Innovare Academic Sciences

International Journal of Pharmacy and Pharmaceutical Sciences

ISSN- 0975-1491 Vol 6, Issue 3, 2014

Review Article

AN OVERVIEW OF ANTIDIABETIC PROFILE OF MANGROVE PLANTS

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Received: 11 Jan 2014, Revised and Accepted: 09 Apr 2014

ABSTRACT

The present article is a review that gives a general idea of diabetic mellitus, its treatment using mangrove plants as herbal drugs. Despite considerable progress in the treatment of diabetes by oral hypoglycemic agents, search for newer drugs continues because the existing synthetic drugs have several limitations. The herbal mangrove plants with antidiabetic activity are yet to be commercially formulated as modern medicines, even though the drugs have been acclaimed for their therapeutic properties in the traditional systems of medicine. This paper highlighted various mangrove plants available in Indian coastal areas and its antidiabetic activities.

Keywords: Mangrove plants, Herbal drugs, Active chemical ingredients, Anti-diabetic activity.

INTRODUCTION

The ancient literature revealed that the diabetes was fairly known and well conceived as an entity in India as "madhumeha". The knowledge of system of diabetes mellitus, as the history reveals, existed with the Indians since prehistoric age. Madhumeha is a disease in which a patient passes sweet urine and exhibits sweetness all over the body including sweat, mucus, breath, blood etc [1, 2].

Diabetes mellitus is a metabolic syndrome characterized by inappropriate hyperglycemia caused by a relative or absolute deficiency of insulin or by a resistance to the action of insulin at the cellular level. It is the most common endocrine disorder, affecting 16 million individuals in the United States and as many as 200 million (approximately 2-7% of the population) worldwide [3]. As the number of people with diabetes multiplies worldwide, the disease takes an ever increasing proportion of national and international health budgets. It is projected to become one of the world's main disablers and killers within the next 25 years. Regions with greatest potential are Asia and Africa, where diabetes mellitus rates could rise to two or three folds than the present rates [4].

Diabetes – an overview

Diabetes has been a clinical model for general medicine. The primary defect in fuel metabolism resulted in widespread, multiorgan complications that ultimately encompass virtually every system of the body and every specialty of medicine [5,6]. Such a deficiency results in increased concentrations of glucose in the blood, which turn damage many of the body's systems, in particular the blood vessels and nerves [7]. The pathogenesis of insulin dependent diabetes mellitus involves environmental causes that may activate autoimmune mechanisms on genetically susceptible individuals, leading to progressive loss if pancreatic islet β-cells resulting in insulin deficiency. The non insulin dependent diabetes mellitus is associated with impaired insulin secretion, obesity, insulin resistance and hereditary disposition in individuals over the age of 40 years [8,9].

Diabetes mellitus is not a single disease, but a group of disorders of varying etiology and pathogenesis that is characterized by increased fasting and postprandial glucose concentration, insulin deficiency and/ or decreased insulin action and abnormalities in glucose, lipid and protein metabolism [10,11]. In India, around one fifth of the population who live in metropolitan areas and are over 30 years old are suffering from both blood pressure and diabetes. According to the new research, the diabetes is more likely to die from colon and breast cancer than those who do not suffer from the condition. The scientists from Colorado School of Public health determined that infants who do not start eating solid food between the ages of four and six months are more likely to develop type 1 diabetes. Measuring the likelihood of obesity is important for medical teams and it can help to mitigate the development of type 2 diabetes or pre diabetes in the young.

Long-term complications of diabetes include retinopathy with potential loss of vision; nephropathy leading to renal failure; peripheral neuropathy with risk of foot ulcers, amputations, and Charcot joints; and autonomic neuropathy causing gastrointestinal, genitourinary, cardiovascular symptoms and sexual dysfunction. Patients with diabetes have an increased incidence of atherosclerotic cardiovascular, peripheral arterial and cerebrovascular disease. Hypertension and abnormalities of lipoprotein metabolism are often found in people with diabetes.

The diabetes mellitus is classified into four major types [12],

1. Type 1 diabetes (cell destruction, usually leading to absolute insulin deficiency, immune mediated and idiopathic).

2. Type 2 diabetes (may range from predominantly insulin resistance with relative insulin deficiency to a predominantly secretory defect with insulin resistance).

3. Gestational diabetes mellitus

4. Other specific types (Genetic defect of β–cell function; genetic defects in insulin action; diseases of the exocrine pancreas; endocrinopathies; drug induced, chemical induced; infections; uncommon forms of immune mediated diabetes; genetic syndromes associated with diabetes)

Medicinal plants

Several medicinal plants have been used as dietary adjunct and in the treatment of numerous diseases without proper knowledge of their function. Although phytotherapy continues to be used in several countries, few medicinal plants have received scientific and medical scrutiny. Moreover, a large number of medicinal plants possess some degree of toxicity. It is reported that one third of medicinal plants used in the treatment of diabetes are considered to be toxic [13, 14].

Mangrove plants as antidiabetic agents

In general, flora of mangrove wetlands are divided into two groups namely, true or exclusive mangrove and associate mangrove species [15]. The knowledge of the geographic range of mangrove species is often incomplete, so checklist of mangrove species for a given area is constantly in need of revision. Traditionally more than 100 numbers of mangroves and mangrove-associated plant used for the treatment of diabetes have been reported, but only a very few number of plants are evaluated and reported scientifically [16].

Recently, the medicinal value of mangroves and associated plants persist to provide priceless therapeutic agents, both in modern medicines and in traditional systems [17]. Also, the ethnopharmacological consequence pointed out the study plant traditionally used for the treatment of rheumatism, painful arthritis, inflammation, asthma, antioxidant, free radical scavenging, anti-inflammatory, antinociceptive, diabetes and hepatoprotective actions [18]. Some recent studies showed the medicinal value of mangroves and associated plants persist to provide invaluable treatment modalities, both in modern and traditional systems of medicine [17,19].

The major families and genus of mangroves having wide medicinal properties are **Acanthaceae** (*Acanthus hirsutus, Acanthus ilicifolius*); **Myrsinaceae** (*Aegiceras corniculatum*); **Avicenniaceae** (*Avicennia officinalis*); **Lecythidaceae** (*Barringtonia racemosa*), **Leguminosae** (*Caesalpinia mimosoides*); **Rhizophoraceae** (*Ceriops decandra*); **Clusiaceae** (*Calophyllum inophyllum*); **Euphorbiaceae** (*Excoecaria agallocha*); **Arecaceae** (*Nypa fruticans*); **Pandanaceae** (*Pandanus foetidus*); **Fabaceae** (*Pongamia pinnata, Derris scandens*); **Tamaricaceae** (*Tamarix indica*); **Convolvulaceae** (*Ipomoea imperati, I. pes-caprae*) and **Sterculiaceae** (*Heritiera littoralis*) [19]. The details regarding the presence of bioactive compounds and medicinal properties in various mangrove plants are interpreted in the table 1.

Aegiceras corniculatum

The leaves of *Aegiceras corniculatum* are reportedly rich in flavonoids with proven anti-inflammatory and antioxidant property [69]. Evaluation of physiological and toxic effects, solvent used for extraction, route of administration, and acute or chronic effect of *A. corniculatum* leaf extract are quite diversified, which is encouraged by delineating the beneficial applications of the study plant and confines various assessments. Alloxan is an oxygenated pyrimidine derivative which selectively destroys insulin secreting beta cells in the experimental animals, which results in alloxan diabetes [70]. In the present investigation, blood sugar level increased as expected in alloxan-injected animals, since alloxan causes a massive reduction in insulin release, by the destruction of the beta cells of the islets of langerhans and inducing hyperglycemia [3, 71].

Table 1: Chemical constituents and medical properties of true mangroves

Plant Name	Part used as medicine	Chemical Constituents	Medicinal properties	References
Acanthus ilicifolius	Bark, Fruits, Leaves, Roots	Alkaloids, long chain alcohols, steroids, sulphur, triterpenes, saponins	Analgesic, anti- inflammatory, blood purifier, antidiabetic, anti-viral, etc.	20 - 27
Aegialitis annulata	Bark, Leaves and Stem	Amino acids, inorganic salts	Anti viral, anti inflammatory, anti-diabetic	28
Aegiceras corniculatum	Bark, Leaves and Stem	Amino acids, benzoquinones, tannins, coumarins, flavanoids, saponins, polyphenols, triterpenes, steroids, quinones	Antidiabetic, asthma, antiviral	28,29
Aegiceras majus	Bark and Leaves	Alkaloids, tannins, benzofurans, flavanoids, saponins	Treatment for haematuria, antidiabetic	30,31
Avicennia africana	Bark	Naphthoquinones	Anticancer, antiulcers	32
Avicennia alba	Bark, Leaves	Lipids, phytoallexin, triterpenoids, naphthoquinones	Anti cancer and antiulcer	32
Avicennia ebracteatus	Fruits	Glycosides	Blood purifier, treatment of boils and snake bite	33
Avicennia germinans	Bark, Leaves	Glycosides	Treatment for throat pain, ulcers	33,34
Avicennia marina	Stem	Phytoalexins, tannins, triterpenes, steroids	Treatment for small pox, ulcers, rheumatism	35 – 40
Avicennia nitida	Bark, Leaves, Seed	Saponins, triterpenoids	Cure for thrush and ulcer	26,41
Avicennia officinalis	Bark, Fruits and Leaves	Arsenic, alkaloids, saponins, tannins, triterpenoids	Aphrodisiac, cure for hepatitis and leprosy	26,41
Avicennia tomentosa	Bark, Stem	Triterpenoids	Treatment of rheumatism	42
Bacopa monniera	Leaves	Saponins, tannins	Nerve tonic	43
Bruguiera caryophylloides	Bark and Leaves	Phylloides	Treatment of ulcers	33,38
Bruguiera conjugata	Stem, Bark	Sulphur containing alkaloids	Antidiabetic	38,44,45
Bruguiera cylindrica	Fruits, Roots Leaves	Alkaloids, tannins	Antidiabetic	33,38
Bruguiera exaristata	Bark	Alkaloids, inositols	Anticancer	33,46,47
Bruguiera gymnorrhiza	Fruits	Anthocyanins, catechins, diterpenes	Treatment for eye diseases	33,36,48
Bruguiera parviflora	Bark	Phenolic compounds	Anticancer, antidiabetic	33,49
Bruguiera rumphii	Bark and Leaves	Tannins, triterpenes	Antidiabetic	33
Bruguiera sexangula	Bark	Phenolics, steroids, alkaloids, tannins	Anticancer, antidiabetic	33,36
Ceriops decandra	Bark, Fruits and Leaves	Polyphenols, tannin, triterpenes	Treatment for hepatitis, antiulcer	33,50
Ceriops roxburghiana	Whole plant	Gibberellins, Procyanidins	Antiucler, antidiabetic	49,51
Ceriops tagal	Bark	Inositols, steroids, polyphenols, tannins	Treatment for haemorrhages	33,52
Dalbergia ecastophyllum	Bark	Chalcones, steroids, isoflavanoids	Antidiabetic	53,54
Derris trifoliata	Whole plant	Alkaloids, steroids, Flavanoids, lipids, rotenone	Stimulant, laxative	21,33
Derris uliginosa	Bark and Fruits	Alkaloids, long chain alkanes	Antispasmodic, stimulant	33
Excoecaria agallocha	Whole plant	Alkaloids, tannins, phorbol esters, polyphenols,	Uterotonic, purgative, antidiabetic	38,39
Heritiera littoralis	Stem, Bark, Fruits and Leaves	Alkaloids, tannins, polyphenols, saponins	Treatment for diarrhea, antifungal	33,55,56
Heritiera macrophylla	Leaves	Carotenoids, tannins	Antidiabetic	57

Heritiera minor	Whole plants	Steroids, saponins, tannins, triterpenes	Treatment for diarrhea	56
Intsia bijuga	Bark	Stilbenes, polyphenols	antiulcer	33
Kandelia candel	Whole plants	Alkaloids, tannins, saponins, polyphenols	Antidiabetic	33,56
Kandelia rheedii	Bark, Fruits and Leaves	Steroids, triterpenes	Antidiabetic	33,58
Nypa fruiticans	Leaves and Fruits	Acetic acid, ethanol	Antidiabetic, treatment for snake bite	33,59
Oncosperma tigillarium	Flowers	Sterols	Antispasmodic	33
Rhizophora apiculata	Bark, Flowers, Fruits and Leaves	Aliphatic alcohols, hydrolysable tannin, steroids, triterpenes, phenolic compounds	Antimicrobial, antiviral, antiseptic	33,61,62
Rhizophora conjugata	Bark	Anthocyanins, steroids, tannins, triterpenes	Antidiabetic	58
Rhizophora gymnorrhiza	Bark	Anthocyanins, Anthocyanidins, tannins, steroids	Antidiabetic	58
Rhizophora lamarckii	Flowers and Leaves	Tannins, triterpenes	Treatment for hepatitis	33,58
Rhizophora mangle	Bark and Leaves	Tannins, triterpenes	Antidiabetic	33,62
Rhizophora mucronata	Bark, Fruits, Flower, Root Leaves	Alkaloids, tannins, gibberellins, Inositol saponins, lipids	Antiviral (antiHIV), antiulcers	33,47,63
Rhizophora racemosa	Flowers and Leaves	Tannins, steroids	Antiviral, antidiabetic	33,39
Rhizophora stylosa	Leaves, roots and seeds	Inositols, steroids	Antiviral, antidiabetic	47,48
Salicornia brachiata	Leaves and Stems	Steroids, triterpenes	Antiviral, antidiabetic, toothache	33,64
Sonneratia acida	Barks and Leaves	Anthraquinones, lactones, triterpenes	Antiulcers, treatment for asthma	33,65
Sonneratia alba	Fruits	Cyclitol, polyol, tannins	Treatment for swelling and sprains	28,2933
Sonneratia apetala	Leaves	Anthroquinoids, triterpenes, steroids	Treatment for hepatitis, antiviral	33,63
Sonneratia caseolaris	Fruits	Steroids	Stop bleeding, treatment for piles	33,36
Sonneratia ovata	Fruits	Steroids	Stop bleeding, antidiabetic	33,66
Thespesia populnea	Bark, Stem	Glycoside, gossypol, mansonones, sterols triterpenes, quinones	Antibacterial and antisteroidgenic	33,67
Xylocarpus granatum	Bark	Alkaloids, steroids, limonoids, tannins, triterpenes	Treat fever, malaria, cholera and antidiabetic	33,58
Xylocarpus moluccensis	Bark, Fruits	Limonoids, xyloccensins	Treat fever, malaria, naphrodisiac and antidiabetic	33,68

Ceriops decandra

The mangrove plant *Ceriops decandra* is reportedly rich in lignins with proven anti-oxidant activity. Alloxan, a β-cytotoxin, induces chemical diabetes in a variety of experimental animals by damaging insulin secreting β-cells, which results in insulin-dependent diabetes mellitus. The body weight of alloxan-induced diabetic rats was reduced compared with control. This could be due to dehydration and the catabolism of fats and proteins in the setting of diabetes mellitus. This issue is easily cured by the administration of *C. decandra.* There are also a number of other plants that reportedly possess antihyperglycemic activity and have an insulin-stimulatory effect including *Eugenia jambolana, Gymnema yunnanese, Boerhaavia diffusa* and *Tinospora cordifolia* [72, 73].

Sonneratia alba

The leaf extract of the mangrove plant, *Sonneratia alba* was evaluated for its antidiabetic activity comparable to glinclamide and identified the specific molecule that shows such property using several chromatographic techniques and proton – Nuclear magnetic resonance spectrometry. The molecular markers are said to be similar among the closely related species of the mangrove groups. Some studies showed that this plant has tremendous blood glucose attenuating activity because it has reduced significantly the sugar level by amount 19% during the first 6 hours and reduced further to 67% after 12 hours [74, 75].

Sphaeranthus indicus

The cytotoxic action of alloxan is mediated by reactive oxygen species, with a simultaneous massive increase in cytosolic calcium concentration, leading to a rapid destruction of beta cells. Experimental studies reveals that the petroleum ether extracts from *Sphaeranthus indicus* flower head (50, 100 and 200 mg/kg) orally administered produced a significant decrease in the blood glucose level in alloxan-induced diabetes rats. It also proves the traditional claim to *S. indicus* for its anti-diabetic activity [76,77].

Terminalia catappa

Some studies indicated that *Terminalia catappa* fruit extracts have good antidiabetic activity. Methanol and aqueous extracts of *T. catappa* exhibited significant anti-hyperglycemic activities in alloxan induced hyperglycemic rats without significant change in body weight. The animals can also improve the condition of diabetes as indicated by parameters like body weight and lipid profile along with serum creatinine, serum urea, and serum alkaline phosphatase. These extracts showed improvement in parameters like body weight and lipid profile as well as regeneration of beta cells of pancreas and so might be of value in diabetes treatment [4, 78].

Bruguiera gymnorrhiza

Bruguiera gymnorrhiza is widely distributed in the southern tropical Indian Ocean through Malaysia and tropical Australia and extending into the Pacific as far east as Tonga and Samoa. Bark contains D-glucose, rhamnose, arabinose, tannins, a mixture of bruguierol and isobruguierol. Hydrolysis of the sterol esters of the leaves gives beta sitosterol, cholesterol, campesterol, stigmasterol, and 28-isofucosterol. The plant has the constituents like alpha-amyrin, beta-amyrin, lupeol, oleanolic acid, ursolic acid, taraxerol, gymnorhizol, ellagic acid and derivatives. The ethanolic extract of *B. gymnorrhiza* had significantly decreased Total Cholesterol, Triglycerides, VLDL, and LDL with increase in HDL which is having a protective function for the heart compared with diabetic control group [79].

Thus, the current review highlighted the importance of the mangrove plants and its antidiabetic activity. The potency of herbal drugs is significant and they have negligible side effects than the synthetic antidiabetic drugs. There is increasing demand by patients to use the natural products with antidiabetic activity. In recent times there has been renewed interest in the plant remedies. Plants hold definite promises in the management of diabetes mellitus.

Further, Photomicrographical data in some studies reinforce healing of pancreas, by mangrove plant extracts, as a plausible mechanism of their antidiabetic activity. This review paper laid the foundation to study the active compounds of such anti diabetic mangrove plants that are responsible for the hypoglycemic activities. Mangroves and associated plants provide a wide domain for therapeutic application in recent years, most yet to be explored. Various parts of the mangrove plants are reportedly rich in flavonoids with proven anti-inflammatory and antioxidant property. Evaluation of physiological and toxic effects, solvent used for extraction, route of administration, and acute or chronic effect of mangrove plant extract are quite diversified, which is encouraged by delineating the beneficial applications of the plant and confines various assessments.

The pharmaceutical properties of mangrove trees provide a wide domain for medical use, requiring further studies for possible drug development. Medicines are reviewed by various research works done in India regarding the common uses of mangroves. This suggests the existence of "Parallel knowledge" in different disciplines with regards to screening of anti diabetic mangrove plants. The mode of action of anti diabetic activity of mangrove plant extract is varies with each type of plants and its parts.

In recent years, screening of mangrove plants for a variety of biological activities is gaining importance. Mangroves are biochemically unique, producing a wide array of novel natural products. Mangrove and mangrove associates contain biologically active anti diabetic, anti inflammatory and anti microbial compounds. Mangrove forests, though essentially common and widespread, are highly threatened. Local societies along with their knowledge about the mangrove also are endangered, while they are still under represented as scientific research topics. So there is a great need to conserve the mangrove forests. With this literature we have tried to give some knowledge on the utilization patterns, and mangrove plants with broad spectrum medicinal and anti diabetic activity, which could be fused together to arrive at an innovative compounds for tackling diabetic oriented problems. Care must be taken in the development of such innovative compounds are ecologically safe and economically viable by performing a role in protection and also prevent the risk of development of novel compounds to cure this insulin deficient disorder.

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