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Review Article

SESBANIA GRANDIFLORA: NEW NUTRACEUTICAL USE AS ANTIDIABETIC

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ABSTRACT

Nutraceuticals are the emerging era in the treatment of diabetes mellitus, one of the seriously problematic due to leading the causes of death in all over the world. The newer anti-hyperglycemic drugs continue searching because the existing synthetic drugs have several limitations. Traditional medicinal plants are used in the treatment of diabetes mellitus more than a century, but only a few of these have proofed their safe and efficacious. The aim of this review article is focused *Sesbania grandiflora* one of the medicinal plants used for antioxidant activities. It contains several kinds of alkaloids, flavonoids, saponins, tannin, diterpenes, triterpenoids, glycosides and phenols. Many researchers have evaluated that these phytochemical substances have the major impact on diabetes mellitus. This review focuses on the hypoglycemic activity of this plant and clears that it has the potential to be considered as a candidate for preparing the new treatment of diabetes mellitus.

Keywords: Diabetes mellitus, Hypoglycemia, Nutraceutical, Plant, *Sesbania grandiflora.*

INTRODUCTION

"Let food be your medicine and medicine be your food" by Hippocrates or "An apple a day keeps the doctor away" are the importance meanings. In recent year there is a growing interest in nutraceuticals which provide health benefits and are alternative to modern medicine [1-3]. "A nutraceutical a day may keep the doctor away" was reported in EMBO-European Molecular Biology Organization in 2005 [4]. Nutrients, herbals and dietary supplements are major constituents of nutraceuticals which make them instrumental in maintaining health, promote the quality of life, and act against various diseases. Nutraceuticals are the emerging era in the treatment and prevention of cancer [5-7], neurodegenerative diseases [8, 9], cardiovascular diseases [10, 11], and diabetes mellitus [12-14]. In 2014, WHO reported the global prevalence of diabetes mellitus was estimated 9% among adult and 1.5 million deaths [15]. The currently six classes of oral anti-hyperglycemic drugs are available: sulfonylureas (e. g., glimepiride), biguanides (e. g., metformin), meglitinides (e. g., repaglinide), dipeptidyl peptidase IV inhibitors (e. g., sitagliptin), α-glucosidase inhibitors (e. g., acarbose), and thiazolidinediones (e. g., pioglitazone), have limited use because of undesirable pathological conditions and high rates of organ failure [16]. There are the ethnobotanical studies of medicinal plants used in the management of diabetes mellitus in many countries.

In Nigeria, Abo *et al.* [17] identified 31 medicinal plant species belonging to 20 families, mostly from the Rutaceae, Leguminosae and Cucurbitaceae, and *Cassia alata* and *Vernonia amygdalina* are exclusively used. Mustafa *et al.* [18] also in Nigeria, conducted field surveys in 45 medicinal plant species belonging to 29 families, mostly from the Apocynaceae, Cucurbitaceae, and Euphorbiaceae and *Rauvolfia vomitoria, Aframomum meleguata, Momordica charantia, Xylopia aethiopica, Senna spp.* and *Vernonia amygdalina* are establishing the anti-diabetic plants. In South Africa, Erasto *et al.* [19] conducted field surveys in 14 medicinal plant species belonging to 6 families, mostly from the Asteraceae, Hypoxidaceae, Apocynaceae, Asphodelaceae, Apiaceae and Buddlejaceae. Four antidiabetic plants were frequently mentioned and highly recommended by both the traditional healers and rural dwellers. These are *Herichrysum odoratissimum, Herichrysum petiolare, Hypoxis hemerocallidea* and *Hypoxis colchicifolia.* Semenya *et al.* [20] also in South Africa, identified 24 medicinal plant species belonging to 20 families, mostly from the Asteraceae (13%), Cucurbitaceae (8%), Sapotaceae (8%), and *Plumeria obtuse* and *Momordica balsamina* are exclusively used. In Bangladesh, Kadir *et al.* [21] identified 83 medicinal plant species belonging to 38 families, mostly from the Fabaceae, Euphorbiaceae, Liliaceae, and Moraceae. The most frequently mentioned plants have been *Asparagus racemosus* and *Azadirachta indica*. Ocvirk *et al.* [22] also in Bangladesh, conducted field surveys in 37 medicinal plant species belonging to 25 families. The most frequently mentioned plants have been Coccinia indica, Azadirachta indica, Trigonella foenum-graecum, Syzygium cumini, Terminalia chebula, Ficus racemosa, Momordica charantia, Swietenia mahagoni. In India, Tarafdar *et al.* [23] conducted field surveys in 39 medicinal plant species belonging to 28 families, mostly from the Acanthaceae, Apocynaceae, Caesalpiniaceae and Euphorbiaceae. The most frequently mentioned plants have been *Scoparia dulcis, Syzygium cumini,* and *Cicca acida*. In Turkey, Durmuskahya and Ozturk [24] conducted field surveys in 27 medicinal plant species belonging to 15 families, mostly from the Rosaceae, Lamiaceae, Fabaceae, and Asteraceae. The most important antidiabetic plants are *Zizyphus jujube*, *Origanum onites*, *Ceracus mahaleb* and *Trigonella foenum-graecum*. In Iran, Bahmani *et al.* [25] conducted field surveys in 30 medicinal plant species belonging to 17 families, mostly from the Lamiaceae, Fabaceae and Rosaceae. The most important antidiabetic plant is *Citrullus colocynthis*. In Thailand, Manosroi *et al.* [26] reported the hypoglycemic activity of five Thai medicinal plants, including *Anogeissus acuminata* (Combretaceae), *Catunaregam tormentosa* (Rubiaceae), *Dioecrescis erythroclada* (Rubiaceae), *Mimosa pudica* (Fabaceae), and *Rauwolfia serpentina* (Apocyanaceae), which have been traditionally used in the Northern part of Thailand.

From these previous surveys, Sesbania grandiflora, one of the medicinal plants has been used in ethnomedicine [27]. It synonym with Sesban grandiflora, Agati grandiflora and Coronilla grandiflora have been widely used as "Traditional Medicinal Plant" in Asia to relief symptoms of various diseases [28]. It is commonly known as a humming bird, flamingo, or the butterfly tree; it belongs to the family Fabaceae.

Nomenclature

There are around 60 global species belonging to the genus Sesbania which are commonly found to be grown in Africa, Australia, and Asia. The vernacular name of *S. grandiflora* is also known as agusta, bagphal, agati (Bengali), caturay, katurai (Chamorro), pwa valet, pwa valye (Creole Patosi), flamingo bill, grandiflora, Australian corkwood tree, August flower, sesban, agati sesbania, west Indian pea, white dragon tree, vegetable-hummingbird, tiger tongue, swamp pea (English), gauai-gauai, katurai, katuday (Filipino), pois vallier, colbri vegetal, fleur papillon, fagotier, (French), basna, chogache, basma, agasti, hatiya, daincha (Hindi), turibaum (German), tuwi, turi, toroy (Indonesian), sesbania (Italian), ângkiëdèi (Khmer), kh'ê khaw, sino-tibetan (Lao), petai belalang, kacang turi, sesban getih, sesban (Malay), agasti (Nepali), agasti, agati, anari (Sanskrit), paloma, cresta

de gallo, baculo, zapaton blanco, gallito, pico de flamenco (Spanish), peragathi, agati, agathi (Tamil), kae-ban, khae, ton kae (Thai), and so dua (Vietnamese) [29, 30].

Morphological characters

S. grandiflora is a small, erect, fast-growing perennial (4-5 m in just 6 months), and sparsely branched tree that reaches 10-15 m in height and a diameter up to 12 cm (fig. 1A) [28]. Leave: The leaves are pari-pinnately compound up to 15-25 cm long with 20-50 leaflets in pairs, dimensions 12-44x5-15 mm, oblong to elliptical in shape and opposite arrangement. Single leaflet is 2-4 cm long and 10-15 mm in breadth, linear, oblong, mucronate, deciduous, stipulus lanceolate or setaceous deciduous (fig. 1B-C) [31, 32]. Stem: The bark is light gray, corky and deeply furrowed and the wood is soft and white (fig. 1D). Flower: The flower clusters hanging at the leaf base. They are fleshy with 2-5 large or giant showy white petals. They are 7.5-10.0 cm long with short axillary racemes, curved about 3 cm wide before opening. Flowers are arrangement to pea flowers with five petals that are differentiated into a standard, wing, and keel petals. The standard petal is usually upright, the wing petals spread out on either side of the flower, and the keel is boat-shaped and in this species is curved down and away from the flower (fig. 1E). Fruit: The fruit looks like flat, long and thin green beans. Pod is sub-cylindrical, straight or slightly curved up to 30-45 cm long and 5-8 mm wide, straw-colored or reddish-brown, containing from 15-50 pale-colored seeds. Seed: The seed is 3-4.5 mm x 2 mm x 2 mm, sub-cylindrical or bean like, elliptical, olive-green or red brown, 6-8 in a pod. There are 55-80 seeds per gram [33-35].

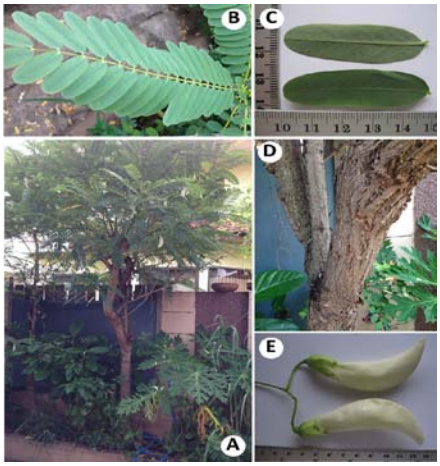

Fig. 1: *S. Grandiflora* small branched tree (A), leaves (B-C), stems (D), and flowers (E)

Phytochemical substances

The nutritive value of *S. grandiflora* leaves contains moisture 73.1 g, protein 8.4g, fat 1.4g, minerals 3.1g, crude fibers 2.2g, carbohydrates 11.8 mg, energy 93 mg, calcium 1,130 mg, phosphorus 80 mg, and iron 3.9 mg [36]. The literature survey of this plant revealed that this plant possesses protein and amino acids: arginine, cysteine, histidine, isoleucine, phenylalanine, tryptophan, valine, threonine, alanine, asparagine, aspartic acid, leucocyanidin and cyaniding. Sugar derivatives are galactose and rhamnose [30, 37]. The phytochemical substances of *S. grandiflora* various parts contain several kinds of alkaloids, triterpenoids, carbohydrates, saponin, tannin, chlorogenic acid, flavonoid, anthocyanin, steroidal glycosides and phenolic compounds [38, 39]. Three isoflavonoids, isovestitol, medicarpin, and sativan, along with other known compound, betulinic acid, were isolated from the root [40]. The active ingredients in the seeds are leucocyanidin and cyaniding [32]. The active ingredients in flowers are cyaniding, delphinidin glucosides, tannins, keampferol, grandiflora, proteins, oleanolic acid, cysteine, isoleucine, asparagine, phenylalanine, valine, nicotinic acid and vitamin C [41].

Traditional uses

S. grandiflora is traditionally used for anti-inflammation [42], antimicrobial activities [40, 43], anticancer [44], antidiabetic activities [45-47], antioxidant activities [48, 49], anti-ulcer activity [50, 51], an immunomodulatory activity [41], and associated diseases such as hepatic diseases [52, 53], respiratory diseases [54], and renal diseases [55]. *S. grandiflora* leaves and pods were reported palatable and non-toxic to cattle [56]. Another report mentions that while the white flower variety of *S. grandiflora* found to be non-toxic, the purple flower type is highly toxic [57].

Hypoglycemic activity

Medicinal plants have gained huge interests from researchers around the world because of their positive bioactivity effects [58]. However, there are still not many data available about the hypoglycemic activity of this medicinal plant, *S. grandiflora*. During the review searches were done on the scientific databases i.e., ScienceDirect, SpringerLink, PubMed, Google Scholar and etc. Moreover internet searches were undertaken on the search engine. Different combinations of keywords as well as synonyms for keywords were used during the searches.

Ghanshyam *et al.* [45] studied the 100, 200 and 400 mg/kg *S. grandiflora* leave for antihyperglycemic activity in glucose overloaded hyperglycemic rats and hypoglycemic activity in overnight fasted normal rats. The highest dose showed both of the activities. Nandi *et al.* [46] studied the 200 and 400 mg/kg *S. grandiflora* fruit using streptozotocin induced diabetic rats. The results showed *S. grandiflora* fruit extract included hypoglycemic agents significantly decreased the levels of blood glucose, cholesterol, triglyceride and low density lipoprotein, Lipid peroxidation significantly reduced and superoxide dismutase and catalase significantly increase. Radhika *et al.* [47] studied the 500 and 750 mg/kg *S. grandiflora* leaves using alloxan induced diabetic rats for 45 days. The results showed that oral administration of this plant restored all the biochemical parameters such as plasma glucose, serum insulin, glucosylated hemoglobin, hepatic glycogen, glucokinase, glucose-6-phosphatase, and serum marker enzymes i.e., aspartate and alanine transaminase and alkaline phosphatase. Sangeetha *et al.* [59] studied the 300 mg/kg *S. grandiflora* leaves using streptozotocin induced diabetic rats for 30 days. The results showed the effects of this plant also restored all the biochemical parameters such as glucose, glycosylated hemoglobin, blood urea nitrogen, uric acid, creatinine, aspartate and alanine transaminase, alkaline phosphatase, glycogen content.

***S. grandiflora* possesses the antidiabetic effect using multiple pathways. From the literature reviews that can be summarized these pathways as following:**

Inhibit enzyme

Two proteins, namely SGF60 and SGF90 isolated from the flowers of this plant have been shown to possess significant inhibitory effect on digestive enzymes, α-amylase and α-glucosidase that responsible for the metabolism of carbohydrates [60]. Glycosylated hemoglobin that form by excess glucose reacts with hemoglobin, can be used as an excellent marker for diabetes, *S. grandiflora* plant extract significantly decreased this marker level [61, 62].

Hypouricemia activity

In addition, a recent research showed that fructose-induced hyperuricemia plays a pathogenic role in metabolic syndrome [63, 64]. Thus, lowering uric acid may be a novel treatment target for preventing diabetes. The levels of urea, serum creatinine and uric acid were restored to near normal level by treatment with *S. grandiflora* leaves extract [59].

Antioxidant properties

Many studies reveal that antioxidants capable of neutralizing free radicals are effective in preventing experimentally induced diabetes in animal models as well as reducing the severity of diabetic complications [45-47, 59]. The elevated oxidative stress marker and diminished antioxidant status were normalized indicating the

antioxidant potential of this plant [59]. Zarena *et al.* [65] reported the 29 kDa protein from *S. grandiflora* leaves named agathi leaf protein (ALP) which possesses antioxidant and cytoprotective activities. Additional, the level of lipid peroxidative markers (thiobarbutric acid reactive substances and lipid hydroperoxides) was significantly reduced on treatment with *S. grandiflora*, the levels of both enzymatic and non-enzymatic antioxidants were also found to be restored on treatment with this plant [66].

Increased hepatic metabolism

The hypoglycemic activity is thought to be due to increased hepatic metabolism. Aqueous homogenate of this plant administered orally to animal model significantly increased hepatic glycogen and free amino acid content, decreased blood glucose, and triglyceride levels [45-47, 67].

Insulin elevation

The hypoglycemic activity is thought to be due to stimulation of synthesis and/or release of insulin from pancreatic beta cells and/or insulin sparing effect [68].

In conclusion, the aim of this review is to focus on the potential utilization of phytochemical constituents which could contribute more effectively to antidiabetic activity of *S. grandiflora*. It aims to explore a proposed of this plant for complementary alternative medicine and especially for human consumption.

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CONFLICT OF INTERESTS

The authors do not have any conflict of interest to declare

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