Phytochemical And Pharmacological Activityof Insulin Plant

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Abstract: Medicinal plant usage is becoming more common in developing nations like South Africa to treat diabetes mellitus. The claims made by traditional healers are being backed by more and more scientificevidence. We rank the anti-diabetic activity and mode of action of the families of previously documented anti- diabetic plants in the Eastern Cape and highlight their therapeutic potentials based on the available data on their pharmacology and toxicity. A thorough literature search of the 45 plants mentioned in ethnobotanical surveys was conducted using the keywords "plant name" and "family" for the primary searches in the electronic databases PubMed, ScienceDirect, Google Scholar, and Elsevier. This helped identify the plants that have been the subject of scientific investigations for their potential to prevent diabetes. After 25 families were found, the most highly reported were Asteraceae, then Asphodelaceae and Alliaceae. A significant number of plants have been investigated for their potential to prevent diabetes, both in vivo and in vitro. The majority of these plants exhibit a greater percentage of insulin release and inhibition of enzymes that break down carbohydrates when compared to insulin mimetic and peripheral glucose uptake. As part of their hypoglycemic action with reduced toxicity, nearly all of the plants under investigation also inhibit oxidative stress. Still lacking, though, is the isolation of their bioactive molecules. This review offers a tool to facilitate comprehensive evaluations of the therapeutic profiles of medicinal plants that are currently available and used in the Eastern Cape, South Africa,to treat diabetes. In order to find new molecules for drug development and discovery, more research isnecessary. One such study that needs to be done is identifying the active ingredients of powerful plants. Diabetes mellitus is a collective term for a range of metabolic diseases that affect a large portion of the global population. The primary feature is persistent hyperglycemia, which is caused by deficiencies in either insulin secretion or insulin action.

Keywords: Ethnopharmacology, diabetes, medicinal plants, diabetes mellitus, anti-diabetics,hyperglycemia.

I. INTRODUCTION

When the body is unable to regulate the metabolism of glucose, the main energy source, it results in diabetes mellitus, a disease marked by elevated blood sugar levels. A relative or absolute insulin deficiency or resistance to the hormone's action at the cellular level are the two reasons for the inappropriate hyperglycemia that characterizes this clinical syndrome.[1]This can occur as a result of an auto-immune reaction in which the immune system accidentally targets and destroys the pancreatic beta cells, resulting in type I diabetes (insufficient insulin availability to control blood glucose levels) or type II diabetes (cells become insensitive toor resistant to the action of insulin). The blood and urine contain higher concentrations of glucose when endogenously synthesised insulin is insufficient or less effective. Advanced diabetes mellitus influences additional lipid metabolic pathways and presents as hyperlipidemia and hypercholesterolemia, both of which are atherosclerosis risk factors.[2-4] Diabetes patients who have poorly controlled diabetes may develop numerous complications that lead to morbidity or death, including peripheral vascular disease, retinopathy, cerebrovascular disease, neuropathy, and nephropathy.[5] Additionally, there is a rise in the concentration of advanced glycation end products (AGEs), which contributes to the development of secondary complications including foot ulcers and impaired wound healing. [6–7] Uncertainty still exists regarding the precise causes of insulin resistance. One of the possible risk factors is increased intramuscular fat and fatty acid metabolites. Insulin resistance has been attributed primarily to excess body weight. Excess free fatty acids leading to ectopic lipid deposition and immune-mediated inflammatory changes have been proposed as the causes of IR in myocytes. The liver receives excess glucose due to disruptions in the muscles' glucose uptake process, which raises lipogenesis and the amount of free fatty acids in circulation. Elevated free fatty acid levels worsen insulin resistance. In addition, genetic disorders such as myotonic dystrophy, Werner syndrome, Rabson-Mendenhall syndrome, and irregularities in the function of insulin receptors and antibodies can also lead to insulin resistance. The hyperinsulinemic-euglycemic clamp is the gold standard for identifying insulin resistance. This technique entails a fast-paced, continuous insulin infusion to prevent the liver from producing glucose. To lowerblood glucose levels in the euglycemic range, 20% dextrose solution is simultaneously given at various rates. Throughout the test, blood glucose is regularly checked. In order to compensate for hyperinsulinemia, the amount of exogenous glucose excreted is reflected in the amount of glucose needed to achieve normoglycemia. Indexes are used to quantify IR instead of this labor-intensive and expensive method. HOMA-IR, or the homeostatic model assessment for insulin resistance, is the widely used technique. It is computed by taking the product of the fasting insulin and fasting glucose levels, and dividing the result by 22.5. [8-10]

Lifestyle modifications should be the mainstay of non-pharmacological treatment for insulin resistance. Dietary adjustments should include a change in eating patterns, a decrease in energy intake (for overweight individuals), and a steer clear of high-glycaemic index and high-glycaemic load carbohydrates, which excessively stimulate insulin secretion. Muscle insulin sensitivity increases with regular exercise.[11, 9, 12, 4]

Morphology of the plant

The tropical perennial plant Costus igneus belongs to the Costaceae family. It has simple, entire, alternating, oblong, 4–8-inch-long evergreen leaves with a parallel venation system. Large, soft, dark green leaves with lightpurple undersides are spirally bound around the tree's stems to form visually appealing, arching clumps that emerge from subterranean rootstocks. It can reach a maximum height of 60 cm, with the tallest stems collapsing to the ground. Gorgeous orange flowers with a diameter of 2.5–12.5 cm, which are produced on hot days, appearon cone-shaped heads at the tips of branches. Stem cutting is the method used to propagate insulin plants. Spiral flag, Insulin plant, Fiery Costus, Step ladder, and spiral ginger are some common names.[13-15]

Fig.No.1: Insulin Plant.[16]

Regional Names of Insulin Plant

Bengali	Piasal
Hindi	Banda, Bija-sal, Peisar, JARUL, Keukand
Kannada	Kempu hone
Malayalam	Honne, Karintakara , Vengai
Venna	maram
Marathi	Honi, Pushkarmula
Odisha	Vengis
Sanskrit	Asana, Bandhukapushpa
Tamil	Neyccarikamaram,
Venkai	c-ciray, Kostam
Telugu	Peddavesiga, Yeangesha
Urdu	Bijasar, Dam al akhwain
Gujarati	Pakarmula
English	Banaba.

Taxonomy

Botanical name	Chemoecostus cuspidatus (Nees & Mart.) C.D. Spech & D.W.Stev. (Costaceae)
Domain	Eukaryota
Kingdom	Plantae
Subkingdom	Viridaeplantae
Phylum	Tracheophyta
Subphylum	Euphyllophytina
Infraphylum	Radiatopses
Class	Liliopsida
Subclass	Commelinidae
Superorder	Zingiberanae
Order	Zingiberales
Family	Costaceae
Subfamily	Asteroideae
Tribe	Coreopsideae
Genus	Chamaecostus
Specific epithet	Cuspidate

Medicinal Uses[16]Leaves

The leaves of the insulin plants must be chewed by the diabetic patients for a month. Meaning that for a week, the patient must take two leaves of absence, one in the morning and one in the evening. Make sure the leaves are thoroughly chewed before consuming. After a week, the patient is to take one leaf in the morning and one in the evening. For thirty days, this dosage should be kept up. This is advised by allopathic physicians as well, and it has been proven to be successful in fully controlling blood sugar levels. "A leaf a day keeps diabetes away" isthe insulin plant's tagline.

Rhizome

The plant known as insulin is said to have a rhizome that is bitter, astringent, acrid, cooling, aphrodisiac, purgative, anthelmintic, depurative, febrifuge, expectorant, and beneficial for skin conditions, fever, inflammations, bronchitis, leprosy, constipation, and burning sensations.

Growth and propagation

Spiral flag can grow in either direct sunlight or some shade. It is frequently planted close to water and requires rich soil and lots of moisture. Plants can be propagated by splitting clumps, taking cuttings, or splitting off offsets, or plantlets, that develop beneath the flower heads. Nematodes and mites can be problematic, particularly in light, sandy soil. There are no serious diseases that affect the plant.[17]

Microscopic Character

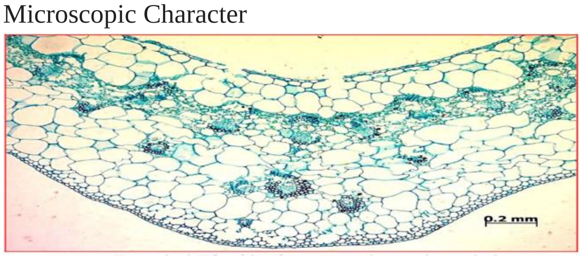
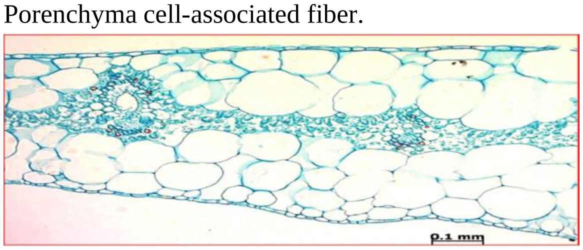


Fig.No.2: TS of leaf passing of leaf passing through lamina.[18]

Mesophyll cells with calcium oxalate crystals. An anomocytic stomata-adorned epidermis.
Porenchyma cell-associated fiber.



II.PHYTOCHEMICAL STUDY

Following a series of screenings for phytochemicals, the leaves of C. igneus were found to be high in protein, iron, and antioxidant elements like flavonoids, terpinoids, α-tocopherol, β-carotene, and ascorbic acid.[19-20] The greatest concentration of phytochemicals, including proteins, carbohydrates, triterpenoids, alkaloids, tannins, saponins, and flavonoids, was discovered in methanolic extract, according to a related study.[21] According to a preliminary phytochemical analysis, 21.2% of the leaves of the insulin plant (C. pictus) are made of fiber. 5.2% extractives in petroleum ether, 1.06% in cyclohexane, 1.33% in acetone, and 2.95% in ethanol were obtained from successive extractions. Steroids were found in every extract after a series of extracts were analyzed. There were alkaloids in the ethanol extract as well. Apart from α-tocopherol and ergastanol, a steroid, the main constituent of the ether fraction was bis (2'-ethylhexyl)-1,2-benzenedicarboxylate (59.04%).[22] Stem revealed the presence of the steroid compound stigmasterol and the terpenoid compound lupeol.[23] The rhizome of C. igneus yielded the bioactive compounds quercetin and diosgenin, a steroidal sapogenin.[24] The elements K, Ca, Cr, Mn, Cu, and Zn are present in significant amounts in the leaves and rhizomes of C. pictus, according to trace elemental analysis.[25]

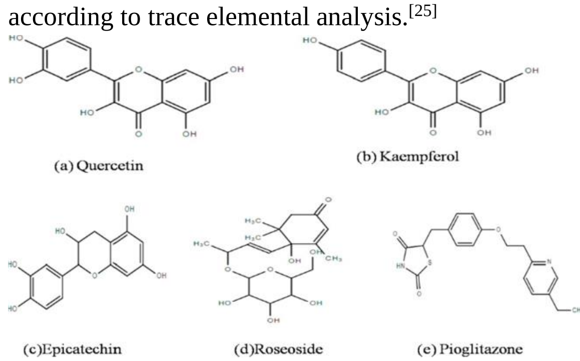


Fig.N.3: 2D Structures of the Ligands.[26]

III. PHARMACOLOGICAL ACTIVITY

Hypolipidemic activity

A comparative analysis of the methanolic and aqueous extracts of C. igneus in rats with diabetes-induced hyperlipidemia was conducted. The study found that the hyperlipidemia brought on by diabetes was reversed by methanolic and aqueous extracts at a dose of 200 mg/kg body weight.[27] In rats treated with triton-induced hyperlipidemia, an alcoholic extract of C. igneus at a dose of 400 mg/kg (p.o.) dramatically reduced the levels ofserum cholesterol, triglycerides, and LDL. Reference. [28]

Antimicrobial Effect

Maximum antibacterial activity against gram-negative strains of Salmonella typhimurium, Pseudomonas aeruginosa, Escherichia coli, Enterobacter aerogenes, and Pseudomonas cerus, Bacillus megaterium, Micrococcus leuteus, Staphylococcus aureus, and Streptococcus lactis was demonstrated by the methanolic extract of C. igneus.[29-30] Of the different parts of C. pictus that were extracted, the stem and flower extracts showed the greatest inhibitory activity at 150 µg/ml on the growth of the microbes that were tested, namely Shigella flexneri, Klebsiella pneumonia, Bacillus subtilis, and Escherichia coli.[28-29] Staphylococcus aureus, Eschericia coli, and Candida albicans were all susceptible to the moderately potent antibacterial and antifungal properties of the isolated compound from the ethanolic extract of Costus igneus.[31-32]

Anti-cancerous Effect

It was discovered that in vitro mammalian fibrosarcoma (HT-1080) cells could be treated against cancer and proliferative disorders by the ethanolic extract of C. pictus leaves. In tests using HT 29 and A549 cells, all bark extracts demonstrated strong anti-cancer effects. The cytotoxicity activities of crude ethanolic extracts from C. cuspidatus and C. subsessilis, as well as six fractions, were assessed in this study using a panel of six human cancer cell lineages (HL60, Jurkat, MDA-MB231, MCF-7, HCT, THP-1). An apoptotic process mediated the cytotoxic effects in the HL60, Jurkat, and THP-1 taxa.[33-36]

Anti-Diabetic Effects

In south Indian gardens, costus igneus is a popular ornamental plant and a historically used medicinal plant. The component that has the greatest antidiabetic effect is the leaf.[37-38] It lowers blood glucose levels after meals and during fasting. However, the precise mode of action for the anti-diabetic effect is still unknown.[39] Insulin plant not only has antidiabetic properties, but it also lowers the complications linked to diabetes; it lowers the level of glycosylated hemoglobin, corrects the lipid profile, raises body weight and insulin levels, and exhibits a significant improvement in the histopathological examination.[40-42]

Antioxidant

Models such as DPPH, β-carotene, Deoxyribose, superoxide anion, reducing power, and metal chelating assay were used to evaluate the antioxidant activities of leaves and rhizomes in extracts of methanol, aqueous, ethanol, and ethyl acetate at varying concentrations. In comparison to standard BHT (Butylated Hydroxy Toulene) (85%), the leaves and rhizomes of C. pictus exhibited good antioxidant activity, measuring approximately 89.5% and 90.0% at a concentration of 400 µg/ml. Comparing the results, it was found that the methanolic extracts of C. pictus leaves and rhizomes had greater antioxidant activity than other extracts.[43] In vitro antioxidant activity against oxidative protein damage is demonstrated by methanolic extracts of the flower and stem of C. pictus. The results of the study made it clear that antioxidants and polyphenols not only scavenge free radicals but also prevent their creation.[44-45]

Toxicity study

According to acute toxicity studies, all of the animals survived the test period and there was no effect on theirgeneral behavior after receiving 1 g/kg b.w./day of aqueous extract for 30 days.[46]

However, results of a study on C. igneus's methanolic extract showed toxicity at 250 mg/kg body weight.[47]

Additionally, in a different study, it was discovered that the primary constituent of C. Pictus's stem, leaf, and rhizome oils was palmitic acid. It was discovered that palmitic acid increases the ratio of LDL to HDL cholesterol, causes myofibrils to degenerate in healthy adult rat cardiomyocytes, and is a key precursor to thedevelopment of coronary heart disease. Thus, it is not advised to treat diabetes by continuously using C. pictusleaves as this could result in major cardiac conditions.[44,30]

IV.CONCLUSION

The plant Chamaecostus cuspidatus is used to treat diabetes without any negative effects.In diabetic patients, the leaves' potential anti-diabetic properties are presently being investigated. New avenues for clinical research are made possible by studies that highlight its involvement in a number of diseases.In order to create a variety of low-cost anti-diabetic medications, it will be necessary to conduct investigations into the mechanisms of action of the compounds and standardize herbal drugs using models. It is therefore preferable to employ medicinal plants rather than traditional medicine for treatment.

REFERENCE

[1] Wadkar KA, Magdum CS, Patil SS, Naikwade NS. Antidiabetic potential and Indian medicinal plants. Journal of herbal medicine and toxicology. 2008;2(1):45-50.

[2] Krishnakumar K, Augusti KT, Vijaymmal PL. Hypoglycaemic and anti-oxidant activity of Salacia oblonga Wall. Extract in Streptezotocin-induced diabetic rats. Indian journal of physiology and pharmacology. 1999 Oct 1;43:510-4.

[3] Ross R. Atherosclerosis—an inflammatory disease. New England journal of medicine. 1999 Jan 14;340(2):115-26.

[4] Schwartz, S.L. Diabetes and dyslipidaemia. Diabetes Obes. Metab. 2006, 8, 355–364.

[5] Khavandi K, Amer H, Ibrahim B, Brownrigg J. Strategies for preventing type 2 diabetes: an update for clinicians. Therapeutic advances in chronic disease. 2013 Sep;4(5):242-61.

[6] Kumar P, Clark ML. Kumar and Clark's clinical medicine E-Book. Elsevier health sciences; 2012 Jun 4.

[7] Ge K, Niu YW, Xie T, Lin WD, Tian M, Xu B, Cui ST, Lu SL. Influence of advanced glycosylation end products on wound healing of burn rats with diabetes. Zhonghua Shao Shang za zhi= Zhonghua Shaoshang Zazhi= Chinese Journal of Burns. 2009 Dec 1;25(6):433-6.

[8] Brown AE, Walker M. Genetics of insulin resistance and the metabolic syndrome. Current cardiology reports. 2016 Aug;18:1-8.

[9] Castro L, Brant L, Diniz MD, Lotufo P, Bensenor IJ, Chor D, Griep R, Barreto SM, Ribeiro AL. Association of hypertension and insulin resistance in individuals free of diabetes in the ELSA- Brasil cohort. Scientific Reports. 2023 Jun 10;13(1):9456.

[10] Pacini, G.; Mari, A. Methods for Clinical Assessment of Insulin Sensitivity and Beta-Cell Function. Best Pract. Res. Clin. Endocrinol. Metab. 2003, 17, 305–322.

[11] Wilcox, G. Insulin and Insulin Resistance. Clin. Biochem. Rev. 2005, 26, 19–39.

[12] Gołąbek, K.; Regulska-Ilow, B. Dietary Support in Insulin Resistance: An Overview of Current Scientific Reports. Adv. Clin. Exp. Med. 2019, 28, 1577–1585.

[13] Jose B, Reddy LJ. Analysis of the essential oils of the stems, leaves and rhizomes of the medicinal plant Costus pictus from southern India. International journal of pharmacy and pharmaceutical sciences. 2010 May;2(2):100-1.

[14] Urooj A. Nutrient profile and antioxidant components of Costus speciosus Sm. and Costus igneus Nak.

[15] Prakash HA, Hegde L, Kumar S, Rao NP. Macro-microscopy and TLC atlas of leaves of Costus igneus Nak. Journal of Ayurveda Medical Sciences. 2016;1:5-11.

[16] Mathew F, Varghese B. A review on medicinal exploration of Costus igneus: the insulin plant. Int J Pharm Sci Rev Res. 2019 Jan;54(2):51-7.

[17] Hegde PK, Rao HA, Rao PN. A review on Insulin plant (Costus igneus Nak). Pharmacognosy reviews. 2014 Jan;8(15):67.

[18] Prakash HA, Hegde L, Kumar S, Rao NP. Macro-microscopy and TLC atlas of leaves of Costus igneus Nak. Journal of Ayurveda Medical Sciences. 2016;1:5-11.

[19] Jothivel N, Ponnusamy SP, Appachi M, Singaravel S, Rasilingam D, Deivasigamani K, Thangavel S. Anti-diabetic activity of methanol leaf extract of Costus pictus D. Don in alloxan-induced diabetic rats. Journal of Health Science. 2007;53(6):655-63.

[20] Urooj A. Nutrient profile and antioxidant components of Costus speciosus Sm. and Costus igneus Nak.

[21] Shankarappa L, Gopalakrishna B, Jagadish NR, Siddalingappa GS. Pharmacognostic and phytochemical analysis of Costus ignitius. Internationale Pharmaceutica Sciencia. 2011;1(2):36- 41.

[22] Jothivel N, Ponnusamy SP, Appachi M, Singaravel S, Rasilingam D, Deivasigamani K, Thangavel S. Anti-diabetic activity of methanol

leaf extract of Costus pictus D. Don in alloxan-induced diabetic rats. Journal of Health Science. 2007;53(6):655-63.

[23] George A, Thankamma A, Devi VR, Fernandez A. Phytochemical investigation of Insulin plant (Costus pictus). Asian Journal of Chemistry. 2007 Jul 1;19(5):3427.

[24] Manjula K, Pazhanichamy K, Kumaran S, Eevera T, Dale Keefe C, Rajendran K. Growth characterization of calcium oxalate monohydrate crystals influenced by Costus igneus aqueous stem extract. Int J Pharm Pharm Sci. 2012;4(Suppl 1):261-70.

[25] Kalailingam P, Sekar AD, Samuel JS, Gandhirajan P, Govindaraju Y, Kesavan M, Kaliaperumal R, Tamilmani E. The efficacy of Costus igneus rhizome on carbohydrate metabolic, hepatoproductive and antioxidative enzymes in streptozotocin-induced diabetic rats. Journal of Health Science. 2011;57(1):37-46.

[26] Reddy Peasari J, sri Motamarry S, Varma KS, Anitha P, Potti RB. Chromatographic analysis of phytochemicals in Costus igneus and computational studies of flavonoids. Informatics in MedicineUnlocked. 2018 Jan 1;13:34-40.

[27] Panagal M, Kumar RA, Bastin TJ, Jenifer S, Muthuvel A. Comparative evaluation of extracts of C.igneus (or C. pictus) for hypoglycemic and hypolipidemic activity in alloxan diabetic rats. International Journal of Pharmacy and Technology. 2010;2(1):183-95.

[28] Majumdar M, Parihar PS. Antibacterial, antioxidant and antiglycation potential of Costus pictus from Southern region, India. Asian Journal of Plant Science & Research. 2011.

[29] Gothandam KM, Aishwarya R, Karthikeyan S. Preliminary screening of antimicrobial properties of few medicinal plants. Journal of phytology. 2010 Jul 21;2(4).

[30] Wagh HM, Sonwane N, Suryawanshi A, Mairal PB. The Review on Insulin Plant: A Plant of Ayurvedic Used (Costus Igneus Plant). IJFMR-International Journal For Multidisciplinary Research.;4(6).

[31] Majumdar M, Parihar PS. Antibacterial, antioxidant and antiglycation potential of Costus pictus from Southern region, India. Asian Journal of Plant Science & Research. 2011.

[32] Saraswathi R, Lokesh U, Venkatakrishnan R, Meera R, Devi P. Isolation and biological evaluation of steroid from stem of Costus igneus. Journal of Chemical and Pharmaceutical Research. 2010;2(5):444-8.

[33] Hegde PK, Rao HA, Rao PN. A review on Insulin plant (Costus igneus Nak). Pharmacognosy reviews. 2014 Jan;8(15):67.

[34] Nadumane V, Rajashekar S, Narayana P, Adinarayana S, Vijayan S, Prakash S, Sharma S. Evaluation of the anticancer potential of Costus pictus on fibrosarcoma (HT-1080) cell line. Journal of Natural Pharmaceuticals. 2011 Apr 1;2(2):72-.

[35] Sathuvan M, Vignesh A, Thangam R, Palani P, Rengasamy R, Murugesan K. In vitro antioxidant and anticancer potential of bark of costus pictus D. Don. Asian Pacific Journal of Tropical Biomedicine. 2012 Feb 1;2(2):S741-9.

[36] Siqueira Filho EP, Zani CL, Nogueira AC, Nelson DL, Souza-Fagundes EM, Cota BB. Chamaecostus subsessilis and Chamaecostus cuspidatus (Nees & Mart) C. Specht and DW Stev as Potential Sources of Anticancer Agents.

[37] Pharmacognosy N. Volume 2 Pharmacognosy, Nanomedicine, and Contemporary Issues.

[38] Shetty AJ, Parampalli SM, Bhandarkar R, Kotian S. Effect of the insulin plant (Costus igneus) leaves on blood glucose levels in diabetic patients: A cross sectional study. Journal of Clinical and Diagnostic Research. 2010 Dec 17;4(3):2617-21.

[39] Pareek A. Negative regulation of glucose uptake by Costus pictus in L6 myotube cell line. Journal of Pharmaceutical Negative Results. 2010 Jan 7;1(1):24-6.

[40] Rupeshkumar M, Kavitha K, Haldar PK. Role of herbal plants in the diabetes mellitus therapy: An overview. Int J Appl Pharm. 2014;6(3):1-3.

[41] Paulose CS. Neurotransmitters Receptor Subtypes Functional Regulation and Diseases: Antidiabetic and Antiepileptic Properties of Herbal Medicines. Ann Natl Acad Med Sci (India). 2009;45(3):195-219.

[42] Panagal M, Kumar RA, Bastin TJ, Jenifer S, Muthuvel A. Comparative evaluation of extracts of C.igneus (or C. pictus) for hypoglycemic and hypolipidemic activity in alloxan diabetic rats. International Journal of Pharmacy and Technology. 2010;2(1):183-95.

[43] Urooj A. Hypoglycemic potential of Morus indica. L and Costus igneus. Nak.—a preliminary study. Ponnanikajamideen M, Rajeshkumar S, Annadurai G. In vivo antidiabetic and in vitro antioxidant and antimicrobial activity of aqueous leaves extract of Chamaecostus cuspidatus. Research Journal of Pharmacy and Technology. 2016;9(8):1204-10.