

**Review Article**

**TRADITIONAL MEDICINAL SYSTEMS FOR TREATMENT OF DIABETES MELLITUS: A REVIEW**

**DIMPLE, ASHWANI KUMAR\*, VIKAS KUMAR, VIDISHA TOMER**

**Food Technology and Nutrition, School of Agriculture, Lovely Professional University, Phagwara, Punjab 144411, India  
Email: ashwanichandel480@gmail.com**

*Received: 19 Feb 2018 Revised and Accepted: 14 Apr 2018*

**ABSTRACT**

Diabetes mellitus (DM) is a chronic disease which has clinched the world. More than 300 million people of the world are suffering from this disease and the number is still increasing at a rapid rate as modern medical science has no permanent solution for the disease. Current scenario of the nutraceuticals has increased patient's faith on the traditional medicinal system and world nutraceutical industry is estimated to reach \$285.0 billion by 2021. The increasing trend of nutraceuticals in diabetes treatment makes it important to collect the traditional knowledge of medicines under one heading as it can help researchers to formulate new functional foods and nutraceuticals which can either lower down the risk or cure DM. In addition, the discussion of market available food products, their active components and possible health benefits can help the patients to understand the herbal medicines in a better way.

**Keywords:** Diabetes mellitus (DM), Herbal medicines, Traditional systems, Herbs

© 2018 The Authors. Published by Innovare Academic Sciences Pvt Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)  
DOI: <http://dx.doi.org/10.22159/ijpps.2018v10i5.25374>

**INTRODUCTION**

World health organization (WHO) has defined diabetes mellitus (DM) as a chronic disease caused by inherited and/or acquired deficiency in the production of insulin by the pancreas, or by the ineffectiveness of the insulin produced [1-3]. It is a metabolic disorder of endocrine system which is characterized by hyperglycemia or hypoglycemia. Diabetes is categorized into two types i.e. insulin-dependent (type 1) and insulin independent (type 2). Type 1 diabetes (insulin dependent) is caused due to the failure of the pancreas to produce insulin. This form develops most frequently in children and adolescents. On the other hand, Type 2 diabetes (insulin independent) results from the impaired action of insulin in the body. This type is more prevalent in adults in comparison to type 1 diabetes [4] and contributes to about 90 percent of the adult cases worldwide. Diabetes is a major risk factor for morbidities like blindness, kidney failure, heart attacks and limb amputation. It was the direct cause for 1.2 million deaths in 2015 [5]. In India, the number of diabetic patients has increased from 31.7 million in 2000 to 69.1 million in 2016 [6]. A record increase of 117% has been noticed in diabetic patients in last 16 y and India has now been declared as "Diabetic Capital" of the world [7]. Diabetes also increases the incidents of hypertension and approximately 70% of diabetic patients suffer from this side effect. Hypertension is related to increased risk of cardiovascular diseases (CVD) in diabetic patients [8]. Diabetes has no permanent cure but can be controlled or suppressed with the help of chemical or natural ways. Various chemical drugs like *miglitol*, *acarbose*, *metformin* etc. are used in the management of diabetes [9] whereas traditional medicinal systems rely on herbs to suppress diabetes. Researchers are still trying to find a medicine or product which can eradicate the disease from the roots [3]. Due to the lack of any solid claimant for the treatment of diabetes till date, many people continue to trust the indigenous

medicinal systems. Hence, it is important to review the various traditional medicinal systems, important herbs, their bioactive compounds and mechanism of treatment to generate useful information to carry future studies and develop drugs for the treatment of DM.

**Search criteria**

The review included articles until 2018. Articles related to indigenous herbal systems like Ayurveda, Chinese traditional medicines system, African medicinal system, Unani herbal system, the Greeco-Arab herbal system were reviewed for the study. Studies were included from Research gate, Google Scholar, Science Direct, Scopus, Pubmed, SciElo by using several keywords for search: world diabetes status, traditional medicinal systems for diabetes, herbs for diabetes, herbal drugs for diabetes, phytochemicals as hypoglycaemic agents. An attempt was made to review all the important literature from the ancient time to modern era. The scenario for the current herbal medicines was added by searching the online retail stores like Amazon and Indiamart. Google Scholar was used for citation and bibliography. CAS source index search tool was used for the abbreviation of journals.

**Blood glucose concentrations**

Glucose is considered as a source of energy and an essential nutrient for the body. Normal blood sugar level varies from person to person and normal range of blood sugar (fasting) and after eating (postprandial) has been reported to range within 70-100 mg/dl and 130-150 mg/dl, respectively [10]. A person having blood sugar level above this limit is said to be diabetic (table 1). In normal condition, insulin keeps blood glucose in a normal range but under diabetic conditions, insulin function is damaged and hence a high blood sugar level is observed. Not only the high blood sugar level but low blood sugar is also considered as a major health problem [11].

**Table 1: Different concentrations of blood glucose levels in different conditions**

Categories	Blood glucose levels	References
Normal (fasting)	70-100 mg/dl	[10]
Normal (post prandial)	130-150 mg/dl	[12]
Hypoglycaemia	Below 70 mg/dl	
Mild	Below 40 mg/dl	[13]
Severe	Below 20 mg/dl	
Hyperglycaemia	Above 250 mg/dl	
Mild (fasting)	>109 mg/dl	[14]
Severe (fasting)	>165 mg/dl	

### Different traditional medicinal systems for the treatment of diabetes mellitus

Every civilization has developed indigenous medicinal systems to treat or cure diseases with the help of locally available materials. The age-old experience of thousand years in medical therapy has made these systems more reliable. Majority of the population trusts the traditional medicinal systems over allopathic system due to its lesser-known health implications. Among the traditional medicinal systems; Indian, Chinese, Arab and African systems are world renowned and a crisp review of these medicinal systems has been presented here. A variety of herbal plants and trees used for the treatment of DM, their bioactive components, mode of action and related animal studies have been discussed here.

### Traditional medicinal system prevalent in India

Ayurveda is the major traditional system practised in India. Three elemental substances (*doshas*) are mentioned in Ayurveda, namely, *Vata*, *Pitta* and *Kapha*. An imbalance in these elements results in disease. This traditional system primarily relies on plants and herbs to treat diseases. A separate ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy (AYUSH) has been constituted under the government of India with a purpose to develop education and research in the indigenous medicinal system. By seeing the popularity of indigenous medicinal systems, All India Institute of Ayurveda has been established in national capital Delhi by the government of India [15].

Many herbs have been employed traditionally to treat diabetes in India (table 2). A list of indigenous flora i.e. *Neem* (*Azadirachta indica*), *Babul* (*Acacia arabica*), *Kawar* (*Aloe barbadensis*), *Peepal* (*Ficus religiosa*), *Jamun* (*Eugenia jambolana*), *Karela* (*Momordica charantia*), *Lahsun* (*Allium sativum*) etc. are used to treat DM [16]. These herbs are rich in antioxidants and phytochemicals. Phytochemicals increase antioxidant enzymes like catalase and glutathione, which suppress the high glucose levels and hence increase the insulin production in the body [17]. Amongst these, bittermelon is one of the most popular herbal plants used by *hakims* for preparation of anti-diabetic medicines in India. Bitter melon juice has been reported to be more effective than other forms as it reacts faster than any other formulation [18]. The beneficial effect of bitter melon has been reported due to its ability to maintain the structural integrity of the pancreatic islets and regulating the synthesis and release of pancreatic hormones [19]. It has also been reported to maintain blood cholesterol. Bitter melon is highly hypoglycaemic, so it has been advised to avoid its consumption with other medicines having a similar effect as it can immediately lower blood glucose level which leads to other health problems [20].

Nutraceutical industry has also knocked the door of medicinal systems and many ready to serve beverages and capsules like Health kart Karela, Diabeta, Neem Tea are commercially available in India. These herbal products claim to suppress the conditions like hepatic and renal problems which arise due to diabetes. Anti-stress properties have also been reported for such products [15]. In spite of commercially available herbal products, people have more faith in local *hakims/vaids* and hence, a large chunk of the traditional medicinal system is still unorganised.

Table 2: Popular Indian herbs used for the treatment of diabetes mellitus

Plant name (botanical name/Family)	Parts used	Bioactive compounds	Related animal studies	References
Peepal ( <i>Ficus religiosa</i> /Moraceae)	Leaves, bark, fruits, roots, seeds	Flavonoids, glycosides, alkaloids, steroids, saponins, vitamin C in non-enzymatic, enzymatic constituents are catalase, peroxidase etc.	Aqueous extracts of bark of peepal (50 and 100 mg/kg body weight) showed hypoglycemic effect in streptozotocin-induced diabetic rats.	[21] [22]
Blackberry ( <i>Syzygium cumini</i> or <i>Eugenia jambolana</i> /Myrtaceae)	Leaves, roots, bark, stem, seeds	Alkaloids, flavonoids, tannins, saponins, sterols, carbohydrates, polyphenols, ellagic acid, salicylic acid, fibre	Aqueous extract of seeds of <i>Syzygium cumini</i> (2.5 g and 5 g/kg body weight) showed a hypoglycemic effect in alloxan-induced diabetic rats. Ethanol extract of seeds of <i>Eugenia jambolana</i> (100 mg/kg body weight) showed hypoglycemic activity in alloxan-induced diabetic rats.	[23] [24]
Fenugreek ( <i>Trigonella foenum graecum</i> /Fabaceae)	Leaves and seeds	Saponins, steroids, methanol extract, gingerol, eugenol, cedrane, vanillin, zingerone.	Alkaloid extracts of fenugreek (60 mg/kg body weight) showed hypoglycemic effects in streptozotocin-induced hyperglycemic rats.	[25] [26]
Bitter melon ( <i>Momordica charantia</i> /Cucurbitaceae)	Pulp, seeds and leaves	Triterpene, protein, steroid, alkaloid, inorganic, lipids and phenolic compounds, saponins, charantin, resins	Aqueous extract of bitter melon lowered the glycemic response to both oral and intraperitoneal glucose load in normal mice without altering the insulin response. Aqueous extract powder of fresh unripe whole fruits at a dose of 20 mg/kg body weight reduced fasting blood glucose by 48%.	[19] [27]
Onion ( <i>Allium cepa</i> /Amaryllidaceae)	Whole	Alkaloids, flavonoids, cardiac glycosides, terpenes, steroids, and resins	A mixture of minerals and vitamin extract of onion juice (1 ml/100 g body weight) showed hypoglycemic activity in alloxan-induced rats.	[28] [29]
Holy basil ( <i>Ocimum sanctum</i> /Lamiaceae)	Leaves	Volatile oil, cirsilineol, circimaritin, isothymusin, rosmeric acid, apigenin, campesterol	Ethanol extracts of basil leaves (200 mg/kg body weight) showed hypoglycemic effects in streptozotocin-induced male albino rats.	[30]
Gum Arabic ( <i>Acacia nilotica</i> /Fabaceae)	Bark, pods, leaves	Tannins, gallic acid, alkaloids, saponins	Aqueous extracts of leaves of gum arabic showed hypoglycemic effects in alloxan-induced diabetic mice.	[31]
<i>Aloe vera</i> ( <i>Barbadensis mill</i> /Asphodelaceae)	Leaves extract	Anthraquinones, glycosides, vitamins (A, C, E), lipids, sterols, gibberlins, pseudoprotinosaponin AIII and prototinosaponins AIII	Anthraquinone extract of leaf pulp of <i>aloe vera</i> (300 mg/kg body weight) showed hypoglycemic effect in streptozotocin-induced adult male albino rats.	[32]
Gooseberry ( <i>Ribes uva- crispa</i> /Grossulariaceae)	Whole	Tannins, phenols, alkaloids, flavonoids, gallic acid, corilagin, geraniin, ellagic acid	Phenol extracts of gooseberry (13.5 mg/kg body weight) showed hypoglycemic activity in type 2 diabetic rat models.	[33] [34]

Mulberry ( <i>Morinda citrifolia</i> /Moraceae) And white mulberry ( <i>Morus alba</i> )	Leaves, fruits	Rutin, isoquercitrin, astragalinal, caffeic acid, ethanol, methanol, kaempferol	Terpenoids and flavonoid extract of white mulberry solids showed hypoglycemic effects in type 2 diabetic murine models of mice. Protein extracts of leaves of mulberry (35 mg/kg body weight) showed hypoglycemic effects in streptozotocin-induced diabetic rats. Methanol extracts of guava leaves (250 mg/kg body weight) showed hypoglycemic effects in streptozotocin and alloxan-induced diabetic mice.	[35] [36] [37]
Guava ( <i>Psidium guajava</i> /Myrtaceae)	Leaves, flowers, bark, roots, buds, twigs, fruits skin	Oxalic acid, malic acid, amylase, phenylpropyl acetate, butenyl acetate, tannins, resins, calcium oxalate, tannic acid, flavonoids, phenolic acid		[38] [39]
Radish ( <i>Raphanus sativus</i> /Brassicaceae)	Roots and leaves	Acetone, acetic acid, trifluoroacetic acid, anthocyanidin, phenols, anthocyanin, potassium chloride, sodium acetate	Aqueous extract of root juice (300 mg/kg body weight) showed hypoglycemic effects in streptozotocin-induced diabetic rats.	[40] [41]
Coriander ( <i>Coriandrum sativum</i> /Umbellifers)	Leaves, roots and seeds	Flavonoids, steroids, amino acids, saponins and tannins	A Dose of 200 mg/kg and 400 mg/kg body weight of a methanolic extract of coriander showed a significant dose-dependent decrease in blood glucose level.	[42] [43]
Cumin ( <i>Syzygium cumini</i> or <i>Cuminum cyminum</i> /Umbellifers)	Seeds	Flavonoids, anthraquinones, phytosterol, saponins, steroids, tannins, triterpenoids	Normal rats maintained on 1.25% cumin powder for 8 w showed reduction in hyperglycaemia and glucosuria.	[44] [45]
Cinnamon ( <i>Cinnamomum cassia</i> /Lauraceae)	Stems, seeds	Methylhydroxychalcone, tannins, flavonoids, glycosides, terpenoids, coumarins, anthraquinones	Streptozotocin-induced diabetic rats showed positive effects with cinnamon methanol extracts (3 g/kg body weight).	[46] [47]
Olives ( <i>Olea europaea</i> /Oleaceae)	Leaves, fruits, roots	Alkaloids, terpenes, secoridoids, ethanol, oleosides, tyrosol	Aqueous extracts of olive leaves (200 mg/kg body weight) showed hypoglycemic effects in streptozotocin-induced diabetic rats. Polyphenol extracts of olive leaves (500 mg/kg body weight in form of a tablet) showed a hypoglycemic effect in streptozotocin-induced diabetic rats.	[48] [49] [50]
Stinging nettle ( <i>Urtica pilulifera</i> or <i>Urtica dioica</i> /Urticaceae)	Leaves, stem, flowers	Ethanol, aluminium chloride, flavonoids, acetylcholine, histamine, phenylpropane, caffeic acid, chlorogenic acid, fatty acids	Acetate extracts of stinging nettle (100 mg/kg body weight) showed hypoglycemic effects in streptozotocin diabetic rats.	[51] [52]
Periwinkle ( <i>Catharanthus roseus</i> or <i>Vinca rosea</i> /Apocynaceae)	Leaves, roots, flowers	Alkaloids, bisphosphatase, fructose, superoxide dismutase, peroxidase, catalase, dichloromethane, methanol	Methanolic extracts of periwinkle (500 mg/kg body weight) showed hypoglycemic activity in alloxan diabetic rats. Organic extracts of the juice of fresh leaves of periwinkle (100 mg/kg body weight) showed hypoglycemic effects in alloxan diabetic rats.	[53] [54] [55]
Garlic ( <i>Allium sativum</i> /Amaryllidaceae)	Whole	Alkaloids, saponins, steroids, carbohydrates, tannins, flavonoids, terpenoids, phenolics	Minerals and vitamin extract of garlic juice (1 ml/100 g body weight) showed hypoglycemic effects in alloxan-induced diabetic rats. Garlic oil (50 mg/kg body weight) showed a hypoglycaemic effect in streptozotocin-induced white male albino rats.	[56] [57] [58]
Ginseng ( <i>Panax quinquefolius</i> /Araliaceae)	Leaves, flowers and berries	Triterpene, saponins, polyacetylenes, polysaccharides, nitrogen-containing compounds, ubiquitous, phenolic compounds	Improvement in renal damage was observed in streptozotocin-induced diabetic rats with ginseng due to heat processing aqueous extracts of ginseng (100 mg/kg body weight).	[59] [60]
Ginger ( <i>Zingiber officinale</i> /Zingiberaceae)	Whole	Flavonoids, saponins, tannins, terpenoids, phenols	Ethanol extract of ginger garlic powder (500 mg/kg body weight) showed a hypoglycemic effect in streptozotocin-induced diabetic rats.	[61] [62]
Lilac/Neem ( <i>Azadirachta indica</i> /Meliaceae)	Leaves, root, stem, flowers, seeds, bark	Isozadriolide, nimbaflavone, nimbandiol, nimbinene, nimbolide, quercetin, quercitrin	Ether extracts of neem seed (2 g/kg body weight) showed antidiabetic effects in streptozotocin-induced diabetic rats.	[63] [64]
Curry leaves ( <i>Murraya koenigii</i> /Rutaceae)	Leaves	Carbohydrates, alkaloids, phytosterols, alcohol, flavonoids, saponins, tannins, glycosides, carbohydrates	Aqueous extracts of curry leaves (300 mg/kg body weight) showed antidiabetic activity in alloxan-induced diabetic rats. Dried powdered curry leaves (35 mg/kg body weight) showed hypoglycemic effects in streptozotocin-induced diabetic rats.	[65] [66] [67]
Gymnema ( <i>Gymnema slyvestre</i> /Asclepiadaceae)	Leaves	Steroids, terpenoids, alkaloids, flavonoids, coumarins, saponins, tannins	Leaf ethanolic extracts showed hypoglycemic activity in streptozotocin-induced diabetic rats.	[68] [69]
Loquat ( <i>Eriobotrya japonica</i> /Rosaceae)	Fruits, dried leaves,	Triterpenes, flavonoids, glycosides, sesquiterpenes, ursolic acid, oleanolic acid, procyanidin B2, chlorogenic acid,	Ethanol extracts of seeds of loquat (8000 mg/kg body weight) showed hypoglycemic activity in Otsuka Long-Evans Tokushima fatty (OLETF)	[70]

Cardamom ( <i>Elettaria cardamomum/Zingiberaceae</i> )	seeds Leaves, fruits, seeds	epicatechin Flavonoids, tannins, saponins, quinone, glycoside, terpenoids, phenol, coumarins, steroids, alkaloids, anthocyanin	rats and mice. Flavonoid extract of cardamom, ginger and cinnamon (250 mg/kg body weight) showed hypoglycaemic activity in alloxan-induced diabetic rats.	[71] [72]
Sesame seed ( <i>Sesamum indicum/Pedaliaceae</i> )	Seeds, leaves	Flavonoids, protein, triterpenes, ethanol, polyphenols	Ethanol extract of sesame seeds (500 mg/kg body weight) showed hypoglycaemic activity in streptozotocin-induced diabetic rats.	[73] [74]
Celery seeds ( <i>Trachyspermum ammi/Apiaceae</i> )	Seeds, leaves	Alkaloids, flavonoids, steroids, tannins, saponins, glycosides, quinones, proteins, coumarins	Flavonoid extract of seeds (400 mg/kg body weight) showed anti glycaemic activity in streptozotocin-induced diabetic rats.	[75] [76]
Black pepper ( <i>Piper nigrum/Piperaceae</i> )	Seeds	Alkaloids, flavonoids, terpenes, steroids, lignans, phenolics	Aqueous extracts (300 mg/kg body weight) showed effect on antioxidant pathways in streptozotocin rats.	[77] [78]
Peppermint ( <i>Mentha piperita/lamiaceae</i> )	Leaves,	Flavonoids, phenols, terpenes	Juice of peppermint (0.29 g/kg body weight) showed anti glycaemic effects in streptozotocin induced male diabetic wistar rats.	[79] [80]

### Traditional medicinal system prevalent in China

In traditional Chinese medicinal system, diabetes is categorised as *Xiaokezheng* and *Xiaodanzheng*. The predominance of *yin* deficiency explains the syndrome differentiation of the disease. According to the religion of China, *yin* deficiency means negative forces which are present in the food and the universe. There should be a positive balance between *yin* (negative forces) and *yang* (positive forces). According to Chinese theory, these forces regulate the life of their people. Even if one of these forces is lacking, it results in the symptoms of DM. Inflammation in the stomach, deficiency of kidney *yin*, deficiency of and *yin* or *yin* and *yang* has been described as the symptoms of DM. The *yin*-deficiency may be due to emotional disorders, overstrain, improper diet and excessive sexual activities. Chinese doctor suggests the use of integrated treatment for diabetes. The treatment includes nourishing *yin*, moistening of dryness and

increasing fluid production. They usually mix two or more herbs together to make one formula which shows hypoglycaemic activity as well as suppresses the symptoms caused by the DM [81].

Chinese herbs (table-3) are reported to be most effective for type 2 DM, when they are consumed in mixture form. Chinese doctors always provide 2 or 3 types of medicines after examining the symptoms to reduce the effects. Indian Ayurveda and Chinese traditional system have many herbs (peepal, blackberry, onion, garlic etc.) in common [82]. Berberine is the most commonly found bioactive compound in major Chinese herbs used for the treatment of diabetes [83]. *Rhizoma coptidis* is the richest source for this bioactive compound [84]. There are 30 anti-diabetic herbal formulas in China which are chemically approved by the Chinese State Food and Drugs Administration (SFDA). This system is being practised for hundred years and is still followed [3].

Table 3: Important Chinese herbs for treatment of diabetes mellitus

Chinese name/English name	Botanical name/family	Parts used	Bioactive compounds	Related animal studies	Reference
<i>Shu di huang/Rehmania root</i>	<i>Rehmannia glutinosa/Scroph ula riaceae</i>	Roots	Catalpol, phenethyl alcohol, leucosceptoside, glycosides, monocyclic sesquiterpenes, pinelllic acid, mannitol, ajugol, uracil, raffinose, terpenoids	Oligosaccharide in <i>rehmanniae</i> (100 mg/kg body weight) showed hypoglycaemic effects in alloxan-induced diabetic rats.	[85]
<i>Guang fang ji/Hang fang ji</i>	<i>Stephania tetrandra moore/Meniper maceae</i>	Roots	Alkaloids, tetrandrine, protoberberine, morphinane, phenanthrene, steroids, terpenoids, lignans, coumarins	Alkaloids present in <i>Stephania tetrandra S. Moore</i> has been reported to cause anti-hyperglycaemic effects in streptozotocin diabetic mice at a dosage of 1 mg/kg body weight.	[86] [87]
<i>Huang lian/Coptis goldthread</i>	<i>Rhizoma coptidis/Ranuncu la</i>	Roots, stem, seeds, leaves	Isoquinoline, alkaloids, berberine, palmatine, jateorrhizine, epiberberine, coptisine	Berberine extract of coptis (200 mg/kg body weight) showed the hypoglycaemic activity in alloxan diabetic rats.	[84] [88]
<i>Huang Qi/Milk vetch root</i>	<i>Radix astragali/Fabace ae</i>	Roots	Isoflavones, isoflavonoids, saponins, galoside 2, astragaloside, polysaccharides	Ethanol extracts (2 g/kg body weight) showed hypoglycaemic activity in db/db induced diabetic mice.	[89] [90]
<i>Bai guo/Maidenhair tree</i>	<i>Ginkgo biloba/Ginkgoace ae</i>	Leaves	Flavonoid glycosides, terpene lactones, ginkgolic acids	<i>Ginkgo</i> protein extracts (200 mg/kg body weight) showed hypoglycaemic activity in pregnant rats and effect on their reproductive outcome.	[91]
<i>Wuweizi/Five flavor berry</i>	<i>Fructus schisandrae/Schis andreae</i>	Fruits	Lignans, polysaccharides	Flavonoids extracts showed hypoglycaemic activity in streptozotocin-induced rats.	[92]
<i>Pueraria /Gegen</i>	<i>Pueraria lobate/Fabaceae</i>	Dried roots	Isoflavonoids, triterpenoids	Isoflavin extracts of <i>pueraria</i> (100 mg/kg body weight) acted on skeletal muscles and improve insulin levels in the body of type 2 diabetic male sprague dawley rats' model.	[93]
<i>Shan zhu yu/Cornelian cherry</i>	<i>Cornus mas/Cornaceae</i>	Carp	Ethanol, ursolic acid, glycosides, loganic acid, oleanolic acid, mevaloside	Ethanol extract of cornelian cherries showed hypoglycaemic activity and directly affected the insulin levels in the pancreas in alloxan diabetic rats.	[94]

### Unani medicinal system

Unani system of medicine deals with various conditions of health and provides promotive, preventive and curative health care. Scientific principles and holistic concepts of health and healing are the basis of Unani treatment system [95]. This system is practiced in India, Bangladesh, Pakistan, Srilanka, Nepal, China, Iran, Iraq, Malaysia, Indonesia, Central Asia, Middle Eastern countries, some African and European countries [96]. Arabs developed the Unani medicinal system into elaborate medical sciences and its teaching was started in Greece. So, Unani medicinal system is also known as Greco-Arab medicinal system [97]. Unani medicinal system is based on four humors. These are 4 fluids of body i.e. blood, phlegm, yellow bile, and black bile which are related to mental, emotional, spiritual and physical causes of any disease. The humors are assigned temperament such as blood is hot and moist, phlegm is cold and moist, yellow bile is hot and dry, black bile is cold and dry [98]. Procedure of diagnosis of any disease in Unani medicinal system includes body heat, urine and stool examination, observation and palpitation. The prescriptions of medicines given by Unani medicinal

system contains detailed instructions about the dosage of the medicine [99]. This system was introduced to India in eighth century by Arabs and Iranians [95]. Herbs used for treatment of DM under Unani system are bitter apple, virgin's mental, cape lilac, spiny gourd, hisawarag, marshmallows, malabar nut, *senna*, fennel, licorice root *etc.* (table 4) [99].

Although the Unani system is known as a Greco-Arab system but with time Greco-Arab system has created a new identity and new system is somewhat different from Unani. In the Greco-Arab medicinal system, a mixture of four herbal plants is prepared. These medicinal plants are leaves of walnut (*Juglans regia*), olive (*Olea europaea*), nettle (*Urtica dioica*) and saltbush (*Atriplex*). The mixture is known as '*Glucoselevel*'. It has been reported to enhance the insulin production in the body and thus maintaining blood glucose level. Medicines prepared from these herbs or their products are used clinically [100]. Along with herbs, mineral extracts from animals are also used to prepare traditional medicines for the treatment of DM [100, 101]. The use of common Indian herbs like garlic and onion has been also reported in this medicinal system.

**Table 4: Herbs used for the treatment of diabetes mellitus in Unani system**

Herb name	Botanical name/family	Parts used	Bioactive compounds	Related animal studies	References
Bitter apple	<i>Citrullus colocynthus/Cucurbitaceae</i>	Fruits, leaves, roots and stem	Glycosides, alkaloids, flavonoids, carbohydrates, phenolic acids, tocopherols, carotenoids	Saponin extracts of the rind of bitter apple (50 mg/kg body weight) showed a hypoglycemic effect in alloxan diabetic rats and rabbits.	[102] [103]
Virgin's mantle	<i>Fagonia indica brum or Fagonia cretica/Zygophyllaceae</i>	Whole plant	Glycosides, saponins, tannins, alkaloids, flavonoids, anthraquinones, coumarins, phenols	Methanolic extracts of juice of virgin's mantle (500 mg/kg body weight) showed hypoglycemic effects in alloxan-induced diabetic rabbits.	[104] [105]
Cape lilac	<i>Melia azedarach/Meliaceae</i>	Fruits, leaves, stem, bark	Flavonoids, phenolic, linoleic acid, saponins, terpenoids, glycosides, rutins, alkaloids	Methanolic leaf extract showed an increase in wound healing capacity in alloxan diabetic rats.	[106] [107] [108]
Spiny gourd	<i>Mimordica dioca/Cucurbits</i>	Fruits, seeds	Phytic acid, alkaloids, flavonoids, steroids, saponins, triterpenoids, lectin	Methanol extracts of spiny gourd (300 mg/kg body weight) showed anti-diabetic activities in streptozotocin-induced diabetic rats.	[109] [110]
Hisawarg	<i>Rhazya stricta decne/Apocynaceae</i>	Fruits, seeds, flowers, leaves	Alkaloids, flavonoids, b-carboline	<i>Rhazya</i> (2-4 g/kg body weight) showed anti-diabetic properties in alloxan-induced diabetic rats. Lyophilized extracts (2.36 g/kg body weight) showed anti-diabetic effects in streptozotocin-induced diabetic rats.	[111] [112] [113]
Malabar nut	<i>Justicia adhatoda or Adhatoda zeylanica/Acanthaceae</i>	Leaves, roots	Carbohydrates, proteins, steroids, alkaloids	Ethanol extracts of leaves (50-100 mg/kg body weight) and roots (100 mg/kg body weight) showed anti-diabetic properties in alloxan-induced diabetic rats.	[114] [115]
<i>Senna</i>	<i>Senna didymobotrya or Senna auriculata/legumes</i>	Leaves	Flavonoids, steroids, phenols, tannins, alkaloids, terpenoids, glycosides, saponins	Ethanol extracts of leaves of <i>senna</i> (150 mg/kg body weight) showed hypoglycemic activity in streptozotocin-induced diabetic mice.	[116] [117]
Fennel	<i>Foeniculum vulgare/Umbellifers</i>	Leaves, flowers	Tannins, saponins, flavonoids, alkaloids, terpenoids	Aqueous extracts (300 mg/kg body weight) showed anti-diabetic activity in streptozotocin induced diabetic rats.	[118] [119]
Licorice root	<i>Glycyrrhiza glabra/legumes</i>	Leaves, fruits, stem, roots	Flavonoids, sterols, amino acids, saponins, triterpene, tannic acid, isoflavonoids, coumarins, still benoids	Flavonoid extract of licorice root oil showed anti-diabetic effects in obese diabetic rats.	[120] [121]

### Traditional medicinal system prevalent in Africa

In Africa, the traditional medicinal system is ritually followed in Guinea [122] and nearly 45000 species of medicinal plants are used in the treatment of various diseases [123]. Herbal medicines used in Africa are very effective and most of them have been approved chemically. According to 2005 data, about 80% of the people in Africa followed herbal treatments and had positive

results [124]. Many surveys have been conducted in Africa which proved the effectiveness of traditional medicines. Tsabang *et al.* conducted a survey on 116 diabetic patients in Cameroon, Africa in 2016 and reported that *Allium cepa*, *Momordica charantia*, *Persea americana* and *Phyllanthus amarus* were the principal plants used for the treatment of DM. Authors concluded that herbal medicine played an important role in the management of diabetes in Cameroon [125].

Table 5: Important herbs used in African medicinal system for the treatment of diabetes mellitus

Name of the herb (Botanical name/Family)	Parts used	Bioactive compounds	Related animal studies	Reference
Roiboss tea plant ( <i>Aspalathus linearis/Fabaceae</i> )	Leaves, stem, seeds	Aspalathin, dihydrochalcone, orientin, flavones, isovitexin, flavanones, tannins, flavanols	Alkaline extracts of rooibos tea (500 mg/kg body weight) showed hypoglycemic activity and reduced the oxidative stress in streptozotocin-induced diabetic rats.	[126] [127]
<i>Gotu kola</i> ( <i>Centella asiatica/Apiaceae</i> )	Leaves	Alkaloids, flavonoids, phenols, tannins, glycosides, steroids, saponins	Ethanol and methanolic extracts of leaves of this plant (250 mg/kg body weight) showed anti-diabetic effects in alloxan-induced diabetic rats.	[128] [129]
Honeybush/kustee/herbal tea ( <i>Cyclopia intermedia/Fabaceae</i> )	Leaves	Xenthone, magniferin, flavone, glycoside, flavanones, luteolin, isomagniferin, hesperetin, eriocitrin	Hot water aqueous honey bush extract (5 mg/kg body weight) showed anti-diabetic activities in streptozotocin-induced diabetic rats as well as in diet-induced diabetic rats.	[130]
Wood spider or devil's claw ( <i>Harpagophytum procumbens/Pedaliaceae</i> )	Leaves, roots	Flavonoids, phytosterols, glycosides, acteoside, isoacteoside	The secondary aqueous root extract of devil's claw plant (800 mg/kg body weight) showed hypoglycemic activity in streptozotocin induced diabetic rats.	[131] [132]
Umckalaabo ( <i>Pelargonium graveolens/Geraniaceae</i> )	Leaves	Terpenoids, flavonoids, phenolics, cinnamic acids, tannins, coumarins, isomenthone	Essential oil of leaves of <i>Pelargonium graveolens</i> (two doses of 75 mg/kg and 150 mg/kg body weight along with reference drug glibenclamide) showed hypoglycemic activity in alloxan-induced diabetic rats.	[133] [134]

#### Herbal formulations available in the market, their dosage and health claims

The traditional herbal medicine system has entered a new era of nutraceuticals. Many formulations of these herbal plants are available in the market in the form of pills, capsules, oils and syrups. These

products may either be a preparation of single herb or formulation of two or more herbs. Health claims for many disorders like obesity, DM, CVD and sex irregularities have been reported for these products [135-171]. These are known to control diabetes either by controlling glycemic index or enhancing the effectiveness of insulin. Major herbal products available in the market have been discussed in table 6.

Table 6: Herbal medicines available in Indian market, their dosage and their health claims

Medicines/Dosage	Herb present	Health claims	References
Stream CP3 Capsules/1 in a day	Peepal	Helps to cure diabetes, constipation treats ear infections, prevents arthritis, and heals wounds, treat skin conditions and show antimicrobial properties.	[135]
Herbal Hills Methi Seed Powder/once in a day	Fenugreek	Helps to treat diabetes and in proper digestion, helps to detoxify the body, supports uterine health.	[136]
Pitambri Karela Tablets/2 in a day, Himalaya Karela Tablets/2 in a day, Gluco Care Karela Medicine/2 in a day, Deemark Diaba Amrit/50 mg in a day	Bitter melon	Used in the treatment of DM, kidney stones, fever, reducing obesity, hypertension, cancer, improving immune functions.	[137] [138] [139] [140]
Reese Fresh Onion Juice/50 g a day,	Onion	Helps to cure DM, slower the rate of occurrence of cancer, CVDs.	[141]
Durkee Garlic Oil/2-5 mg,	Garlic	Helps to cure diabetes, CVD, hyperlipidemia, hypertension, helps in cancer, fungal infections, have antimicrobial effects.	[142] [143]
Bhumija Tulsi Capsules/2 in a day, Shivalik Tulsi Capsules/1 in a day, Patanjali Aloe vera Juice/10-20 ml daily, Triphala Aloe vera Juice/1 cap twice a day	Holy basil <i>Aloe vera</i>	Helps in diabetes fever, common cold, cough, sore throat, kidney stone and heart disorders. Helps to treat diabetes, hypertension, skin problems, rashes, wounds and hyperlipidemia.	[144] [145] [146] [147] [148]
Patanjali Amla Juice/20-30 ml daily, Himalaya Amla Capsules/1 in a day, Cure Garden Gluco Balance/2 in a day(added cumin)	Gooseberry	Helps to cure diabetes, improve digestion problems, good for hair health and also helps to cure respiratory problems.	[149] [150] [151]
Best Naturals Mulberry Leaf Extract/1g in a day	Mulberry	Helps to cure diabetes, prevent atherosclerosis, suppress effects of cancer and enhances immunity.	[152] [153]
Shri ji Neem Tablets/1-2 tablets daily, Ayurleaf Neem Capsules/1 d,	Lilac	Helps to cure diabetes, treat skin infections, helps in heart diseases, in fever, breathing conditions, cure malaria.	[154] [155]
Gold 350 Raw Coriander Seeds/In meal time vegetables we can add	Coriander	Helps to cure diabetes, high blood pressure, cholesterol and in urinary infections also.	[156]
Health Thru Nutrition Black Cumin Seed Oil/once in a day, Raw jeera seeds/in meal we can use	Cumin	Helps to cure diabetes, constipation, insomnia, bloating, and blood pressure.	[157]
The vitagreem Cinnamon/1 capsule in a day, Glucocare/1 capsule in a day, Nutri flair Ceylon Cinnamon Capsules/2 in a day	Cinnamon, bitter melon and turmeric	Helps to cure diabetes, allergies, relieve cold and flu, boost energy and improves digestion.	[158] [159] [160]
Livestamin Ashwagandha Capsules/2 in a day, Herbal Hills Dia Care Churna/2 spoons in morning in empty stomach	Ginseng	Helps to cure diabetes, to treat stress, boost the immune system, enhance stamina, and reduces high cholesterol, prevention of heart disease.	[161] [162]
In life Diastan/2 capsules in a day	Gymnema, basil,	Helps to cure diabetes, maintain lipid levels in the body,	[163]

Sunergetic Olive Leaf Extract/once in a day, Disano Olive Oil/can be taken with salads or in foods	peepal, fenugreek Olives	promotes healthy functioning of pancreatic cells. Helps to cure diabetes, maintain healthy heart, helps in weight loss, improve brain health, improve skin health and helps in hormone balancing.	[164] [165]
Planetary Herbals <i>Rehmannia Endurance</i> 150 Tabs/1 tablet 3 times a day	Rehmania root	Helps to cure DM, treat menopause, impotence, hair loss and other hormone deficiencies.	[166]
Radiant Natural Whole Herb Berberine 900 mg/2 capsules daily	Coptis goldthread	Helps to cure diabetes, maintain healthy cholesterol levels, manage triglycerides and support healthy lipid levels.	[167]
Pure Mountain Botanicals Immuno Well RX Capsules/1 capsule twice daily	Milk-vetch root, mushroom, garlic	Helps to cure diabetes, fight ageing signs, CVD and sometimes cancer.	[168]
Herbal Hills Dhamasa Powder/3 gms, 1 to 2 times daily	Dhamasa	Helps to cure diabetes, heart problems, support healthy liver functions, have antioxidant and thrombolytic properties.	[169]
Shri ji Herbal Spenai Bitter Powder Anidiabetic Medicine/2-3 teaspoons a day	Spiny gourd	Helps to cure diabetes, reduces weakness, controls excessive hunger, excessive thirst, maintains functions of organs, improves digestion and clears the bowel.	[170]
Piping Rock Licorice Root Liquid Extract (alcohol and sugar free)/2 ml, 2-3 times a day	Licorice root	Helps to cure diabetes, has antibacterial properties, beneficial for digestion, sooth irritation and helps relieve stomach ulcers.	[171]

## CONCLUSION

Increase in the number of diabetic patients, high cost for medical treatments, unsatisfactory treatment response and mistrust of people in present-day health care facilities signifies the still incomplete nature of the modern medicinal system. These factors are the major reasons for the continuous trust of people in the traditional medicinal systems. All the major traditional medicinal systems, viz., Indian, Chinese, African and Unani medicinal systems provide strong evidence for their effectiveness and the rationale for why people continue to trust traditional knowledge. It can be concluded that important constituents of Ayurveda and other traditional medicinal systems can provide a base for development of more effective drugs in modern medicinal system.

## AUTHORS CONTRIBUTIONS

All the authors have contributed equally

## CONFLICT OF INTERESTS

Declared none

## REFERENCES

- World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications: report of a WHO consultation. Part 1. Diagnosis and classification of diabetes mellitus; 1999.
- American Diabetic Association. Classification Diagnosis Diabetes 2015;38 Suppl 1:S8-16.
- Li WL, Zheng HC, Bukuru J, De Kimpe N. Natural medicines used in the traditional Chinese medical system for therapy of diabetes mellitus. *J Ethnopharmacol* 2004;92:1-21.
- Nagalakshmi K, Sujatha S. Nanoencapsulation augments release efficiency and glucose tolerance of 14-deoxy, 11,12-didehydro andrographolide loaded polycaprolactoe nanoparticles in streptozotocin-nicotinamide induced type 2 diabetes. *Int J Appl Pharm* 2017;9:51-3.
- About diabetes as a risk factor. Available from: <http://www.who.int/mediacentre/factsheets/fs312/en/> [Last accessed on 04 Apr 2018]
- Khavane Karna B, Magar Vidya K, Payghan S. A current status of diabetes mellitus in India: a review. *World J Pharm Pharm Sci* 2017;6:235-43.
- About Diabetes Capital of the world. Available from: <https://timesofindia.indiatimes.com/life-style/health-fitness/health-news/India-is-the-diabetes-capital-of-the-world/articleshow/50753461.cms> [Last accessed on 29 Nov 2017]
- Dhaliwali C, Erinmacpherson, Richardson J. Effectiveness of telephone-delivered interventions for increasing physical activity levels in persons with type 2 diabetes or hypertension: a systematic review. *J Crit Rev* 2015;2:6-11.
- About chemical drugs. Available from: [https://www.accessdata.fda.gov/drugsatfda\\_docs/label/2009/020682s0081bl.pdf](https://www.accessdata.fda.gov/drugsatfda_docs/label/2009/020682s0081bl.pdf). [Last accessed on 16 Mar 2018].
- About blood sugar levels. Available from: <https://www.LiveScience.Com/44498-what-is-normal-blood-sugar.html> [Last accessed on 29 Nov 2017].
- About blood sugar levels. Available from: <https://www.diabetesselfmanagement.com/blog/what-is-a-normal-blood-sugar-level/> [Last accessed on 29 Nov 2017]
- Srilakshmi B. Dietetics. 7<sup>th</sup>ed. New age international publishers; 2014.
- About blood glucose levels. Available from: <https://www.stlukesonline.org/health-services/health-information/healthwise/2017/06/27/13/25/diabetes-related-high-and-low-blood-sugar-levels> [Last accessed on 29 Nov 2017]
- About hyperglycemia. Available from: [https://www.emedicinehealth.com/high\\_blood\\_sugar\\_hyperglycemia/article\\_em.htm#high\\_blood\\_sugar\\_hyperglycemia\\_facts](https://www.emedicinehealth.com/high_blood_sugar_hyperglycemia/article_em.htm#high_blood_sugar_hyperglycemia_facts) [Last accessed on 29 Nov 2017].
- About AYUSH. Available from: <http://zeenews.india.com/india/prime-minister-narendra-modi-to-inaugurate-first-all-india-institute-of-ayurveda-on-ayurveda-day-dhanteras-2017-2050583.html> [Last accessed on 28 Nov 2017]
- Modak M, Dixit P, Londhe J, Ghaskadbi S, Devasagayam TP. Recent advances in Indian herbal drug research guest editor: Thomas Paul Asir Devasagayam Indian herbs and herbal drugs used for the treatment of diabetes. *J Clin Biochem Nutr* 2007;40:163-73.
- Rizvi SI, Mishra N. Traditional Indian medicines used for the management of diabetes mellitus. *J Diabetes Res* 2013:1-11. <http://dx.doi.org/10.1155/2013/712092>
- Abascal K, Yarnell E. Using bitter melon to treat diabetes. *J Altern Complement* 2005;11:179-84.
- Alam MA, Uddin R, Subhan N, Rahman MM, Jain P, Reza HM. Beneficial role of bitter melon supplementation in obesity and related complications in metabolic syndrome. *J Lipids* 2015;1-18. <http://dx.doi.org/10.1155/2015/496169>
- Bhowmik D, Tripathi K, Das B. Natural medicines used in the traditional Indian medical system for therapy of diabetes mellitus. *J Ethnopharmacol* 2007;92:1-21.
- Makhija IK, Sharma IP, Khamar D. Phytochemistry and pharmacological properties of *Ficus religiosa*: an overview. *Ann Biol Res* 2010;1:171-80.
- Pandit R, Phadke A, Jagtap A. Antidiabetic effect of *Ficus religiosa* extract in streptozotocin-induced diabetic rats. *J Ethnopharmacol* 2010;128:462-6.
- Prince PS, Menon VP, Pari L. Hypoglycaemic activity of *Syzigium cumini* seeds: effect on lipid peroxidation in alloxan diabetic rats. *J Ethnopharmacol* 1998;61:1-7.
- Sharma SB, Nasir A, Prabhu KM, Murthy PS, Dev G. Hypoglycaemic and hypolipidemic effect of ethanolic extract of seeds of *Eugenia jambolana* in alloxan-induced diabetic rabbits. *J Ethnopharmacol* 2003;85:201-6.
- El-Soud NH, Khalil MY, Hussein JS, Oraby FS, Farrag AH. Antidiabetic effects of fenugreek alkaloid extract in streptozotocin induced hyperglycemic rats. *J Appl Sci Res* 2007;3:1073-83.
- Al-Daghri NM, Alokail MS, Alkharfy KM, Mohammed AK, Abd-Alrahman SH, Yakout SM, *et al.* Fenugreek extract as an inducer

- of cellular death via autophagy in human T lymphoma jurkat cells. *BMC J Altern Complement* 2012;12:202.
27. Joseph B, Jini D. Antidiabetic effects of *Momordica charantia* (bitter melon) and its medicinal potency. *Asian Pac J Trop Dis* 2013;3:93-102.
  28. Gazuwa SY, Makanjuola ER, Jaryum KH, Kutshik JR, Mafulul SG. The Phytochemical composition of *Allium cepa*/*Allium sativum* and the effect of their aqueous extracts (cooked and raw forms) on the lipid profile and other hepatic biochemical parameters in female albino wistar rats. *Asian J Exp Biol Sci* Vol 2013;4:406-10.
  29. El-Demerdash FM, Yousef MI, El-Naga NA. Biochemical study on the hypoglycemic effects of onion and garlic in alloxan-induced diabetic rats. *Food Chem Toxicol* 2005;43:57-63.
  30. Vats V, Yadav SP, Grover JK. Ethanolic extract of *Ocimum sanctum* leaves partially attenuates streptozotocin-induced alterations in glycogen content and carbohydrate metabolism in rats. *J Ethnopharmacol* 2004;90:155-60.
  31. Mukundi MJ, Piero NM, Mwaniki NE, Murugi NJ, Daniel AS, Peter GK, et al. Antidiabetic effects of aqueous leaf extracts of *Acacia nilotica* in alloxan induced diabetic mice. *J Diabetes Metab* 2015;6:1-6.
  32. Abo-Youssef AM, Messiha BA. Beneficial effects of *Aloe vera* in treatment of diabetes: comparative *in vivo* and *in vitro* studies. *Bull Faculty Pharm Cairo University* 2013;51:7-11.
  33. Krishnaveni M, Mirunalini S. Amla-the role of ayurvedic therapeutic herb in cancer. *Asian J Pharm Clin Res* 2011;4:13-7.
  34. Pinto MDS, Kwon YI, Apostolidis E, Lajolo F, Genovese MI, Shetty K. Evaluation of red currants (*Ribes rubrum* L.), black currants (*Ribes nigrum* L.), red and green gooseberries (*Ribes uva-crispa*) for potential management of type 2 diabetes and hypertension using *in vitro* models. *J Food Biochem* 2010;34:639-60.
  35. Lee SY, Park SL, Hwang JT, Yi SH, Nam YD, Lim SI. Antidiabetic effect of *Morinda citrifolia* (Noni) fermented by cheonggukjang in KK-Ay diabetic mice. *J Evidence Based Complementary Altern Med* 2012;2256-64. <http://dx.doi.org/10.1155/2012/163280>.
  36. Shoaib ZM, Muhammad F, Javed I, Akhtar M, Khaliq T, Aslam B, et al. White mulberry (*Morus alba*): a brief phytochemical and pharmacological evaluations account. *Int J Environ Agric Res* 2013;15:612-20.
  37. Jeszka Skowron M, Flaczyk E, Jeszka J, Krejpcio Z, Krol E, Buchowski MS. Mulberry leaf extract intake reduces hyperglycaemia in streptozotocin (STZ)-induced diabetic rats fed high-fat diet. *J Funct Foods* 2014;8:9-17.
  38. Gutiérrez RM, Mitchell S, Solis RV. *Psidium guajava*: a review of its traditional uses, phytochemistry and pharmacology. *J Ethnopharmacol* 2008;117:1-27.
  39. Sengupta R, Sawant CS, Karmarkar SM, Bhagwat AM. Antihyperglycaemic anti diabetic effect of the leaf extracts of *Albizia lebbek* linn. (*benth*) and *Psidium guajava* linn. On alloxan and streptozotocin induced diabetic mice. *Asian J Pharm Clin Res* 2011;4:129-31.
  40. Hanlon PR, Barnes DM. Phytochemical composition and biological activity of 8 varieties of radish (*Raphanus sativus* L.) sprouts and mature taproots. *J Food Sci* 2011;76:185-92.
  41. Shukla S, Chatterji S, Mehta S, Rai PK, Singh RK, Yadav DK, et al. Antidiabetic effect of *Raphanus sativus* root juice. *Pharm Biol* 2011;49:32-7.
  42. Uma B, Prabhakar K, Rajendran S, Sarayu YL. Antimicrobial activity and phytochemical analysis of *Coriandrum sativum* against infectious diarrhea. *Ethnobot Leaflets* 2009;13:590-4.
  43. Mazhar J, Mazumder A. Evaluation of antidiabetic activity of methanolic leaf extract of *Coriandrum sativum* in alloxan induced diabetic rats. *Res J Pharm Biol Chem Sci* 2013;4:500-7.
  44. Kumar A, Ilavarasan R, Jayachandran T, Decaraman M, Aravindhana P, Padmanabhan N, et al. Phytochemicals investigation on a tropical plant, *Syzygium cumini* from Kattuppalayam, Erode district, Tamil Nadu, South India. *Pak J Nutr* 2009;8:83-5.
  45. Willatgamuwa SA, Platel K, Saraswathi G, Srinivasan K. Antidiabetic influence of dietary cumin seeds (*Cuminum cyminum*) in streptozotocin induced diabetic rats. *Nutr Res* 1998;18:131-42.
  46. Shihabudeen HM, Priscilla DH, Thirumurugan K. Cinnamon extract inhibits  $\alpha$ -glucosidase activity and dampens postprandial glucose excursion in diabetic rats. *Nutr Metab* 2011;8:1-11.
  47. Khaki A, Khaki AA, Hajhosseini L, Golzar FS, Ainehchi N. The anti-oxidant effects of ginger and cinnamon on spermatogenesis dys-function of diabetes rats. *African J Tradit Complement Altern Med* 2014;11:1-8.
  48. Omar SH. Oleuropein in olive and its pharmacological effects. *Sci Pharm* 2010;78:133-54.
  49. El-Amin M, Virk P, Elobeid MA, Almarhoon ZM, Hassan ZK, Omer SA, et al. Anti-diabetic effect of *Murraya koenigii* (L) and *Olea europaea* (L) leaf extracts on streptozotocin induced diabetic rats. *Pak J Pharm Sci* 2013;26:359-65.
  50. Wainstein J, Ganz T, Boaz M, Bar Dayan Y, Dolev E, Kerem Z, et al. Olive leaf extract as a hypoglycemic agent in both human diabetic subjects and in rats. *J Med Food* 2012;15:605-10.
  51. Kavalalı G, Tuncel H, Göksel S, Hatemi HH. Hypoglycemic activity of *Urtica pilulifera* in streptozotocin-diabetic rats. *J Ethnopharmacol* 2003;84:241-5.
  52. Farzami B, Ahmadvand D, Vardasbi S, Majin FJ, Khaghani SH. Induction of insulin secretion by a component of *Urtica dioica* leave extract in perfused islets of langerhans and its *in vivo* effects in normal and streptozotocin diabetic rats. *J Ethnopharmacol* 2003;89:47-53.
  53. Ahmed MF, Kazim SM, Ghori SS, Mehjabeen SS, Ahmed SR, Ali SM, et al. Antidiabetic activity of *Vinca rosea* extracts in alloxan-induced diabetic rats. *Int J Endocrinol* 2010:1-6. [Doi:10.1155/2010/841090](https://doi.org/10.1155/2010/841090).
  54. Nammi S, Boini MK, Lodagala SD, Behara RB. The juice of fresh leaves of *Catharanthus roseus* Linn. reduces blood glucose in normal and alloxan diabetic rabbits. *BMC Complementary Altern Med* 2003;3:1-4.
  55. Gajalakshmi S, Vijayalakshmi S, Devi RV. Pharmacological activities of *Catharanthus roseus*: a perspective review. *Int J Pharma Bio Sci* 2013;4:431-9.
  56. Divya BJ, Suman B, Venkataswamy M, Thyagaraju K. A study on phytochemicals, functional groups and mineral composition of *Allium sativum* (garlic) cloves. *Int J Curr Pharm Res* 2017;9:42-5.
  57. El-Demerdash FM, Yousef MI, El-Naga NA. Biochemical study on the hypoglycemic effects of onion and garlic in alloxan-induced diabetic rats. *Food Chem Toxicol* 2005;43:57-63.
  58. Ohaeri OC. Effect of garlic oil on the levels of various enzymes in the serum and tissue of streptozotocin diabetic rats. *Biosci Rep* 2001;21:19-24.
  59. Angelova N, Kong HW, Heijden R, Yang SY, Choi YH, Kim HK, et al. Recent methodology in the phytochemical analysis of ginseng. *Phytochem Anal* 2008;19:2-16.
  60. Kim HY, Kang KS, Yamabe N, Nagai R, Yokozawa T. Protective effect of heat-processed American ginseng against diabetic renal damage in rats. *J Agric Food Chem* 2007;55:8491-7.
  61. Hassan NA, Karunakaran R, Sankar U, Aye KM. Anti-inflammatory effect of *Zingiber officinale* on sprague dawley rats. *Asian J Pharm Clin Res* 2017;10:353-5.
  62. Islam MS, Choi H. Comparative effects of dietary ginger (*Zingiber officinale*) and garlic (*Allium sativum*) investigated in a type 2 diabetes model of rats. *J Med Food* 2008;11:152-9.
  63. Subapriya R, Nagini S. Medicinal properties of neem leaves: a review. *Curr Med Chem Anticancer Agents* 2005;5:149-56.
  64. Gupta S, Kataria M, Gupta PK, Murganandan S, Yashroy RC. Protective role of extracts of neem seeds in diabetes caused by streptozotocin in rats. *J Ethnopharmacol* 2004;90:185-9.
  65. Arulselvan P, Subramanian SP. Beneficial effects of *Murraya koenigii* leaves on antioxidant defense system and ultra-structural changes of pancreatic  $\beta$ -cells in experimental diabetes in rats. *Chem Biol Interact* 2007;165:155-64.
  66. Kesari AN, Kesari S, Singh SK, Gupta RK, Watal G. Studies on the glycemic and lipidemic effect of *Murraya koenigii* in experimental animals. *J Ethnopharmacol* 2007;112:305-11.
  67. Yadav S, Vats V, Dhunoo Y, Grover JK. Hypoglycemic and antihyperglycemic activity of *Murraya koenigii* leaves in diabetic rats. *J Ethnopharmacol* 2002;82:111-6.
  68. Gopinath S, Rakesh C, Murthy T, Dayananda K. Preliminary phytochemical evaluation of leaf extracts of *Gymnema sylvestre*, *Phyllanthus amarus*, *Phyllanthus reticulatus* of siddarabetta,

- Tumkur district, Karnatka. J Pharmacogn Phytochem 2012;4:109-11.
69. Kang MH, Lee MS, Choi MK, Min KS, Shibamoto T. Hypoglycemic activity of *Gymnema sylvestre* extracts on oxidative stress and antioxidant status in diabetic rats. J Agric Food Chem 2012;60:2517-24.
  70. Tanaka K, Nishizono S, Makino N, Tamaru S, Terai O, Ikeda I. Hypoglycemic activity of *Eriobotrya japonica* seeds in type 2 diabetic rats and mice. Biosci Biotechnol Biochem 2008;72:686-93.
  71. Vishwakarma S, Chandan K, Jeba RC, Khushbu S. Comparative study of qualitative phytochemical screening and antioxidant activity of *Mentha arvensis*, *Elettaria cardamomum* and *Allium porrum*. Indo Am J Pharm Res 2014;4:2538-56.
  72. El-Yamani MA. Cinnamon, cardamom and ginger impacts as evaluated on hyperglycemic rats. Res J Specific Education 2011;20:665-78.
  73. Park SH, Ryu SN, Bu Y, Kim H, Simon JE, Kim KS. Antioxidant components as potential neuroprotective agents in sesame (*Sesamum indicum*). Food Rev Int 2010;26:103-21.
  74. Bhuvanawari P, Krishnakumari S. Antihyperglycemic potential of *Sesamum indicum* (Linn) seeds in streptozotocin induced diabetic rats. Int J Pharm Sci 2012;4:527-31.
  75. Khadse PM, Deshmukh VR. Qualitative phytochemical analysis, pharmacological studies and traditional benefits of *Trachyspermum ammi* (L.) Spraug. Int J Appl Res 2017;3:49-51.
  76. Niaz K, Gull S, Zia MA. Antihyperglycemic/hypoglycemic effect of celery seeds (ajwain/ajmod) in streptozotocin induced diabetic rats. J Rawalpindi Med Coll 2013;17:134-7.
  77. Ahmad N, Fazal H, Abbasi BH, Farooq S, Ali M, Khan MA. Biological role of *Piper nigrum* L. (black pepper): a review. Asian Pac J Trop Biomed 2012;2:S1945-53.
  78. Rauscher FM, Sanders RA, Watkins JB. Effects of *piperine* on antioxidant pathways in tissues from normal and streptozotocin-induced diabetic rats. J Biochem Mol Toxicol 2000;14:329-34.
  79. Sharafi SM, Rasooli I, Owlia P, Taghizadeh M, Astaneh SD. Protective effects of bioactive phytochemicals from *Mentha piperita* with multiple health potentials. Pharmacogn Mag 2010;6:147-53.
  80. Barbalho SM, Damasceno DC, Spada AP, Silva VS, Martuchi KA, Oshiiwa M, et al. Metabolic profile of offspring from diabetic wistar rats treated with *Mentha piperita* (peppermint). Evid Based Complement Alternat Med 2011;1-6. <http://dx.doi.org/10.1155/2011/430237>
  81. Xie W, Zhao Y, Zhang Y. Traditional Chinese medicines in treatment of patients with type 2 diabetes mellitus. Evid Based Complement Alternat Med 2011;1-13. Doi:10.1155/2011/726723.
  82. Patwardhan B, Warude D, Pushpangadan P, Bhatt N. Ayurveda and traditional Chinese medicine: a comparative overview. J Evidence-Based Complementary Altern Med 2005;2:465-73.
  83. Lee YS, Kim WS, Kim KH, Yoon MJ, Cho HJ, Shen Y, et al. Berberine, a natural plant product, activates AMP-activated protein kinase with beneficial metabolic effects in diabetic and insulin-resistant states. Diabetes 2006;55:2256-64.
  84. Tang LQ, Wei W, Chen LM, Liu S. Effects of berberine on diabetes induced by alloxan and a high-fat/high-cholesterol diet in rats. J Ethnopharmacol 2006;108:109-15.
  85. Zhang R, Zhou J, Jia Z, Zhang Y, Gu G. Hypoglycemic effect of *Rehmannia glutinosa* oligosaccharide in hyperglycemic and alloxan-induced diabetic rats and its mechanism. J Ethnopharmacol 2004;90:39-43.
  86. Semwal DK, Badoni R, Semwal R, Kothiyal SK, Singh GJ, Rawat U. The genus *Stephania* (Menispermaceae): Chemical and pharmacological perspectives. J Ethnopharmacol 2010;132:369-83.
  87. Jung M, Park M, Lee HC, Kang YH, Kang ES, Kim SK. Antidiabetic agents from medicinal plants. Curr Med Chem 2006;13:1203-18.
  88. Wang D, Liu Z, Guo M, Liu S. Structural elucidation and identification of alkaloids in *Rhizoma coptidis* by electrospray ionization tandem mass spectrometry. J Mass Spectrom 2004;39:1356-65.
  89. Xiao W, Han L, Shi B. Microwave-assisted extraction of flavonoids from *Radix astragali*. Sep Purif Technol 2008;62:614-8.
  90. Hoo RL, Wong JY, Qiao CF, Xu A, Xu HX, Lam KS. The effective fraction isolated from *Radix astragali* alleviates glucose intolerance, insulin resistance and hypertriglyceridemia in db/db diabetic mice through its anti-inflammatory activity. J Clin Nutr Metab 2010;7:1-12.
  91. Rudge MV, Damasceno DC, Volpato GT, Almeida FC, Calderon ID, Lemonica IP. Effect of *Ginkgo biloba* on the reproductive outcome and oxidative stress biomarkers of streptozotocin-induced diabetic rats. Braz J Med Biol Res 2007;40:1095-9.
  92. Kim JO, Kim KS, Lee GD, Kwon JH. Antihyperglycemic and antioxidative effects of new herbal formula in streptozotocin-induced diabetic rats. J Med Food 2009;12:728-35.
  93. Chen X, Wang L, Fan S, Song S, Min H, Wu Y, et al. *Puerarin* acts on the skeletal muscle to improve insulin sensitivity in diabetic rats involving  $\mu$ -opioid receptor. Eur J Pharmacol 2018;818:115-23.
  94. Asgary S, Rafieian Kopaei M, Shamsi F, Najafi S, Sahebkar A. Biochemical and histopathological study of the anti-hyperglycemic and anti-hyperlipidemic effects of cornelian cherry (*Cornus mas* L.) in alloxan-induced diabetic rats. J Complementary Int Med 2014;11:63-9.
  95. Subbarayappa BV. The roots of ancient medicine: an historical outline. J Biosci 2001;26:135-43.
  96. Rahman R, Pasha S, Katoch D, Siddiqui K, Khan M, Jamil S. Unani system of medicine the science of health and healing; 2013. p. 1-16.
  97. Husain A, Sofi GD, Tajuddin T, Dang R, Kumar N. Unani system of medicine-introduction and challenges. Med J Islamic World Acad Sci 2010;18:27-30.
  98. Rahman SZ, Khan RA, Latif A. Importance of pharmaco vigilance in Unani system of medicine. Indian J Pharmacol 2008;40:S17-20.
  99. Said HM. The Unani system of health and medicare; 1983. p. 61-7.
  100. Said O, Fulder S, Khalil K, Azaizeh H, Kassis E, Saad B. Maintaining a physiological blood glucose level with 'glucoselevel', a combination of four anti-diabetes plants used in the traditional Arab herbal medicine. J Evidence-Based Complementary Altern Med 2008;5:421-8.
  101. Zaid H, Said O, Hadieh B, Saad AK. Diabetes prevention and treatment with Greco-Arab and Islamic-based natural products. Civilization 2011;15:19-38.
  102. Abdel-Hassan IA, Abdel-Barry JA, Mohammeda ST. The hypoglycaemic and antihyperglycaemic effect of *Citrullus colocynthis* fruit aqueous extract in normal and alloxan diabetic rabbits. J Ethnopharmacol 2000;71:325-30.
  103. Hussain AI, Rathore HA, Sattar MZ, Chatha SA, Sarker SD, Gilani AH. *Citrullus colocynthis* (L.) Schrad (bitter apple fruit): A review of its phytochemistry, pharmacology, traditional uses and nutritional potential. J Ethnopharmacol 2014;155:54-66.
  104. Anil P, Nikhil B, Manoj G, Prakash NB. Phytochemicals and biological activities of *Fagonia indica*. Int Res J Pharm 2012;3:56-9.
  105. Kamran SH, Shoaib RM, Mobasher Ahmad SI, Anwar R. Antidiabetic and renoprotective effect of *Fagonia cretica* L. methanolic extract and Citrus paradise Macfad. juice in alloxan induced diabetic rabbits. J Pharm Pharmacogn Res 2017;5:365-80.
  106. Munir A, Sultana B, Babar T, Bashir A, Amjad M, Hassan Q. Investigation on the antioxidant activity of leaves, fruit and stem bark of Dhraik (*Melia azedarach*). European J Appl Sci 2012;4:47-51.
  107. Sultana S, Asif HM, Akhtar N, Waqas M, Rehman SU. Comprehensive review on ethanobotanical uses, phytochemistry and pharmacological properties of *Melia azedarach* Linn. Asian J Pharm Clin Res 2014;6:26-32.
  108. Vijaya VT, Srinivasan D, Sengottuvelu S. Wound healing potential of *Melia azedarach* L. leaves in alloxan induced diabetic rats. Glob J Res Med Plants Indig Med 2012;1:265-71.
  109. Talukdar SN, Hossain MN. Phytochemical, phytotherapeutical and pharmacological study of *Momordica dioica*. J Evidence Based Complementary Altern Med 2014;1-11.
  110. Gupta R, Katariya P, Mathur M, Bajaj VK, Yadav S, Kamal R, et al. Antidiabetic and renoprotective activity of *Momordica dioica* in diabetic rats. Diabetologia Croatia 2011;40:81-8.
  111. Ali BH, Al-Qarawi AA, Bashir AK, Tanira MO. Phytochemistry, pharmacology and toxicity of *Rhazya stricta decne*: a review. Phytother Res 2000;14:229-34.

112. Ali BH. The effect on plasma glucose, insulin and glucagon levels of treatment of diabetic rats with the medicinal plant *Rhazya stricta* and with glibenclamide, alone and in combination. *J Pharm Pharmacol* 1997;49:1003-7.
113. Wasfi IA, Bashir AK, Amiri MH, Abdalla AA. The effect of *Rhazya stricta* on glucose homeostasis in normal and streptozotocin diabetic rats. *J Ethnopharmacol* 1994;43:141-7.
114. Bhatt M, Gahlot M, Juyal V, Singh A. Phytochemical investigation and antidiabetic activity of *Adhatoda zeylanica*. *Asian J Pharm Clin Res* 2011;4:27-30.
115. Gulfranz M, Ahmad A, Asad MJ, Afzal U, Imran M, Anwar P, et al. Antidiabetic activities of leaves and root extracts of *Justicia adhatoda* Linn against alloxan induced diabetes in rats. *Afr J Biotechnol* 2011;10:6101-6.
116. Ngule CM, Swamy A. Phytochemical and bioactivity evaluation of *Senna didymobotrya* Fresen Irwin used by the Nandi community in Kenya. *Int J Bioassays* 2013;2:1037-43.
117. Shanmugasundaram R, Devi KV, Soris TP, Maruthupandian A, Mohan VR. Antidiabetic, antihyperlipidaemic and antioxidant activity of *Senna auriculata* (L.) Roxb. leaves in alloxan induced diabetic rats. *Int J Pharm Tech Res* 2011;3:747-56.
118. Anitha T, Balakumar C, Ilango KB, Benedict Jose C, Vetrivel D. Antidiabetic activity of the aqueous extracts of *Foeniculum vulgare* on streptozotocin-induced diabetic rats. *Int J Adv Pharm Biol Chem* 2014;3:487-94.
119. Jamwal NS, Kumar S, Rana AC. Phytochemical and pharmacological review on *Foeniculum vulgare*. *Pharma Sci Monit* 2013;4:327-41.
120. Bahmani M, Sarrafchi A, Shirzad H, Shahinfard N, Rafieian-Kopaei M, Shahsavari S, et al. Pharmaceutical, phytochemical, and economical potentials of *Glycyrrhiza glabra* L: a review. *J Chem Pharm Sci* 2015;8:683-92.
121. Nakagawa K, Kishida H, Arai N, Nishiyama T, Mae T. Licorice flavonoids suppress abdominal fat accumulation and increase in blood glucose level in obese diabetic KK-Ay mice. *Biol Pharm Bull* 2004;27:1775-8.
122. Baldé NM, Youla A, Balde MD, Kake A, Diallo MM, Baldé MA, et al. Herbal medicine and treatment of diabetes in Africa: an example from Guinea. *Diabetes Metab* 2006;32:171-5.
123. Mahomoodally MF. Traditional medicines in Africa: an appraisal of ten potent African medicinal plants. *J Evidence Based Complementary Altern Med* 2013;1-14. Doi:10.1155/2013/617459.
124. Elujoba AA, Odeleye OM, Ogunyemi CM. Traditional medicine development for medical and dental primary health care delivery system in Africa. *Afr J Tradit Complement Altern Med* 2006;2:46-61.
125. Tsabang N, Ngah N, Estella FT, Agbor GA. Herbal medicine and treatment of diabetes in Africa: case study in cameroon. *Diabetes Case Rep* 2016;1:1-6.
126. Marnewick JL. Rooibos and honeybush: recent advances in chemistry, biological activity and pharmacognosy. *African Natural Plant Products: New Discoveries and Challenges in Chemistry and Quality*, Edition: 1. Chapter: 16, Publisher: Oxford University Press: Editors. Juliani HR, Simon JE, Ho C-T. 2009. p. 277-94.
127. Ulicna O, Vancova O, Bozek P, Carsky J. Rooibos tea (*Aspalathus linearis*) partially prevents oxidative stress in streptozotocin-induced diabetic rats. *Physiol Res* 2006;55:157-64.
128. Devi NN, Prabakaran JJ, Wahab F. Phytochemical analysis and enzyme analysis of endophytic fungi from *Centella asiatica*. *Asian Pac J Trop Biomed* 2012;2:S1280-4.
129. Chauhan PK, Pandey IP, Dhatwalia VK. Evaluation of the anti-diabetic effect of ethanolic and methanolic extracts of *Centella asiatica* leaves extract on alloxan induced diabetic rats. *Adv Biol Res* 2010;4:27-30.
130. Muller CJF, Joubert E, Gabuza K, Beer D, Fey SJ, Louw J. Assessment of the antidiabetic potential of an aqueous extract of honeybush (*Cyclopia intermedia*) in streptozotocin and obese insulin resistant wistar rats. In: Rasooli I. editor. *Phytochemicals-bioactivities and impact on health*. INTECH publishers; 2011. p. 313-34.
131. Mncwangi N, Chen W, Vermaak I, Viljoen AM, Gericke N. Devil's claw-a review of the ethnobotany, phytochemistry and biological activity of *Harpagophytum procumbens*. *J Ethnopharmacol* 2012;143:755-71.
132. Mahomed IM, Ojewole JA. Analgesic, antiinflammatory and antidiabetic properties of *Harpagophytum procumbens* DC (*Pedaliaceae*) secondary root aqueous extract. *Phytother Res* 2004;18:982-9.
133. Asgarpanah J, Ramezanloo F. An overview on phytopharmacology of *Pelargonium graveolens* L. *Indian J Traditional Knowledge* 2015;14:558-63.
134. Boukhris M, Bouaziz M, Feki I, Jemai H, Feki AE, Sayadi S. Hypoglycemic and antioxidant effects of leaf essential oil of *Pelargonium graveolens* L'Her. In alloxan induced diabetic rats. *Lipids Health Dis* 2012;11:1-10.
135. Stream CP3 Capsules. Available from: <https://www.indiamart.com/proddetail/stream-cp-3-capsules-15763594288.html> [Last accessed on 18 Dec 2017]
136. Herbal Hills Methi Powder. Available from: [https://www.amazon.com/Herbal-Hills-Methi-Powder-Fenugreek/dp/B00PJOPX86/ref=sr\\_1\\_2\\_a\\_it?ie=UTF8&qid=1517825999&sr=8-2&keywords=herbal+hills+methi+seed+powder](https://www.amazon.com/Herbal-Hills-Methi-Powder-Fenugreek/dp/B00PJOPX86/ref=sr_1_2_a_it?ie=UTF8&qid=1517825999&sr=8-2&keywords=herbal+hills+methi+seed+powder). [Last accessed on 18 Dec 2017].
137. Pitambri Karela Tablets. Available from: <https://dir.indiamart.com/search.mp?ss=Pitambri+Karela+Tablets> [Last accessed on 18 Dec 2017]
138. Himalaya Karela Tablets. Available from: <https://www.indiamart.com/proddetail/karela-tablets-16516304791.html> [Last accessed on 18 Dec 2017]
139. Gluco Care Karela Medicine. Available from: <https://dir.indiamart.com/proddetail/deemark-diaba-amrit-11256098630.html> [Last accessed on 18 Dec 2017]
140. Reese Onion Juice. Available from: [https://www.amazon.com/Reese-Onion-Juice-Use-Powdered-1-Bottle/dp/B079DD6Q3M/ref=sr\\_1\\_1\\_a\\_it?ie=UTF8&qid=1517852382&sr=8-1&keywords=Reese+Fresh+Onion+Juice](https://www.amazon.com/Reese-Onion-Juice-Use-Powdered-1-Bottle/dp/B079DD6Q3M/ref=sr_1_1_a_it?ie=UTF8&qid=1517852382&sr=8-1&keywords=Reese+Fresh+Onion+Juice) [Last accessed on 20 Dec 2017].
141. Durkee Garlic Oil. Available from: [https://www.amazon.com/Durkee-Liquid-Garlic-32-Ounce/dp/B007KZJOPK/ref=sr\\_1\\_fkmr1\\_1\\_s\\_it?s=grocery&ie=UTF8&qid=1517852898&sr=1-1-fkmr1&keywords=Falcon+Garlic+Oil](https://www.amazon.com/Durkee-Liquid-Garlic-32-Ounce/dp/B007KZJOPK/ref=sr_1_fkmr1_1_s_it?s=grocery&ie=UTF8&qid=1517852898&sr=1-1-fkmr1&keywords=Falcon+Garlic+Oil) [Last accessed on 20 Dec 2017]
142. Bongiorno PB, Fratellone PM, LoGiudice P. Potential health benefits of garlic (*Allium sativum*): a narrative review. *J Complementary Integr Med* 2008;5:1-24.
143. Bhumija Tulsi Capsules. Available from: <https://www.indiamart.com/proddetail/tulsi-capsules-11193144488.html> [Last accessed on 20 Dec 2017]
144. Shivalik Tulsi Capsules. Available from: <https://www.indiamart.com/proddetail/tulsi-capsules-7249169897.html> [Last accessed on 20 Dec 2017]
145. Patanjali Aloe vera Juice. Available from: <https://www.indiamart.com/proddetail/patanjali-aloe-vera-juice-13718436862.html> [Last accessed on 20 Dec 2017]
146. Triphala Aloe vera Juice. Available from: <https://www.indiamart.com/proddetail/triphala-aloe-vera-juice-12294363430.html> [Last accessed on 20 Dec 2017]
147. Loots DT, Westhuizen FH, Botes L. *Aloe ferox* leaf gel phytochemical content, antioxidant capacity, and possible health benefits. *J Agric Food Chem* 2007;55:6891-6.
148. Patanjali Amla Juice. Available from: <https://www.indiamart.com/proddetail/patanjali-amla-juice-17957857533.html> [Last accessed on 20 Dec 2017]
149. Himalaya Organic Amla Capsules. Available from: [https://www.amazon.com/Himalaya-Organic-Natural-Antioxidant-Support/dp/B001GCTT10/ref=sr\\_1\\_1\\_a\\_it?s=grocery&ie=UTF8&qid=1517853752&sr=8-1&keywords=Himalaya+Amla+Capsules](https://www.amazon.com/Himalaya-Organic-Natural-Antioxidant-Support/dp/B001GCTT10/ref=sr_1_1_a_it?s=grocery&ie=UTF8&qid=1517853752&sr=8-1&keywords=Himalaya+Amla+Capsules) [Last accessed on 20 Dec 2017].
150. Cure Garden Gluco Balance. Available from: <https://dir.indiamart.com/search.mp?ss=Cure+Garden+Gluco+Balance> [Last accessed on 20 Dec 2017].
151. Best Naturals Mulberry Extract. Available from: <https://www.amazon.com/Best-Naturals-Mulberry-Extract->

- Count/dp/B00FM9RUNY/ref=sr\_1\_1\_a\_it?s=groceryandie=UTF8&andqid=1517854008&andsr=8-1&andkeywords=Swanson+White+Mulberry+Leaf+Extract [Last accessed on 20 Dec 2017]
152. Butt MS, Nazir A, Sultan MT, Schroën K. *Morus alba L.* nature's functional tonic. Trends Food Sci Technol 2008;19:505-12.
  153. Neem Capsules. Available from: <https://www.indiamart.com/proddetail/neem-capsules-10344830488.html> [Last accessed on 23 Dec 2017].
  154. Ayurleaf Neem Capsules. Available from: <http://www.ayurleaf.in/ayurvedic-supplements.html#neem-capsules> [Last accessed on 23 Dec 2017].
  155. Coriander Gold 350 Seeds. Available from: <http://www.sikkoindustries.net/vegetable-seeds.html#coriander-gold-350-seeds> [Last accessed on 23 Dec 2017]
  156. Black Cumin Seed Oil Softgels. Available from: [https://www.amazon.com/Black-Cumin-Seed-Oil-Softgels/dp/B01M1CKOSN/ref=sr\\_1\\_1\\_sspa?ie=UTF8&andqid=1517938031&andsr=8-1-sponsandkeywords=health%2Bthru%2Bnutrition%2Bblack%2Bcumin%2Bseed%2Boil&andth=1](https://www.amazon.com/Black-Cumin-Seed-Oil-Softgels/dp/B01M1CKOSN/ref=sr_1_1_sspa?ie=UTF8&andqid=1517938031&andsr=8-1-sponsandkeywords=health%2Bthru%2Bnutrition%2Bblack%2Bcumin%2Bseed%2Boil&andth=1) [Last accessed on 23 Dec 2017]
  157. Dalchini Capsules. Available from: <http://www.vitawinherbal.com/single-herb-capsule.html#dalchini-capsule> [Last accessed on 25 Dec 2017]
  158. Himalaya Gluco Care Diabecon Gymnema Capsules. Available from: [https://www.amazon.com/Himalaya-GlucoCare-Diabecon-Gymnema-Capsules/dp/B000H89G2I/ref=sr\\_1\\_1\\_s\\_it?s=hpcandie=UTF8&andqid=1517938388&andsr=1&andkeywords=GlucoCare&anddpID=61iHqD6l5vL&andpreST=\\_S\\_X300\\_QL70\\_&anddpSrc=src](https://www.amazon.com/Himalaya-GlucoCare-Diabecon-Gymnema-Capsules/dp/B000H89G2I/ref=sr_1_1_s_it?s=hpcandie=UTF8&andqid=1517938388&andsr=1&andkeywords=GlucoCare&anddpID=61iHqD6l5vL&andpreST=_S_X300_QL70_&anddpSrc=src) [Last accessed on 25 Dec 2017]
  159. Nutria Flair Cinnamon Organic Serving Capsules. Available from: [https://www.amazon.com/NutriFlair-Cinnamon-Organic-Serving-Capsules/dp/B01GNUJEZV/ref=sr\\_1\\_1\\_sspa?s=hpcandie=UTF8&andqid=1517938692&andsr=1-1-sponsandkeywords=Ceylon+Cinnamon+Powder+for+diabetic+patients&andpsc=1](https://www.amazon.com/NutriFlair-Cinnamon-Organic-Serving-Capsules/dp/B01GNUJEZV/ref=sr_1_1_sspa?s=hpcandie=UTF8&andqid=1517938692&andsr=1-1-sponsandkeywords=Ceylon+Cinnamon+Powder+for+diabetic+patients&andpsc=1) [Last accessed on 25 Dec 2017].
  160. Ashwagandha Capsules. Available from: <https://www.indiamart.com/proddetail/ashwagandha-capsules-12717607512.html> [Last accessed on 25 Dec 2017]
  161. Herbal Hills Dia Care Churna. Available from: [https://www.amazon.com/Herbal-Hills-Dia-Care-Churna/dp/B00PJOLZXL/ref=sr\\_1\\_2\\_s\\_it?s=hpcandie=UTF8&andqid=1517939478&andsr=1-2&andkeywords=Herbal+Hills+Dia+Care+Churna](https://www.amazon.com/Herbal-Hills-Dia-Care-Churna/dp/B00PJOLZXL/ref=sr_1_2_s_it?s=hpcandie=UTF8&andqid=1517939478&andsr=1-2&andkeywords=Herbal+Hills+Dia+Care+Churna) [Last accessed on 25 Dec 2017]
  162. Inlife Diastan Diabetic Balance Supplement. Available from: [https://www.amazon.com/INLIFE-Diastan-Diabetic-Balance-Supplement/dp/B0776RLDL3/ref=sr\\_1\\_1\\_s\\_it?s=hpcandie=UTF8&andqid=1517939753&andsr=1-1&andkeywords=Inlife+Diastan](https://www.amazon.com/INLIFE-Diastan-Diabetic-Balance-Supplement/dp/B0776RLDL3/ref=sr_1_1_s_it?s=hpcandie=UTF8&andqid=1517939753&andsr=1-1&andkeywords=Inlife+Diastan) [Last accessed on 27 Dec 2017]
  163. Sunergetic Olive Leaf Extract. Available from: [https://www.amazon.com/gp/product/B01H46PX8Q/ref=abs\\_brd\\_tag\\_dp](https://www.amazon.com/gp/product/B01H46PX8Q/ref=abs_brd_tag_dp) [Last accessed on 27 Dec 2017]
  164. Disano Olive Extra Light Flavour. Available from: [https://www.amazon.com/Disano-Olive-Extra-Light-Flavour/dp/B016DM4PTK/ref=sr\\_1\\_1\\_a\\_it?ie=UTF8&andqid=1517940492&andsr=8-1&andkeywords=Disano+Olive+Oil](https://www.amazon.com/Disano-Olive-Extra-Light-Flavour/dp/B016DM4PTK/ref=sr_1_1_a_it?ie=UTF8&andqid=1517940492&andsr=8-1&andkeywords=Disano+Olive+Oil) [Last accessed on 27 Dec 2017]
  165. Planetary Herbals Rehmannia Endurance 150 Tabs. Available from: [https://www.amazon.com/Rehmannia-Endurance-Planetary-Herbals-Tabs/dp/B005P0NKES/ref=sr\\_1\\_1\\_a\\_it?s=groceryandie=UTF8&andqid=1517940559&andsr=8-1&andkeywords=Planetary+Herbals+Rehmannia+Endurance+150+Tab&anddpID=416A5r-954L&andpreST=\\_SY300\\_QL70\\_&anddpSrc=srch](https://www.amazon.com/Rehmannia-Endurance-Planetary-Herbals-Tabs/dp/B005P0NKES/ref=sr_1_1_a_it?s=groceryandie=UTF8&andqid=1517940559&andsr=8-1&andkeywords=Planetary+Herbals+Rehmannia+Endurance+150+Tab&anddpID=416A5r-954L&andpreST=_SY300_QL70_&anddpSrc=srch) [Last accessed on 27 Dec 2017]
  166. Pure Berberine 900 mg Serving Capsules. Available from: <https://www.amazon.com/Pure-Berberine-900-mg-Serving-Capsules/dp/B017DULZKI> [Last accessed on 27 Dec 2017]
  167. Pure Mountain Botanicals Immuno Well RX Capsules. Available from: [https://www.amazon.com/Immuno-Well-Capsules-Organic-Astragalus/dp/B00SLU00SI/ref=sr\\_1\\_1\\_a\\_it?s=groceryandie=UTF8&andqid=1517942154&andsr=8-1&andkeywords=Pure+Mountain+Botanicals+Astragalus+Capsules](https://www.amazon.com/Immuno-Well-Capsules-Organic-Astragalus/dp/B00SLU00SI/ref=sr_1_1_a_it?s=groceryandie=UTF8&andqid=1517942154&andsr=8-1&andkeywords=Pure+Mountain+Botanicals+Astragalus+Capsules) [Last accessed on 27 Dec 2017]
  168. Herbal Hills Dhamasa Powder. Available from: [https://www.amazon.com/Herbal-Hills-Dhamasa-Powder-Pack/dp/B0146M8UEA/ref=sr\\_1\\_1\\_s\\_it?s=groceryandie=UTF8&andqid=1517942606&andsr=1-1&andkeywords=Herbal+Hills+Dhamasa+Powder&anddpID=51Llnphr8sL&andpreST=\\_SY300\\_QL70\\_&anddpSrc=srch](https://www.amazon.com/Herbal-Hills-Dhamasa-Powder-Pack/dp/B0146M8UEA/ref=sr_1_1_s_it?s=groceryandie=UTF8&andqid=1517942606&andsr=1-1&andkeywords=Herbal+Hills+Dhamasa+Powder&anddpID=51Llnphr8sL&andpreST=_SY300_QL70_&anddpSrc=srch) [Last accessed on 27 Dec 2017]
  169. Shri ji Herbal Spenai Bitter Powder. Available from: <http://www.shrijiherbalproducts.net/anti-diabetic-medicines.html#spenai-powder> [Last accessed on 28 Dec 2017]
  170. Piping Rock Licorice Extract. Available from: [https://www.amazon.com/Piping-Rock-Licorice-Extract-Dropper/dp/B01E4GDWAU/ref=sr\\_1\\_1\\_a\\_it?s=groceryandie=UTF8&andqid=1517943202&andsr=8-1&andkeywords=Piping%2BRock%2BLicorice%2BRoot%2BLiquid%2BExtract&andth=1](https://www.amazon.com/Piping-Rock-Licorice-Extract-Dropper/dp/B01E4GDWAU/ref=sr_1_1_a_it?s=groceryandie=UTF8&andqid=1517943202&andsr=8-1&andkeywords=Piping%2BRock%2BLicorice%2BRoot%2BLiquid%2BExtract&andth=1) [Last accessed on 28 Dec 2017]