



EFFECT OF AN INDIGENOUS HERBAL FORMULA IN THE MANAGEMENT OF DIABETES MELLITUS; A CRITICAL ANALYSIS

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Abstract: Indigenous system of medicine in Sri Lanka, consist with strong literature evidence and outstanding clinical practice from generation to generation since thousands of years. Most of exceptional information on indigenous system of medical approaches in Sri Lanka were written over ola leave manuscripts. The current study was based on a critical analysis on an indigenous herbal formula that widely used in the management of diabetes mellitus in Sri Lanka. The manuscript is inherited to a tradition of indigenous medicine and granted it from generation to generation. The formula consisted with *Aponogeton crispus*, *Sida cordifolia*, *Syzygium cumini*, *Musa paradisiaca*, *Curcuma Longa* and *Coscinium fenestratum*. antidiabetic, hypoglycemic and hyperglycemic effects including other pharmacological activities were studied. The study revealed that all the ingredients of the formula is highly responsible in management of diabetes mellitus due to antidiabetic and hypoglycemic effects of the ingredients. Similarly, all the ingredients were found having exceptional pharmacological properties which is beneficial in management of various diseases.

Index Terms - Indigenous medicine, herbal formula, diabetes mellitus, hyperglycemic.

I. INTRODUCTION

Diabetes mellitus is known as a serious, chronic disease characterized by chronic hyperglycemia due to insufficient functions of insulin that occurs with malfunction of the pancreas likely insufficient production of insulin (insulin deficiency) or insulin resistance leading to abnormalities in almost the entire metabolic system, including carbohydrate, lipid and protein metabolism [1].

Diabetes mellitus is related with an extensive array of clinical features basis of the status of metabolic disorder [2]. The long-term persistence of metabolic disorders leading to susceptible complications and also foster arteriosclerosis leading to substantial morbidity and mortality [3]. As long-term effects or chronic complications of diabetes mellitus include risk of cardiovascular diseases, renal diseases, leading to visual impairments, and risk of limb amputations [4].

In diabetes mellitus, it is requiring effective lifelong medical care for prevention of complications. The optimal control of serum glucose level is highly effective in significant decrease in the development of complications. Management of diabetes mellitus requires the combination of treatment and prevention [5].

In Sri Lanka, Traditional and Ayurvedic physicians treat diabetes mellitus very effectively using various parts of several herbs: flowers (*Butea monospema*), leaves (*Adhathoda vasica*), fruits (*Momordica dioica*), seeds (*Syzygium cumini*), stems (*Tinospora cordifolia*), stem bark (*Ficus religiosa*), root bark (*Salacia reticulate*) roots (*Oryza sativa*), aerial roots (*Ficus benghalensis*), rhizome (*Alpinia galanga*) bulb (*Allium sativum*), creeper (*Passiflora foetida*) and entire plant (*Scoparia dulcis*). Similarly, some of plants contain hyperglycemic properties such as *Cyperus rotundus* and *Aloe vera* are useful in minimize drastic hypoglycaemic complications as usually evident with allopathic drugs. In addition, patients are recommended to consume antidiabetic herbs as food or drinks: as chyme (*Osbeckia octandra*), curries (*Lassia spinos*), salads (*Centella asiatica*), spices (*Trigonella foenum-graecu*), fresh fruits (*Phyllanthus embelica*), or as a drink (*Camellia sinesis*). About one hundred and twenty-six plants belonging to fifty-one families are used to treat diabetic patients in Sri Lanka [6].

In indigenous system of medicine in Sri Lanka consist with strong literature evidence that granted since ancient era. Most of indigenous medical literature were written over ola leaves and those manuscripts were still used as a hub of knowledge. The current study based on an indigenous medicinal formula that widely used in diabetes in Sri Lanka that written over a ola leaf manuscript.

The study critically analyzed the pharmacological activities of the ingredients in selected formula in the management of diabetes mellitus.

Selected Ola Leaves Manuscript

The manuscript was written by Mohandiram Ralahami who was traditional Ayurveda medical practitioner, born in 1872. And it was granted by Dr. U. A. Algama. This manuscript consists 300 pages and 18 cm long, width is 5cm. It includes multiple medical formulas which are related to various kind of diseases. Among those formulas the following herbal formulation (Table 1) decoction was selected to treat diabetes mellitus.

Table 1: Herbal formulation

Scientific name	Family name	Sinhala name	Sanskrit name	Part of use
<i>Aponogeton crispus</i>	Aponogetonaceae	Kekatiya	Ambuvallika	Tuber
<i>Sida cordifolia</i>	Malvaceae	Babila	Bala	Root
<i>Syzygium cumini</i>	Myrtaceae	Madan	Jambu	Bark
<i>Musa paradisiaca</i>	Scitamineae	Alu Kesel	Kadali	Alukesel Muha
<i>Curcuma Longa</i>	Zingiberaceae	Viyali Kaha	Nisha	Rhizomes
<i>Coscinium fenestratum</i>	Menispermaceae	Venival Gata	Daru Haridra	Whole Plant

II. PHARMACOLOGICAL REVIEW

Aponogeton crispus – Kekatiya (tubers)

Leaves of *A. crispus* grow up to 20 inches long. Leaf edges are rippled and extremely wavy. Single-spiked flowers are white, self-fertile and easy to propagate. Leaves of *A. crispus* grow up to 20 inches long. Leaf edges are rippled and extremely wavy. Single-spiked flowers are white, self-fertile and easy to propagate [7].

The phytochemical constituents of the *Aponogeton* species were found to be comprised of various polyphenolic compounds flavonoids, flavones alkaloids, tannin, saponin, sesquiterpene and glycosides [7].

The plant consists with an antioxidant activity which has always been acknowledged as a powerful source of natural antioxidants from an ancient period of times. In Asia, many of the indigenous aquatic plants of the genus *Aponogeton* are extensively used in traditional medicine and various research works were done to investigate the bioactivity and phytochemical constituents. Tubers and whole plants of *Aponogeton crispus* is used for treatments of burning sensation of the body, wounds, heart disease, excessive thirst, nausea and diabetes mellitus. The herb effective in reduction of aggravated pitha dosha and increases vatha and kapha dosha and improves vision [7].

Anti- diabetes action among *Aponogeton* species *A. appendiculatus*, *A. natans*, *A. crispus* possesses antidiabetic property [8-10]. A literature review revealed that *Aponogeton natans* Linn. leaf extracts can be used as an antidiabetic agent. This activity was experimented by Oral Glucose Tolerance Test in alloxan-induced diabetic rats [7].

Sida cordifolia – babila (roots)

Sida cordifolia is a small, erect, downy shrub. Leaves of the plant are cordate-oblong or ovate oblong and fruits with a pair of awns each carpel. Root of the plant which constitute a drug are 5-15 cm long with few lateral roots of smaller size. The tap roots are generally branched at the tip [11].

Phytochemical constitutions of the plant has been found as Ephedrine, Pseudoephedrine, Sterculic, malvalic and coronaric acid, Fatty acids, Saponine, Betaphenethylamine, Hypaphorine, Ecdysterone, Indole alkaloids, Palmitic, stearic and β – sitosterol [11].

In the Ayurvedic system of medicine, it is used as antirheumatic, analgesic, antipyretic, antiasthmatic, nasal anticongestant, antiviral, laxative, diuretic, aphrodisiac, hypoglycemic, hepatoprotective and in the treatment of Parkinson's disease. Bala, is used to treat bronchial asthma, cold and flu, chills, lack of perspiration, headache, nasal congestion, aching joints and bones, cough and wheezing, and edema. The root infusion is given in nervous and urinary diseases and also in disorders of the blood and bile. *Sida cordifolia* has been reported to possess analgesic, anti-inflammatory and hypoglycemic activities as well as hepatoprotective activity. Traditionally, the plant *Sida cordifolia* (linn) syn has been used as central nervous system depressant, loose fat, analgesics, anti-inflammatory, hypotensive, and hepatoprotective agent. Presence of ephedrine has highlighted the utility of this plant. Various pharmacological preparation of this plant has been widely used in asthma diseases, overweight, obesity and as an energy booster, Similarly, used for management of pain, swellings, and heart diseases [12].

This plant has Antidiabetic activity. Kanth and Diwan was studied hypoglycemic, analgesic and anti-inflammatory activities with aerial and roots of *Sida cordifolia* extracts. Mahrukh Ahmad was evaluated hypoglycemic, anti-hyperlipidemia and antioxidant potential of alcoholic extract of *Sida cordifolia* at a dose of (200 and 400 mg/kg) in streptozotocin- induced diabetes rats at the dose of 55 mg/kg. At a dose of 400 mg/kg *Sida cordifolia* extracts showed significant reduction of the blood glucose level in diabetic rats and there was a decrease in total cholesterol, triglycerides, low density lipid, plasma-creatinine, plasma-urea nitrogen. There was a significant increase in antioxidant enzymes such as catalase and superoxide-dismutase activity were observed [13].

***Syzygium cumini* – Madan (bark)**

Syzygium cumini is a large evergreen and densely foliaceous tree with greyish-brown thick bark, exfoliating in woody scales. The wood is whitish, close grained and durable; affords brown dyes and a kind of a gum *Kino*. The leaves are leathery, oblong-ovate to elliptic or obovate-elliptic with 6 to 12 centimeters long, the tip being broad and less acuminate. Flowers are scented, greenish-white, in clusters of just a few or 10 to 40 and are round or oblong in shape and found in dichotomous paniculate cymes. The fruits are berries and are often obviously oblong, 1.5 to 3.5 centimeters long, dark-purple or nearly black, luscious, fleshy, and edible; it contains a single large seed. The plant produces small purple plums, which have a very sweet flavor, turning slightly astringent on the edges of the pulp as the fruit becomes mature [14].

The roots are rich in flavonoid glycosides and isorhamnetin 3-O-rutinoside. The leaves are rich in acylated flavonol glycosides, quercetin, myricetin, myricitin, myricetin 3-O-4-Acetyl-L-rhamnopyranoside, triterpenoids, esterase, galloyl carboxylase, and tannin. The stem bark is rich in betulinic acid, friedelin, epi-friedelanol, β -sitosterol, eugenin and fatty acid ester of epi-friedelanol, β -sitosterol, quercetin kaempferol, myricetin, gallic acid and ellagic acid, bergenins, flavonoids and tannins. The presence of gallo- and ellagi-tannins. The fruits are rich in raffinose, glucose, fructose, citric acid, mallic acid, gallic acid, anthocyanins; delphinidin-3-gentiobioside, malvidin-3-laminaribioside, petunidin-3-gentiobioside, cyanidin diglycoside, petunidin and malvidin. The sourness of fruits may be due to presence of gallic acid [14].

All parts of the plant can be used medicinally including cough, diabetes, dysentery, inflammation and ringworm. Similarly, different parts of the plant have been used in the treatment of diabetes, blisters in mouth, cancer, colic, diarrhea, digestive complaints, dysentery, piles, pimples and stomachache. The bark is acrid, sweet, digestive, astringent to the bowels, anthelmintic and used for the treatment of sore throat, bronchitis, asthma, thirst, biliousness, dysentery and ulcers. It is also a good blood purifier. The fruit is acrid, sweet, cooling and astringent to the bowels and alleviate halitosis, biliousness, stomachic, astringent, diuretic and antidiabetic properties are available [14].

In the early 1960s to 1970s, some preliminary reports on the antidiabetic activity of different parts of the plant in diabetic animals were reported. It is widely distributed throughout India and Indian folk medicine that has been mentioned its uses for the treatment of diabetes mellitus. Various traditional practitioners in India use the different parts of the plant in the treatment of diabetes [14].

***Musa paradisiaca* – Alukesel (Alukesel muha)**

Musa paradisiaca is an herbaceous plant up to 9 m long with a robust treelike pseudo stem, a crown of large elongated oval deep-green leaves (up to 365 cm in length and 61 cm in width), with a prominent midrib, each plant produces a single inflorescence like drooping spike, and large bracts opening in succession, ovate, 15-20 cm long, concave, dark red in color and somewhat fleshy. Fruits are oblong, fleshy, 5-7cm long in wild form and longer in the cultivated varieties. *Musa sapientum* is a treelike perennial herb that grows 5 - 9 m in height, with tuberous rhizome, hard, long pseudo stem. The inflorescence is big with a reddish-brown bract and is eaten as vegetables. The ripe fruits are sweet, juicy and full of seeds and the peel is thicker than other banana [15].

Phytochemical constitution has been found consisting Catecholamines such as norepinephrine, serotonin, dopamine, tryptophan, indole compounds, pectin have been found in the pulp. Several flavonoids and related compounds (Leucocyanidin, quercetin and its 3-O-galactoside, 3-O-glucoside, and 3-O-rhamnosyl glucoside) were isolated from the unripe pulp of plantain. Serotonin, nor-epinephrine, tryptophan, indole compounds, tannin, starch, iron, crystallisable and non-crystallisable sugars, vitamin C, B-vitamins, albuminoids, fats, mineral salts have been found in the fruit pulp of *M. paradisiaca* and *M. sapientum*. Acyl steryl glycosides such as sitoindoside-I, sitoindoside-II, sitoindoside-III, sitoindoside-IV and steryl glycosides such as sitosterol gentiobioside, sitosterol myo-inosityl β -D-glucoside have been isolated from fruits of *M. paradisiaca* [15].

Plant used to treat peptic ulcer disease. It showed antimicrobial activity against *Staphylococcus* and *Pseudomonas* species in dehydrogenase assay. The green fruit of *M. paradisiaca* has been reported to have hypoglycemic effect due to stimulation of insulin production and glucose utilization, Flavonoids isolated from unripe fruits showed. Hypolipidemic activity, antihypertensive effect, wound healing activity, diuretic activity, antimalarial activity and antioxidant activity were also reported [15].

The Antidiabetic activity of the flowers has been reported in the literature, but not studied systematically all parts of the *M. paradisiacal* (Linn.) [16]. A comparative evaluation of the antidiabetic and hypoglycemic potential of the extracts from different plant parts of *Musa paradisiaca* (MP) was carried out in vitro. MP extracts were prepared sequentially with methanol, chloroform and petroleum ether. A comparison was made between the action of extracts from different parts. Different concentrations of each extract were made by using phosphate buffer and subjected to α -amylase and α -glucosidase inhibitory assays using maltose and 2-Chloro-4-Nitrophenyl- α -Maltotriose as substrates respectively. Using this method, the percentage of α -amylase inhibitory activities of each extract were calculated. The enzymes were extracted from the sheep intestines. The absorbencies were read at 595 nm and 405nm respectively using spectrophotometer. Methanol extracts were found to show higher inhibition. It was found that fruit and stem extract showed high rate of inhibition. At 100 μ g/ml concentration of the stem extract a high of 83% inhibition of α -amylase was recorded. A high of 80% inhibition was recorded for α -glucosidase activity when 100 μ g/ml of stem extracts were used. Leaf and flower extracts were also good in Index Terms- *Musa paradisiaca*, antidiabetic, diabetic mellitus, hypoglycemic [17].

***Curcuma longa* – Viyali kaha (Rhizomes)**

Is a member of the ginger family (Zingiberaceae) a perennial herb, with a short stem, tufted leaf and the rhizomes, which are short and thick and from root to leaves about 2 feet long, deeply veined leaves that project upward from stems that grow from the base of the plant. The leaf color is deep green and the surface is glossy and smooths. The flowers range from white to light yellow and form a tall spike. The rhizomes, specialized underground stems that are root-like in structure have a brown surface and bright orange or yellow interior flesh and after cutting, it is in curved cylindrical or oblong tubers 2 or 3 inches in length, and an inch in diameter, pointed or tapering at one end, yellowish externally, with transverse, parallel rings internally deep orange or reddish brown, marked with shining points, dense, solid, short, granular fracture, forming a lemon yellow powder [18].

Phytochemical constitutions were found as flavonoid, alkaloid, saponin, terpenoid, quercetin, tannin, essential oil, phenol, catechin and coumarin [19].

Plant has been used for inflammatory conditions and diseases such as biliary disorders, anorexia, cough, diabetic wounds, hepatic disorders, rheumatism and sinusitis, antioxidant, antineoplastic, antiviral, anti-inflammatory, antibacterial, antifungal, antidiabetic, anticoagulant, antifertility, cardiovascular protective, hepatoprotective, and immunostimulant activity in animals [19].

Curcuma longa rhizome extract showed blood glucose lowering activity in experimental, induced- diabetic rats. Curcumin treatment also significantly reduced macrophage infiltration of white adipose tissue, increased adipose tissue adiponectin production, and decreased hepatic nuclear factor-kappa B activity, hepatomegaly, and markers of hepatic inflammation. We therefore conclude that orally ingested curcumin reverses many of the inflammatory and metabolic derangements associated with obesity and improve glycemic control in case of diabetic rat [20].

***Coscinium fenestratum* – Venivelgata (whole plant)**

A large dioecious liana up to 10 m long, with yellow wood and sap. The stem and root slices are hard and woody. Wood is yellowish-brown in color externally and yellow internally. The drug occurs in large woody, cylindrical, straight pieces, sometimes as much as 10 cm in diameter. Leaves simple, alternate, exstipulate, broadly ovate, rounded, truncate or shallowly cordate at base, acuminate at apex, 10-32x8-22 cm [21].

The major alkaloids are yellow crystalline berberine, protoberberine and jatrorrhizine. Many other alkaloids, mainly of the protoberberine type, isolated from stem and root which were magnoflorine, berberrubine, thalifendine, palmitine and oxyberberine. The stem and root also contain ceryl-alcohol, saponin, hentriacontane, sitosterol, palmitic acid, oleic acid and sitosterol glucoside [21].

The drug is useful in vitiated conditions of *kapha* and *vata*, inflammations, wounds, ulcers, jaundice, burns, skin diseases, abdominal disorders, diabetes, fever and general debility. An infusion, tincture and concentrated liquor are also prepared to wash wounds and skin rashes. Stem pieces are boiled and one cup is given in case of a fresh, deep cut, being the most common use against tetanus. Decoction of stem is given internally in cases of bites from monkeys, snakes, brahmin-lizards and geckos. The root bark is used for dressing wounds, ulcers and in cutaneous leishmaniasis. It is known to treat influenza and eye diseases. Simply boiling the pieces and bathing with the water relieves body pain. *Coscinium* is also used to treat bleeding piles and excessive bleeding during menstruation. For snakebite poisoning, paste of *Coscinium* and turmeric is applied [21].

The antihyperglycemic potential of the aqueous stem extract of *Coscinium fenestratum*, widely used in traditional Ayurveda and Sidhda system of medicine for the treatment of diabetes mellitus, was evaluated in the streptozotocinnicotinamide-induced type 2 diabetic model. In extract-treated diabetic rats, an insulin-independent action with significant reduction in blood glucose, serum triglycerides and cholesterol level were observed [22].

III. CONCLUSION

The Indigenous medicinal formula consisted with *Aponogeton crispus*, *Sida cordifolia*, *Syzygium cumini*, *Musa paradisiaca*, *Curcuma Longa* and *Coscinium fenestratum* elaborated antidiabetic, hypoglycemic effects including other pharmacological activities due to the consistence of rich phytochemistry and other chemical compounds. The study revealed that all the ingredients of the formula is highly responsible in management of diabetes mellitus due to antidiabetic and hypoglycemic effects of the ingredients. Similarly, all the ingredients were found having exceptional pharmacological properties which is beneficial in management of various diseases.

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