

POTENTIAL ANTI-DIABETIC MEDICINAL PLANTS IN BANGLADESH: A COMPREHENSIVE REVIEW

Md. Mominul Islam^{1*}, Rokeya Nazneen Jarna^{1,2}, Preeti Jain¹, Md. Ashraful Alam¹, Hasan Mahmud Reza¹, Murad Hossain¹, Sourabh Paul¹, S. M. Rayan Kabir¹, Dr. Md. Majedur Rahamn³

¹Department of Pharmaceutical Sciences, North South University, Dhaka-1229, Bangladesh.

²Amneal Pharmaceuticals, 50 Horseblock Road Brookhaven, New York 11779, USA.

³Shahabuddin Medical College and Hospital, Dhaka-1212, Bangladesh.

Article Received on
09 March 2019,
Revised on 30 March 2019,
Accepted on 19 April 2019,
DOI: 10.20959/wjpr20196-14849

*Corresponding Author

Dr. Md. Mominul Islam

Department of
Pharmaceutical Sciences,
North South University,
Dhaka-1229, Bangladesh.

ABSTRACT

Diabetes is one of the utmost causes of mortality and the number of diabetes patients are increasing at an alarming rate worldwide. The medicine available for the treatment of diabetes in the market is not less in number, yet no drug capable of completely curing is available. Additionally, they are not completely safe and have many side effects. However, some medicinal plants and plant derived products have proved therapeutically effective and safer treatment option for diabetes. Medicinal plants that have anti-diabetic potentiality or natural products and plant analogue have been recognized as propelling anti-diabetic agents and gradually the anti-diabetic controls of different medicinal

plants are being accepted. Therefore, recognized and highlighted medicinal plants along with advanced plant species that stained as anti -diabetic values available in Bangladesh are the main concern of our endeavour is being made throughout the review.

KEYWORDS: Anti-diabetic, Medicinal plants, Bangladesh.

INTRODUCTION

Diabetes is becoming the most alarming public health threat not only in developed countries but also in developing countries like Bangladesh. Diabetes is a chronic disease that due to occur either inadequate insulin production by the pancreas or when body itself is unable to use produced insulin properly. In conformity with International Diabetes Federation (IDF), the number of diabetic patients has been increased remarkably and it is elapsed 366 million in the

year of 2011, whether a large number individuals (4.6 million) deaths per year due to diabetes.^[1] According to World Health Organization (WHO) reports that the number of diabetic population is likely to progress to 300 million or more.^[2]

In Bangladesh, currently available antidiabetic agents include sulfonylureas, biguanides, α -glucosidase inhibitor; glinides etc. along with insulin therapy. These available therapies are sometimes used as monotherapy or in combination to decrease blood glucose at a satisfactory level for better management of diabetes. However, these therapies are not free from adverse effects or in some context severe side effects.^[3] According to WHO, currently almost 4 billion people of across the world are using herbal medicines as the primary treatment options^[4], because of their lesser side effect and toxic effects. The Indian subcontinent has been marked as one of the most epidemic region for diabetes in the world, where Bangladesh has the highest percentage of diabetic patients between the age group 20-79.^[1] The most common and largely effective antidiabetic medicinal plants of Bangladesh with phytochemical properties are Kajubadam (*Anacardium Occidentale L.*), Ata (*Annona Squamosa L.*), Punarnava (*Boerhaavia Diffusa L.*), Nayantara (*Catharethus Roseus L.*), Daikhai (*Cocculus Hirsutus L.*), Kakdumur (*Ficus Hispida L.*), Kalojam (*Syzygium Cumini L.*), Haritaki (*Terminalia Chebula*), Kath Badam (*Terminalia Catappa L.*), Am (*Mangifera Indica L.*), Karolla (*Momordica Charantia L.*), Jam or Kalojam (*Syzygium cumini L.*), Haritaki (*Terminalia Chebula*), Kath Badam (*Terminalia catappa*). The listed plants rich of phytochemicals and antidiabetic potentials may be the best option for regulation of diabetes mellitus in Bangladesh. The current review focuses on the management of medicinal plants of Bangladesh that could serve as economic and effective treatment options of diabetes mellitus (a major chronic disease) with lesser or no side effects.

1. MEDICINAL PLANTS WITH ANTIDIABETIC PROPERTIES AVAILABLE IN BANGLADESH

1.1 *Anacardium Occidentale L.*

Anacardium occidentale L. is a Latin American originated herb, belonging to anacardiaceae family which is locally familiar as kaju, kajubadam or Hisjlibadam. It is a cultivated plant, which is found in a reserved scale in hill tract area (Chittagong) of Bangladesh.^[5] The bark of this herb has the hypoglycemic and antihypertensive potentiality.^[6] This plant was used as folk medicine in the various African communities for the treatment of diabetes mellitus. It has been narrated that, the leaves of this herb are opportunistic for renal impairment and as

hypoglycemic based on the streptozotocin treated diabetes rats. The study also claimed that, it has a good impact on diabetes- associated kidney problems like histological and functional alteration.^[7] In diabetes animal model studies (*Anacardium occidentale*) has shown remarkably decrease in the collection of mucopolysaccharides in the kidneys.^[8]

1.2 *Annona Squamosa L.*

Annona squamosa L. belongin to Annonaceae family is frequently cultivated throughout Bangladesh. In Bengali it's known as Ata, Sharifa, Luna and in English as Custard Apple, Sweet stop.^[9] The different part of this plant has such as seeds, leaves and aerial parts has important pharmacological properties due to presence of active medicinal ingredients.^[10] *A.Squamosa* helps in diabetes regulation in two different ways. Firstly, acts by increasing the extra amount of insulin from pancreatic isletsmuscle. Similarly, it increase the utilization of glucose by muscle and liver glucose get interrupted to increase blood glucose level.^[11] Leaf extracts of this plant is effective in the management of blood sugar and lipid level. Aqueous root extracts of *Annona squamosa* has not only shown in reduction in blood glucose level after administration to STZ-initiated diabetic rats but also rise in the antioxidant properties of enzyme along with decrease the renal and liver lipid peroxidation.^[12]

1.3 *Boerhaavia Diffusa L.*

Boerhaavia diffusa L. is a native medicinal plant of Bangladesh. This belongs to the family of Nyctaginaceae and It is small perennial pervading herb. In Bengali, this is commonly known as Punarnava and in English widely known as “Red Hogweed.”^[13] It is taken as a herbal medicine for pain relief in many parts of Bangladesh. It is widely cultivated in fallow lands all over Bangladesh.^[13] Roots and whole plant have been used for the treatment of stress, dyspepsia, abdominal pain, inflammation, diabetes, jaundice, enlargement of the spleen enlargement and also microbial infections.^[11] Alloxan-induced hyperglycemic rats model exhibited tremendous antihyperglycemic activities when treated with ethanolic *Boerhaavia*.^[14] Overweight obesity related high serum cholesterol as well as triglyceride levels of diabetes may be improved by using extract of this plant.^[15] A study investigated the effect of an aqueous extracts of *Boerhaavia diffusa* leaf (200mg/kg) on alloxan induced and normal diabetic rats for investigating the blood glucose concentration along with hepatic enzymes in daily oral administration for four weeks. It not only showed remarkable decrease in blood glucose level but also significantly increase in plasma insulin level on the normal and alloxan-induced rat model. The herb of this plant has been found responsible for reducing blood

glucose level and increasing insulin sensitivity.^[14]

1.4 Catharanthus Roseus L.

Catharanthus roseus Linn. is a belongs to the family Apocynaceae. This plant is commonly grown in garden. In Bengali, it is known as Nayantara and as Madagascar Periwinkle in english.^[16] The plant not only has antidiabetic properties but also anticancer properties. Many tropical and subtropical regions of the world use the whole plant or the leaves of *Catharanthus roseus*, processed it with hot water decoction and yields are used for the antidiabetic properties.^[11] Alkaloids of the leaf extract are active and play a significant in lowering the blood glucose level.^[17] Dichloromethane-methanol extract(1:1) of the leaves and twigs was tested for antidiabetic activity and its effect on enzymes of carbohydrate metabolism was explored.^[18] In a study, both normal and diabetic rabbits exhibited the dose-dependent reduction in blood glucose level followed by administration of extracts of *C. roseus*, and the results were comparable with a standard hypoglycemic agent, glibenclamide. The outcome may be the result of enhanced secretion of insulin.^[19]

1.5 Cocculus Hirsutus L.

Cocculus hirsutus Linn. is a member of Menispermaceae family that is grow throughout Bangladesh, especially in dry regions like Dhaka, Bagerhat, Dinajpur, Jhalakathi, Kustia etc. This is commonly known as Daikhai, Jalajmani, Heyer in Bengali.^[20] The roots are bitter in taste and its decoction acts as laxative, demulcent and antiperiodic in fever. Leaf juice mixed with water forms jelly, which has the cooling and soothing effect in case of prurigo, eczema, and gonorrhoea.^[20] Badole et al. have demonstrated the antihyperglycemic activity of aqueous extract of leaves of *Cocculus hirsutus* (L) Diels in alloxan-induced diabetic mice. It has been found, that aqueous extract of leaves of *C. hirsutus* minimized the serum glucose level and improved glucose tolerance significantly in the presence of alkaloids. Moreover, the leaf extract exhibited prevention in loss of body weight in diabetic mice.^[21] The possible reason behind the antihyperglycemic activity of *C. hirsutus* may be the insulinogenic activity of the extract. Hence, it can be said that, *C. hirsutus* extract may stimulate the secretion from remnant cells and from regenerated cells.^[22]

1.6 Ficus Hispida L.

Ficus hispida Linn. is a small tree, found throughout Bangladesh. In Bengali, it is called Kakdumur, Khoksha-dumur, Dumur, Dhungri, Thoska etc. In Tribal regions, it is known as Tammang gas (Tanchangya), Dhumur gula (Chakma), Fah shai ba (Marma), Thainjang

(Tripura), Luhuk (Murong) etc.^[23] Traditionally, it is used for the treatment of diabetes mellitus. Different parts of *Ficus hispida* (FH) have been explored and found useful in dysentery, ulcers, psoriasis, anemia, piles, jaundice and diseases of the blood. Hypoglycemic property of *F. bengalensis* Linn. (Bark) in normal and diabetic albino rats showed that, the water-soluble fraction of the alcoholic extract of *Ficus hispida* significantly decreases fasting blood glucose levels in normal and alloxan- induced diabetic rats. The extract showed a direct action on β cells but drug interaction may occur when *Ficus hispida* bark extract and insulin administered simultaneously.^[24]

1.7 *Momordica Charantia* L.

Momordica charantia is a member of Cucurbitaceae-Cucumber family, the most frequently used traditional herbal medicine in primary medical problems. Karolla, Uchhe, Usta etc are the common names in Bengali for this plant. In English it is mostly known as Bitter Gourd.^[25] The plant is widely cultivated through Bangladesh for use as vegetable as well as medicine. It grows well in tropical areas of Asia, Amazon, East Africa, and the Caribbean.^[26] It grows mostly used as an antidiabetic and antihyperglycemic agent in Asian and Latin American countries.^[27] According to study, *Momordica charantia* showed significant antidiabetic potential in streptozotocin or alloxan induced experimental diabetic rats, mice, rabbit, generally diabetic mice and in human with type2 diabetes. It also stimulates the pancreatic secretion along with the recovery of partial cells of the pancreas, otherwise, permit to the renewal of partially destroyed cells. It has been indicated that, plasma insulin level increases at a satisfactory level if streptozotocin-induced diabetic rats were treated with *Momordica charantia*.^[17,28]

1.8 *Mangifera Indica* L.

Mangifera indica is a member of Anacardiaceae family, locally known as Aam, In English as Mango, cultivated throughout the country. The leaves of *Mangifera indica* are used as an antidiabetic agent in traditional medicine in Bangladesh.^[29] It is also used for its medicinal effects in tropical Africa. The leaf juice of *mangifera indica* processed by decoction is used in fever, diarrhea and toothache. In Chittagong (Southeastern coast of Bangladesh), young leaves are given for the treatment of diarrhea.^[29,30] According to Aderibigbe et al. the aqueous extract of *Mangifera indica* leaves showed potentiality in hypoglycemic value was proved towards glucose induced hyperglycemic rats and mice.^[30] It has been found that, aqueous extract of *Mangifera indica* leaves have no alteration towards blood glucose level in case of

normoglycemic or STZ induced hyperglycemic rats. It is decreased the progression of blood glucose levels in glucose-induced hyperglycemia and it is assumed that the extract might decrease the intestinal absorption of glucose.^[31]

1.9 *Syzygium cumini* L.

Syzygiumcumini Linn. is a traditional medicinal plant belonging to the family, It is planted all over the country and termed as Jam, Kalojam, Kalajam etc in vernacular name and in English Black Plum, Jambolan, Java Plum, Indian black-berry etc.^[32] *Syzygiumcumini* Linn. (Formerly *Eugenia jambolana*), is mostly used for its antidiabetic effects.^[33] Among Asian countries, mostly Indian subcontinent like Bangladesh, India, Srilanka has been used the different parts of the plant (fruit, seeds, bark, leaves extract) in the treatment of diabetes. It has been demonstrated that leaves, seeds, fruits and bark of *Syzygiumcumini* have the antihyperglycemic effects, but on the other hand researchers were not successful identifying any blood glucose lowering effect with extracts or tea prepared from leaves of the plant in streptozotocin (STZ) induced diabetes mellitus and in normal rats.^[34] Isolated compound mycaminose (50 mg/kg) from the seed, ethyl acetate & methanol and also *S. cumini* seed extract (200 and 400 mg/kg) was given to check the anti-diabetic activity against streptozotocin (STZ) induced diabetic rats. The compound isolated from seed namely 'Mycaminose' and ethyl acetate and methanol extracted produced significant ($p < 0.05$) reduction in blood glucose level.^[35] Extract or tea prepared from leaves of *S. cumini* has no hypoglycemic effect but, its mechanism of action could depend on specific abnormalities with the disease condition, the effect of diabetes is still possible.^[34]

1.10 *Terminalia Chebula*

Terminalia chebula Retz. (Family: Combretaceae), Haritaki or Hartaki is as known in English term in Bengali and In English Black Myrobalan, Chebulic Myrobalan, Ink Nut, Gall nut etc. Mostly found in Dhaka, Chittagong, Tangail but also cultivated in many parts of the country.^[36] It has been widely used for the treatment of diabetes in Ayurveda medicinal system and widely distributed in Bangladesh as well as in Indian subcontinent. The ethanolic extract of fruits *terminaliachebula* (200mg/kg body weight /rat/day) significantly decreased the blood glucose and glycosylated hemoglobin levels in diabetic rats during one month oral drug administration dosage regimen. Study also revealed the insulin stimulating potential of the extract.^[37] Ethanolic extracts of *terminaliachebula* are proved showed as potential antidiabetic activity without any toxicity and side effects.^[38]

1.11 *Terminalia Catappa L.*

Terminalia catappa Linn. is a traditional medicinal plant of Combretaceae family cultivated throughout Bangladesh but mostly in North Bengal districts which are comparatively warmer and well known as Kath badam.^[39] Petroleum ether, methanol and aqueous extract of *T. catappa* fruits were administered to alloxan induced diabetic rats for measuring the fasting blood glucose levels and analyzing biochemical serum levels.^[40] At dose levels of 1/5th of the lethal doses all the extracts of *T. catappa* showed a significant antidiabetic activity. It is also claimed in the experiment that, the extract is helpful in the regeneration of β -cells.^[41]

Table 1: Analysis of remedies obtained from different plant parts for diabetes mellitus and other Pharmacological aspects of available Antidiabetic Plants in Bangladesh.

Botanical name	Family	Local name	Important Parts	Active Chemical Constituents	Pharmacological Properties
<i>Anacardium occidentale</i>	Anacardiaceae	Kaju, Kajubadam, Hijlibadam	Fruit, Bark and Leaf	Alkyl phenols, Ancardic acid, Biflavonoid Glycoside	Antihypertensive and Hypoglycaemic
<i>Boerhaavia diffusa</i>	Nyctaginaceae	Punarnava, Gandhapurna, Shetapurna.	Root and Leaf	Alkaloids-punarnovine I and punarnovine II, glycoside, hypoxanthine-9- L-arabinofuranoside	Hypoglycemic, Laxative, Expectorant and Anticancer properties.
<i>Catharethus roseus</i>	Apocynaceae.	Nayantara	Root, Leaf and bark	Alkaloid, Vincoline	Antidiabetic, Anticancer, sedative and Tranquillizing agent.
<i>Cocculus hirsutus</i>	Menispermaceae	Daikhai, Jalajmani, Heyer, Huyer	Root, Leaf and stem	Isoquinoline alkaloids	Antihyperglycemic, sedative, Hypotensive, Bradycardiac and Cardiotonic
<i>Ficus hispida</i>	Moraceae	Kakdumur, Khoksha, Dumur, Dhungri, Thoska	Whole Plant	β -amyrin, β -sitosterol, ascorbic acid and 10- keto-tetracosylarachidate	Hypoglycemic, purgative, Emetic and stop menstrual Hemorrhage.
<i>Momordica charantia</i>	Cucurbitaceae	Karolla, Uchhe, Usta	Leaf and Fruit	Charantin, 5-hydroxytryptamine	Antidiabetic, antihyperglycemic and Anthelmintic
<i>Mangifera Indica</i>	Anacardiaceae	Am	Fruit, Bark	Polyphenol-xanthones, mangiferin	Decrease blood glucose level progression, Astringent and Laxative
<i>Syzygium</i>	Myrtaceae	Jam,	Leaf,	Anthocyanins,	Antihyperglycemic,

<i>cumini</i>		Kalojam, Kalajam	Bark, Fruit, Seed.	Glucoside, Flavonoids	Stomachic, Carminative, diuretic and Astringent
<i>Terminalia Chebula</i>	Combretaceae	Haritaki, Hartaki	Leaf, Fruit	Anthraquinone, Steroidal triterpenoids and Flavonoids	Antidiabetic, Expectorant, Antibacterial and Antifungal
<i>Terminalia Catappa</i>	Combretaceae	Bangla Badam, Kath Badam	Fruit, Bark, Leaf	Gallic acid, Flavonoids	Antidiabetic, Antibacterial, Antifungal
<i>Cocculus hirsutus</i>	Menispermaceae	Daikhai, Jalajmani, Heyer, Huyer	Leaf, Stem, Root.	Isoquinoline Alkaloids, Magnoflorine trilobine	Sedative, Hypotensive, Bradycardiac and Spasmolytic

****Source:** Medicinal Plant Database of Bangladesh (MPBD) and "Ethnobotanical Database of Banglades (EDB)"; Plants of Bangladesh; Author: Dr. Shaikh Bokhtear Uddin.

3.0 CONCLUSION

The present review has presented information on medicinal plants available in Bangladesh having the possibility to be used in diabetes or be used as an adjuvant in diabetes treatment. It shows that the plants listed above have potent hypoglycemic effects in diabetes management. Natural products obtained from potential medicinal plants have play a significant role in the management of diabetes. Advanced investigations including isolation of pure plant on the above-mentioned plants. The compounds undesired toxic effects of these plants should also be elucidated.

REFERENCES

1. Rizvi SI, Mishra N, Traditional Indian Medicines Used for the Management of Diabetes Mellitus, Journal of Diabetes Research, 2013; 2013: 712092. DOI: 10.1155/2013/712092.
2. Jung M, Park M, Lee HC, Kang YH, Kang ES, Kim SK, Antidiabetic agents from medicinal plants, Curr Med Chem., 2006; 13: 1203-1218.
3. Rafe MR, A review of five traditionally used anti-diabetic plants of Bangladesh and their pharmacological activities, Asian Pacific Journal of Tropical Medicine, 2017. DOI: <https://doi.org/10.1016/j.apjtm, 2017; 09: 002>.
4. Mishra SB, Rao C, Ojha S, Vijayakumar M, Verma A, An analytical review of plants for anti diabetic activity with their phytoconstituent and mechanism of action, Int J Pharm Sci Res., 2010; 1: 1647-1652.
5. Uddin DSB, Medicinal plants of Bangladesh : ANACARDIUM OCCIDENTALE L., 2011-2014.

6. Uddin DB. Medicinal Plants: Medicinal plants of Bangladesh; *Catharanthus Roseus* L.; (n.d); Accessed from <http://www.mpbd.info/plants/catharanthus-roseus.php>; (Accessed on 12th July, 2017). In.
7. Malviya N, Jain S, Malviya S, Antidiabetic potential of medicinal plants, *Acta Pol Pharm*, 2010; 67: 113-118.
8. Teonard L. AJT, Dimo T., Paul D et. al, *African Journal of Traditional, Complementary, and Alternative Medicines*, 2006.
9. Uddin DB, Medicinal Plants: medicinal Plants In Bangladesh. *ANNONA SQUAMOSA* L.(n.d) accessed from <http://www.mpbd.info/plants/annona-squamosa.php>., 2012.
10. Bokhtear UD, Bangladesh Ethnobotany Online Database: Ethnobotany Plants Profile- *Annona squamosa* L.(n.d.) accessed from <http://www.ebbd.info/annona-squamosa.html>.
11. neesh malviya sjasm, Antidiabetic Potential Of Medicinal Plants : Review; Department of Pharmacognosy, Smriti College of Pharmaceutical Education, Dewas Naka, Indore-452010 Madhya Pradesh, India, 2010.
12. Sahu U, Tiwari SP, Roy A, Comprehensive Notes on Anti diabetic Potential of Medicinal Plants and Polyherbal Formulation, *UK Journal of Pharmaceutical and Biosciences*, 2015; 3: 57-64.
13. Uddin DB. Medicinal plants online database: Medicinal Plants of Bangladesh; *Boerhaavia diffusa* L. (n.d.); accessed from <http://www.mpbd.info/plants/boerhaavia-diffusa.php> In.
14. Pari L, Amarnath Satheesh M, Antidiabetic activity of *Boerhaavia diffusa* L.: effect on hepatic key enzymes in experimental diabetes, *J Ethnopharmacol*, 2004; 91: 109-113. DOI: 10.1016/j.jep.2003.12.013.
15. Mahesh A, Kumar H, Ranganath M, Devkar RA, Detail study on *Boerhavia Diffusa* plant for its medicinal importance-a review, *Res J Pharm Sci.*, 2012; 1: 28-36.
16. Uddin DB. Medicinal plants online database: Medicinal plants in Bangladesh; (n.d.); *Catharanthus roseus* G. Don; accessed from <http://www.ebbd.info/catharanthus-roseus.html> (Accessed on 4th october, 2017). In.
17. Chauhan A, Sharma P, Srivastava P, Kumar N, Dudhe R, Plants having potential antidiabetic activity: a review, *Der Pharmacia Lettre.*, 2010; 2: 369-387.
18. Singh SN, Vats P, Suri S, Shyam R, Kumria MML, Ranganathan S, Sridharan K, Effect of an antidiabetic extract of *Catharanthus roseus* on enzymic activities in streptozotocin induced diabetic rats, *J Ethnopharmacol*, 2001; 76: 269-277. DOI: [https://doi.org/10.1016/S0378-8741\(01\)00254-9](https://doi.org/10.1016/S0378-8741(01)00254-9).

19. Nammi S, Boini MK, Lodagala SD, Behara RBS, The juice of fresh leaves of *Catharanthus roseus* Linn. reduces blood glucose in normal and alloxan diabetic rabbits, *BMC Complementary and Alternative Medicine*, 2003; 3: 4. DOI: 10.1186/1472-6882-3-4.
20. Uddin DSB, Medicinal Plants Database: Medicinal Plants in Bangladesh; (n.d.); accessed from <http://www.mpbd.info/plants/cocculus-hirsutus.php>; (accessed on 6th October, 2017).
21. Badole S, Patel N, Bodhankar S, Jain B, Bhardwaj S, Antihyperglycemic activity of aqueous extract of leaves of *Cocculus hirsutus* (L.) Diels in alloxan-induced diabetic mice, *Indian journal of pharmacology*, 2006; 38: 49.
22. Sangameswaran B, Jayakar B, Anti-diabetic and spermatogenic activity of *Cocculus hirsutus* (L) Diels, *African Journal of Biotechnology*, 2007; 6.
23. Uddin DSB, Medicinal Plants database: Medicinal Plants in Bangladesh; (n.d.); accessed from <http://www.mpbd.info/plants/ficus-hispida.php> (accessed on 8th October, 2017).
24. Ghosh R, Sharatchandra K, Rita S, Thokchom I, Hypoglycemic activity of *Ficus hispida* (bark) in normal and diabetic albino rats, *Indian journal of pharmacology* 2004; 36: 222.
25. Uddin DSB, Bangladesh Ethnobotany Online Database: *Momordica charantia* L.; accessed from <http://www.ebbd.info/momordica-charantia.html>; (Accessed on 12th October, 2017).
26. Grover J, Yadav S, Pharmacological actions and potential uses of *Momordica charantia*: a review, *J Ethnopharmacol*, 2004; 93: 123-132.
27. Ahmed I, Lakhani MS, Gillett M, John A, Raza H, Hypotriglyceridemic and hypocholesterolemic effects of anti-diabetic *Momordica charantia* (karela) fruit extract in streptozotocin-induced diabetic rats, *Diabetes Research and Clinical Practice*, 2001; 51: 155-161. DOI: [https://doi.org/10.1016/S0168-8227\(00\)00224-2](https://doi.org/10.1016/S0168-8227(00)00224-2).
28. Raman A, Lau C, Anti-diabetic properties and phytochemistry of *Momordica charantia* L. (Cucurbitaceae), *Phytomedicine*, 1996; 2: 349-362. DOI: [https://doi.org/10.1016/S0944-7113\(96\)80080-8](https://doi.org/10.1016/S0944-7113(96)80080-8).
29. Uddin DSB, Medicinal Plants Database: Medicinal Plants in Bangladesh; accessed from <http://www.mpbd.info/plants/mangifera-indica.php>; (accessed on 15th October, 2017).
30. Aderibigbe AO, Emudianughe TS, Lawal BA, Antihyperglycaemic effect of *Mangifera indica* in rat, *Phytother Res.*, 1999; 13: 504-507.
31. Muruganandan S, Srinivasan K, Gupta S, Gupta PK, Lal J, Effect of mangiferin on hyperglycemia and atherogenicity in streptozotocin diabetic rats, *J Ethnopharmacol*, 2005;

- 97: 497-501. DOI: <https://doi.org/10.1016/j.jep.2004.12.010>.
32. Uddin DSB, Medicinal Plants Database: Medicinal plants In Bangladesh: *Syzygium cumini* L; accessed from <http://www.mpbd.info/plants/syzygium-cumini.php>; (accessed on 18th October, 2017)
33. Ayyanar M, Subash-Babu P, *Syzygium cumini* (L.) Skeels: A review of its phytochemical constituents and traditional uses, *Asian Pacific Journal of Tropical Biomedicine*, 2012; 2: 240-246. DOI: [https://doi.org/10.1016/S2221-1691\(12\)60050-1](https://doi.org/10.1016/S2221-1691(12)60050-1).
34. Teixeira CC, Fuchs FD, Weinert LS, Esteves J, The efficacy of folk medicines in the management of type 2 diabetes mellitus: results of a randomized controlled trial of *Syzygium cumini* (L.) Skeels, *J Clin Pharm Ther.*, 2006; 31: 1-5. DOI: 10.1111/j.1365-2710.2006.00700.x.
35. Kumar A, Ilavarasan R, Deecaraman M, Aravindan P, Padmanabhan N, Krishan M, Anti-diabetic activity of *Syzygium cumini* and its isolated compound against streptozotocin-induced diabetic rats, *Journal of Medicinal Plants Research*, 2013; 2: 246-249.
36. Uddin DSB, Medicinal Plants of Bangladesh: *Terminalia chebula*; Accessed from: <http://www.mpbd.info/plants/terminalia-chebula.php>; (accessed on 21st October, 2017).
37. Kumar GPS, Arulselvan P, Kumar DS, Subramanian SP, Anti-diabetic activity of fruits of *Terminalia chebula* on streptozotocin induced diabetic rats, *Journal of health science*, 2006; 52: 283-291.
38. Kannan VR, Rajasekar GS, Rajesh P, Balasubramanian V, Ramesh N, Solomon EK, Nivas D, Chandru S, Anti-diabetic Activity on Ethanolic Extracts of Fruits of, *American Journal of Drug Discovery and Development*, 2012; 2: 135-142.
39. Uddin DMB. Medicinal Plants of Bangladesh: *Terminalia Catappa* L.; Accessed from <http://www.mpbd.info/plants/terminalia-catappa.php>; (accessed on 23rd October, 2017). In.
40. Nagappa A, Thakurdesai P, Rao NV, Singh J, Antidiabetic activity of *Terminalia catappa* Linn fruits, *J Ethnopharmacol*, 2003; 88: 45-50.
41. Ahmed SM, Swamy V, Gopkumar P, Dhanapal R, Anti-Diabetic Activity of *Terminalia catappa* Linn. Leaf Extracts in Alloxan-Induced Diabetic Rats, 2, 2006; 4: 36-30.