



A Mini-Review on the Highly Important Effective Medicinal Plants Possessing Insulin Mimetic Activity in Ethnobotanical Evidence of India

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Abstract

The vast ethnobotanical survey is found in India since the past. The values of ethnobotany have been realized over the centuries, which support the indigenous system of medicine in the healthcare sector. There are several methods of ethnobotanical research, which gives the relevant information about the medicinal plants based on the literature, herbarium, and field studies. Some plants have been reported for its active principle responsible for the treatment of disease. The detailed studies on the ethnobotanical aspects in India provide the number of ways to promote the traditional herbal medicinal plants for the benefit of the public. Diabetes mellitus is an endocrine disorder, which affects the majority of the population around the globe. Modern therapeutics are utilized to cure Non-Insulin Dependent Diabetic Mellitus, like dietary modification, oral hypoglycaemic agents, and insulin, which have their own limitations. As an exemplary source of medicine, plants have been used since ancient times. In last few decades, some of the plants have been used for the anti-diabetic activity. This review paper, Insulin mimetic, ethno-botany, Medicinal Plants, and traditional medicine were used as key words to search in Web of Science, PubMed, Scopus, EBSCO and EMBASE to select the relevant articles. Hence the findings emphasis on the ethnobotanical studies on various antidiabetic medicinal plants found in India and its biodiversity conservation approaches have been highlighted.

Keywords

Ethnobotany, Medicinal plants, Diabetes Mellitus, Insulin Mimetic Property, India.

1. INTRODUCTION

1.1 Traditional Medicine

India is known for its heritage of herbal medicine. The ethnic and tribal people living in remote forest area depend widely on the indigenous system of medicine. The ethnobotany reveals the historical and present details about the plant's application for human disease, species conservation, and

sustainable use of resources (Rahul Jitin, 2013). These studies are revealing the importance of locally available plants and their discovery of novel drugs (Upreti Yadav et al., 2010; Bharat Bhushan and Mukesh Kumar., 2013). Exclusively countries like India, China, Burma etc, use the complementary and alternative medicine to treat the various ailments. Traditional medicine is the highly affordable source

to the world's poorest patients. According to National Medicinal Plants Board and Botanical Survey of India (BSI), Govt. of India, nearly 18,000 flowering plants species was found to be flowering plants, of which 7500 species found to be used in Ayurveda, Unani, Siddha, and Homoeopathy medicine (Perumal samy and Ignacimuthu, 1998). Among these 800 plants were having the ethnobotanical information which is highly used for its insulin mimetic activity.

1.2 Diabetes Mellitus and Oral Hypoglycemic Agents

Diabetes mellitus (DM) is a well known common endocrine metabolic disorder found predominant around the world. It is characterized by chronic hyperglycemia, with changes in carbohydrates, protein, fat metabolism that results in the alteration of insulin secretion, insulin action or both. According to WHO, nearly 180 million people worldwide is estimated to have DM disorder and also expected to be 7th leading disease which will cause death in 2030 (WHO, 2004; Patel, M et al., 1986). The highest is found in the developing countries, especially in India, the rate of commonness of diabetes is estimated to be 2-5 % (Verma, et al., 1986; Rao et al., 1989). It was observed from history that, in early 700-200 BC, DM was categorized into two types; one is as genetic disorder and other results from dietary behaviour. (Oubre, et al., 1997; Deb, et al., 2006) Also few other complications are linked with diabetes like retinopathy, polyuria, polydipsia, weakness, kidney disease, neuropathy, heart disease etc, which lead to fatal for the individual, even in the working population. (Donga et al., 2010; Matsuda et al., 2002) Diabetes mellitus is a metabolic disorder of multiple disease and characterized with hypoglycaemic with higher variations in carbohydrates, fat, and protein metabolism which alters the insulin secretion (high or low periodically), insulin action or both the conditions. (Shah et al., 1997) Insulin and oral hypoglycemic agents like alpha-glucosidase inhibitors, sulfonylureas, biguanides and glinides were used as monotherapy or in combination to reduce the sugar level. These oral antidiabetic agents have serious of adverse side effects; managing diabetes without side effects is still a challenge. (Shane-McWhorter., 2001).

1.3 Plant as a source for Insulin Mimetic Activity

Since olden times, plants have been used as the source in traditional medicine, either directly or indirectly for curing the different ailments. From the ethnobotanical study it was identified, nearly 800 plants may possess the antidiabetic activity (Saxena, and Vikram, 2004; Alarcon-Aguilara et al., 1998). Based on the ethno-pharmacological perspective, it

is important to understand the disease at an interface of biomedical and local or traditional treatment. A wide array of plants has been presently used as an antidiabetic agent based on the active principles demonstrating the application on Non-Insulin Dependent Diabetic Mellitus (NIDDM) (Bailey and Day, 1989; Ivorra et al., 1988). The secondary metabolites derived from plants include alkaloids, glycosides, galactomannan, polysaccharides, peptidoglycans, guanidine, steroids, glycopeptides, terpenoids, amino acids, carbohydrates, and inorganic compounds. Even after the discovery of metformin (Biguanide) - is a derivative of the natural product, galegine a guanidine isolated from *Galega officinalis* L. used to relieve the intense urination in diabetic patients (Marles, and Farnsworth, 1995). Thus plants act as a potential source for antidiabetic drugs among the practitioners, since the active principles are curative in nature, well defined, also vary tremendously in their active principles, quality and safety. In modern era, it is important to note that the further development of such active components, will act as lead molecules in to the treatment of various disorders. (Lee A. Witters., 2001; Rang and Dale, 1991) In most of the studies, have not explained about the impact on the plants on the course of DM. This review emphasizes the information on plants in the international literature and highlights the ethno-pharmacological, phytochemical application which is mostly used. Since there was a paucity of the literature published about the plant related research, this article will give a detailed idea for the future pharmacognosist or ethnobotanist.

1.4 Antidiabetic potential from plant origin- A Review

Developing a lead candidate from the natural source is a challenging role for the scientist and researchers. To design and develop a drug, it is important to check the following factors like the easy availability, compatible formulation, less or no side effects and less cost for the rural areas. Several valuable reviews on the ethnobotanical use of plants around the globe are available, but many are found to be specific based on the region, monographs etc. the most commonly families amaranthaceae, pinaceae, sterculiaceae, rosaceae, liliaceae, leguminosae, Annonaceae, compositae, oxalidaceae, meliaceae, chenopodiaceae, bixaceae, lauraceae, Rutaceae, umbelliferae, myrtaceae etc. (Arumugam, et al., 2013) The list of hypoglycaemic plants with their scientific name, family, plant part used for the preparation, pharmacological study, and their active principles is tabulated in Table No. 1

Table 1 List of Plants having Insulin Mimetic Activity

Scientific name	Vernacular name	Family	Plant's Part Used	Phytochemical component	Reference
<i>Abies pindrow</i> <i>Royle</i>	Pindrow Fir, West Himalayan Fir	<i>Pinaceae</i>	Entire plant	Volatile oil	Xiang et al., 2013
<i>Abroma augusta</i> <i>Linn</i>	Devil's cotton	<i>Malvaceae</i>	Roots & Leaves	Fixed oils, Alkaloid	Halim, 2003
<i>Acacia Arabica</i>	Babul, Kikar, Gum Arabic tree	<i>Leguminosae</i>	Seed	Arabin	Wadood et al., 1989
<i>Achyranthus aspera</i> L	Chaff flower, devil's horsewhip, apamarga Kanta chaulai	<i>Amaranthaceae</i>	Entire plant	Triterpenoid saponins- possess oleanolic ass a glycone. Achyranthine, betaine, pentatriaontane	Akhtar, and Iqbal., 1991
<i>Acacia arabica</i>	Indian Gum, Babul	<i>Fabaceae</i>	Seed	Gum	Singh et al., 1975
<i>Amaranthus spinosus</i> L	Spiny amaranth, pigweed, thorny amaranth	<i>Amaranthaceae</i>	Stem	Alkaloids, Terpenes, sesqueterinoids	Sangameswaran and Jayakar, 2008.
<i>Anacardium occidentale</i> L	Kaju	<i>Anacardiaceae</i>	Entire plant	Flavonols, terpenoids, caumarin, phenolic compounds, essential oils	Kamtchouing, et al., 1998
<i>Andrographis paniculata</i>	Kirayat, siriyaa Nangai. Kalamegha	<i>Acanthaceae</i>	Whole plant	Diterpenoid lactone –andrographolide	Yu, et al., 2003
<i>Annona squamosa</i>	Sharifa, sugar apples	<i>Annonaceae</i>	Leaves, seed, bark	Acetogenin- squamosin B, annonin, squamosamide, reticulatain- 2, isosquamosin	Annie shirwaikar et al., 2004
<i>Agrimony eupatoria</i> L	Church steeples, sticklewort.	<i>Rosaceae</i>	Leaves	Flavonoids, apigenin, triterpene – euscasic acid, tormentic acid.	Watkins et al., 2012
<i>Agele marmelose</i>	Bael, siruphal, Holy Fruit tree, golden apple	<i>Rutaceae</i>	Leaves, fruits, roots	Aeglemarmelosine, coumarins, alkaloids	Laphookhieo et al., 2011
<i>Allium cepa</i>	Pyaj, onion	<i>Amaryllidaceae</i>	Tuber, leaves	Polyphenolic, essential nutrients	Augusti., 1973a
<i>Allium sativum</i>	Lahasun, garlic	<i>Amaryllidaceae</i>	Bulb	Allin, ajoene, saponins, flavonoids	Augusti, and Mathew, 1973b
<i>Aloe vera or Aloe barbadensis</i>	Ghee kunwar, kumar panthu	<i>Liliaceae</i>	Steam roasted, Juice of leaves	Barbaloin, isobarbaloin resin, Polysacchrides, flavonoids	Ajabnoor, 1990
<i>Artemisia pallens wall</i>	Davana	<i>Compositae</i>	Aerial parts	Essential oils, davanone	Subramoniam et al., 1996
<i>Areca catechu</i>	Supari, betalnurt, pinang palm	<i>Piperaceae</i>	Leaf & Seed	Alkaloid, Arecaidine, Arecaidine	Chempakam, 1993



<i>Azadirachta indica</i>	Neem	<i>Meliaceae</i>	Leaves	Nimbidin, nimbin, nimbidol, nimboesterol	Chattopadhyay, 1996
<i>Ambrosia artemisifolia</i> L	Bitterweed, Blackweed, annual ragweed	<i>Asteraceae</i>	Aerial plant	Sesquiterpene, psilostachyin, B, C	Tunali et al., 1998
<i>Anacardium Occidentale</i>	Cashew	<i>Anacardiaceae</i>	Bark	Anacardic acids, cardol, cardanol	Jaiswal, et al., 2016
<i>Beta vulgaris</i>	Chukkander, garden beet	<i>Chenopodiaceae</i>	Leaves, Root extract	Betalain betanin, indicaxanthin	Manisha Modak et al., 2007
<i>Bidens pilosa</i>	Black jack, beggar-ticks, cobbler's pegs	<i>Compositae</i>	Ariel plant	Polyacetylenic glycoside	Ubillas, et al., 2000
<i>Biophytum sensitivum</i>	Lajjalu, Laksmana	<i>Oxalidaceae</i>	Leaf	Amentoflabone, cupressuflavone, isoorientin	Puri and Baral., 1998
<i>Bixa Orellana</i>	Annotta	<i>Bixaceae</i>	Entire plant	Oleo-resin	Russel et al., 2005
<i>Boerhavia diffusa</i> L	Purnarnava	<i>Nyctaginaceae</i>	Leaves and entire plant	Alkaloid punarnavaine, punarnavoside	Amarnath Satheesh, and Pari, 2004
<i>Brassica juncea</i>	Rai	<i>Cruciferae</i>	Leaves & seed	Isothiocyanate glycoside singrin, protein, fixed oil	Grover, et al., 2003
<i>Caesalpinia bonducella</i>	Kantkarej, kantikaranja	<i>Leguminose</i>	Seed kernels	Fatty oils	Sharma et al., 1997
<i>Carum carvi</i> linn	Shia jir	<i>Umbelliferae</i>	Fruits	Resin, carvone, fixed oils	Eddouks et al., 2004
<i>Cajanus cajan</i>	Tuvar, reg gram or pigeon pea	<i>Fabaceae</i>	Seed, plant	Amino acids, protein	Amalraj, and Ignacimuthu, 1998a
<i>Capparis decidua</i>	Kurel, Kerda, pinju caper plant	<i>Capparaceae</i>	Flower, leaves	Glycoside	Yadav et al., 1997
<i>Camellia sinesis</i>	Green tea –chai	<i>Theaceace</i>	Leaves	Polyphenolic compounds	Lia Ardiana., et al., 2018
<i>Capsicum frutescens</i> linn	Mirch	<i>Solanaceae</i>	Entire plant	Volatile oils, resin, carvone, fixed oils	Talan et al., 2001
<i>Cassia alata</i>	Ringworm senna	<i>Caesalpinaceae</i>	Flower	Saponins, glycosides	Palanichamy et al., 1988
<i>Cantharanthus roseus</i>	Sadabahar, Madagascar periwinkle	<i>Apocynaceae</i>	Leaves , twigs, flower	Indole alkaloid, vincristine, vinblastin	Singh et al., 2001
<i>Cirtullus colocynthis</i>	Badi indrayan, makkal, bitter apple, vine of Sodom, wild gourd	<i>Cucurbitaceae</i>	Leaves	Micronutrients, minerals	Batol Barghamdi et al., 2016

<i>Cinnamomum zeylanicum</i>	Dalchini	<i>Lauraceae</i>	Bark	Tannin, mannitol	Verspohl, et al., 2005
<i>Coccinia indica</i>	Bimb, kanturi, ivy gaurd	<i>Cucurbitaceae</i>	Fruits	Triterpines, Alkaloid, flavonoid, β -carotene	Hossain, et al., 1992
<i>Cryptolepis sanguniolenta</i>	Anatmul	<i>Asclepidaceae</i>	Entire plant	cryptolepine	Newman Osafo et al., 2017
<i>Eclipta alba lin</i>	Bhringraj	<i>Compositae</i>	Entire plant	Ecliptin alkaloid	Ananthi et al., 2003
<i>Embellica officinalis</i>	Amla	<i>Euphorbiaceae</i>	Fruits	Vitamin C, tannin	Rao et al., 2005
<i>Enicostemma littorale</i>	Chhota chirayata	<i>Gentianaceae</i>	Entire plant	Swertiamarine glycoside	Maroo et al., 2003
<i>Eucalyptus globulus</i>	Safeda	<i>Myrtaceae</i>	Leaves	Essential oil, cineol	Gray, and Flatt, 1998.
<i>Euphrasia officinale</i>	Eyebright	<i>Scrophulariaceae</i>	Leaves , bark	Alkaloids	Porchenzhian et al., 2000
<i>Eugenia jambolana</i>	Jamun	<i>Myrtaceae</i>	Leaves, kernel, bark	Protein, fibre, nutrients	Sharma et al., 2003
<i>Eugenia uniflora</i>	Pitanga, Surinam cherry	<i>Myrtaceae</i>	Leaves	Resins. Vitamin A.	Arai, et al., 1999
<i>Ficus bengalensis</i>	Indian banyan tree, bur	<i>Moraceae</i>	Bark	Tannin	Cherian and Augusti, 1993
<i>Ficus religiosa</i>	Peepal	<i>Moraceae</i>	Entire plant	Tannin	Chandrasekar et al., 2010
<i>Gymnema sylvestre</i>	Gudmar, merasingi, periploca of the woods	<i>Asclepiadaceae</i>	Leaves	Gymnemic acid, quercital	Gholap and Kar., 2003
<i>Gentiana Olivieri</i>	-	<i>Gentianaceae</i>	Flowers	Iso-orientin C-glycoside	Sezik et al., 2005
<i>Glycyrrhiza glabra linn</i>	Mulethi	<i>Leguminosae</i>	Root	Triterpenoid, saponins, glycyrrhizin	Swanston-flatt, et al., 1990
<i>Helicteres isora linn</i>	Indian screw tree	<i>Sterculiaceae</i>	Root	Saponins, tannin, ligin	Chakrabarti et al., 2002
<i>Hibiscus rosasinesis</i>	Gudhal, jasson, shoe flower	<i>Malvaceae</i>	Flower, entire plant	Vitamin C, B, fats	Sachdewa and Khemani., 1999
<i>Ipomoea batatas</i>	Sakkargand, mitha alu, sweet potato, kumara	<i>Convolvulaceae</i>	Tubers	Provitamin A, Vitamin B ₆ , micronutrients	Kusano and Abe 2000
<i>Lupinus albus linn</i>	Turmass	<i>Fabaceae</i>	Seed	Alkaloid, fatty oil, asparagine	Tsiordas., et al., 1999
<i>Lagerstroemia speciosa</i>	Jarul, pride of India	<i>Lythraceae</i>	Leaves	Corosolic acid, masilinic acid	Kakuda et al., 1996
<i>Mangifera indica</i>	Aam, amb, mango	<i>Anacardiaceae</i>	Leaf	Mangiferin	Aderibigbe, et al., 1999
<i>Memecylon umbellatum</i>	Anjani, Ali, Iron wood,	<i>Melastomataceae</i>	Leaf	Glucoside, dye	Amalraj, and Ignacinuthu, 1998.



<i>Momordica cymbalaria</i>	Kadavanchi, athalaki	<i>Cucurbitaceae</i>	Fruit , seed	Isoproterenol	Rao et al., 1999
<i>Momordica charantia</i>	Karela, bitter gourd	<i>Cucurbitaceae</i>	Fruit, pulp, seed, leaf-whole plant	Momordicine alkaloid, ascorbic acid	Chaturvedi, et al., 2004
<i>Morus alba</i>	Shetnut, tut, white mulberry	<i>Moraceae</i>	Leaves	Alkaloids	Asano et al., 1994
<i>Musa sapientum</i>	Kela, banana, tundan	<i>Musaceae</i>	Fresh flowers	Carbohydrates	Pari, and Umamaheswari, 2000.
<i>Mucuna pruriens</i>	Kabach, cowitch, Bengal velvet bean cowage	<i>Fabaceae</i>	Seed	L-Dopa, Mucunain, dimethyltryptamine- noxide	Akhtar, et al., 1990
<i>Murraya koeingii</i>	Kurry patta, curry leaf	<i>Rutaceae</i>	Leaves	Mahanimbine, Girnimbine, undecalactone. 2- methyl-3- methyl carbazole	Arulselvan, et al., 2006
<i>Nelumbo neucifera</i>	Kamal, lotus	<i>Nymphaeaceae</i>	Rhizome	Nuciferin, nornuciferin	Mukherjee, et al., 1997
<i>Ocimum sanctum</i>	Tulsi, holy basil	<i>Labiatae</i>	Leaf	Phenol, aldehyde, alkaloid, tannin, vitamin C	Chatopadhyay., 1993.
<i>Olea europia</i>	Olive	<i>Oleacea</i>	Leaves	Oleuropeoside	Gonzalez., 1992
<i>Panax ginseng</i>	Pannag	<i>Araliaceae</i>	Root & entire plant	Glycans, panaxans	Oshima, et al., 1985
<i>Punica granatum</i>	Anar	<i>Punicaceae</i>	Seed	Protein, tannin, gallic acid, pelletierine	Ashish K. Das et al., 2001
<i>Picrorrhiza kurroa royale</i>	Katuka	<i>Scrophuariaceae</i>	Entire plant	Picrorrhizin, kutkin	Joy and Kuttan, 1999
<i>Phyllanthus amarus</i>	Bhui amala	<i>Euphorbiaceae</i>	Entire plant	alkaloid	Srividya and Periwal,1995
<i>Pterocarpus marsupium</i>	Vijayasar, bijasal, indian Malabar	<i>Fabaceae</i>	Wood	Pterostilbene	Chakravarthy et al., 1980
<i>Salacia reticulata</i>	Vairi, pitica	<i>Celastraceae</i>	Root bark	Kotalanol, salacinol	Yoshikawa et al., 1998
<i>Salacia oblonga</i>	Ponkoranti	<i>Celastraceae</i>	Root bark	Kotalanol, salacinol , kotalagenin 16- acetate	Matsuda et al., 1999
<i>Swertia chirayita</i>	Chirata	<i>Gentianaceae</i>	Whole plant	Swerschirin, zanthone mangiferin, gentianine	Saxena et al., 1996
<i>Syzigium cumini</i>	Eugenia jambolana, Jamblang, black berry	<i>Myrtaceae</i>	Dry leaves	Protein, fibre	Mahapatra, et al., 1985
<i>Trigonella foenum graecum</i>	Methi, mutti, fenugreek	<i>Fabaceae</i>	Seeds	Saponins, proteins, 4- hydroxyisoleucine	Ajabnoor, and Tilmisany, 1988.



<i>Tinospora cordifolia</i>	Amarta, guduci	<i>Menispermaceae</i>	Root	Berberin, starch	Noor, and Ashcroft., 1989
<i>Termamnus labialis</i>	Mashoni	<i>Fabaceae</i>	Aerial parts	Caumarin-fraxidin	Fort et al., 2000
<i>Urtifca dioica</i>	Bichhu booti	<i>Urticaceae</i>	Leaves	Fatty oils	Bigan Farzami et al., 2003
<i>Withania somnifera</i>	Ashwagandha	<i>Solanaceae</i>	Root	Withanine, somnine, withaferine, withanolides	Andallu et al., 2000
<i>Xanthium struarium</i>	Chhota gokhru	<i>Compositae</i>	Fruits	Phenolic compounds, caffeic acid	Hsu et al., 2000
<i>Zingiber officinale</i>	Adrak	<i>Zingiberaceae</i>	Rhizome	Sesquiterpene	Akhani, et al., 2004
<i>Zizyphus sativa</i>	Pitni-ber	<i>Rhamnaceae</i>	Leaves	tannin	Anand, et al., 1989

2. CONCLUSION

Due to the modern health care system in developing countries such as India, is still suffering to reach the healthcare goals. From an ethno pharmacological perspective, this review would be interesting to analyse the phytoconstituents highly responsible for the anti-diabetic activity. It is important that during the ethnobotanical survey, discarding of plastic and other waste should be prohibited, thus shape the ways to protect the endangered species or rare species. The healthcare professionals should look into the monitor and educate the public, in order to avoid the sedentary way of life. Strict rules should be implemented to control the sale of plants in the market, which will avoid people for auto-consumption. The production of medicinal plants should be done with quality that could be affordable for the poor families. These initiatives should be promoted during the training and education programmes for the patients suffering from diabetes, physicians, and healthcare professionals to ensure the safety of the public. India is rich in plant biodiversity, still lacks the training for physicians and pharmacist in Ayurvedic and Siddha medicine. Also the presence of such resources would lead to the new class of drugs having significant antidiabetic activity. The conservation of ethnobotanical resources and wild crops should be considered for the future breeding programmes.

The isolation of active principle is highly important level in R & D for developing the novel phytomedicine. The quality control will help the healthcare professionals to follow the authenticated samples for the public use. Another unresolved issue is the intellectual property of these species. Since these phytomedicines are commercialized into the market, the government and other institution can develop the ways to sustainable use of plants bearing antidiabetic activity. More investigation should be carried to explain the mechanism of action of active principle obtained from plants with antidiabetic effect. The toxic side effects of the plants should also be focused for the better living of the public.

CONFLICTS OF INTEREST

The Author declared no competing interests.

ETHICAL CONSIDERATION

Ethical issues (Fabrication of Table data, Plagiarism) have been completely noticed by the author through the institution committee and turn-tin software.

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REFERENCE

1. Aderibigbe, A.O., Emudianughe, T. S., Lawal, B. A. Anti-hyperglycaemic effect of *Mangifera indica* in rats. *Phytother Res.* 13(6): 504-507 (1999).
2. Ajabnoor, M. A., Effect of aloes on blood glucose levels in normal and alloxan diabetic mice. *J. Ethnopharmacol.* 28, 215-220, (1990).
3. Ajabnoor, M.A., and Tilmisany, A. K., Effect of *Trigonella foenum graecum* on blood glucose level in normal and alloxan diabetic mice. *J. ethnopharmacol*, 22(1): 45-49, (1988).
4. Akhani, S.P., Vishwakarma, S. L., and Goyal, R. K., Antidiabetic activity of *Zingiber officinale* in streptozotocin induced type I diabetic rats. *J. pharma and pharmacol*, 56:101-105, (2004).
5. Akhtar, M. S., and Iqbal J., Evaluation of hypoglycaemic effect of *Achyranthes aspera* in normal and alloxan diabetic rabbits. *J. Ethnopharmacol*, 31(1): 49-57, (1991).
6. Akhtar, M. S., Qureshi, A. Q and Iqbal J., Hypoglycemic evaluation of *Mucuna pruriens* Linn seed. *Journal of Pakistan Medical Association.* 40: 147-150, (1990).
7. Alarcon-Aguilar, F.J., Roman-Ramos, R., Perez-Gutierrez, S., Aguilar- Contreras, A., Contreras-Weber, C.C., Flores-Saenz, J.L., Study of the anti-hyperglycemic effect of plants used as antidiabetics. *Journal of Ethnopharmacol*, 61(2): 101-110, (1998).
8. Amalraj, T., and Ignacinuthu, S., Evaluation of the hypoglycaemic effect of *Memecylon umbellatum* in normal and alloxan induced diabetic mice. *J. Ethanopharmacol*, 62(3): 247-250, (1998).
9. Amalraj, T., Ignacinuthu, S., Hypoglycemic activity of *Cajanus cajan* (seeds) in mice. *Indian Journal of Experimental Biology* 36: 1032-1033, (1998).
10. Amarnath Satheesh, M., and Pari, L., Antioxidant effect of *Boerhavia diffusa* L in tissue of alloxan induced diabetic rat. *Indian J. of Exp. Biol*, 42(10): 989-992, (2004).
11. Anand, K. K., Singh, B., Chand, D., Chandan, B. K., and Gupta, V.N., Effect of *Zizyphus sativa* leaves on blood glucose level in normal and alloxan diabetic rats. *J. Ethnopharmacol*, 27: 121-127, (1989).
12. Ananthi, J., Prakasam, A., and Pugalendi, K. V., Antihyperglycemic activity of *eclipta alba* leaf on alloxan induced diabetic rats. *Yale Journal of Biology and Medicine*, 76 (3): 97-102, (2003).
13. Andallu, B., and Radhika B., Hypoglycemic diuretic and hypocholesterolemic effect of winter cherry. (*Withania somnifera* Dunal) root. *Indian J. Exp. Biol*, 38(6): 607-609, (2000).
14. Annie shirwaikar., Rajendran, K., and Kumar, C., Oral antidiabetic activity of *Annona squamosa* leaf alcohol extract in NIDDM rats. *Pharmaceutical biology*, 42(1): 30-35, (2004).

15. Arai, I., Amagaya, S., Komatsu, Y., Okada, M., Hayashi, T., Kasai M., Arisawa, M., and Momose, Y., Improving effects of the extracts from *Eugenia uniflora* on hyperglycemia and hypertriglyceridemia in mice. *J. Ethnopharmacol*, 68(1-3), 307-314 (1999).
16. Arulselvan P., Senthilkumar G.P., Sathish kumar D., Subramanian, S., Antidiabetic effect of *Murraya koenigii* leaves on streptozotocin induced diabetic rats. *Pharmazie*, 61(10): 874-877, (2006).
17. Arumugam, G., Manjula P., and Paari, N., A review: Anti diabetic medicinal plants used for diabetes mellitus. *J. of Acute Disease*, 2(3): 196-200, (2013).
18. Asano K. T., Oseki K., Tomioka E., Kizu. H., Matsui K., N-containing sugars from *Morus alba* and their glycosidase inhibitory activities. *Carbohydr Res*, 259(2): 243-255 (1994).
19. Ashish, K. Das., Subhash, C. Mandal., Sanjay, K. Baberjee., Sanghamitra, Sinha., Saha. B. P., and Pal, M., Studies on the hypoglycemic activities of *Punica granatum* seed in streptozotocin induced diabetic rats. *Phytother. Res*. 15(7): 628-629, (2001).
20. Augusti, K.T., Studies on the effects of a hypoglycemic principle from *Allium cepa* Linn. *Indian J. Med. Res*, 61(7): 1066-1071, (1973a).
21. Augusti, K.T., and Mathew, P.T., Effect of long-term feeding of the aqueous extracts of Onion (*Allium cepa* Linn.) and garlic (*Allium sativum* Linn.) on normal rats. *Indian J. Exp. Biol*, 11: 239-241, (1973b).
22. Bailey, C.J., and Day, C. 1989. Traditional plant medicines as treatment for diabetes. *Diabetes Care*. 12(8): 553-564, (1989).
23. Batol Barghamdi., Fereshteh Ghorat., Khairollah Asadollahi., Kourosh Sayehmiri., Robab Peyghambari., and Ghobad Abangah., Therapeutic effects of *Citrullus colocynthis* fruit in patients with type II diabetes: A clinical trial study. *J. of Pharm. Bioallied Science*, 8(2): 130-134, (2016).
24. Bharat Bhushan and Mukesh Kumar., Ethnobotanically important medicinal plants of Tehail Billawar, District, Kathua, J&K, India. *J. of Pharmacog. and Phytochem*, 2(4): 14-21, (2013).
25. Bigan Farzami, Ahmadvand D, Vardosbi S, Majin FJ and Khaghani S., Induction of Insulin secretion by a component of *Utricia dioica* leaf extract in perfused inlets of Langerhans and its in vivo effects in normal and streptozotocin diabetic rat. *J. Ethnopharmacol*, 89: 47-57 (2003).
26. Chakrabarti, R., Vikramadityan, R.K., Mullangi R. et al., Hypoglycemic and hypolipidemic activity of *Helicteres isora* in animal models. *J. Ethnopharmacol*, 81(3): 343-349, (2002).
27. Chakravarthy B.K., Gupta S., Gambhir S. S., Gode K.D., Pancreatic beta cell regeneration. A novel antidiabetic mechanism of *Pteroxarpus marsupium* Roxb. *Indian J. Pharmacol*, 12: 123-127, (1980).
28. Chandrasekar, S. B., Bhanumathy, M., Pawar, A. T., and Somasundaram, T., *Phytopharmacology of Ficus religiosa*. *Pharmacogn. Rev*, 4(8): 195-199, (2010).
29. Chattopadhyay R. R., Hypoglycemic effect of *Ocimum sanctum* leaf extract in normal and streptozotocin diabetic rats. *Indian J. Exp. Biol*, 31(11): 891-893, (1993).
30. Chattopadhyay, R. R., Possible mechanism of antihyperglycemic effect of *Azadirachta indica* leaf extract. Part IV. General Pharmacology, 27(3): 431-434, (1996).
31. Chaturvedi, P., George, S., Milinganyo, M., and Tripathi, Y. B., Effect of *Momordica charantia* on lipid profile and oral glucose tolerance in diabetic rats. *Phytother. Res*, 18(11): 954-956 (2004).
32. Chempakam, B., Hypoglycaemic activity of arecoline in betel nut *Areca Catechu* L. *Indian J. Exp. Biol*, 31(5): 474-475, (1993).
33. Cherian S and Augusti K. T., Antidiabetic effect of a glycoside of lecupelargonidin isolated from *Ficus bengalensis* Linn. *Indian J Exp Biol*, 31(1): 26-29s, (1993).
34. Deb, L. and Dutta, A., Diabetes Mellitus its possible pharmacological evaluation techniques and naturapathy, *Int. J. of Green pharmacy*, 1(7): 28-30, (2006).
35. Donga J. J., Surani V. S, et al., A systemic review on natural medicine used for therapy of diabetes mellitus of some Indian medicinal plants, *Int. J. of Pharma. Sci*, 148-152, (2010).
36. Eddouks, M., Lemhadri, A., and Michel, J.B., Caraway and caper: potential antihyperglycaemic plants in diabetic rats. *J. Ethnopharmacol*, 94(1): 143-148, (2004).
37. Fort, D. M., Rao, K., Jolad, S. D., Luo, J., Carlson, T.J., and King, S.R., Antihyperglycemic activity of *Termnus labialis* (Fabaceae). *Phytomed*, 6(6): 465-467, (2000).
38. Gholap S. and Kar A., Effect of *Innula racemose* root and *Gymnema sylvestre* leaf extract in the regulation of corticosteroid induced diabetes mellitus: involvement of thyroid hormone. *Pharmazie*, 58(6): 413-415, (2003).
39. Gonzalez, M., Zarzuelo A., Gamez M. J., Utrilla M. P., Jimenez J and Osuna I., Hypoglycemic activity of olive leaf. *Planta Med*, 58(6): 513-515, (1992).
40. Gray A. M., and Platt P. R., Antihyperglycemic action of *Eucalyptus globus* (Eucalyptus) are associated with pancreatic and extra-pancreatic effects in mice. *The Journal of Nutrition*, 128(12): 2319-2323, (1998).
41. Grover, J. K., Yadav, S. P., and Vats, V., Effect of feeding *Murraya Kowlingii* & *Brassica juncea* diet on kidney function and glucose level in streptozotocin diabetic mice. *J. Ethnopharmacol*, 85(1): 1-5, (2003).
42. Halim, E.M., Lowering of blood sugar by water extract of *azadirachta indica* and *abroma augusta* in diabetic rats. *Indian. J. Exp. Bol*, 41(6): 636-640, (2003).
43. Hossain, M. Z., Shibib, B. A., and Rahman. R., Hypoglycemic effects of *Coccinia indica*: Inhibition of key gluconeogenic enzyme, glucose – 6 - phosphatase. *Indian J. Exp. Biol*, 30(5): 418-420, (1992).
44. Hsu, F.L, Chen, Y. C., and Cheng J. T., Caffeic acid as active principle from the fruit of *Xanthium strumarium*

- to lower plasma glucose in diabetic rats. *Planta med.* 66(3): 228-230, (2000).
45. Ivorra, M.D., Paya, M., Villar, A., Hypoglycemic and insulin release effect of tormentic acid: a new hypoglycemic natural product. *Planta Med*, 54: 282-286, (1988).
 46. Jaiswal, Y. S., Tatke, P. A., Gabhe S. Y., and Vaidhya A. B., Antidiabetic activity of extracts of *Anacardium occidentale* Linn. Leaves on n-streptozotocin diabetic rats. *J. Tradit. Complement. Med*, 7(4): 421-427, (2016).
 47. Joy K. L and Kuttan R., Antidiabetic activity of *Picrorrhiza kurroa* extract. *J. Ethnopharmacol*, 67: 143-148, (1999).
 48. Kakuda, T., Sakane, I., Takiyama, T., Ozaki, Y., Takeuchi, H., and Kuriyanagi, M., Hypoglycemic effect of extract from *Lagerstroemia Speciosa* L. Leaves in genetically diabetic KK-A^y-mice. *Biosci. Biotechnol. Biochem*, 60(2): 204-208, (1996).
 49. Kamtchouing, P., Sokeng, S.D., et al., Protective role of *Anacardium occidentale* extract against streptozotocin-induced diabetes in rats. *J. of Ethnopharmacol*, 62 (2): 95-99, (1998).
 50. Kusano S and Abe H., Antidiabetic activity of white skinned potato (*Ipomoea batata*) in obese Zucker fatty rats. *Biol. Pharm Bull*, 23(1): 23-26, (2000).
 51. Laphookhieo, Surat., Chalita phungpanya., et al., Chemical constituents from *Aegle marmelos*, *J. Braz. Chem. Soc.* 22(1): (2011) <http://dx.doi.org/10.1590/S0103-50532011000100024>
 52. Lee A.Witters., The blooming of the French lilac. *J. Clin Invest*, 108(8): 1105-1107, (2001).
 53. Lia Ardiana., Rani Sauriasari and Berna Elya, Antidiabetic activity studies of white tea (*Camellia sinensis* L. O. Kuntze) ethanolic extracts in streptozotocin –nicotinamide induced Diabetic rats. *Pharmacog. J.* 10(1): 186-189, (2018).
 54. Mahapatra P. K., Pal. M., Chaudhuri, A.K. N., Chakraborty, D., Basu A., Preliminary studies on glycemic effect of *Syzygium cumini* seeds. *IRCS. Medical Science Biochemistry*, 13(7): 631-632, (1985).
 55. Manisha Modak., Priyanjali Dixit., Jayant Londhe et al., Indian herbs and herbal drugs used for the treatment of Diabetes. *J. Clin. Biochem. Nutr*, 40(3): 163-173, (2007).
 56. Marles, R.J., and Farnsworth, N.R., Antidiabetic plants and their active constituents. *Phytomedicine*, 2(2): 133-189, (1995).
 57. Maroo, J., Vasu, V.T., and Gupta, S., Dose dependent hypoglycaemic effect of aqueous extract of *Enicostemma littorale* Blume in alloxan induced diabetic rats. *Phytomedicine*, 10(2-3): 196-199, (2003).
 58. Matsuda, H., Murakami, T., Yashiro, K., Yamahara, J., and Yoshikawa, M., Hypoglycemic principles of natural medicine IV aldose reductase & alpha glucosidase inhibitors from the root of *Salacia oblonga* Wall. (Celastraceae) Structure of a new Friedelane type triene Kotalagenin-16-acetate. *Chem. Pharma Bull*, 47: 1725-1729, (1999).
 59. Matsuda, H.; Morikawa, T.; Yoshikawa, M., Anti-diabetogenic constituents from several natural medicines. *Pure Appl. Chem.*, 74(7): 1301-1308, (2002).
 60. Mukherjee, P. K., Saha, K., Pal. M., and Saha. B. P., Effect of *Nelumbo neucifera* rhizome extract on blood sugar level in rats. *J. Ethnopharmacol*, 58(3): 207-213, (1997).
 61. Newman Osafo., Kwesi Boadu Mensah., and Oduro Kofi Yeboah., Phytochemical and pharmacological review of *Cryptolepis sanguinolenta* (Lindl.) Schlechter. *Advances in Pharmacological Sciences*, 1-13: (2017). <https://doi.org/10.1155/2017/3026370>.
 62. Noor H, and Ashcroft S. J., Antidiabetic effects of *Tinospora crispa* in rat, *J. Ethnopharmacol*, 27(1-2): 149-161, (1989).
 63. Oshima Y., Konno C. and Hikino K., Isolation and hypoglycemic activity of Panaxans glycans of *Panax ginseng* root. *J. Ethnopharmacol*, 14(2-3): 255-259, (1985).
 64. Oubre, A.Y., Carlson, T.J., King, S.R., and Reaven, G.M., From plant to patient: an ethnomedical approach to the identification of new drugs for the treatment of NIDDM. *Diabetologia*, 40(5): 614- 617, (1997).
 65. Palanichamy S, Nagarajan S and Devasagaya, M., Effect of *cassia alata* leaf extract on hyperglycemic rats. *J. Ethnopharmacol*, 22(1): 81-90, (1988).
 66. Pari, L., and Umamaheswari, J., Antihyperglycemic activity of *Musa sapientum* flower: effect on lipid peroxidation in alloxan induced diabetic rats. *Phytother Res*, 14(2): 136-138, (2000).
 67. Patel, M., Jamrozik, K., Allen, O., Martin, F.I., Eng, J., and Dean, B., A high prevalence of diabetes in a rural village in Papua New Guinea. *Diabetes Research and Clinical Practice*, 2(2): 97-103, (1986).
 68. Perumal samy, R and Ignacimuthu, S., Screening 34 Indian medicinal plants for antibacterial properties, *J. of Ethnopharmacology*, 62(2): 173-182, (1998).
 69. Porchenzhian, E., Ansari, S. H., and Shreedharan, N. K., Antihyperglycemic activity of *Euphorbia officinale* leaves. *Fitoterapia*, 71(5): 522-526, (2000).
 70. Puri, D., and Baral, N., Hypoglycemic effect of *Biophytum sensitivum* in the alloxan diabetic rabbits. *Indian J Physiol Pharmacol*, 42(3): 401-416, (1998).
 71. Rahul Jitin., An ethnobotanical study of medicinal plants in Taindol Village, District Jhansi, Region of Bundelkhand, Uttar Pradesh, India. *J. Med. Plants*, 1(5): 59-71, (2013).
 72. Rang, H.P. and Dale, M.M., *The Endocrine System Pharmacology* Second ed., Longman Group Ltd, Harlow, UK, 504-508, (1991).
 73. Rao B. K., Kesavulu M. M., Giri, R., and Appa Rao C., Antidiabetic and hypolipidemic effect of *Momordica cymbalaria* Hook. fruit powder in alloxan diabetic rats. *J. Ethnopharmacol*, 67(1): 103-109, (1999).
 74. Rao T. P, Sakaguchi N, Juneja L. R, Wada E. and Yokojawa T, Amla (*Embellica officinalis Gaertn*)

- extract reduce oxidative stress in streptozotocin induced diabetic rats. Journal of Medicinal Food. 8(3): 362-368, (2005).
75. Rao, P.V., Ushabala, P., Seshiah, V., Ahuja, M.M., and Mather, H.M., The Eluru survey: prevalence of known diabetes in a rural Indian population. Diabetes Research and Clinical Practice, 7(1): 29-31, (1989).
76. Russel, K. R.M., Morrison, E. A., and Ragoobirsingh, D., The effect of annatto on insulin binding properties in the dog. Phytotherapy research, 19(5): 82-83, (2005).
77. Sachdewa A and Khemani L. D., A Preliminary investigation of possible hypoglycemic activity of *Hibiscus rosa-sinensis*. Biomed Environ Sci, 12(3): 222-226, (1999).
78. Sangameswaran B, and Jayakar B, Anti-diabetic, anhti-hyperlipidemic and spermatogenic effect of *Amaranthus spinosus* linn on streptozotocin-induced diabetic rats. J. Nat. med, 62(1): 79-82, (2008).
79. Saxena, A. M., Mukherjee SK and Murthy P.S., Mode of action of three structurally different hypoglycemic agents: a comparative study. Indian J. Exp. Boil, 34(4): 351-355, (1996).
80. Saxena, A., and Vikram, N.K., Role of selected medicinal Indian plants in management of type 2 diabetes: A review. J. Altern. Complement. Med, 10(2): 369- 278, (2004).
81. Sezik, E., Aslan, M., Yesilada, E., and Ito, S., Hypoglycaemic activity of *Gentiana olivieri* and isolation of the active constituent through bioassay-directed fractionation techniques. Life Sci, 76(11): 1224-1238, (2005).
82. Shah, V. O., Dorin, R.I., Sun, Y., Braun, M., and Zager, P. G., Aldose reductase gene expression is increased in Diabetic Nephropathy, Journal of Clinical Endocrinology and metabolism, 82 (7): 2294- 2298, (1997).
83. Shane-McWhorter, L., Biological complementary therapies: A focus on botanical products in diabetes. Diabetes Spectrum, 14(4): 199-208, (2001).
84. Sharma, S. B, Nasir, A., Prabhu, K. M., Murthy, P. S., and Dev, G., Hypoglycemic and hypolipidemic effect of ethanolic extract of seeds of *Eugenia jambolana* in alloxan induced diabetic rabbits. J. Ethnopharmacol, 85(2-3): 201-206, (2003).
85. Sharma, S.R., Dwivedi, S.K., and Swarup, D., Hypoglycaemic, antihyperglycaemic and hypolipidemic activities of *Caesalpinia bonducella* seeds in rats. J Ethnopharmacol, 58 (1): 39-44, (1997).
86. Singh, K. N., Chandra, V., and Barthwal, K. C., Hypoglycemic activity of *Acacia arabica*, *Acacia benthami* and *Acacia modesta* leguminous seed diets in normal young albino rats. Indian J. Physiol. Pharmacol, 19(3): 167-168, (1975).
87. Singh, S., Vats, P., Suri, S., and M. M. L. Radhe, Effect of an antidiabetic extract of *Cantharanthus roseus* on enzymic activities in streptozotocin induced diabetic rats. J. Ethnopharmacol, 76: 269- 277, (2001).
88. Srividya N and Periwal S., Diuretic, hypotensive and hypoglycaemic effect of *Phyllanthus amarus*. Indian J. Exp. Biol. 33(11): 861-864, (1995).
89. Subramoniam, A., Pushpangadan, P., Rajasekharan, S., Evans, D.A., Latha, P.G., Valsaraj, R., Effects of *Artemisia pallens* Wall. on blood glucose levels in normal and alloxan-induced diabetic rats. J. Ethnopharmacol, 50(1): 13- 17, (1996)
90. Swanston-flatt, S. K., Day, C., Bailey, C. J., and Flatt P.R., Traditional plant treatment for diabetes studies in normal and streptozotocin diabetic mice. Diabetologia, 33(8): 462-464, (1990).
91. Talan, I., Ragoobirsingh D., and Morrison E.Y., The effect of capsaicin on blood glucose plasma insulin level and insulin binding in dog models. Phytotherapy Research. 15(5): 391-394, (2001).
92. Tsiodras, S., Shin, R. K., Chritian, M., Shaw, L. M., and Sass, D. A., Anticholinergic toxicity associated with lupine seed as a home remedy for diabetes mellitus. Annals of Emergency Medicine. 33(6): 715-717, (1999).
93. Tunalı, T., Yarat, A., Yanardag, R., Ozcelik, F., Ozsoy, O., Ergenekon, G., Emekli, N., The effect of chard (*Beta vulgaris* L. var. *cicla*) on the skin of streptozotocin induced diabetic rats. Die Pharmazie, 53(9): 638-640, (1998).
94. Ubillas, R. P., Mendez, C.D., Jolad, S. D., et al. Antihyperglycemic acetylenic glucosides from *Bidens pilosa*. Planta Med, 66(1): 82-83, (2000).
95. Uprety Yadav., Hugo Asselin., Emmaneul K, Boon., Saroj Yadav., and Krishna K. Shrestha., Indigenous use and Bio-efficacy of medicinal plants in the Rasuwa district, Central Nepal. J. Ethnobiol. and ethnomed, 6(3): 1-10, (2010).
96. Verma, N. P., Mehta, S. P., Madhu, S., Mather, H. M., and Keen, H., Prevalence of known diabetes in an urban Indian environment: The Darya Ganj diabetes survey. British Medical Journal, 293(6544): 423-424, (1986).
97. Verspohl, E. J., Bauer, K., and Neddermann, E., Antidiabetic effect of *Cinnamomum zeylanicum* *in vivo* & *in vitro*. Phytother Res, 19(3): 203-206, (2005).
98. Wadood, A., Wadood, N., and Shah S, A., Effect of *Acacia arabica* and *Caralluma edulison* blood glucose level of normal and alloxan diabetic rabbits. J. of Pakistan Medical Association. 39(8): 208- 212, (1989).
99. Watkins, Frances and Pendry, Barbara and Sanchez-medina, Alberto and Corcoran, Olivia., Antibacterial assays on three native British plants used in Anglo-Saxon medicine for wound healing formulation in 10th century England original research article. J. Ethnopharmacol, 144(2): 408-415 (2012).
100. World Health Organization, 2004. Web page <http://www.who.org> (accessed January 2004).
101. Xiang, Q., Carter, G., and Rushforth, K., Abies pindrow. The IUCN list of threatened species, 2013: e.T42294A2970337 <http://dx.doi.org/10.2305>
102. Yadav, P., Sarkar, S., and Batnagar, D., Action of Capparis Decidua against alloxan induced oxidative

- stress and diabetes in rat tissues. *Pharmacol. Res.* 36 (3): 221-228, (1997).
103. Yoshikawa, M., Murakami, T., Yashiro, K and Matsuda, H., Kotalanol-a –potent alpha glucosidase inhibitor with thio sugar sulfonium sulfate structure from hypoglycemic Ayurvedic medicine *Salacia reticulate*. *Chem. Pharma Bull.* 46: 1339-1340, (1998).
104. Yu, B.C., Hung, C.R., Chen, W.C., and Cheng, J.T., Antihyperglycemic effect of andrographolide in streptozotocin-induced diabetic rats. *Planta med.* 69(12): 1075-1079, (2003).