic effect on *Pheretima Posthuma* earthworm [45]. The hydro-alcoholic effect of *C. pictus* rhizome showed significant activity at a dose level of 0.5, 0.75 and 1 g against a standard drug piperazine citrate [46].

**Diuretic Effect:** The aqueous extract of *C. pictus* of leaves at 100 & 200 mg/kg b/w when treated on rats in comparison with furosemide at 4 mg/kg, *C. pictus* extract induced a natriuretic effect similar to furosemide drug also increase of sodium and potassium ion excretion in urine of rats [47].

**Anti-inflammatory Activity:** The *in-vitro* assessment of anti-inflammatory activity showed a maximum percentage of inhibition at 400 mg/ml at 97.87% [31].

**Hypothyroid:** The leaf extract was extracted with 80% methanol showed a dramatic decrease in the thyroid stimulating hormone TSH and can be used as a potential source for resorting thyroid hormone levels and prevent biochemical complication due to thyroid hormone insufficiency. LC-mass spectrometry analysis showed the presence of pentacyclic trite pens α and β marines. DPPH 38.82 ± 1.26µg/ml IC $_{50}$ 6.73 ± 0.15µg/ml, FRAP 2.98 ± 0.03mmol $Fe^{2+}$ positive ascorbic acid 18.76 ± 0.38 mol $Fe^{2+}$ g [48].

**Enzymatic Activities:** The α amylase inhibitory activity of methanolic extract of *C. igneus* shows a significant amount of inhibition of amylase enzyme greater inhibition showed a higher concentration of 500µg help to prevent hyperglycemic problem [49]. The α-amylase and α-glucosidase enzyme action were studied using *in-vitro* assay in *C. pictus* leaf using porcine pancreatic α-amylase with starch as a substrate, α-glucosidase inhibitory evaluation using p-nitrophenyl-α-D-Glucopyranoside (PNPG) as substrate fresh aqueous extract exhibited a strong inhibitory effect on α-glucosidase then α-amylase [50]. The study on pepsin enzyme, which shows close resemblance with HIV protease in proteolytic activity, pepsin used as a substitute for HIV protease inhibitory activity, the fresh hydro-alcoholic extract revealed the highest inhibitory activity [50].

**Synthesis of Nano-particles:** The leaf extract of *C. pictus* when mixed with aqueous solution of silver nitrate changed into brown color due to the excitation of surface plasmon vibrations indicated the formation of methanolic extract of *C. pictus* silver nanoparticles (MECPAgNP's) examined under UV visible spectroscopy analysis of nanoparticles showed the broadening of the peak indicated the particles are polydispersed at 420 nm. The average particle size 132-6 nm is polydispersity index 0.2480 and zeta value of 25.1mv with the peak area of 100% intensity. SEM image showed that the silver nanoparticles formed were spherical with an average size of around 100 nm [51].

Comparative study of the *in-vitro* antioxidant activity of methanolic extract of *C. pictus* and its silver nanoparticles (MECPAgNP's) were studied by various methods, DPPH assay, $H_2O_2$ Scavenging activity, phosphor-molybdenum method, FRAP and reducing power assay. Total phenolic content, flavonoid content, vitamin C. The nanoparticle showed as dose-dependent reducing ability showed much better activity than the extract alone. The phenolic, flavonoid and vitamin C amount was higher in MECPAgNP's then in MECP thus *C. pictus* can be used as biologically synthesized nanoparticles rendering more effective, exceptionally stable and also with minimum toxicity and cost-effective [52]. The leaf extracts of *C. pictus* used for the synthesis of bio-compactable ZnO and MgO nanoparticles from the zinc nitrate by green process [54].

**Micropropagation:** *C. pictus* is a medicinally important plant and fast disappearing, threatened species due to tremendous utilization of the leaf

and plant parts for various therapeutic properties. It is a rhizomatous plant due to its poor seed viability; low rate of germination, reproduction is only by vegetative method and production of advantageous propagules. The need of this plant is great demand; thus conversation, and mass production of the same is important. It is reported that the when rhizome explants when cultured on MS medium with different concentration of benzyl adenine and kinetin maximum no of shoots were obtained in 2.5mg/l and kin 1mg/l. High frequency of rooting was obtained in rhizome explants produced shoots on half strength MS with IAA 1.5 mg/l [55].

The nodal explants were treated with MS medium supplemented with 3-4µM BAP+0.2µM NAA and 0.6µM NAA+3µM BAP highest percentage of dormant bud were regenerated. Maximum shoot formation in 0.6µM NAA and 8µM BAP rooted on 1-12µM NAA and 3µM BAP. The maximum number of root found in 8µM NAA and 3µM BAP. The dormancy of the *in-vitro* raised plants was successively done by decapitating and culturing on MS medium with 0.6µM NAA, 7µM BAP and 5-13% sucrose. Rhizome when cultured on half strength MS medium 2-4µM NAA, 32µM BAP, micro rhizome formed in 9% sucrose [56].

Similarly when nodal segments cultured on MS medium with 1-4mg/l BAP +0.1-6mg/l IAA, maximum propagation were observed on 2.7mg/l BAP and 0.2mg/l IAA [57]. It has been reported that when leaves were cultured on MS +2,4-D/KIN 1+0.5mg/l and IAA/BAP 1mg/l produced good callus, at 3% and 6% sucrose and pH 5.5 [58]. Similarly, when leaf and nodal explants produced callus in MS+0.5mg/l IAA and 2.5mg/l BAP. Induction of callus was also noticed by culturing on MS with IAA, KIN leaf callus was obtained MS+0.5 mg IAA +2mg BAP [59]. The Nodal segments when cultured on SH media with 1mg/l BAP +1mg/l IBA+25mg/l AdSO4. Rooting, regenerated of shoots were maximum [60]. Multiple shoots were obtained from stem nodal region when cultured on 1ppm NAA, 4ppm BAP and 10ppm urea, root induction found in 2ppm BAP+1ppm IAA as the best combination for root induction, maximum root length found in 1ppm NAA+4ppm BAP+10ppm urea [61]. The leaf stem nodal and rhizome explants of *C. igneus* when cultured on MS and LS showed maximum callus in BAP 0.4mg/l+KIN 0.2mg/l+NAA 0.1mg/l+ IAA (0.2mg/l)+ IBA (0.2mg/l) shoot regeneration on MS and LS medium with BAP 0.4mg/l+KIN 0.25mg/l+NAA 0.1mg/l+IAA 0.2mg/l [62].

**Molecular Studies:** *C. pictus* plant is well known as insulin plant, and economically important medicinal plant consists of the high value of secondary metabolites, bioactive compounds, and a remarkable number of flowering features. MicroRNA's are a class of short (-21nucleotides) endogenous, non-coding RNA molecule plays a vital role in regulating gene expression. Thus computer-based homology approach to identify conserved miRNA in transcribed sequence assemblies (TSA) of *C. pictus* led us to identify 42 miRNA's of 13 different families in *C. pictus* by PCR assays. Total of 109 potential target genes were identified miRNA's that regulates several metabolic pathways. Total 42 homolog miRNA's of 11 different families, namely miR166, miR394, miR168, miR172, miR169, miR858, miR167, miR5658, miR396, miR444, were observed. This finding helps in finding the growth pattern cellular developmental process, signal transduction, stress response, and ubiquitin-proteosome degradation pathways [63].

The *C. pictus* species is reproduced by vegetative method thus much genetic variation is noticed when rhizomes of 3 different agro-climatic regions of Kerala Thiruvananthapuram, Ernakulam and Kannur studied based on their morphological, biochemical, gas and water vapor exchange and RAPD analysis. There was no significant difference in gas water vapor exchange parameters like net photosynthesis, stomatal conductance, transcription rat, and PSII efficiency measured by chlorophyll fluorescence did not show any marked difference in the respective samples. The RADP analyses using 40 primers and 10 decamers at 3 accessions did not reveal any genetic discrepancies [64].

Similarly when *C. pictus* plant was collected from 15 different geographical regions of India, the RAPD and ISSR markers were selected with 25 RAPD and 20 ISSR primers, it generated 343 loci, 124 were polymorphic average of 4.96 loci/primer, whereas in ISSR primers 177 loci 77 were polymeric, average of 3.85 loci/primer. The

similarity co-efficient ranged from 0.86-0.99, 0.84-0.95 and 0.86-0.96. The dendrogram graphically did not reveal much variation with a low level of divergence. Highest level of polymorphism in ISSR 42.47% and RAPD 35.57% were observed [65].

**CONCLUSION:** Diabetes mellitus is a chronic disorder in recent times becoming a major treat for the human being worldwide; it is caused due to increased production of insulin from pancreas or inefficient utilization of insulin. The body cells losses its ability to utilize the production of glucose in the blood due to hormonal imbalance, in the earlier stages by the pancreatic disorder. Diabetes a complex disease due to the inhibitory action of consumption of carbohydrates, protein, fats, deficiency in secretion and utilization of insulin, due to the destruction of the immune system and reduces the efficiency of the pancreas cells.

There are many secondary metabolites as natural compounds like alkaloids, flavonoids, phenols, saponins, tannin, steroids, terpenoids, *etc*. act as a supplements for treating various therapeutic properties like anti-diabetes, anti-microbial, anti-cancerous, diuretic, anti-helminthic, anti-oxidant, anti-fertility, *etc*. thus plants acts as a novel drug for reduction of hyperglycemic to hypoglycemic condition. Plants act as a good source of medicine in the treatment of various types of diseases, there are many medicinal plants still too identified for their bioactive phyto-constituent, and active metabolites are obtained from plants due to plant-based drugs are more effective cost-effective and possess valuable compounds.

The traditional medicine obtained as a natural product shows very less or no side effects, thus it is believed that plants and plant-based products are very convenient and safe to be used in treating various disorders for mankind. The review on this present study gives a clear idea that *C. pictus* plant is very important medicinal plant grown in South India well grown easily grown as an ornamental plant can be utilized to reduce and maintain the blood glucose level in diabetic patients. Consumption of "a leaf day reduces high blood glucose, presence of bixin compound acts as the precursor for the anti-diabetic property. *Costus pictus* very popularly has known worldwide for its anti-diabetic properties in most of the world as well in India; diabetic patients are increasing tremendously, around 422 million adults were living with diabetes in 2014 when compared to 108 million in 1980. The rate of diabetic patients increased by 4.7% in 1980 to 8.5% in 2014. The diabetes patients are doubled since 1980 form 4.7% to 8.7% as per the survey of the World Health Organization (WHO). Thus, identification of many medicinal plants and study on therapeutic properties identification of bioactive compounds, a modern trend in the ear of science and research development is necessary and further investigation of valuable metabolites in this plant is necessary.

**ACKNOWLEDGEMENT:** The author would like to express her thanks to all facility, Department of Botany, Bangalore University, Bangalore and thanks for Manoj Kumar, GE Health care. UGC commission for Financial grants.

**CONFLICT OF INTEREST:** The authors declare that there is no conflict of interest regarding this review paper.

## REFERENCES:

1. Sabu M: Zingiberaceae and Costaceae of South India. Indian Association of Angiosperm taxonomy, Calicut, India 2006.
2. Elavarasi S and Saravanan K: Ethno botanical study of plants used to treat diabetes by tribal people of Kolli Hills, Namakkal District, Tamil Nadu, Southern India. Int J Pharm Tech Res 2012; 4: 404-11.
3. Kare MA, Mule DA, Paithane VA and Bhuktar AS: *Costus pictus* D. Don ex Lindl new records to flora of Maharashtra, India. International Multidisciplinary Research Journal 2012; 2(12): 21.
4. Murgan and Kalidas C: *Costus pictus* Ex.Lindl (Costaceae) new to Odisha India. J on Biological Reports 2016; 5(2): 99-102.
5. Kress WJ, Prince LM and Williams KJ: The phylogeny and a new classification of the gingers (Zingiberaceae): evidence from molecular data. Am J Bot 2002; 89: 1682-96
6. Larsen K, Lock JM, Maas H and Maas PJM: Zingiberaceae. Flowering plants, Monocotyledons, Springer-Verlag, Berlin, Heidelberg 1998; 474-75.
7. Specht DC: Systematic and evolution of the tropical monocot family Costaceae (Zingiberales): A multiple data set approach; Systematic Botany 2006; 31(1): 89-06.
8. Kay KM, Reeves PA, Olmstead RG and Schemske DW: Rapid speciation and the evolution of hummingbird pollination in Neotropical *Costus* subgenus *Costus* (Costaceae): evidence from nrDNA ITS and ETS sequences. American J of Botany 2005; 92: 1899-10.
9. Specht DC: Gondwanan Vicariance or dispersal in the tropics: the Biogeo graphic History of the tropical monocot family Costaceae (Zingiberales). ALISCO 2006; 22(1), 631-42.

10. Kirchoff BK and Rutishauser R: The phyllotaxy of Costus (Costaceae). Bot Gaz 1990; 151: 88-05.
11. Hegde PK, Rao HA and Rao PN: A review on Insulin plant (*C. igneus* Nak). Pharmacognosy Reviews 2014; 8(15): 67-72. doi: 10.4103/0973-7847.125536.
12. George A, Thankamma A, Rema Devi VK and Fernandez A: Phytochemcial investigation of insulin plant. Asian Journal of Chemistry 2007; 19: 3427-30.
13. Shiny CT, Yadav KS, Yadav NP, Lugman S and Palni LMS: Comparative evaluation of *Costus pictus* D.Don leaf extracts against glucose challenged mice. Annuals of Phytomedicine 2013; 2(2); 57-62.
14. Remya R and Daniel M: Phytochemical and pharma-cognostic investigation of anti-diabetic *Costus pictus* D. Don. Int J Pharm Bio Med Res 2013; 3(1): 30-39.
15. Aruna A, Venkatachalam RN, Bose KP, Jagadeesh S and Lakshmi PKV: Insulin Plant (*Costus pictus*) leaves; Pharmacognostical standardization and phytochemical evaluation. American Journal of Pharmacy and Health Research 2014; 2(8): 107-19.
16. Nayagam JR: Ergastic crystals in identification of *Costus pictus*: An medicinal spiral ginger in Herbal Medicine. J of Exp Biology and Agricultural 2015; 3(4): 378-83.
17. Ashwini S, Sridhar BZ and Clectus: Insulin plant (*Costus pictus*) extracts restores thyroid hormone levels in Experimental Hypothyroidisum. Pharmacognosy Research 2017; 9(1): 51-59.
18. Prakash: Macro-microscopy and TLC Atlas of leaves of *Costus igneus* Nak. J Ayru Med Sci 2016; 1(1): 5-11.
19. Meshram PV, Moregaonkar SD, Gatne MM, Gaikwad RV, Zende RJ, Ingole SD and Vanage GR: Physiochemical and phytochemical screening of aqueous and ethanolic extracts of *Costus pictus* D.Don and *Enicostema litterale* Blum. Chemical Sciences Review 2017; 6(21): 426-34.
20. Manjula K, Rajendran K, Eenera T and Kumaran S: Quantitative estimation of lupeol and stigmasterol in *Costus Igneus* by High Performance Thin Layer Chromatography. Journal of Liquid Chromatography and Related Technologies 2013; 36: 197-12.
21. Nadumane VK, Rajashekar S, Narayana P, Adhinarayana S, Vijayan S and Prakash S: Evaluation of the anticancer potential of *C. pictus* on fibrosarcoma (HT-1080) cell line. J Nat Pharm 2011; 2: 72-76.
22. Veena S, Deokar G and Kshirsaga S: Pharmacognostic investigation, isolation and evaluation of diosgenin from *Costus pictus* D.Don; International Journal of Institutional Pharmacy and Life Sciences 2016; 6(3): 389-04.
23. Raj RS and Augustin A: Oxalic acid and oxalate oxidase enzymes in *Costus pictus* D. Don. Acta Physiol Plant 2012; 34(2): 657-67.
24. Jayasri MA, Mathew L and Radha A: A report on the anti-oxidant activity of leaves and rhizome of *Costus pictus* D. Don. Int J Integre Biol 2008; 5(1): 20-26.
25. Jayasri MA, Gunasekaran S, Radha A and Mathew TL: Antidiabetic effect of *Costus pictus* leaves in normal and streptozotocin- induced diabetes rats. Int J Diabetes and Metabolism 2008; 16: 117-22.
26. Arun Kumar AR, Bastin TM, Jenifer S and Arumugam M: Comparative evaluation of extracts of *C. igneus* (*C. pictus*) for hypoglycemic and hypolipidemic activity in alloxan diabetes rats. Int J Pharm Tech 2010; 2: 182-95.
27. Issac ST and Alphonse JK: Comparative study of hypoglycemic activity of *C. pictus* & *C. igneus* in strepto-zotocin induced diabetic rats. J Phar Res 2011; 4: 3628-29.
28. Narmadha R, Gopalakrishna VK and Devaki K: Hypoglycemic effect of *Costus pictus* D. Don on alloxan induced type 2 diabetes mellitus in albino rats. Asian Pac J Trop Diseases 2012; 2: 117-23.
29. Gireesh G, Thomas SK, Joseph B and Paulose CS: Anti-hyperglycemic and insulin secretory activity of *Costus pictus* leaf extract in streptozotocin induced diabetes rats and in *in-vitro* pancreatic islets of langerhan culture. J Ethno Pharmacology 2009; 123: 470-74.
30. Jayasri MA, Radha and Mathew TL: α –amylase and α-glucosidase inhibitory activity of *Costus pictus* D.Don in the Management of diabetes. J of Herbal Medicine and Toxicology 2009; 3(1): 91-94.
31. Ramu FA and Kumar SR: Scientific evaluation of traditionally known insulin plant *Costus species* for the treatment of diabetes in human. Int J of Current Research in Biosciences and Plant Biology 2016; 3(6): 87-91.
32. Al-Romaiyan A, Jayasri MA, Mathew TL, Hunang GC, Amiel S and Jones PM: *C. pictus* extracts stimulate insulin secretion from mouse and human islets of langerhans. *In-vitro* Cell Physiol Bio Chem 2010; 26: 1051-58.
33. Annadurai: Next generation sequencing and de-nova transcriptome analysis of *Costus pictus* D.Don a non model plant with potent anti-diabetic properties. BMC Genomics 2012; 13: 1-15.
34. Jyotrimoy: Estimation of the anti-proliferative potential of *C. pictus* on Molt-4 human cancer cell lines. Int J of Bio Pharmaceutical and Toxicology Research 2012; 2: 244-50.
35. Reddy LJ and Jose B: Evaluation of antibacterial activity of the leaf essential oil *Costus pictus* D.Don from South India. Int J of Current Pharmaceutical Research 2010; 2(3) 68-70.
36. Sulakshana G and Sabitha Rani A: Standardization of micropropagation form nodal segments of *C. pictus* an anti-diabetic plant. Int J Current Research 2016; 8(8): 36680-84.
37. Sardessai Y, Angle GP, Joshi A, Carvalho S and Bhobe M: Anti-bacterial activity of methanolic extract of the rhizome of *Costus igneus*. 2014; 2(3): 176-85.
38. Dhanasekaran, Akshaya M and Preethi S: *In-vitro* anti-proliferative potential of leaves of *Costus igneus*. International in Engineering and Technology 2014; 4(4): 277-83.
39. Prejeena V, Suresh SN and Varsha V: Phytochemical screening, anti-oxidant analysis and anti-proliferative effect of *Costus pictus*. D.Don leaf extracts. Int J of Recent Advances in Multi-Disciplinary Research 2017; 4(3): 2373-78.
40. Kavitha R: *In-vitro* anti-oxidant studies of *Costus pictus* leaf. J of Research in Pharmaceutical and Bio Medical Sciences 2013; 4(1): 159-64.
41. Prakash S, Elizabeth G, Thottacherry D, Rai S, Nishchal, Nandhini M, Kumarachandra R, Fahim, Natesh and Pallavi LC: Evaluation of anti-oxidant potential of *Costus igneus* in ethanol induced preoxidative damage in albino rats. J of Applied Pharmaceutical Sciences 2014; (08): 52-55.
42. Maruthappan V and Sree KS: Ameliorative effect of *Costus pictus*. D.Don rhizome on mitochondrial enzymes in male albino rats. Int J of Integ Biol 2010; 9(2) 62-66.
43. Suchitra: Comparative phytochemical and anti-oxidant Properties of *C. pictus* and *C. speciosus*. 2017; 2(1): 21-8.
44. Nivedhana YS, Arthi P and Agarwal A: Anti-fertility activity of ethanolic extract of *Costus pictus* rhizome in female rats. Scholar's Journal of Applied Medical Sciences 2017; 5(1A): 62-64.
45. Raj JB and Kalaivani RK: Comparative *in-vitro* evaluation of anthelmintic property of leaves and rhizome of *Costus pictus* D.Don against albendazole. National Journal of

Physiology, Pharmacy & Pharmacology 2016; 6(5): 438-41.
46. Saju Thomas DR and Devi BS: Phytochemical and *in-vitro* anthelmintic studies of hydro alcoholic extract of *Costus pictus* D.Don. Int J of Pharmacy and Pharmaceutical Sciences 2013; 5(3).
47. Comargo MEM, Wajera CR, Torres RS and Alderate MEC: Evaluation of the diuretic effect of the aqueous extract of *Costus pictus* D.Don in rat. Poc West Pharmacol Soc 2006; 49; 72-74.
48. Ashwini S, Bobby Z, Joseph M, Jacob SE and Priya RP: Insulin plant (*Costus pictus*) extract improves insulin sensitivity and ameliorater artherogenic dyslipidaemia in fructose induced Insulin resistant rats. Molecular Mechanism 2015; 745-60.
49. Ranjitha VH, Narayanaswamy M, Krishnaswamy A, Sathyanarayana ML and Upendra HA: Effect of Aqueous extracts of *Costus pictus* & *Solanum nigrum* leaves on blood glucose levels and histo-architecture of pancreatic islets in alloxan-induced diabetic rats. Journal of Cell and Tissue Research 2013; 13(3): 3983-88.
50. Rege AR, Ambaye RY and Chowdhary A: Effect of *C. pictus* D .Don on pepsin enzymes; Int J of Pharmacy and Pharmaceutical Sciences 2014; 6(5): 178-80.
51. Aruna A, Nadine SR, Karthikeyan V, Bose P and Vijayalakshmi K: Comparative *in-vitro* anti-oxidant screening of methanolic extract of *Costus pictus* and its silver nanoparticles. Int J of Pharmaceutical Science and Drug Research 2014; 6(4): 334-40.
52. Aruna A, Nandhini SR, Karthikeyan V and Bose P: Synthesis and Characterization of silver nanoparticles of Insulin Plant (*Costus pictus*. D.Don) leaves. Asian Jof Bio-medical and Pharmaceutical Sciences 2014; 4(34); 1-6.
53. Suresh J, Pradheesh G, Alexamani V, Sundarajan M and Hong SI: Green synthesis and characterization of Zinc oxide nanoparticles using insulin plant (*Costus pictus* D.Don) and investigation of its anti-microbial as well as anticancer activities. Advances in Natural Science, Nanoscience and Nanotechnology 2018; 9(1): 015008.
54. Suresh J, Pradheesh G, Alexamani V, Sundrarajan M and Hong SI: Green synthesis and characterization of hexagonal shaped MgO nanoparticles using insulin plant (*Costus pictus* D. Don) leaves extract and its anti-microbial as well as anticancer activity. Advanced Power Technology 2018; 26(5): 1294-99.
55. Ali B, Ahmed A and Kumar RA: *In-vitro* propagation of monocot *Costus pictus* D. Don an antidiabetic medicinal plant. Jou of Agricultural Technology 2009; 5(2): 361-69.
56. Pani KP and Sharma JG: Micropropagation and micro-rhizome in *Costus pictus* D. Don using *in-vitro* and *ex-vitro* nodal segments as explants. Noctulae Scientia Biologicae. 2012; 4(2): 72-78.
57. Satyanaryan ND, Miriji MS, Anantacharya and Giri SK: Amylase inhibitory activity of *Costus igneus* leaf extract. International Research Journal of Pharmaceutical and Applied Sciences 2015; 5(1): 12-15.
58. Wani SJ, Kageli IA, Tamboli PS, Nirmalkar VS, Patil SN and Sidhu AK: Optimization of MS media for callus and Suspension culture of *Costus pictus*. Int J of Scientific and engineering Research 2014; 5: 390-94.
59. Jadhav A, Vishwanth and Waghwae: Micropropagation studies in Insulin plant *Costus pictus* D.Don. Int J of advanced Research in Computer Sciences and Software Engineering 2015; 5(7): 607-609.
60. Sulakshana G, Rani AS and Saidulu B: Evaluation of anti-bacterial activity in species of *Costus*. Int J Current Microbiology App Sci 2013; 2(10): 26-30.
61. Khan A, Sharma V and Shukla RK: Establishment of multiplication protocol for insulin plant (*Costus pictus* D.Don) by using stem node as explants. International Journal of Bio-technology and Research 2017; 7(1): 11-18.
62. Kunthavai PK, Subramanian B and Kaliaperumal R: Isolation and quantification of flavonoids from ethanol extract of *Costus igneus* rhizome (CiREE) and impact of CiREE on hypoglycemic, electron microscopic studies of the pancreas in streptozotocin STZ induced diabetic rats. Biomedicine and Prevention Nutrition 2013; 3(3): 285-97.
63. Das A, Das P and Kalita MC: Computational identification target prediction and validation of conserved miRNA's in Insulin plant (*Costus pictus* D.Don). Applied Biochemistry Biotechnology 2016; 178: 513-26.
64. Thomas SC and Palani LMS: Taxonomic, molecular and physiological evaluation of *Costus pictus* D. Don plants originally obtained from different parts of Kerala. Journal of Applied and Fundamental Sciences 2016; 2(2): 141-48.
65. Naik A, Parjapat P, Krishnamurthy R and Pathak JM: Assessment of genetic diversity in *Costus pictus* accession based on RAPD and ISSR markers. Biotech 2017; 3(7): 70.

**How to cite this article:**
Devi GMR: A comprehensive review on *Costus pictus* D. Don. Int J Pharm Sci & Res 2019; 10(7): 3187-95. doi: 10.13040/IJPSR.0975-8232.10(7).3187-95.