December 30, 2020

PharmacologyOnLine

Archives • 2020 • vol.3 • 81-88

Anti diabetic medicinal plants used in Bangladesh for diabetes mellitus : A review

Md. Mizanur Rahman*[1], Md. Abu Saleh Roni[1], Sujana Al- Erfan[1], Sristy Bepary[1], Md. Al–Amin[1], Sammy Sultana Munny[1], Aklima Akter[1] and Shamia Zaman Tanny[2]

[1]Department of Pharmacy, Daffodil International University, Dhaka-1207, Bangladesh.

[2]Department of Pharmacy, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Gopalganj, Bangladesh.

*mizanur.ph@diu.edu.bd

Abstract

The aim of the current research is to analyze the different medicinal plants used for antidiabetic activity. Diabetes mellitus is one of the most common non-communicable diseases in the world. It is the fourth leading cause of death in the most developed nations, and in many developing and recently advanced countries it has been found to be a significant disease. In this research report, we're only searching for some possible herbal herbs, anti-diabetic operation in Bangladesh. Knowledge available on traditional anti-diabetic uses of these plants and their pharmacological activities has been obtained from a number of internet sources, such as Pubmed, SciFinder, Elsevier, Springer, Scopus, Science Direct, Google Scholar and the Science Site, which have also been used to gather information in addition to these locally accessible papers. This study will help to strengthen the relationship between traditional medicine, pharmacology and the development of drugs. A clue to the discovery of new and improved anti-diabetic drugs can be found from the evidence presented in this study.

Keywords: *Diabetes mellitus, metabolic disorder, herbs, herbal plants, hypoglycemic action, antioxidant movement*.

Introduction

Diabetes mellitus is a metabolic illness considered by high blood glucose level owing to insulin excretion deficiencies, insulin exploit and/or together.[1] It is a long lasting sickness that disturbs the daytime absorption of carbohydrates, fat, proteins and electrolytes, resulting in complications addicted to acute, sub-acute and chronic complications. [2]

At least 30 million people worldwide suffering from diabetes mellitus. This disease may have the life expectancy, mainly in emerging nations where its occurrence is growing and there is often a lack of adequate treatment. Uniform in established nations such as USA, where sophisticated therapy is widely available, extra deaths are official to diabetes than to lung cancer, breast cancer, or accidents involving mechanical vehicle (World Health Organization 1985). Not only does diabetes murders nevertheless it is also a significant reason of mature blindness, kidney disaster, gangrene, neuropathy, heart attacks, and strokes.[3] Traditional drug is used in developing countries for action of diabetes where the rate of conservative drugs is a problem to the people. [4] A lot of native Indian therapeutic plants have been initiated to be beneficial in managing diabetes effectively. One of the major benefits of therapeutic plants is that they are available willingly and have actual little side effects. Plants have long been an excellent foundation of medicines and various of the medicines obtainable today have been resulting directly or indirectly extracted from them. [5] World Health Organization has reported that 80 percent of global public are using herbal drugs in the same way at initial stage of health remedy, and they need to be scientifically tasted for their efficacy. [6] As a main cause of food complements, plants are actual in regulating blood glucose and stopping difficulties in type II diabetes over the long term. [7] Many herbal medicines have been already recognized the beneficial effects of in reducing blood glucose and its complications. [8-9] Records of ethnobotanical knowledge on 800 plants which may have antidiabetic potential [10]. These medicinal plants play a vital role in supplying rural people with primary health maintenance facilities. Ethno-botanical lessons have shown that in Bangladesh, additional 60 therapeutic plants are used historically used to diagnose diabetes. Among these, around 16 therapeutic plants are primarly used by traditional herbal experts in Bangladesh, as well as medicinal systems in Ayurveda, Unani and Herbal of delicacy diabetes [11,12]. From the knowledge and detailed survey of the medicinal plants we might be able to discover new drugs, which are therapeutically active and also cheaper. In this review description about the antidiabetic medicinal plants are given which are reported to have good therapeutic activity by thorough literature survey.

Methods

Search strategy:
Conventional textbooks and databases such as PubMed, SciFinder, Elsevier, Springer, Scopus, Science Direct, Google Scholar and Web of Science were examined, using the following descriptors: "herbal medicine" or "drug", "medicinal plant" or "medicine traditional"

Inclusion and exclusion criteria:

Equally original works and reviews on therapeutic plants were observed, with individuals referencing the diabetes-referenced plant types, by botanical documentation properly identified giving to the Bangladesh Ethnobotanical Database (EDB) and Therapeutic Plants of Bangladesh.

Results

Antidiabetic effect of traditional medicinal plants in Bangladesh:

Allium cepa L. (Piyaj): (Alliaceae)
The Allium cepa bulb part has the anti-diabetic function [13]. It tracked glucose production 6 phosphatase and HMG CO A reductase [14]. It expressively precise blood glucose levels to alloxan with the administration of amino acid sulfur (200 mg/kg for 45 days) [15]. When oral administration of 50gm of onion juice post- prandial glucose levels was suggestively regulated [16].

Asparagus racemosus (satamuli, Satavar): (Asparagaceae)
The Asparagus racemosus root extracts display insulin tropic behavior. Ethanol extract, chloroform, hexane in the root part of Asparagus racemosus were found in dose dependent insulin secretions in isolated beta cells [17].

Brassica nigra L (kalo sorse, Sorsa): (Brassicaceae)
The Brassica nigra seed portion has been used for anti-diabetic function. With the provision of 200 mg/kg of aqueous extract body weight in diabetic animals for 30 days, it is possible to reduce the action of fasting serum glucose level, where the unprocessed community of fasting serum glucose level remainders advanced rate. As applied to controlled and untreated animals, the amount of glycosylated hemoglobin and serum lipids was much lower [18].

Aloe vera (Ghritokumari): (Liliaceae)
It is use for effecting hypoglycemic. The plant's main ingredients include Pseudoprototinosaponin AIII and prototinosaponins AIII [19]. Glucose acceptance besides insulin released in contradiction of glycogenolysis or gluconeogenesis path are significant uses of these constituent [20].

Capsicum frutescens (Chilli): (Solanaceae)
In rat type 2 diabetes model, chilli is used for insulinotropic movement instead of hypoglycemic and raises serum insulin absorption in high fat food [21].

Annona squamosa(Ata): (Annonaceae)
Leaf and Fruit-Tissue have been used for the Annona squamosa antidiabetic function [22]. Extract of ethanolic and aqueous substances was found [23,24]. Reduced glucose, lipid and lipid peroxidation concentrations [25,26].

Terminalia chebula (Horitoki) : (Combretaceae)
The Terminalia chebula seed and fruit portion were used in antidiabetic impact. Extracts are used in aqueous besides chloroform. Subordinate metabolite consists of Shikimic, Gallic, Triacontanoic, Palmitic acid, β-sitosterol, and Daucosterol. Act by taking down the level of glucose [27,28].

Cinnamon zeylaniucm :
Cinnamaldehyde is the main ingredient of Cinnamon zeylaniucm, which acts to release insulin level. Another essential feature of cinnamaldehyde is its insulinotropic result due to improved absorption via translocation of the glucose transporter [29].

Psidium guajava L.(Peyara): (Myrtaceae)
Psidium guajava's leaf and fruit portion has powerful antidiabetic and hypoglycemic movement. The plant's dynamic ingredients include Terpen, Flavonoid, Strictinin, Isostrictinin, Pedunculagin, and Polysaccharides. Practical action is reduction of glucose level [30-32].
In alloxan-induced hyperglycemic rats, ethanol extract from shoot barks demonstrates substantial hypoglycemic action. Aqueous Psidium guajava extracts have exercised several antidiabetic effects, hypoglycemic movement, and hypolipidemia behavior [33,34].

Curcuma longa L.(Haldi): (Zingiberaceae)
Curcuma longa exhibits different kinds of antidiabetic effects such as hypoglycemic and similarly plays a major role in activating PPAR gamma [35].

Tamarindus indica L (Tentul): (Caesalpiniaceae)
Fruits of T. indica L is used for carminative, laxative and digestive properties in Bangladeshi folk medicine. Leaves and seeds are astringent whilst tender leaves and flowers have anti-establishment properties. Bark is recommended for asthma, amenorrhea and as febrifuge [36]. when administered in moderate diabetic or serious diabetics, aqueous extract of Tamarindus indica shows some significant antidiabetic activity with hyperglycemia attenuation of and hyperlipidemia [37].

Piper betle (Pan) : (Piperaceae)
when directed in minor diabetic, aqueous extract of Tamarindus indica displays nearly significant antidiabetic action with hyperglycemia decrease and hyperlipidemia [38,39].

Amaranthus esculentus : (Amaranthaceae)
The entire portion of Amaranthus esculentus has been used in antidiabetic properties for beneficial

effect. The plant's primary function is to lower glucose level [40]. Increasing insulin secretion is another main task [26].

Scoparia dulcis: (Scrophulariacae)
The whole plant's aqueous extract has been used for antidiabetic effects including reduced concentration of glucose, falling lipid and oxidative tension. It rises the insulin secretion [41,42].

Hordeum vulgare : (Gramineae)
In non-insulin dependent diabetic mellitus, the germinanting fruits of Hordeum vulgare exhibit hypoglycemic and hyperinsulinemia effects [43].

Cuminum nigrum L (Shahi jeera) : (Apiaceae)
Flavonoid is the main active ingredients of Cuminum nigrum causing hypoglycemic impact in equally normal and alloxan-diabetic rabbits [44]. It increases insulin sensitivity as a possible antidiabetic agent, and promotes activation of AMPK [45].

Swertia chirayita : (Gentianaceae)
Swertia chirayita improved plasma insulin dramatically, also decreased blood sugar [46]. Only oral management of swerchirin to rats triggered decreased blood glucose with noticeable reduction of beta granules marked with aldehyde fuchsin [47].

Eugenia jambolana (Jamun) : (Myrtaceae)
The antidiabetic effect was used with Fruit, pulp and Seed. They find aqueous and ethanolic extract. This plant's Primary functions include diminished blood glucose and lipid. Typically, improved activity around glucose acceptance [48,49].

Azadirachta-indica A. Juss. (Neem): (Meliaceae)
The part of the leaf act as a powerful powder forming antidiabetic agent. Aqueous extract and alcoholic extract were acting in high dose as an essential hypoglycemic operation [50]. It has several possible benefits, with anti-bacterial, antimalarial, antifertility, hepatoprotective and antioxidant [51].

Ocimum sanctum L. (Tulsi):
The aqueous leaf extract demonstrates substantial decreasing behavior of blood sugar levels in equally usual and alloxan encouraged diabetic rats [52]. It also serves as a decrease in fasting blood glucose, uronic acid, total cholesterol, hypoglycemic and diabetic rat hypolipidemics. [53] Many primary effects include antioxidant, antibacterial, antifungal, antiviral, anti-asthmatic, antistress, antitumor, involvement of gastric antiulcer, antimutagenic and immunostimulant activities. [54]

Mangifera indica L. (Aam) : (Anacardiaceae)
Mangifera indica plays an important part in the treatment of antidiabetics. The plant's aqueous extract induces a decrease in blood glucose levels, but has no outcome on streptozotocin encouraged diabetic mice below the similar situations when associated to that of an oral chlorpropamide amount, it displays high hypoglycemic behavior [55].

Abelmoschus moschatus Medik (Kasturidana) : (Malvaceae)
Myricelin is the main active ingredient of this plant, which enhances insulin compassion through improved post receptor insulin signaling refereed by enhancements in IRS-1-related PI3- kinase and GLUT 4 action in muscles of obese Zucker rats. [56]

Discussion

Medicinal plants have been used since ancient times to treat many diseases, such as diabetes. Herbs are commonly used in therapy since they are known to be safer and more effective. By using ethno botanical and ethno pharmacological information, we have come to know about medicinal plants with potent antidiabetic action. This review article describes medicinal plants, which are commonly used for the treatment of diabetes. The parts of the plant, such as the leaf and the specific extract that is more effective are also described here. It is also clear that a number of studies have also been carried out in order to develop successful treatment for diabetes both in Bangladesh and abroad.

Conclusion

Traditional therapeutic plants are a significant component of original medical systems in

Bangladesh and rest of the world. These therapeutic plants play a vital role in provided that primary health care facilities to rural public in Bangladesh. Therefore, treating diabetes mellitus with plant derivative mixtures, which are available and do not need difficult pharmaceutical synthesis seems highly attractive. In the present review an effort has been completed to study the antidiabetic medicinal plants and may be useful to the health professionals, scientists and scholars working in the field of pharmacology and therapeutics to develop antidiabetic drugs.

References

1. Khan, A., Zaman, G., & Anderson, R. A. (2009). Bay leaves improve glucose and lipid profile of people with type 2 diabetes. *Journal of clinical biochemistry and nutrition*, *44*(1), 52-56.
2. Rang, H. P., & Dale, M. M. (1991). The Endocrine System or Pharmacology.
3. Bransome, E. D. (1992). Financing the care of diabetes mellitus in the US. *Diabetes care*, *15*(Suppl. 1), 1-5.
4. Saravanan, G., & Pari, L. (2008). Hypoglycaemic and antihyperglycaemic effect of Syzygium cumini bark in streptozotocin-induced diabetic rats. *Journal of pharmacology and toxicology*, *3*(1), 1-10.
5. Alarcon-Aguilara, F. J., Roman-Ramos, R., Perez-Gutierrez, S., Aguilar-Contreras, A., Contreras-Weber, C. C., & Flores-Saenz, J. L. (1998). Study of the anti-hyperglycemic effect of plants used as antidiabetics. *Journal of ethnopharmacology*, *61*(2), 101-110.
6. Kennedy, J. (2005). Herb and supplement use in the US adult population. *Clinical therapeutics*, *27*(11), 1847-1858.
7. Gallagher, A. M., Flatt, P. R., Duffy, G. A. W. Y., & Abdel-Wahab, Y. H. A. (2003). The effects of traditional antidiabetic plants on in vitro glucose diffusion. *Nutrition research*, *23*(3), 413-424.
8. Marles, R. J., & Farnsworth, N. R. (1995). Antidiabetic plants and their active constituents. *Phytomedicine*, *2*(2), 137-189.
9. Akbari, F., Ansari Samani, R., Karimi, A., Mortazaei, S., Shahinfard, N., & Rafieian-Kopaei, M. (2013). Effect of turnip on glucose and lipid profiles of alloxan-induced diabetic rats. *Iranian Journal of Endocrinology and Metabolism*, *14*(5).
10. Aguilara, F. A., Ramos, R. R., Gutirrez, S. P., Contretras, A. A., Weber, C. C., & Saenz, J. F. (1998). Study of the anti-hyperglycaemic effect of plants used as antidiabetics. *J Ethnopharmacol*, *61*, 101-10.
11. Ghani, A. (1998). *Medicinal plants of Bangladesh: chemical constituents and uses*. Asiatic society of Bangladesh.
12. Uddin, S. N. (2006). *Traditional uses of ethnomedicinal plants of the Chittagong Hill Tracts*. Bangladesh National Herbarium.
13. Bhushan, M. S., Rao, C. H. V., Ojha, S. K., Vijayakumar, M., & Verma, A. (2010). An analytical review of plants for anti diabetic activity with their phytoconstituent & mechanism of action. *Int J Pharm Sci Res*, *1*(1), 29-46.
14. Roman-Ramos, R., Flores-Saenz, J. L., & Alarcon-Aguilar, F. J. (1995). Anti-hyperglycemic effect of some edible plants. *Journal of Ethnopharmacology*, *48*(1), 25-32.
15. Kumari, K., Mathew, B. C., & Augusti, K. T. (1995). Antidiabetic and hypolipidemic effects of S-methyl cysteine sulfoxide isolated from Allium cepa Linn. *Indian journal of biochemistry & biophysics*, *32*(1), 49-54.
16. Mathew, P. T., & Augusti, K. T. (1975). Hypoglycaemic effects of onion, Allium cepa Linn. on diabetes mellitus-a preliminary

report. *Indian Journal of physiology and pharmacology*, *19*(4), 213-217.

17. Gomase, V. S., & Sherkhane, A. S. (2010). Isolation, structure elucidation and biotransformation studies on secondary metabolites from Asparagus racemosus. *International Journal of Microbiology Research*, *2*(1), 7.

18. Anand, P., Murali, K. Y., Tandon, V., Chandra, R., & Murthy, P. S. (2007). Preliminary studies on antihyperglycemic effect of aqueous extract of Brassica nigra (L.) Koch in streptozotocin induced diabetic rats.

19. Bnouham, M., Ziyyat, A., Mekhfi, H., Tahri, A., & Legssyer, A. (2006). Medicinal plants with potential antidiabetic activity-A review of ten years of herbal medicine research (1990-2000). *International Journal of Diabetes and Metabolism*, *14*(1), 1.

20. Singh, L. W. (2011). Traditional medicinal plants of Manipur as anti-diabetics. *Journal of medicinal plants research*, *5*(5), 677-687.
21. Islam, M. S., & Choi, H. (2008). Dietary red chilli (Capsicum frutescens L.) is insulinotropic rather than hypoglycemic in type 2 diabetes model of rats. *Phytotherapy Research*, *22*(8), 1025-1029.

22. Gupta, R. K., Kesari, A. N., Watal, G., Murthy, P. S., Chandra, R., & Tandon, V. (2005). Nutritional and hypoglycemic effect of fruit pulp of Annona squamosa in normal healthy and alloxan-induced diabetic rabbits. *Annals of nutrition and Metabolism*, *49*(6), 407-413.

23. Andrade-Cetto, A., Martinez-Zurita, E., & Wiedenfeld, H. (2005). Hypoglycemic effect of Malmea depressa root on streptozotocin diabetic rats. *Journal of ethnopharmacology*, *100*(3), 319-322.

24. Kaleem, M., Asif, M., Ahmed, Q. U., & Bano, B. (2006). Antidiabetic and antioxidant activity of Annona squamosa extract in streptozotocin-induced diabetic rats. *Singapore medical journal*, *47*(8), 670.

25. Ojewole, J. A. (2005). Antinociceptive, anti-inflammatory and antidiabetic effects of Bryophyllum pinnatum (Crassulaceae) leaf aqueous extract. *Journal of ethnopharmacology*, *99*(1), 13-19.

26. Fröde, T. S., & Medeiros, Y. S. (2008). Animal models to test drugs with potential antidiabetic activity. *Journal of Ethnopharmacology*, *115*(2), 173-183.

27. Sharma, R., & Arya, V. (2011). A review on fruits having anti-diabetic potential. *Journal of Chemical and Pharmaceutical Research*, *3*(2), 204-212.

28. Rao, N. K., & Nammi, S. (2006). Antidiabetic and renoprotective effects of the chloroform extract of Terminalia chebula Retz. seeds in streptozotocin-induced diabetic rats. *BMC complementary and alternative medicine*, *6*(1), 17.

29. Anand, P., Murali, K. Y., Tandon, V., Murthy, P. S., & Chandra, R. (2010). Insulinotropic effect of cinnamaldehyde on transcriptional regulation of pyruvate kinase, phosphoenolpyruvate carboxykinase, and GLUT4 translocation in experimental diabetic rats. *Chemico-biological interactions*, *186*(1), 72-81.

30. Ojewole, J. A. O. (2005). Hypoglycemic and hypotensive effects of Psidium guajava Linn.(Myrtaceae) leaf aqueous extract. *Methods and findings in experimental and clinical pharmacology*, *27*(10), 689-696.

31. Chauhan, A., Sharma, P. K., Srivastava, P., Kumar, N., & Dudhe, R. (2010). Plants having potential antidiabetic activity: a review. *Der Pharmacia Lettre*, *2*(3), 369-387.

32. Makheswari, M. U., & Sudarsanam, D. (2012). Database on antidiabetic indigenous plants of Tamil Nadhu, India. *Int J Pharma Sci Res*, *3*(2), 287-293.

33. Mukhtar, H. M., Ansari, S. H., Bhat, Z. A., Naved, T., & Singh, P. (2006). Antidiabetic activity of an ethanol extract obtained from

the stem bark of Psidium guajava (Myrtaceae). *Die Pharmazie-An International Journal of Pharmaceutical Sciences*, *61*(8), 725-727.

34. Rai, P. K., Mehta, S., & Watal, G. (2010). Hypolipidaemic & hepatoprotective effects of Psidium guajava raw fruit peel in experimental diabetes. *Indian J Med Res*, *131*(820), 820-4.

35. Kuroda, M., Mimaki, Y., Nishiyama, T., Mae, T., Kishida, H., Tsukagawa, M., ... & Kitahara, M. (2005). Hypoglycemic effects of turmeric (Curcuma longa L. rhizomes) on genetically diabetic KK-Ay mice. *Biological and Pharmaceutical Bulletin*, *28*(5), 937-939.

36. Yusuf, M., Chowdhury, J. U., Wahab, M. A., & Begum, J. (1994). Medicinal plants of Bangladesh. *Bangladesh Council of Scientific and Industrial Research, Dhaka, Bangladesh*, 192.

37. Maiti, R., Das, U. K., & Ghosh, D. (2005). Attenuation of hyperglycemia and hyperlipidemia in streptozotocin-induced diabetic rats by aqueous extract of seed of Tamarindus indica. *Biological and Pharmaceutical Bulletin*, *28*(7), 1172-1176.

38. Arambewela LS, Arawwawala LD, Ratnasooriya WD. Antidiabetic activities of aqueous and ethanolic extracts of Piper betle leaves in rats. J Ethnopharmacol 2005; 102:239-245.

39. Santhakumari, P., Prakasam, A., & Pugalendi, K. V. (2006). Antihyperglycemic activity of Piper betle leaf on streptozotocin-induced diabetic rats. *Journal of medicinal food*, *9*(1), 108-112.

40. Gupta, R. K., Kesari, A. N., Murthy, P. S., Chandra, R., Tandon, V., & Watal, G. (2005). Hypoglycemic and antidiabetic effect of ethanolic extract of leaves of Annona squamosa L. in experimental animals. *Journal of ethnopharmacology*, *99*(1), 75-81.

41. Latha, M., & Pari, L. (2005). Effect of an aqueous extract of Scoparia dulcis on plasma and tissue glycoproteins in streptozotocin induced diabetic rats. *Die Pharmazie-An International Journal of Pharmaceutical Sciences*, *60*(2), 151-154.

42. Pari, L., & Latha, M. (2006). Antihyperlipidemic effect of Scoparia dulcis (sweet broomweed) in streptozotocin diabetic rats. *Journal of Medicinal food*, *9*(1), 102-107.

43. Chauhan, A., Sharma, P. K., Srivastava, P., Kumar, N., & Dudhe, R. (2010). Plants having potential antidiabetic activity: a review. *Der Pharmacia Lettre*, *2*(3), 369-387.

44. Ahmad, M., Akhtar, M. S., Malik, T., & Gilani, A. H. (2000). Hypoglycaemic action of the flavonoid fraction of Cuminum nigrum seeds. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, *14*(2), 103-106.

45. Kang, C., & Kim, E. (2010). Synergistic effect of curcumin and insulin on muscle cell glucose metabolism. *Food and chemical toxicology*, *48*(8-9), 2366-2373.

46. Grover, J. K., Yadav, S., & Vats, V. (2002). Medicinal plants of India with anti-diabetic potential. *Journal of ethnopharmacology*, *81*(1), 81-100.

47. Bnouham, M., Ziyyat, A., Mekhfi, H., Tahri, A., & Legssyer, A. (2006). Medicinal plants with potential antidiabetic activity-A review of ten years of herbal medicine research (1990-2000). *International Journal of Diabetes and Metabolism*, *14*(1), 1.

48. Sharma, S. B., Nasir, A., Prabhu, K. M., & Murthy, P. S. (2006). Antihyperglycemic effect of the fruit-pulp of Eugenia jambolana in experimental diabetes mellitus. *Journal of ethnopharmacology*, *104*(3), 367-373

49. Ravi, K., Rajasekaran, S., & Subramanian, S. (2005). Antihyperlipidemic effect of Eugenia jambolana seed kernel on streptozotocin-

induced diabetes in rats. *Food and Chemical Toxicology*, *43*(9), 1433-1439.

50. Waheed, A., Miana, G. A., & Ahmad, S. I. (2006). Clinical investigation of hypoglycemic effect of seeds of Azadirachta-inidca in type-2 (NIDDM) diabetes mellitus. *Pakistan journal of pharmaceutical sciences*, *19*(4), 322.

51. Biswas, K., Chattopadhyay, I., Banerjee, R. K., & Bandyopadhyay, U. (2002). Biological activities and medicinal properties of neem (Azadirachta indica). *CURRENT SCIENCE-BANGALORE-*, *82*(11), 1336-1345.

52. Shibly, A. Z., Zohora, F. T., Islam, M. S., & Islam, M. R. (2015). A comprehensive review on ethno pharmacological antidiabetic potential of traditional ayurvedic plants of Bangladesh. *Journal of Pharmacognosy and Phytochemistry*, *4*(1).

53. Rai, V. A., Iyer, U., & Mani, U. V. (1997). Effect of Tulasi (Ocimum sanctum) leaf powder supplementation on blood sugar levels, serum lipids and tissues lipids in diabetic rats. *Plant foods for human nutrition*, *50*(1), 9-16.

54. Vats, V., Yadav, S. P., & Grover, J. K. (2004). Ethanolic extract of Ocimum sanctum leaves partially attenuates streptozotocin-induced alterations in glycogen content and carbohydrate metabolism in rats. *Journal of ethnopharmacology*, *90*(1), 155-160.

55. Aderibigbe, A. O., Emudianughe, T. S., & Lawal, B. A. S. (2001). Evaluation of the antidiabetic action of Mangifera indica in mice. *Phytotherapy research*, *15*(5), 456-458.

56. Liu, I. M., Tzeng, T. F., Liou, S. S., & Lan, T. W. (2007). Improvement of insulin sensitivity in obese Zucker rats by myricetin extracted from Abelmoschus moschatus. *Planta Medica*, *73*(10), 1054-1060.