

Diabetes: Rescue by *Boerhaavia diffusa*

Sweta Arora and Chandana Haldar*

Pineal Research Laboratory, Department of Zoology, Institute of Science, Banaras Hindu University, Varanasi – 221005, Uttar Pradesh, India, chaldar@yahoo.com

Abstract

The incidence of diabetes, a metabolic disorder, is increasing at a very rapid pace globally but hypoglycemic drugs like insulin, bioguanides, thiazolidiones and sulphonylureas, which produce several adverse side effects, are still the main stay for its treatment. However, the traditional medicines derived from plants have lesser side effects and are of low cost. *Boerhaavia diffusa*, belonging to Nyctaginaceae family, also known as Punarnava, has great many medicinal properties and is one of the oldest medicines described in Ayurveda for the treatment of a number of diseases including diabetes. *B. diffusa* has been reported to be diuretic, anti-inflammatory, anticonvulsant, antifibrotic, antibacterial, antidiabetic, hepatoprotective, immunosuppressive, nephroprotective, antiasthmatic, antihelminthic, etc. It contains alkaloids, flavanoids, lipids, carbohydrates, steroids, lignins, proteins, triterpenoids, glycoproteins, β -sitosterol, α -2-sitosterol, ester of β -sitosterol, palmitic acid, β -ecdysone, hexacosanoic, tetracosanoic, arachidonic and stearic acids, etc., which might be responsible for its curative properties. The present review focuses on the antidiabetic/hypoglycaemic property of this miracle plant.

Keywords: Antidiabetic, *Boerhaavia diffusa*, Diabetes, Hypoglycemic, Punarnava

1. Introduction

The incidence of diabetes, a metabolic disorder, is increasing at a very rapid pace in both developed and developing countries. It is estimated that by the year 2030, this lifestyle disorder would affect 439 million people globally¹. The two main types of diabetes are type 1 (T1D) and type 2 (T2D). T1D is insulin dependent whereas T2D is non-insulin dependent. 90-95% of diabetes patients belong to T2D. T2D is characterized by alterations in lipid, protein and carbohydrate metabolism, insulin resistance and loss of pancreatic β -cell function². At more advanced stages patients with T2D remain at high risk of developing complications like nephropathy, neuropathy, cardiomyopathy, and retinopathy²⁻⁵. The current treatment and therapy for T2D include mainly drugs such as α -glucosidase inhibitors, thiazolidinediones, biguanides, sulphonylureas, D-phenylalanine, and meglitinides, in addition to insulin⁵⁻⁷. These commercially available drugs used as hypoglycaemic agents show different grades of undesirable side effects and are not efficient in completely curing

T2D^{8,9}. Therefore, there has always been a demand for more efficacious, safer and better alternative therapies. Traditional medicines involving natural and plant products have emerged as better alternatives for treatment of this dreaded ailment, diabetes⁶⁻⁹.

One of the plants of high repute in the field of herbal medicines is *Boerhaavia diffusa*, popularly known as Punarnava. *Boerhaavia diffusa* derived its name in honor of a famous Dutch physician Hermann Boerhaave. Punarnava (in Sanskrit *Punah punarnava bhawati iti*) in English means “one that rejuvenates or renders one feel fresh again and again”^{10,11}. The genus *Boerhaavia* includes 40 species¹². Most of them are found in tropical and subtropical parts of Asia, Australia, America and Africa. *B. diffusa* is among one of the 40 species. *B. diffusa* is also known by different vernacular names like Punarnava, Gondhopurna, Raktapushpa, Spreading hog weed, Pigweed, etc. It is a perennial herb belonging to the family Nyctaginaceae^{7,11,12}. The plant is also said to be a miracle plant because of the properties possessed by each and every part of the plant^{4,11}. It has a long history of medicinal

*Author for correspondence

use in Ayurvedic and Unani medicines. It is commonly consumed as a green leafy vegetable by South Asian population because of its nutraceutical properties^{3,13}. It contains alkaloids, flavanoids, lipids, carbohydrates, steroids, lignins, proteins, triterpenoids, glycoproteins, β -sitosterol, α -2-sitosterol, ester of β -sitosterol, palmitic acid, β -ecdysone, hexacosanoic, tetracosanoic, arachidic and stearic acids, etc., which might be the reason for its excellent ability to cure several ailments^{5,14,15}. *B. diffusa* is reported to be diuretic, anti-inflammatory, anticonvulsant, antifibrotic, antibacterial, antidiabetic, hepatoprotective, immunosuppressive, nephroprotective, antiasthmatic, antihelminthic etc.^{5,7,8,11,12,15}. The hypoglycaemic/antidiabetic activity of the plant has been extensively investigated by several workers.

2. Antidiabetic Effect of *B. diffusa* Whole Plant Extract

Nim *et al.*¹⁶ elucidated the antihyperglycemic activity of two different doses of *B. diffusa* extract in high fat diet fed and streptozotocin-induced diabetic albino rats. The study found *B. diffusa* to possess time-dependent antihyperglycemic activity but the therapeutic drug glibenclamide was more efficacious than *B. diffusa* extract.

3. Antidiabetic Effect of *B. diffusa* Leaf

Chude *et al.*¹⁷ and Anamika and Kumar¹⁸ demonstrated the hypoglycaemic activity of *B. diffusa* leaf extract. The alloxan-induced diabetic rats exhibited a dose-independent decrease in blood glucose level following the treatment of aqueous leaf extract of *B. diffusa*. The tannins, glycosides, flavonoids and saponins found in this extract are considered to be the factors responsible for the hypoglycemic effect.

Aqueous leaf extract of *B. diffusa* was administered through oral route to alloxan-diabetic rats to find its effect on blood glucose level and hepatic enzymes. The treatment resulted in a significant decrease in blood glucose and a significant increase in plasma insulin levels; a significant reduction of glycosylated haemoglobin and an increase in total haemoglobin were also found. The activity of hepatic hexokinase was significantly increased and the activities of glucose-6-phosphatase, and fruc-

tose-1,6-biphosphatase were significantly decreased. The effects of aqueous leaf extract of *B. diffusa* were found to be more effective as compared to glibenclamide⁸.

Satheesh and Pari¹⁷, considering oxidative stress to be one of the major basis for diabetic pathogenesis, demonstrated a remarkable antioxidant and antidiabetic effects of aqueous leaf extract of *B. diffusa* in alloxan-induced diabetic rats. The authors found a significant reduction in thiobarbituric acid-reactive substances and hydroperoxides, while the activities of the antioxidant enzymes superoxide dismutase, catalase, glutathione peroxidase and glutathione-S-transferase were increased significantly in the liver and kidney of diabetic rats.

Nalamolu *et al.*¹⁴ evaluated the antidiabetic activity of a chronic administration of chloroform extract of leaf powder of *B. diffusa* in streptozotocin-induced non-insulin-dependent diabetes mellitus (NIDDM) model rats. A dose-dependent reduction in blood glucose was found as compared to glibenclamide. The mechanism explained for the reduction in blood glucose by chloroform extract of *B. diffusa* was rejuvenation of pancreatic β -cells or an extra pancreatic action.

Bhatia *et al.*³ found that the methanol / ethanol extracts of the whole aerial parts *B. diffusa* are significantly antihyperglycemic in alloxan/streptozotocin diabetic rats. The extracts also improved body weight and lipid profile.

4. Antidiabetic Effect of *B. diffusa* Root

The hypoglycemic and antihyperlipidemic effects of ethanolic root extract of *B. diffusa* in streptozotocin-induced diabetic rats were reported by Murti *et al.*⁴. The study found a reduction in blood sugar level, total cholesterol, LDL cholesterol, and VLDL cholesterol after oral administration of extracts of *B. diffusa*. There was also an increase of HDL cholesterol in diabetic rats after the treatment.

Chauhan *et al.*¹⁵ demonstrated the antidiabetic and antioxidant effects of ethanolic root extract of *B. diffusa* in streptozotocin-induced diabetic rats. Along with blood glucose, serum insulin, lipid profiles, and biomarker enzymes, these authors determined the liver glycogen, and kidney and liver antioxidant systems also. Oral administration of this extract reduced the fasting blood glucose level significantly. Moreover, the extract treatment increased the glycogen level in liver significantly. The activities of antioxidant enzymes which were

increased due to streptozotocin treatment were reduced significantly, to control level, on treatment of *B. diffusa*.

Malhotra *et al.*⁵ reported the hypoglycemic effect of extract of *B. diffusa* root, which was suggested as due to stimulation of the residual pancreatic β -cell function or an extra-pancreatic mechanism leading to increased peripheral utilization of glucose. It also added that the glycosides, flavonoids, tannins and saponins present in the extract may be responsible for this action.

In another study, Alam *et al.*²⁰ found that pre-treatment of Wistar rat with *B. diffusa* methanolic root extract (100 and 200 mg/kg b.w.) in streptozotocin-induced diabetic rats resulted in significant improvement in blood glucose and liver glycogen levels.

5. Conclusion

In recent years there has been great emphasis on traditional medicines and development of new plant-based drugs. The plant derived drugs/medicines are believed to be safe and cheaper for human use. *B. diffusa* is an important medicinal plant; it contains diverse phytochemicals which are known to be effective against a large number of ailments such as diuresis, cancer, inflammation, liver disorders, immune deficiency, diabetes, etc. Numerous investigations have now established that *B. diffusa* is an important medicinal plant having antidiabetic/hypoglycaemic properties. However, further extensive biochemical and molecular investigations are needed in order to identify the active compounds concerned with the hypoglycemic effect.

6. References

- Arora S, Haldar C, Gupta S. Hamster as a model for diabetic study. *Int J Res Med Sci Tech*. 2018; 6:245–50.
- Li XY, Lu SS, Wang HL, et al. Effects of fenugreek extracts on high fat diet-fed and streptozotocin-induced type 2 diabetic mice. *Animal Model Exp Med*. 2018;1(1):68–73.
- Bhatia V, Kinja K, Bishnoi H, Savita S, Gnaneshwari D. Antidiabetic activity of the alcoholic extract of the aerial part of *Boerhaavia diffusa* in rats. *Recent Res Sci Technol*. 2011; 3(7):04–07.
- Murti K, Lambole V, Panchal M, Kumar U. Antidiabetic and antihyperlipidemic activity of roots of *Boerhaavia diffusa* on streptozotocin induced diabetic rats. *Pharmacologyonline* 2011; 1:15–21.
- Malhotra D, Ishaq F, Khan A. Antihyperglycemic activity of *Boerhaavia diffusa* in streptozotocin induced diabetic rats. *Int J Chem Anal Sci*. 2014; 5(1):21–23.
- Tiwari BK, Pandey KB, Abidi AB, Rizvi SI. Therapeutic potential of Indian medicinal plants in diabetic condition. *Ann Phytomed*. 2013; 2(1): 37–43.
- Nisha M, Vinod BM, Sunil C. Evaluation of *Boerhaavia erecta* L. for potential antidiabetic and antihyperlipidemic activities in streptozotocin-induced diabetic Wistar rats. *Future J Pharma Sci*. 2018; 4:150–5.
- Pari L, Satheesh MA. Antidiabetic activity of *Boerhaavia diffusa* L.: effect on hepatic key enzymes in experimental diabetes. *J Ethnopharmacol*. 2004; 91:109–13.
- Modak M, Dixit P, Jayant L, Ghaskadbi S, Devasagayam TPA. Indian herbs and herbal drugs used for the treatment of diabetes. *J Clin Biochem Nutr*. 2007; 40:163–73.
- Rajpoot K, Mishra R N. *Boerhaavia diffusa* roots (Punarnava mool)-Review as Rasayana (Rejuvenator/Antiaging). *Int J Res Pharma Biomed Sci.* 2011; 2(4):1451–60.
- Rao PP. Ophthalmic uses of *Boerhaavia diffusa* L. (Punarnava): Review. *Int J Herbal Med*. 2016; 4(2):05–09.
- Mishra S, Aeri V, Gaur PK, Jhachak SM. Phytochemical, therapeutic, and ethnopharmacological overview for a traditionally important herb: *Boerhaavia diffusa* Linn. *Biomed Res Int*. 2014; Doi:10.1155/2014/808302.
- Olaleye, MT, Akinmoladun, AC, Ogunboye, AA, Akindahunsi, AA. Antioxidant activity and hepatoprotective property of leaf extracts of *Boerhaavia diffusa* Linn against acetaminophen-induced liver damage in rats. *Food Chem Toxicol*. 2010; 48:2200–05.
- Nalamolu RK, Boini KM, Nammi S. Effect of chronic administration of *Boerhaavia diffusa* Linn. leaf extract on experimental diabetes in rats. *Trop J Pharm Res*. 2004; 3(1):305–09.
- Chauhan SK, Thapliyal RP, Ojha SK, Rai H, Singh P, Singh M. Antidiabetic and antioxidant effect of ethanolic root extract of *Boerhaavia diffusa* in streptozotocin-induced diabetic rats. *J Pharm Res*. 2011; 4(2):446–48.
- Nim DK, Shankar P, Chaurasia R, Goel B, Dixit RK. Clinical evaluation of anti-hyperglycemic activity of *Boerhaavia diffusa* in comparison with glibenclamide in the rat model of T2DM. *JGTPS*. 2013; 4(1):973–82.
- Chude MA, Orisakwe OE, Afonne OJ, et al.. Hypoglycemic effect of the aqueous extract of *Boerhaavia diffusa* leaves. *Indian J Pharmacol*. 2001; 33:215–6.
- Anamika S, Kumar GR. Effect of the aqueous extract of *Boerhaavia diffusa* roots and leaves of hypoglycemic as well as immuno support activity. *Int Res J Biol Sci*. 2012; 1(6):62–5.
- Satheesh MA, Pari L. Antioxidant effect of *Boerhaavia diffusa* L. in tissues of alloxan induced diabetic rats. *Indian J Exp Biol*. 2004; 42(10):989–92.
- Alam P, Shahzad N, Gupta AK, et al. Anti-diabetic effect of *Boerhaavia diffusa* L. root extract via free radical scavenging and antioxidant mechanism. *Toxicol Environ Health Sci*. 2018; 10:220–7.