

Medicinal Herbal Plants Useful for Diabetes

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Abstract: *The world is currently facing a diabetes epidemic. The World Health Organization (WHO) reported that the global prevalence of DM was 171 million in 2000 and will increase to approximately 366 million by 2030. However, the global prevalence of DM has already reached 346 million in 2010. About 1.6 million deaths are directly attributable to diabetes. Another 2.2 million deaths were caused by high blood sugar in 2012. The prevalence of diabetes has increased more rapidly in middle- and low-income countries. The exponentially increasing future high prevalence of DM accounts for most of the mortality and morbidity worldwide. Danger sign of diabetes and related diseases. India has been the source of human development and revolution since ancient times. We have a rich history and knowledge of the plants and animals used in the healing system. Plants have been used in medicine since the ancient Indian system of Ayurveda. Thus, we found that the diabetic drug system is highly dependent on the composition of synthetic drugs. In this review, we try to complete the traditional, phytochemical and pharmacological studies of medicinal plants. Natural products were considered the best choice because they are less harmful to the environment and other non-target organisms.*

Keywords: Diabetes, Prevalence, Medicinal herbs, Ayurveda's, Plant

I. INTRODUCTION

Diabetes is a metabolic disorder characterized by high fasting and postprandial blood sugar. Diabetes has become a major health problem affecting about 65 million people in India. This number is likely to double by 2030. The World Health Organization (WHO) has estimated that diabetes will be the seventh leading cause of death by 2030 and has suggested that a healthy lifestyle and the right medicines can prevent and avoid the consequences of diabetes. For decades, medicinal plants have been a useful tool in the treatment of diseases, including diabetes .

Types of diabetes:

The most common types are type I, type II and gestational diabetes.

Type 1. diabetes:

Also called IIDM (insulin-dependent diabetes mellitus or juvenile diabetes).

Type 2.diabetes:

Also called NIIDM (non-insulin-dependent diabetes mellitus or "adult-onset" diabetes) .

Type 3 .Gestational diabetes:

When pregnant women with no history of diabetes have high blood sugar during pregnancy. This can lead to the development of type II DM. Congenital diabetes, cystic fibrosis are other forms of diabetes.

Symptoms of Diabetes :

1. Type 1 Diabetes symptoms :



Fig :1

2. Type 2 Diabetes symptoms :

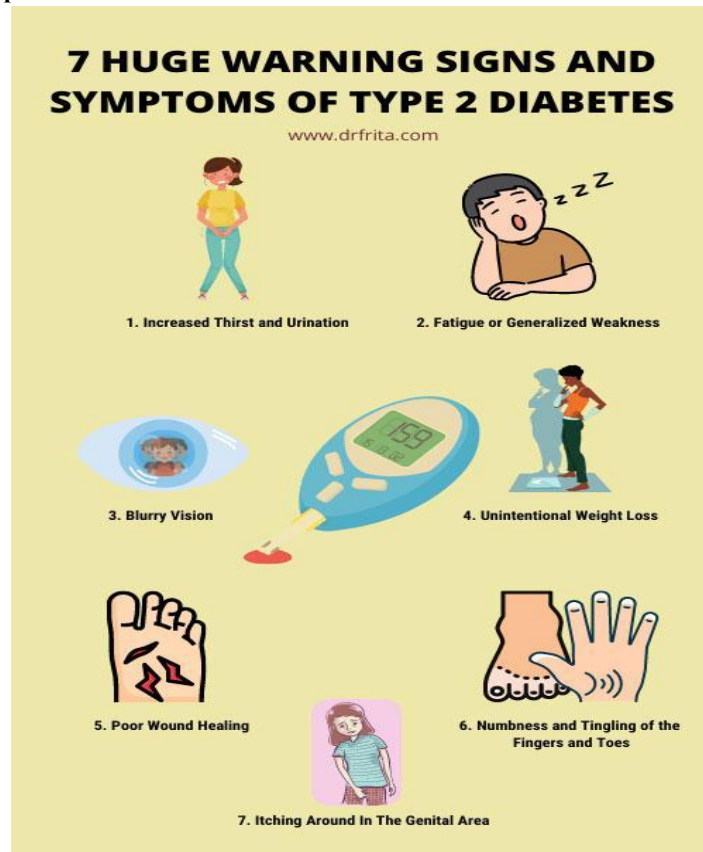


Fig : 2

Medicinal herbal plants Which are useful in diabetes are :



Fig : 3

Abrus precatorius

Family: Fabaceae

Local Name: Gunchi

Common Name: Rosary Pea

Name Part Used :Leaf

Mode Of Application : Leaf juice (2 teaspoon) given orally twice a day till cure.

Active Constituents :Glycyrrhizin, terpene, glycosides, pinitol

The plant is native to India and grows in tropical and subtropical areas of the world where it has been introduced. The principal constituents of *Abrus precatorius* are flavonoids, triterpene glycosides, abrin and alkaloids. Pharmacological activities include antibacterial, antifungal, antitumor, analgesic, anti-inflammatory, antispasmodic, anti-diabetic, antiserotonergic, anti-migraine. Its leaves are used as nerve tonic, applied on cuts and swellings and mouth ulcer. *Abrus precatorius* is also used as an abortifacient, laxative, sedative and aphrodisiac. The Roots are used for gonorrhoea, jaundice and haemoglobinuria bile. The leaves are used for their anti-supportive properties.



Fig : 4

Aegle marmelos

Family: Rutaceae

Local Name: Bael

Common Name: Stone apple

Name Part Used :Leaf

Mode Of Application :powder with cow' s milk is taken orally/extracted juice mixed with a pinch of black pepper is taken orally with water daily for about one month.

Active Constituents : rutin , flavone, glycoside

The trees grow throughout deciduous forest of India and ripen fruits are commonly used for delicacy. Aegle marmelos is widely used in Indian Ayurvedic medicine in the treatment of diabetes mellitus. The Bael tree contains furocoumarins, including xanthotoxol and the methyl ester of alloimperatorin as well as flavonoids, rutin and marmesin; a number of essential oils and among its alkaloids. The pharmacological activities of Aegle marmelos is Antidiarrheal, Antimicrobial Antiviral, Antipyretic, Anticancer, Chemo-protective action, Diuretic activity, Antigenotoxic, Anti-fertility, and Anti-inflammatory. The fresh ripe pulp of the higher quality cultivars and the "sherbet" made from it are taken for their mild laxative, tonic and digestive effects. A decoction of the unripe fruit, with fennel and ginger, is prescribed in cases of haemorrhoids. Bael fruits are also used in the treatment of chronic diarrhoea, dysentery and peptic ulcers, as a laxative.



Fig : 5

Allium cepa Linn

Family: Amaryllidaceae

Local name: Piyaj

Common name: Onion

Name Part Used :Leaf

Mode Of Application: Leaf juice is taken orally with honey or milk till cure

Active Constituents : Quercetin, sterol, glycosides, gibberlin

The plant is cultivated all over India. Onion bulb and leaves are the important part of diet. In a clinical study treatment of diabetic patients by juice of Allium cepa bulb, controlled the blood sugar level. Onion has been found to contain quercetin, fructose, quercetin 3- glucoside, isohamnetin 4- glucoside, xylose, galactose, glucose, mannose, organosulfur compounds, allylsulfides, flavenols, S-alk(en)yl cysteine sulfoxides, cycloalliin, selenium, thiosulfates and sulphur and seleno compounds. The pharmacological activities such as anticancer, ant diabetic, anti-platelet, antithrombotic, anti-asthmatic, anti-oxidant, antimicrobial, anti-arthritis, fibrinolytic, anti- expectorant, febrifuge, hypoglycaemic, hypotensive and hypo-cholesterol emic properties. Onion is used as a folk remedy includes bruises, colic, ear-ache, bronchitis, colds, fever, intestinal parasites, high blood pressure, jaundice, sores and impotence.



Fig : 6

Allium sativum Linn.

Family: Amaryllidaceae

Local name: Lahsun;

Common name: Garlic

Name Part Used : Leaf and bulb

Mode Of Application: Leaf and bulb taken orally to treat diabetes

Active Constituents : Minerals, flavanoids

The plant is cultivated all over India. It is an important part of dietary ingredients. Allicin from garlic exhibited pronounce hypoglycaemia in mild diabetic rabbits[4]. Fresh or crushed garlic produces the sulphur containing alliin, ajoene, diallyl polysulfides, vinyl dithiins, S-allylcysteine and enzymes, saponins, flavonoids and maillard reaction products. The pharmacological activities are antimicrobial, hypocholesterolemic, hypotensive, anti platelet, anti cancer .Garlic is reported to be a wonderful medicinal plant owing to its preventive characteristics in cardiovascular disease, regulating blood pressure, lowering blood sugar and cholesterol levels, effective against bacterial, viral, fungal and parasitic infections, enhancing the immune system and having anti-tumoral and antioxidant features.



Fig: 7

Aloe vera:

Family: Liliaceae

Local name: Gheekumari;

Common name: Aloe-vera

Name Part Used : Leaves

Mode of Application: Juice of whole plant

Active Constituents : Aloin, Barbaloin

It is cultivated in Europe and the North-West Himalayan region in India. Aloe contains a mixture of crystalline glycosides known as aloin 4-5% in cape Aloe 18-25% in Curacao Aloe, resin (16-37%), emodin and volatile oil. It also possess the anthraquinone glycoside like barbaloin (aloe-emodinanthrone C-10 glucoside), chrysophanic acid, B-barbaloin and iso-barbaloin. The pharmacological actions of Aloe vera include anti-inflammatory and anti-arthritis activity and antibacterial and hypoglycaemic effects. It's used in traditional Indian medicine for constipation, skin diseases, worm infestation, and infections and as a natural remedy for colic natural. It's also used as a natural remedy for asthma, stomach ulcers, and diabetes and for soothing side effects of radiation treatment. Aloe latex is used to naturally treat depression, constipation, asthma and diabetes. [6-8]



Fig : 8

Andrographis paniculate

Family: Acanthaceae

Local name: Kirayat;

Common name: Kariyat

Name Part Used : Leaf

Mode of Application: Decoction of the leaves i.e. 50ml is given three times a day after food or fresh raw leaves eaten daily.

Active Constituents : Andrographosterol, homoandrographolide and andrographone

This is an annual herb that grows throughout India. Plant extract effectively produced hypoglycaemic and antihyperglycaemic activity in normal rats [7]. Andrographolide is the major constituent. Some known constituents are: andrographine, andrographolide, neoandrographolide, panicoline, paniculide. The pharmacological activities are Hepatoprotective effects, Antimicrobial, Anti parasitic, Cardiovascular effects, Antioxidant, Anti-inflammatory, Anti hyperglycaemic. A primary modern use of A. paniculate is for the prevention and treatment of the common cold. It appears to have antithrombotic actions, suggesting a possible benefit in cardiovascular disease. It is beneficial in disease like cancer and HIV infections. [9-10]



Fig : 9

Annona squamosa

Family: Annonaceae

Localname: Sitaphal;

Common name: Sugar apple tree

Name Part Used : Leaf Caryophyllene,

Mode of Application: 25g. leaves are taken orally with milk daily in the morning a day after food or fresh raw leaves eaten daily.

Active Constituents :Caryophyllene, germacrene D

A.Squamosa also known as custard apple, is commonly found in deciduous forests, also cultivated in wild in various parts of India, the chemical constituents present in A. squamosa are the alkaloids oxophoebine, reticuline, isocorydine, and methylcorydaldine, and the flavonoid quercetin-3-O'Glucoside, the most abundant alkaloid present in the root is atisine. The pharmacological activities of A.squamosa are anti-bacterial, analgesics, anti-inflammatory, antioxidant, anti-lipidemic, anti-fungal. Annona squamosa Vell was astringent and was found to be useful for the treatment of chronic diarrhoea and estomatic disease and also useful as an insecticide. Its leaves were used as the insecticidal and antispasmodic agents that were used in the rheumatism treatment and painful spleen. [11-13]



Fig : 10

Aristolochia indica

Family: Aristolochiaceae

Local name: Hooka-bel,

Common name: Indian birthwort

Name Part Used : Seed

Mode Of Application: Ground seeds are mixed with black pepper and made into a paste and given three times a day.

Active Constituents : Aristolochic acid

This species is globally distributed in India, Sri Lanka, Nepal and Bangladesh. Within India, it is found throughout in the plains and low hills. Several phytoconstituents like aristolochic acid, ceryl alcohol, ù-sitosterol, stigmast-4-en-3-one, friedelin, cycloeucalenol and rutin have been isolated from different parts of the plant. Pharmacological activities anti-diabetic anti-fertility effect, Anti-implantation activity, interceptive activity, abortifacient activity, It has been recommended for the treatment of dry cough, joints pain, inflammation, dysphoea of children, snake bites and also used as abortifacient. [14]



Fig : 11

Azadirachta indica

Family: Meliaceae,

Local name: Neem

Common name: Neem,

Name Part Used : Leaf

Mode Of Application: Leaves antidiabetic

Active Constituents : Isomeldenin, nimbin, 6-desacetyl nimbinin, nimbandioli, immobile, nimocinol, quercetin, and beta-sitosterol

This is an evergreen grows throughout India. Fresh leaves decoction induced anti-hyperglycaemic activity [15] and increased the peripheral glucose utilization in normal rats. The phytochemical such as Azadirachtin, Nimbin, Nimbinin, Nimbidinin, Nimbolide, Nimbidic acid and sodium nimbidate. Neem plant poses variety of pharmacological activities such as antipyretic, antiviral, analgesic, antibacterial, contraceptive and hepatoprotective effect. Neem oil is also used for healthy hair, to improve liver function, detoxify the blood and balance blood sugar level. It is used in skin diseases like eczema, psoriasis. It is used to treat cough, asthma, ulcers, piles, urinary disease. [16]

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Fig : 12

Brassica juncea

Family: Brassicaceae

Local name: Sarson

Common name: Indian mustard

Name Part Used : Seed

Mode of Application: Ground powdered seeds mixed with lime juice is given for about 15 days to cure diabetes.

Active Constituents : Vanillin, sinigrin, catechin, quercetin

Brassica juncea is an economically important plant that has been well-known in India for centuries for its medicinal and nutritive values. B. juncea seed oil afforded β -sitosterol, campesterol and brassicasterol. The chemical constituents of B. juncea include glucosinolates, ascorbate, folate and sterols (brassicasterol, sitosterol and brassinosteroids).

The seeds are also reported to be hypoglycaemic, anti-oxidant, anti-diabetic, hyperglycaemic, anxiolytic, goiterogenic and hepatoprotective.

The mustard seeds have been used traditionally for the treatment of muscular rheumatism, inflammatory neuralgic affections, vomiting and dengue. It is also used in the treatment of tumours; leaves are used in soups for bladder infections, inflammation or haemorrhage.



Fig : 13

Cajanus cajan Linn

Family: Fabaceae

Local name: Arhar

Common name: Congo pea

Name Part Used : Seed

Mode Of Application: Seeds cooked and taken along with food.

Active Constituents :Alkaloids and flavonoids

Since its domestication in India at least 3,500 years ago, its seeds have become a common food grain in Asia, Africa, and Latin America. It is consumed on a large scale mainly in south asia and is a major source of protien for the population of that subcontinent.C. cajan leaves are rich in flavonoids and stilbenes. They additionally contain saponins, conspicuous amount of tannins, and moderate quantities of reducing sugars, resins and terpenoids. Pharmacological activities- Antimicrobial activity, antibacterial activity, Hypocholesterolemic effects, anti-diabetic effects, Neuroactive properties, antioxidant activities, anticancer activity, Hepatoprotective Effects, Anthelmintic activity. The leaves of C. cajan are used in food poisoning, as colic and in constipation. In Chinese folk medicine pigeon pea leaves are used to staunch blood, as an analgesic and to kill parasites. In some parts of Tamil Nadu, India, the leaf, seeds and young stems are used to cure gingivitis, stomatitis and as a toothbrush. [18] It is also an important folk medicine in eastern Rajasthan as fresh juice/boiled leaves are given orally to nullify the effect of intoxication and as a laxative. Leaf paste is applied in oral ulcers and inflammations. Leaves and seeds are applied as poultice over the breast to induce lactation.



Fig: 14

Cassia fistula

Family: Fabaceae

Local name: Amaltas,

Common name: Golden shower tree

Name Part Used : Seed

Mode Of Application : One teaspoon powder of seeds is given once in the morning for about 15days or more.

Active Constituents :Palmitic acid,linoleic acid,stearic acid, caprylic acid and myristic acid

The species is local to the Indian subcontinent and neighboring areas of south-east Asia. It is state blossom of kerala in India and of gigantic significance among the Malayali populace. The plant is rich in sugars, Linoleic, Oleic, and Stearic acid. Leaf of Cassia fistula for the most part contains Oxalic Acids, Tannins, Oxyanthra-quinones, Anthraquinones subordinates. Fruit of Cassia fistula contains Rhein Glycosides Fistulic Acids, Sennosides A B, Anthraquinones, and Flavonoid-3-ol-subidiaries.

Ceryl Alcohol, Kaempferol, Anthraquinone Glycosides, Fistulin, Essential Oils, Volatile Components, Phytol (16.1%), 2-Hexadecanone (12%), Crystals, 4-Hydroxy Benzoic Acids Hydrate have been accounted for from the plant.

The pharmacological activities of *Cassia fistula* are anti-diabetic, antioxidant, antitumor, hepatoprotective, hypolipidemic, anti-pyretic, anti-inflammatory, antitussive, antimicrobial, antiulcer activity. *Cassia fistula* is also employed as a remedy for tumours of the abdomen, glands, liver, stomach, and throat, for burns, cancer, constipation, convulsions, delirium, diarrhoea, dysuria, epilepsy, gravel, haematuria, pimples, and glandular tumours. In Ayurvedic medicine systems, the seeds are attributed with ant bilious, aperitif, carminative, and laxative properties while the root is used for adenopathy, burning sensations, leprosy, skin diseases, syphilis, and tubercular glands. [19].



Figure : 15

Cassia occidentals

Family: Fabaceae

Local name: Kasunda ,

Common name: Coffee weed

Name Part Used : Seed

Mode Of Application: One teaspoon seeds with water is taken orally for about 15 days

Active Constituents : anthraquinones, flavonoids, phytosterols and polysaccharides

Cassia occidentalis usually grows in the southern part of India which is known as kasmard in sanskrit. *Cassia Occidentalis* chemical Constituents are Cassiollin, a phytosphanol, Physcion, Occidentol I, II. Seeds contain tannic acid, 36% mucilage, and Emodin. The pharmacological activities are antibacterial, antifungal, antimalarial, anti-inflammatory, anti-oxidant, hepatoprotective, immunosuppressant activity. *Cassia occidentalis* is a medicinal plant mainly used in respiratory problems like cough, asthma, bronchitis, skin diseases [20]



Figure : 16

Cassia sophera

Family: Fabaceae

Hindi name: Kasaunda,

Common name: Sophera senna

Name Part Used : Seed

Mode Of Application: Bark infusion is given in diabetes.

Active Constituents : ascorbic acid, dihydroascorbic acid and β -sitosterol

Cassia sophera is originate all over India and in most tropical countries. It is common in waste lands, on road sides and in the forests. Leaves contain a flavanol-C-glycoside and sennosides. Root bark contains anthraquinones, chrysophanol and physcion and β -sitosterol. Heartwood contains chrysophanolphysicon, chrysophanic acid, emodin, sopheranin, quercetin and β -sitosterol. Flowers contain anthraquinone and flavanol glycosides, including chrysophanol, rhamnetin glucoside and campesterol, sitosterol and fucosterol. Cassia sophera leaves possess antiasthmatic activity, hepatoprotective activity, antiinflammatory activity, antidiabetic and antioxidant activity. Seeds of Cassia sophera possess anticonvulsant and analgesic activity. The plant is credited with an indistinguishable property from C. occidentalis. Leaf juice is particular for ringworm; utilized as apart of asthma, bronchitis and hiccup. Infusion of the leaves is helpful in gonorrhea and syphilitic bruises. Bark, leaves and seeds are utilized as a cathartic; given in diabetes. Root bark ground into a glue is an application for ringworm, pityriasis and psoriasis

[22-23]



Figure : 17

Cassia tora

Family: Fabaceae

Local name: Chakunda

Common name: Sickie pod,

Name Part Used : Root

Mode Of Application: Root juice i.e 10 gram of root in 400 ml of water is boiled and taken orally once a day for another 15 days .

Active Constituents : Anthraquinone

Cassia tora is distributed throughout India on waysides and waste places, on hills of low elevation up to 800m as well as in plains. It grows in dry soil throughout tropical parts of India, special middle and south India. Cassia tora chemical constituents are Fistucacidin, emodin, Rubro fusarin Torosachryson, Isotalactone, Questin, Obtusin, Obtusifolin, Alaternins, Cassiaside etc.

Chrysophenol is its marker compound. Seeds contain cinnamaldehyde, gum, tannins, mannitol, coumarins, aldehydes, eugenol and pinene, sugars, resins. Root contains Beta sitosterol, Beta-Dglucoside, palmitic acid, stearic acid, uridine, quercetin, iso-quercetin. The pharmacological activities are anti-inflammatory, antinociceptive, hypolipidemic, estrogenic, anti-oxidant, antimicrobial, antihelmintic, hepatoprotective. It is indicated in fever, skin disease, asthma, chronic respiratory disorders, cough, cold diabetes, UTI, anorexia. [24-25]

II. CONCLUSION

Plants are the basic source of knowledge of modern and traditional medicine. The relatively lower incidence of adverse reactions to plant preparations compared to modern conventional pharmaceuticals, coupled with their reduced cost, is encouraging both the consuming public and national health care institutions to consider plant medicines as alternative to synthetic drugs. Now a-days herbal drugs are prescribed widely even when their biologically active compounds are unknown because of their effectiveness and no side effect in clinical experience. Natural products are considered to be the best option as they have less harmful. From the above bunch knowledge of plants, it is concluded that these all plants have great potential use as Phyto- constituents as they have, anti-diabetic and antioxidant activities. So, these plants can be utilized to find bioactive characteristic products that may fill as feeds for the advancement of new pharmaceuticals compounds. Development of Phyto-constituents is relatively inexpensive and less time consuming and also suitable to our economic condition.

REFERENCES

- [1] Balekari Umamahesh and Cidi Veeresham, Antihyperglycemic and Insulin Secretagogue Activities of *Abrus precatorius* Leaf Extract. *Pharmacognoy Res.* 2016 Oct-Dec; 8(4): 303–308. PMID: PMC5004524.
- [2] Shaedur Rahman and Rashida Parvin, Therapeutic potential of *Aegle marmelos* (L.)-An overview. *Asian Pac J Trop Dis.* 2014 Feb; 4(1): 71–77. PMID: PMC4027346.
- [3] Mathew, P.T. and Augusti, K.T.: Hypoglycemic effects of onion, *Allium cepa* Linn. on diabetes mellitus- a preliminary report. *Ind. J. Physiol. Pharmacol.*, 19, 213–217, 1975.
- [4] Sheela, C.G. and Augusti, K.T.: Antidiabetic effects of S-allyl cysteine sulphoxide isolated from garlic *Allium sativum* Linn. *Indian J. Exp. Biol.*, 30, 523–526, 1992.
- [5] Zacharias, N.T., Sebastian, K.L., Philip, B., and Augusti, K.T.: Hypoglycemic and hypolipidaemic effects of garlic in sucrose fed rabbits. *Ind. J. Physiol. Pharmacol.*, 24, 151– 154, 1980.
- [6] Karunanayake, E.H., Welihinda, J., Sirimanne, S.R., and Sinnadorai, G.: Oral hypoglycemic activity of some medicinal plants of Sri Lanka. *J. Ethnopharmacol.*, 11, 223–231, 1984.
- [7] Al-Awadi, F.M. and Gumaa, K.A.: Studies on the activity of individual plants of an antidiabetic plant mixture. *Acta Diabetologica*, 24, 37–41, 1987.
- [8] Ajabnoor, M.A.: Effect of aloes on blood glucose levels in normal and alloxan diabetic mice. *J. Ethnopharmacol.*, 28, 215–220, 1990.
- [9] Md. Sanower Hossain, Zannat Urbi, Abubakar Sule, and K.M.Hafizur Rahman *Andrographis paniculata* (Burm. f.) Wall. ex Nees: A Review of Ethnobotany, Phytochemistry, and Pharmacology. *Scientific World Journal.* 2014; 2014: 274905, PMID: PMC4408759.
- [10] Akbar S. *Andrographis paniculata*: a review of pharmacological activities and clinical effects. *Alternative Medicine Review.* 2011;16(1):66–77.
- [11] Kaleem, M., Asif, M., Ahmed, Q.U., and Bano, B.: Antidiabetic and antioxidant activity of *Annona squamosa* extract in streptozotocin-induced diabetic rats. *Singapore Med. J.*, 47, 670– 675, 2006.
- [12] Gupta, R.K., Kesari, A.N., Murthy, P.S., Chandra, R., Tandon, V., and Watal, G.: Hypoglycemic and antidiabetic effect of ethanolic extract of leaves of *Annona squamosa* L. in experimental animals. *J. Ethnopharmacol.*, 99, 75–81, 2005.
- [13] Gupta, R.K., Kesari, A.N., Watal, G., Murthy, P.S., Chandra, R., and Tandon, V.: Nutritional and hypoglycemic effect of fruit pulp of *Annona squamosa* in normal healthy and alloxan- induced diabetic rabbits. *Ann. Nutr. Metab.*, 49, 407–413, 2005.
- [14] Michl J., Simmonds M., Ingrouille M., Heinrich M., Toxicological risk assessment of *Aristolochia* species.. *Planta Medica.* Conference: 59th International Congress and Annual Meeting of the Society for Medicinal Plant and Natural Product Research Antalya Turkey.
- [15] Biswas, K., Chattopadhyay, I., Banerjee, R.K., and Bandyopadhyay, U.: Biological activities and medicinal properties of neem (*Azadiracta indica*). *Curr. Sci.*, 82, 1336–1345, 2002.
- [16] Karunanayake, E.H., Welihinda, J., Sirimanne, S.R., and Sinnadorai, G.: Oral hypoglycemic activity of some medicinal plants of Sri Lanka. *J. Ethnopharmacol.*, 11, 223–231, 1984.

- [17] Khan, B.A., Abraham, A., and Leelamma, S.: Hypoglycemic action of Murraya koenigii (curry leaf) and Brassica juncea (mustard) mechanism of action. *Ind. J. Biochem. Biophys.*, 32, 106–108, 1995.
- [18] Chhetri DR, Parajuli P, Subba GC. Antidiabetic plants used by Sikkim and Darjeeling Himalayan tribes, India. *J Ethnopharmacol.* 2005; 99:199–202.
- [19] Sen AB, Shukia YN. Chemical examination of Cassia fistula. *J Indian Chem Soc.* 1968;(45):744.
- [20] Saraf S, Dixit VK, Tripathi SC, Patnaik GK. Antihepatotoxic Activity of Cassia occidentalis. *Pharm Biol.* 1994;32:178–83.
- [21] Laxmi Verma, P.K. Singour, P.K. Chaurasiya, H.Rajak, R.S.Pawar, and U.K.Patil, Effect of ethanolic extract of Cassia occidentalis Linn. for the management of alloxan-induced diabetics rats *Pharmacognosy Res.* 2010 May-Jun; 2(3): 132–137. PMID: PMC3141303.
- [22] Bilal A, Khan NA, Inamuddin GA. Pharmacological investigation of Cassia sophera Linn. Var. purpurea, Roxb. *Med J Islam World Acad Sci.* 2005;15:105–9.
- [23] Rambir Singh, Priyanka Bhardwaj, and Poonam Sharma, Antioxidant and toxicological evaluation of Cassia sophera in streptozotocin-induced diabetic Wistar rats. *Pharmacognosy Res.* 2013 Oct-Dec; 5(4): 225–232. PMID: PMC3807985.
- [24] Jeongsu N Nam and Hyunju Choi, Effect of butanol fraction from Cassia tora L. seeds on glycemic control and insulin secretion in diabetic rats *Nutr Res Pract.* 2008 Winter; 2(4): 240–246. PMID: PMC2788183.
- [25] Kim SH, Choi JS, Moon YH. Antioxidative activity and anticlastogenicity of Cassia tora L. seeds extract and its major component, nor-rubrofusarin-6-β-D-glucoside. *Journal of Food Hygiene and Safety.* 1998; 13:394–399.