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A comprehensive review on ethno pharmacological antidiabetic potential of traditional ayurvedic plants of Bangladesh

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Abstract

Diabetes mellitus (DM) is a common and metabolic disorder throughout the world. In recent years, there have been various types of research and survey works are studied. Bangladesh is the land of beauty whereas the natural plants have exclusive medicinal ayurvedic activity against Insulin Dependent Diabetic Mellitus (IDDM) and Non-Insulin Dependent Diabetic Mellitus (NIDDM). Among many medications and other alternative medicines, several herbs have been known to cure and control diabetes; additionally they have no side effects. In the last few years, there has been an exponential growth in the field of herbal medicine and gaining popularity both in developing and developed countries because of their natural origin and less side effects. In this review work, we just figure out some potential herbal plants (25) antidiabetic activity in Bangladesh. A comprehensive review of the present paper is an attempt to list of the plants with anti-diabetic and related beneficial effects originating from different parts of world. History showed that medicinal plants have been used in traditional healing around the world for a long time to treat diabetes; this is because such herbal plants have hypoglycemic properties and other beneficial properties, as reported in scientific literature. This work enhanced the future researchers for further research on the potential use of medicinal plants having antidiabetic potential including hypoglycemic activity, insulin mimetic activity and antioxidant activity.

Keywords: Diabetes mellitus, herbal plants, metabolic disorder, antioxidant activity, hypoglycemic activity, antidiabetic activity.

1. Introduction

There are huge source of medicinal plants in Bangladesh, those exhibit potential, rapid and accurate biological activities [1]. From the last 2000 years, there has been very strong evidence, to use traditional systems of drugs including ayurvedic, unani, born and practiced, which so rapid in the eastern continent. These types of traditional uses are still now gradually developing day by day in the era of modern biotechnology. Even today, 80% of the peoples in the developing countries strongly depend on ayurvedic practitioners used [2]. These ayurvedic plants contain valuable secondary metabolites, which can be used in therapeutics purposes [3]. Diabetes mellitus (DM) is the condition arising due to various types of complications such as, micro vascular (retinopathy, neuropathy, and nephropathy), macro vascular (heart attack and stroke), abnormality of carbohydrate metabolism, low blood sugar level and insensitivity of target organs to insulin [4]. Antioxidative mechanisms of human body which responsible for minimizing the various types of degenerative diseases including diabetics [5]. Today's, antidiabetic activity of herbal drugs till now commercially formulated as modern medicines [6]. Diabetic is rapidly increasing worldwide, and affecting all parts of the world, due to people suffering from high blood glucose level [7]. It is made of 2 types type I and type II diabetics, where the type I is termed as juvenile diabetes which is insulin dependent. The type II is non-insulin dependent, usually develops in the age of adults over 40. Chronic hyperglycemia of diabetes is associated with long term abnormality and dysfunction and eventually the failure of valuable organs, especially the eyes, nerves, kidneys and hearts etc [8]. The most important compound presents in the ayurvedic plants have been reported possess beta cells regenerating, insulin releasing and fighting the problems arise against insulin resistance [9]. In recent research work, it is already proved that the hypoglycemic herbs increase insulin secretion, enhance the ability of glucose uptake by adipose or muscle tissues, and inhibit the rate of glucose absorption from intestinal mucosa and from the liver production of glucose [10]. About 400 plant species in Bangladesh, have been reported hypoglycemic activity and those

ayurvedic plants contains glycosides, alkaloids, terpenoids, flavonoids, carotenoids and so on, that has rapid action of antidiabetic effect [11].

2. Medicinal plants with antidiabetic and related beneficial properties in Bangladesh

2.1 *Allium cepa* L. (onion): (Liliaceae)

The bulb part of *Allium cepa* has the anti-diabetic activity [12]. It controlled the activity of glucose 6 phosphatase and HMG CO A reductase [13]. With administration of sulfur containing amino acid (200 mg/kg for 45 days), it significantly controlled the blood glucose level to alloxan [14]. When, 50gm of onion juice were orally administered post- prandial glucose levels were significantly controlled [15].

2.2 *Asparagus racemosus* (Liliaceae)

The root extracts of *Asparagus racemosus* have insulinotropic activity. Dose dependent insulin secretions in isolated beta cells were observed by ethanol extract, chloroform, hexane in root part of *Asparagus racemosus* [16].

2.3 *Brassica nigra* L (Brassicaceae)

The seed part of *Brassica nigra* was used for anti-diabetic effect. With providing 200 mg/kg body weight of aqueous extract for one month in diabetic animal have ability to reducing the activity of fasting serum glucose level, where the untreated group of fasting serum glucose level remains higher value. glycosylated hemoglobin and serum lipids level were so less if compared to treated and untreated animals [17].

2.4 *Catharanthus roseus* L (Apocynaceae)

The blood glucose level is reduced by *Catharanthus roseus* in diabetic rabbits and the mode of action of the active compounds is mediated through insulin secretion increasing from the beta cells of langerhans [18].

2.5 *Allium sativum* (Alliaceae)

Lowering the blood sugar level and antihyperglycemic activity was reported with 5 *Allium sativum*. The bulb part of this plant having antidiabetic effect [19]. Allicin, a sulfur containing compound provide significant hypoglycemic activity due to increased in hepatic metabolism and insulin secretion from beta cells. S allyl cystein sulfoxide is the precursor of allicin and garlic oil which provides the antioxidant activity [20, 21].

2.6 *Aloe vera* (Liliaceae)

Aloe vera is used for hypoglycemic effect. The active constituents of this plant including Pseudoprotinosaponin AIII and protinosaponins AIII [22]. Significant use of these constituents is glucose uptake and insulin released against glycogenolysis or gluconeogenesis pathway [23].

2.7 *Capsicum frutescens* (Solanaceae)

Capsicum frutescens is used for insulinotropic activity rather than hypoglycemic in type 2 diabetes model of rats and increase serum insulin concentration in high fat diet [24].

2.8 *Annona squamosa* (Annonaceae)

Leaf and Fruit-Pulp was used for the antidiabetic activity of *Annona squamosa* [25]. Ethanol and aqueous extract were found [26, 27]. Reduced the concentration of glucose, lipid and lipid peroxidation [28, 29].

2.9 *Terminalia chebula* (Combretaceae)

The seed and fruit part of *Terminalia chebula* was used in

antidiabetic effect. Extracts are found in aqueous and chloroform. Secondary metabolite includes Shikimic, Gallic, Triacetic, Palmitic acid, β -sitosterol, and Daucosterol. Act by reducing the glucose level [30, 31].

2.10 *Andrographis paniculata* Burm. (Acanthaceae)

Andrographis paniculata significantly increases the activity of SOD and Catalase. It also reduced blood glucose level due to antioxidant activity [32]. The ethanolic extract of *Andrographis paniculata* possesses antidiabetic property and hypotriglyceridemic effect [33].

2.11 *Cinnamom zeylanicum* (Lauraceae)

Cinnamaldehyde is the primary active constituents of *Cinnamom zeylanicum*, which act as an increasing level of insulin released. Another important activity of cinnamaldehyde is insulinotropic effect due to glucose uptake increased through the glucose transporter translocation [34].

2.12 *Psidium guajava* L. (Myrtaceae)

Leaf and fruit part of *Psidium guajava* has potent antidiabetic and hypoglycemic activity. The active constituents of this plant including Terpen, Flavonoid, Strictinin, Isostrictinin, Pedunculagin, and Polysaccharides. Functional activity is decrease glucose level [45, 46, 47, 48]. Ethanol extract of stem barks exhibits significant hypoglycemic activity in alloxan induced hyperglycemic rats. Aqueous extracts of *Psidium guajava* also performed various antidiabetic effect, hypoglycemic activity, and hypolipidemia activity [35, 36].

2.13 *Curcuma longa* L. (Zingiberaceae)

Curcuma longa perform various types of antidiabetic effect like as hypoglycemic and also plays a significant effect in PPAR gamma activation [37].

2.14 *Tamarindus indica* L. (Caesalpinaceae)

Aqueous extract of *Tamarindus indica* when administered in mild diabetic or severe diabetic, its shows some important antidiabetic activity with attenuation of hyperglycemia and hyperlipidemia [38].

2.15 *Piper betle* (Piperaceae)

Aqueous extract of leaf used in important antidiabetic effects, which perform decreasing glucose concentration level and also decreased the rate of glycosylated hemoglobin [39, 40].

2.16 *Amaranthus esculentus* (Amaranthaceae)

The whole part of *Amaranthus esculentus* was used in beneficial effect in antidiabetic properties. The primary function of this plant is reducing the glucose level [41]. Another most important activity is increase insulin secretion [42].

2.17 *Scoparia dulcis* (Scrophulariaceae)

The aqueous extract of the whole plant was used in antidiabetic effects including decreased glucose concentration, reducing lipid and oxidative stress. It increases the insulin secretion [43, 44].

2.18 *Hordeum vulgare* (Gramineae)

The germinant fruits of *Hordeum vulgare* perform hypoglycemic and hyperinsulinemic effects in non-insulin dependent diabetic mellitus [49].

2.19 *Cuminum nigrum* L (Apiaceae)

Flavonoid is the primary active constituents of *Cuminum nigrum* which causes hypoglycemic effect both in normal and alloxan-diabetic rabbits [50]. As a potential antidiabetic agent it increased insulin sensitivity and promotes AMPK activation [51].

2.20 *Swertia chirayita* (Gentianaceae)

Swertia chirayita significantly increased the plasma insulin and reduced blood sugar [52]. Single oral administration of swerchirin to rats caused decreasing blood glucose with marked depletion of aldehyde fuchsin stained beta granules [53].

2.21 *Eugenia jambolana* (Asteraceae)

Fruit, pulp and Seed were used in antidiabetic effect. Aqueous and ethanolic extract were found. Primary functions of this plant including decreased blood glucose and lipid. Mostly increased glucose tolerance activity [54, 55].

2.22 *Azadirachta-indica* A. Juss. (Meliaceae)

Commonly known as Neem. It is a tree native to Bangladesh, India, Sri Lanka, Malaysia and Pakistan, growing in tropical and semi-tropical regions. The leaf part act as a strong antidiabetic agent of powder form. Aqueous extract and alcoholic extract were act as a significant hypoglycemic activity in high dose [56]. This plant also has some potential activity including anti-bacterial, antimalarial, antifertility, hepatoprotective and antioxidant effects [57].

2.23 *Ocimum sanctum* L. (Lamiaceae)

It is commonly known as Tulsi, found in Bangladesh. Since ancient times, this plant is known for its medicinal properties. The aqueous extract of leaves shows significant activity of decrease in blood sugar level in both normal and alloxan induced diabetic rats [58]. It also functions as a reduction of fasting blood glucose, uronic acid, total cholesterol, hypoglycemic and hypolipidemic in diabetic rats [59]. Primary another effects including antioxidant, antibacterial, antifungal,

antiviral, antiasthmatic, antistress, antitumor, gastric antiulcer activity, antimutagenic and immunostimulant activities [60].

2.24 *Mangifera indica* L. (Anacardiaceae)

Mangifera indica play an important role in antidiabetic effects. The aqueous extract of this plant produces decrease in blood glucose level, but does not have any effect on streptozotocin-induced diabetic mice under the same conditions when compared with that of an oral dose of chlorpropamide, it shows strong hypoglycemic activity [61].

2.25 *Abelmoschus moschatus* Medik (Malvaceae)

Abelmoschus moschatus is an aromatic medicinal plant commonly found in Bangladesh and nearly India. Myricelin is the primary active constituents of this plant, which improves insulin sensitivity through increased post receptor insulin signaling mediated by enhancements in IRS-1-associated PI3-kinase and GLUT 4 activity in muscles of obese Zucker rats [62].

Plant forms include the climbers, herbs, shrubs and trees. The plant parts used mostly from the identified plants include mostly the leaves, fruits and roots. Plant parts used in the treatment of diabetes and their frequencies are as shown in Figure 1.

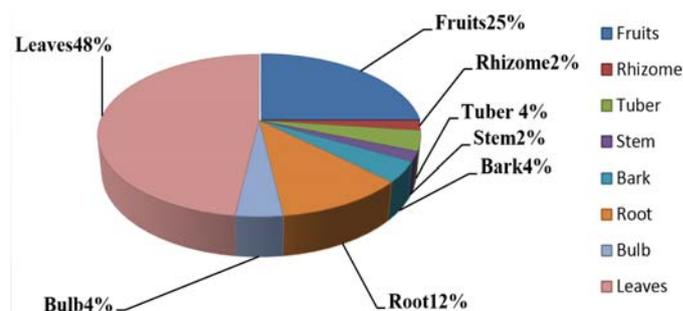


Fig 1: percentage occurrence of plants parts used for diabetes treatment [65]

Table 1: List of plants parts used with their antidiabetic effects.

S/ No.	Parts used	Botanical name of plants	Family	Antidiabetic and other beneficial effects	References
1.	Bulb	<i>Allium cepa</i>	Liliaceae	Controlled the activity of glucose 6 phosphatase and HMG- CO a reductase	[12,13,14,15]
2.	Root	<i>Asparagus racemosus</i>		Have insulinotropic activity	[16]
3.	Leaf	<i>Aloe vera</i>		Glucose uptake and insulin released against glycogenolysis or gluconeogenesis pathway	[22,23]
4.	Seed	<i>Brassica nigra</i>	Brassicaceae	Have ability to reducing the activity of fasting serum glucose level	[17]
5.	Full plant	<i>Catharanthus roseus</i>	Apocynaceae	The blood glucose level is reduced by <i>Catharanthus roseus</i>	[18]
6.	Bulb	<i>Allium sativum</i>	Alliaceae	Bulb part of this plant having antidiabetic effect.	[19,20,21]
7.	Fruit	<i>Capsicum frutescens</i>	Solanaceae	Increase serum insulin concentration in high fat diet	[24]
8.	Leaf and Fruit-Pulp	<i>Annona squamosa</i>	Annonaceae	Reduced the concentration of glucose, lipid and lipid peroxidation	[25,26,27,28,29]
9.	seed and fruit	<i>Terminalia chebula</i>	Combretaceae	Act by reducing the glucose level	[30,31]
10.	Leaf	<i>Andrographis paniculata</i>	Acanthaceae	Possesses antidiabetic property and hypotriglyceridemic effect	[32,33]
11.	Bark	<i>Cinnamon zeylanicum</i>	Lauraceae	Insulinotropic effect due to glucose uptake increased through the glucose transporter translocation	[50,51]
12.	Leaf and fruit	<i>Psidium guajava</i>	Myrtaceae	Performed various antidiabetic effect, hypoglycemic activity, and hypolipidemia activity	[35,36,45,46,47,48]

13.	Bark	<i>Curcuma longa</i>	Zingiberaceae	Perform various types of antidiabetic effect like as hypoglycemic activity	[37]
14.	Leaf	<i>Tamarindus indica</i>	Caesalpinaceae	Shows some important antidiabetic activity with attenuation of hyperglycemia and hyperlipidemia	[38]
15.	Leaf	<i>Piper betle</i>	Piperaceae	Perform decreasing glucose concentration level and also decreased the rate of glycosylated hemoglobin	[39,40]
16.	whole plant	<i>Amaranthus esculentus</i>	Amaranthaceae	Reducing the glucose level	[41,42]
17.	Whole plant	<i>Scoparia dulcis</i>	Scrophulariaceae	Increased the insulin secretion	[43,44]
18.	Fruit	<i>Hordeum vulgare</i>	Gramineae	Perform hypoglycemic and hyperinsulinemic effects in non insulin dependent diabetic mellitus	[49]
19.	Leaf	<i>Cuminum nigrum</i>	Apiaceae	Increased insulin sensitivity and promotes AMPK activation	[50,51]
20.	Leaf and Fruit	<i>Swertia chirayita</i>	Gentianaceae	Increased the plasma insulin and reduced blood sugar	[52,53]
21.	Fruit, pulp and Seed	<i>Eugenia jambolana</i>	Asteraceae	Increased glucose tolerance activity	[54,55]
22.	Leaf and bark	<i>Azadirachta indica</i>	Meliaceae	Has some potential activity including anti-bacterial, antimalarial, antifertility, hepatoprotective and antioxidant effects	[56,57]
23.	Whole plant	<i>Ocimum sanctum</i>	Lamiaceae	Decreased in blood sugar level	[58,59,60]
24.	Leaf and fruit	<i>Mangifera indica</i>	Anacardiaceae	Shows strong hypoglycemic activity	[61]
25.	Whole plant	<i>Abelmoschus moschatus</i>	Malvaceae	Improves insulin sensitivity	[62]

3. Discussion

In Bangladesh, Diabetes mellitus is a serious metabolic disorder. This type of diseases is caused by insufficient carbohydrate, fat and protein metabolism, obesity; hormonal irregularation. Moreover, uncontrolled diabetes leads to many chronic complications such as blindness, heart disease, and renal failure, etc. At present in the modern biological science diabetes is now treatment of reducing the hyperglycemic activity with ayurvedic plants formulations [63, 64]. The practice of traditional medicine has been with us from time immemorial and it is upon it that the rural population depends. Therefore treating diabetes mellitus with plant derived compounds which are accessible and do not require laborious pharmaceutical synthesis seems highly attractive. The presence of bioactive chemicals is mainly responsible for this antidiabetic action. However, many other active agents obtained from plants have not been well characterized. More investigations must be carried out to evaluate the mechanism of action of medicinal plants with antidiabetic effect.

4. Conflict of interest statement

We the authors declare that we have no conflict of interest.

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