Asian Journal of Medicine and Health Sciences Vol 6 Issue 2, November 2023

REVIEW ARTICLE

A Review of Antidiabetic Activity of *Bauhinia purpurea* plant and its Phytochemical Constituents.

Tavamani Balan[1], Yushanani Yusari[1], Laavanya Rajendhiran[1], Nur Ainina Hani Ghazali[1], Suganya Murugesu[1], Sharon Fatinathan[1], Zainul Amiruddin Zakaria[2], Charles Gnanaraj[1], Mohd Hijaz Mohd Sani[2], Vikneswari Perumal[1*].

[1]Faculty of Pharmacy and Health Sciences, Royal College of Medicine Perak, Universiti Kuala Lumpur, Malaysia.
[2]Department of Biomedical Sciences, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia.

Corresponding Author
Vikneswari Perumal
Faculty Pharmacy and Health Sciences, Universiti Kuala Lumpur Royal College of Medicine Perak, 30450 Ipoh, Perak, Malaysia.
Email: vikneswari@unikl.edu.my

Submitted: 29/09/2023. Revised edition:20/10/2023. Accepted: 21/10/2023. Published online: 01/11/2023.

Abstract

Plant *Bauhinia purpurea* L. (Caesalpinioideae), known as ‘‘tapak kuda’’ in Malay, has been reported for its therapeutic value from various parts of the plant supported by various scientific evidence. The objective of this narration is to assemble all data and information associated with the antidiabetic activity of *B. purpurea* and to cite all the information as a comprehensive article review. Literature was retrieved from Wiley, Science Direct, Springer Link, Google Scholar and Research Gate databases. The antidiabetic activity of this plant was proven by *in vitro* activities that involve alpha-glucosidase, alpha-amylase and dipeptidyl peptidase IV inhibitory activities. On the other hand, *in vivo* antidiabetic activity of *B. purpurea* was carried out using a streptozotocin-induced animal model. Furthermore, the details about the phytochemical constituents present in this plant were collected from various published journals. The literature search discovered that *B. purpurea* exerts significant antidiabetic activity in both *in vitro* and *in vivo* models. In addition, it can be deduced that the significant antidiabetic activity possessed by *B. purpurea* could be due to various phytochemical constituents such as flavonoids, glycosides and saponins. In conclusion, *B. purpurea* possesses impressive therapeutic value, which needs to be explored and extended for further studies. Therefore, this review paper opens the door for many researchers to explore further the plant's antidiabetic potential, including the metabolic pathways and the bioactive compounds that could contribute to discovering new drug entities.

Keywords: *alpha-amylase, alpha-glucosidase, animal model, Bauhinia purpurea, dipeptidyl peptidase IV.*

Introduction

Diabetes is one of the most common endocrine diseases, that is related to a metabolic disorder that can be identified by chronic hyperglycaemia with disruption of protein metabolism, carbohydrate, acidosis lipid, ketosis, and glycosuria affected by insulin action and secretion dysfunction [1,2]. Figure 1 shows the mechanisms of pathophysiology of Type 1 and Type 2 diabetes. The International Diabetes Federation (IDF) stated more than 415 million people worldwide have diabetes. It has been predicted that in 2035, about 592 million will have diabetes due to pre-diabetes and diabetes prevalence and its complications [3]. In Malaysia, the percentage of diabetes patients has tripled over the past thirty years. The number increased from 6.3% to 17.5% from 1986 to 2015, including 3.5 million adults above 18 years [4]. In a recent publication, the prevalence of pre-diabetes and diabetes in Malaysia were 10.8% and 11.9%, respectively [5].

Synthetic drugs have a monopoly on the pharmaceutical industry market as they are synthesized and produced easily in the lab. However, many adverse effects including hypertension, hyperuricemia, diarrhoea, abdominal cramps, lactic acidosis and other uncertain side effects may be encountered from consuming synthetic antidiabetic drugs [6, 7]. If the disease can't be monitored, it will lead to other chronic complications that cause microangiopathy, ketoacidosis and other related infections [8,9].

Bauhinia purpurea, known as "butterfly trees,", is a medicinal plant native to India and China [10]. It has garnered significant interest among researchers due to its phytochemical constituents, which exhibit medicinal properties, including antidiabetic activity [11]. Therefore, this review aims to demonstrate that *B. purpurea* is a promising antidiabetic agent that merits further exploration. This exploration could benefit future researchers in identifying the antidiabetic principles from within the plant, that could be useful for the treatment of diabetes.

According to Marimuthu & Dhanalakshmi, *B. purpurea* is a medium-sized deciduous flowering tree, and the bark is dark brown [12]. This plant is classified under the Leguminosae family and the Caesalpinioideae subfamily, and it is commonly grown in India. *B. purpurea* typically reaches a height of up to 17m tall. As depicted in Figure 2, the tree of *B. purpurea* displays ashy dark brown bark, and its leaves measure 7.5-15 cm (Figure 3). The flowers of *B. purpurea* are unique because they have five pink, fragrant petals, as shown in Figure 4. The petals are 3.8-5 cm long, and the flowers have brown, flat seed pods. The leaves are approximately 10–20 cm long, rounded, broad, alternate, and blobbed at the base and apex. Additionally, *B. purpurea* produces fruits in the form of pods, each about 30 cm in length,, containing 12 to 16 seeds that resembles peas in shape. Usually, this *B. purpurea* plant will bear flowers and fruits in December, and this plant is also known as the Purple Orchid tree or Mandaram [14].

B. purpurea is used in traditional medicines to treat wounds, sores and diarrhoea [13]. In India, people have used *B. purpurea* to treat ulcer wounds, stomach tumours, fever, glandular swelling, and goiter [15,16]. Similarly, the leaves of *B. purpurea* were extensively used to treat wounds [12,13]. Furthermore, *B. purpurea* has found use in traditional medicine for its antifungal, antimalarial and cytotoxic properties [17]. It is commonly used to treat inflammation, epilepsy and convulsions [10]. According to Brahmachari et al. [15], this plant's stems, leaves and roots are traditionally used to alleviate pain, combat infections, treat jaundice, antidiabetic, cough and leprosy [18]. Asolker et al. [19] mentioned that *B. purpurea* is traditionally used to treat rheumatism, pain, dropsy, delirium, septicaemia and convulsions [19]. There is also a report stated by Janardhanan et al. [20] this plant is widely used in primitive medicine for the healing of body pain, indigestion, fever and cancerous growth in the stomach. Moreover, the aqueous leaves extracted

from these plants are universally used for pain, infection and antidiabetic treatment [11].

Methodology

This review compiles the information on the plant *B. purpurea* reported from 1981 to 2023. The study selection was based on the following inclusion criteria: Research articles and narrative reviews related to *B. purpurea* plant that cover botanical aspects, traditional use, phytochemical constituents and antidiabetic activity of B. purpurea. The searched papers included antidiabetic studies conducted through in vitro assays using enzyme inhibition activity and in vivo studies using diabetic-induced animal models. The in vitro and in vivo studies were analysed and discussed separately in the result section. Studies on different species of *Bauhinia* were excluded. Electronic searches were conducted, and information was gathered from databases, including Google Scholar, Science Direct, Springer Link, Wiley and Research Gate. The specific search terms used for this research were "antidiabetic properties in *B. purpurea*", "lowering blood sugar level", and "phytochemical constituents in *B. purpurea*".

Results

Phytochemical constituents in B. purpurea

Various phytochemical constituents have been isolated from different parts of *B.* p*urpurea*. Table 1 shows the summary of phytochemical constituents isolated from *B. purpurea.* Bhartiya et al. [21] were the first to isolate bioactive compounds from the seeds of *B. purpurea.* They reported isolating chalcone glycosides 3,4-dihydroxychalcone, galactose and arabinose at the Department of Chemistry, University of Allahabad, India. This was followed by Ramadan et al. [22], who reported the presence of fatty acid, phospholipid, glycolipid, triacylglycerol, esterified sterol, diacylglycerol, monoacylglycerol, campesterol, stigmasterol, βsitosterol, 5-avenasterol, 7-avenasterol, 7-stigmasterol, β-tocopherol and δ-tocopherol from seeds of *B. purpurea* as prepared in *n*-hexane extract.

Other compounds from heartwoods of *B. purpurea* were recorded to contain flavonoids, phenols, chromones, glycerol derivatives such 2,3-dihydroxypropyl oleate, 2,3 dihydroxypropyl linoleate, 2,3-dihydroxypropyl 16-hydroxyhexadecanoic, 6-butyl-3-hydroxy avanone, and 6-(30xobutyl)-taxifolin [23]. In the year 2000, Yavada and Tripathi [24] claimed the compound flavone glycosides were present in ethanolic extract of *B. purpurea* stems, namely 5,6-dihydroxy-7-methoxyflavone 6-O-b-D-xylopyranoside, 7-methoxy-5,6-dihydroxy flavone, xylose, 2,3,4-tri-O-methyl-D-xylose, chalcone glycosides and amino acids. Boonphong et al. [25] further isolated bioactive compounds from the roots of this plant, specifically bauhinoxepins, lectins, flavonones, flavone glycosides, bibenzyls, dihydrodibenzoxepin, dihydrobenzofuran and spirochromane-2,1'-hexanedione prepared as dichloromethane extract. Salatino et al. [26] reported phenolic compounds in the flower part of *B. purpurea*, namely kaempferol, caffeic acid, syringic acid, and vanillic acid. Another study aimed to isolate the bioactive compounds from the leaves of *B. purpurea*, collected in Rio de Janeiro Botanical Garden, Brazil [27]. The methanol extract of this plant was first reported to contain glycosides compounds, specifically kaempferol, quercetin, isorhamnetin, myricetin and glycosides. Ragasa et al. [28] noted the leaves of a plant composed of phytyl esters (1a-1f), lutein and β-sitosterol. Zakaria et al. [29] isolated phytochemical compounds like catechin, rutin, fisetin, saponins, triterpenes and steroids from leaves *B. purpurea* collected from natural habitat in Shah Alam, Selangor.

In other studies published by Verma et al. [30] the isolation of triterpenoids and α-amyrin caprylate was performed on the ethanol extract of *B. purpurea* leaves collected from Paneer, Deralakatte, Karnataka, India [30]. Murugan et al. [31] reported the presence of compound saponins,

steroids, tannins, xanthoprotein, coumarins, phenol, alkaloids, anthraquinones, catechin, flavonoids, and terpenoids were present from the isolation of leaf parts of *B. purpurea*. However, ethnobotanical studies report a large number of phytochemical constituents may possess antidiabetic potential.

In a recent study, isoflavonoids were isolated from *B. purpurea* stem bark using solvent extraction and column chromatography methods and the compounds were tested for its antipsychotic activity [32]. Htay et al. [33], reported that both the leaf and flower extracts contained alkaloids, flavonoids, saponins, carbohydrates, polyphenols, and phenolics. In contrast, the aqueous extracts of the stem barks and roots of *B. purpurea* only contained alkaloids, flavonoids, and phenolics.

Antidiabetic activity of *B. purpurea*

In vitro studies

B. purpurea's antidiabetic activity was initially determined in 2013 by Vadivel and Biesalski [34]. The collection of *B. purpurea* seeds was carried out from different locations in Tamil Nadu, India, and prepared as methanolic extracts (MEBPs). The findings indicated that MEBPs exhibited inhibitory effects of approximately 63.74% and 80.69% on the α-glucosidase and α-amylase enzymes, respectively. Another study on *α*-glucosidase activity of *B. purpurea* was initiated in 2015 by Dej-Adisai et al. [35]. This study utilized ethanol extract (EEBP) and plants were collected from Surat Thani, Songkla, Thailand. About 19 plant varieties belonging to the Fabaceae family were assessed for their ability to inhibit the α-glucosidase enzyme using p-nitrophenyl-D-glucopyranoside (pNPG) substrate. The results showed a moderate *α*-glucosidase inhibition activity, with the pods part exhibiting 19.85% inhibition, branches showing 58.22% inhibition, and leaves 27.56% inhibition of *α*-glucosidase activity. In another study, forty types of plants were assessed for their *α*-glucosidase inhibitory activity in Phu Yen province, Vietnam. The finding showed that the stem part in *B. purpurea* plant has 54.1% α-glucosidase inhibitory activity [36]. The fresh stem bark part of the *B. purpurea* plant was collected from the Directorate of Medicinal and Aromatic Plants Research (DMAPR), Boriavi, Anand. Extracts were prepared as petroleum ether extract (PEBPb) and hexane extract (HEBPb) with various concentrations of 20, 40, 60, 80 and 100 mg/ml. Plant extracts within the concentration range of 60 mg/ml to 100 mg/ml demonstrated substantial α-amylase inhibition activity exceeding 80%. These results indicate that the plant extracts were notably effective at inhibiting enzyme activity compared to acarbose, the standard drug used in this study [37].

In addition, only one study was reported on the DPP-IV inhibitory activity of *B. purpurea* plant, conducted by Singh e*t al.* [38]. In their study, three samples of different plants namely *Withania somnifera*, *Trigonella foenum* and *B. purpurea*, were prepared in methanol extracts of 1 mg/ml. The results indicated that *B. purpurea* exhibited a DPP-IV inhibitory activity of 63.5%, which was compared to sitagliptin, a standard drug, with an inhibition rate of 96.3%.

Endophytic fungi isolated from *B. purpurea* L. were recently screened for potential antidiabetic activities via α-glucosidase inhibition. The ethyl acetate extract of *Nigrospora sphaerica* BRN 01 (NEE) displayed a high degree of inhibition of α-glucosidase activity with an IC_{50} value of 0.020 ± 0.001 mg/ml, which was significantly greater than that of the standard drug acarbose [39].

In vivo studies

The first study to investigate the antidiabetic activity of *B. purpurea* was published in 2012, using the streptozotocin (STZ)-induced hyperglycemic rat model [40]. In this study, the methanolic extract of *B. purpurea* (MEBP), derived from the bark of *B. purpurea*, collected from Greater Noida, India, in June 2010 was used. The impact of MEBP on glucose levels in diabetic rats induced by STZ demonstrated a significant reduction ($P < 0.001$) in blood glucose levels

compared to the diabetic control group. The blood glucose level decreased from 140.50 ± 0.61 mg/dl to 123.33 ± 16.27 mg/dl. Gupta et al. [41] investigated the antihyperglycemic properties of aqueous extracts from a combination of plant extracts derived from *B. purpurea* and *Momordica charantia* in rats induced with STZ. The plants were collected in the local area of Meerut, India and prepared as an aqueous extract. The three-week treatment showed that the aqueous combined plant extracts showed significant antidiabetic activity ($P<0.0001$) against STZ-induced diabetic rats at a dose of 500 mg/kg. This effect was comparable to the standard drug glibenclamide (600 µg/kg), which served as a positive control.

Recently, a polyherbal formulation (PHF) consisting of three nutraceuticals (*Piper nigrum, Terminalia paniculata,* and *B. purpurea*) was evaluated for its impact on inflammation and oxidative stress in diabetic cardiomyopathy (DCM). DCM was induced in rats through the administration of streptozotocin and nicotinamide. Rats with induced DCM were given PHF supplementation at 250 and 500 mg/kg/BW doses for 45 days. Semi-quantitative polymerase chain reaction analysis was conducted on cardiac tissues to assess the expressions of NrF2, HO-1, SOD, CAT, TNF-α, and NF-κB. The results revealed that diabetic rats treated with a high supplementation of PHF (500 mg) showed significantly increased mRNA levels of Nrf-2, HO-1, SOD, and CAT, and suppressed levels of TNF-α and NF-kB compared to untreated rats. This study demonstrates that PHF significantly regulates the NF-kB/Nrf-2/HO-1 pathway to attenuate oxidative stress and inflammation. PHF protects cardiac myocytes against damage caused by hyperglycemia [42].

Discussion

According to review papers, all the studies consistently noted that the extract of *B. purpurea* holds promise for its antidiabetic potential, as they can effectively lower blood sugar levels. In *in vitro* studies, *B. purpurea* exerted inhibition of α-glucosidase, α-amylase and DPP-IV enzymes. The reported evidence strongly proved that *α*-glucosidase is an enzyme responsible for the hydrolysis of carbohydrates to simplify the passage of glucose to the bloodstream. This is because *B. purpurea* extract has a potent hypoglycemic agent that will contributes to the inhibition of *α*-glucosidase [43]. Additionally, Truc et al. [32] have highlighted that *B. purpurea* extract can reduce the rate of hydrolytic cleavage, potentially mitigating complications in diabetic patients.

The inhibition of α-amylase activity is associated with a decrease in postprandial blood glucose levels. This enzyme slows down glucose absorption and facilitates its removal. Vadivel and Biesalski stated that inhibition of α-amylase in *B. purpurea* is correlated to the early degradation of glycosidic linkages and eventually reduced blood sugar level [34]. The inhibition of α-glucosidase decrease the rate of hydrolytic cleavage of oligosaccharides that reduces postprandial blood glucose levels and diabetic complications [36].

Furthermore, DPP-IV inhibition enhances glucose levels in cultured cells, leading to the stimulation of *ß*-cell regeneration and the prevention of *ß*-cell apoptosis. This can improve glucose tolerance in diabetic patients by augmenting the insulinotropic effects [44]. Additionally, as noted by Kanstrup et al. [45], DPP-IV inhibitors, which are substrates of insulinotropic hormones, can help regulate glucose metabolism by utilising *B. purpurea* extract. Conversely, in *in vivo* findings, *B. purpurea* demonstrated its antidiabetic potential in rats with diabetes induced by STZ. One of the mechanisms through which antidiabetic agents alleviate hyperglycemia involves the stimulation of insulin secretion from pancreatic *β*-cells. The insulin released assists in the uptake of glucose by insulin-sensitive cells, such as those in the liver, muscles, and adipocytes, thereby reducing hyperglycemia. The choice of STZ as the diabetes-inducing agent was due to its known

property of inducing diabetes by relative necrotic action on the *β*-cells of the pancreas, leading to insulin deficiency with a single dose of intraperitoneal administration. Based on the results obtained by Gupta et al. [41], plant extracts of *B. purpurea* showed significant antidiabetic activity and reduced the glucose levels in induced diabetic rats.

The significant potential antidiabetic activity exerted by *B. purpurea* might be related to its powerful antioxidant properties. Antioxidant agents protect cells from free radicals and excessive reactive oxygen species (ROS) associated with glucotoxicity, which can impair *β*-cell function due to elevated glucose concentrations in the body. This situation also provides benefits for improving blood glucose metabolism and can be considered an alternative approach to treating diabetes [46]. It is possible that these extracts may reduce the impact of inflammatory cytokine release during diabetes, which could be one of the contributing factors to tissue damage and insulin resistance [47].

In addition, the extracts of *B. purpurea* are reported to consist of many phytochemicals that include saponins, phenols, alkaloids, tannins, terpenoids, steroids and glycosides [31]. One of the major phytochemical compounds reported is saponins. The compound saponins are believed to exhibit enhanced antidiabetic activity by lowering the glucose level, targeting insulin resistance, improving pancreatic functions and glucose absorption in the body. Other bioactive compounds, such as flavonoids, were found in the extract of *B. purpurea* including quercetin and kaempferol. These compounds are considered to have therapeutic potential for diabetes.

Missoun et al. [48] claimed that the compound kaempferol and quercetin have potential in the treatment of diabetes disease. Kaempferol is a flavonol and can be found in grapefruit or edible berries, which are highly content with antioxidants that are also reported to enhance insulin resistance and lower blood glucose fasting significantly. Next, the quercetin compound can be easily taken from natural fruits and vegetables such as apples, berries, or broccoli. The administration of quercetin helps to protect against excessive vasoconstriction against diabetes-induced due to reduced serum levels in C-reactive protein and tumour necrosis factor-alpha (TNF-α) [49].

Future recommendation

The current study has successfully discussed the validated antidiabetic activity *B. purpurea* and the phytochemical constituents contributing to its antihyperglycemic activity. The potential bioactive compounds responsible for antidiabetic activity were obtained throughout the review. Even though the study has managed to understand *B. purpurea* as an alternative therapy for diabetes, additional studies on chronic toxicity need to be done to evaluate its effectiveness in long-term usage fully. This information will contribute to the development of herbal drug formulation. Other parts of this plant should be assessed for further research since the current research only reported on the bark of *B. purpurea* for *in vivo* studies. Furthermore, metabolomic studies could be used to determine the metabolic pathways which can expedite the understanding of mechanisms of action extract of *B. purpurea* at the molecular level.

Conclusion

In conclusion, this showed that *B. purpurea* has antihyperglycaemic effect. This plant is used in traditional medicine for diabetic treatment. The *in vitro* and *in vivo* studies results supported its antidiabetic action. Further investigations must be carried out to evaluate the mechanism of action of medicinal plants with antidiabetic effects. Most of the findings confirmed the antidiabetic activity of *B. purpurea* plants via inhibition of cyclooxygenase, regeneration of *β* cells, synthesis of glycogen and inhibition of intestinal glucose absorption.

Conflict of interest statement

The authors declare that there is no conflict of interest.

Acknowledgement

The authors would like to thank the Ministry of Higher Education (MOHE) Malaysia for the support provided via Fundamental Research Grant Scheme (Reference code: FRGS/1/2020/SKK06/UNIKL/02/2).The authors acknowledge the Universiti Kuala Lumpur, Royal College of Medicine Perak, Malaysia for providing UERGS (UniKL/CoRI/UER21017) to support this review.

Table 1. Summary of phytochemical constituents isolated from *B. purpurea*

Part of plant	Phytochemical constituents	Type of extract	Location of plant collection	References
Seeds	Chalcone glycosides, 3,4-dihydroxychalcone, Galactose, Arabinose	NA	Department of Chemistry, University of Allahabad, India.	Bhartiya & Gupta, 1981 [21]
Seeds	Fatty acid, Phospholipid, Glycolipid, Triacylglycerol, Esterified sterol, Diacylglycerol, Monoacylglycerol, Campesterol, Stigmasterol,β Sitosterol, 5-Avenasterol, 7-Avenasterol, β- Stigmasterol, β-Tocopherol, δ-Tocopherol	n-Hexane	Gulbarga University Campus, India.	Ramadan et al., 2006 [22]
Heartwoods	Flavonoids, Phenols, Chromones, Glycerol derivatives, 2,3-dihydroxypropyl oleate, 2,3- dihydroxypropyl linoleate, 2,3-dihydroxypropyl, 16- hydroxyhexadecanoic, 6-butyl-3-hydroxy avanone, 6-(30-oxobutyl)-taxifolin	Methanol	Campus of the National Taiwan University.	Kuo et al., 1998 [23]
Stems	Chalcone glycosides, Amino acids, Flavone glycoside 5,6-dihydroxy-7- methoxyflavone 6-Ob-D-xylopyranoside, 7-methoxy-5,6-dihydroxy flavone, Xylose, 2,3,4-tri-O-methyl-D-xylose	Ethanolic	Dhamoni forest, Sagar region, India.	Yadava and Tripathi, 2000 [24]
Roots	Bauhinoxepins, Lectins, Flavonones, Flavone glycosides, Bibenzyls, Dihydrodibenzoxepin, Dihydrobenzofuran, Spirochromane-2,1'-hexanedione	Dichloromethane	Phitsanulok Province, Thailand.	Boonphong et al., 2007 [25]
Leaves	Glycosides, Kaempferol, Quercetin, Isorhamnetin, Myricetin	Methanol extract	Rio de Janeiro Botanical Garden, Brazil.	Salatino et al., 1999 [26]
Flowers	Phenolics, Kaempferol, Caffeic acid, Syringic acid, Vanillic acid	Petroleum ether	National Botanical Research Institute, Lucknow, India.	Gupta et al., 2015 [27]
Leaves	Phytyl esters (1a-1f), Lutein, β-sitosterol	NA	NA	Ragasa et al., 2004 [28]
Leaves	Catechin, Rutins, Fisetin, Saponins,Triterpenes, Steroids	Aqueous extract	Natural habitat in Shah Alam, Selangor.	Zakaria et al., 2007 [29]
Leaves	Triterpenoids, α-amyrin caprylate	Ethanol extract	Paneer, Deralakatte, India.	Verma et al., 2009 [30]
Leaves, Stem bark	Saponins, Steroids, Tannins, Xanthoprotein, Coumarins, Phenols, Alkaloids, Anthraquinones, Catechin, Flavonoids, Terpenoids	Acetone, Methanol, Chloroform, Petroleum ether, Aqueous extract	Grizzled Giant Squirrel Wildlife Sanctuary, Western Ghats, Srivilliputhur, Tamil Nadu.	Murugan & Mohan, 2011 [31]
Leaves, Flowers, Stem bark, Roots	Leaves and flower: alkaloids, flavonoids, saponins, carbohydrates, polyphenols, Stem barks and root: alkaloids, flavonoids, and phenolics.	Petroleum ether, Chloroform, Acetate, Ester, Ethanol, Ethylalcohol, Water	Davanagere district, Karnataka, India.	Shamala et al., 2022 [32]

NA: Not applicable

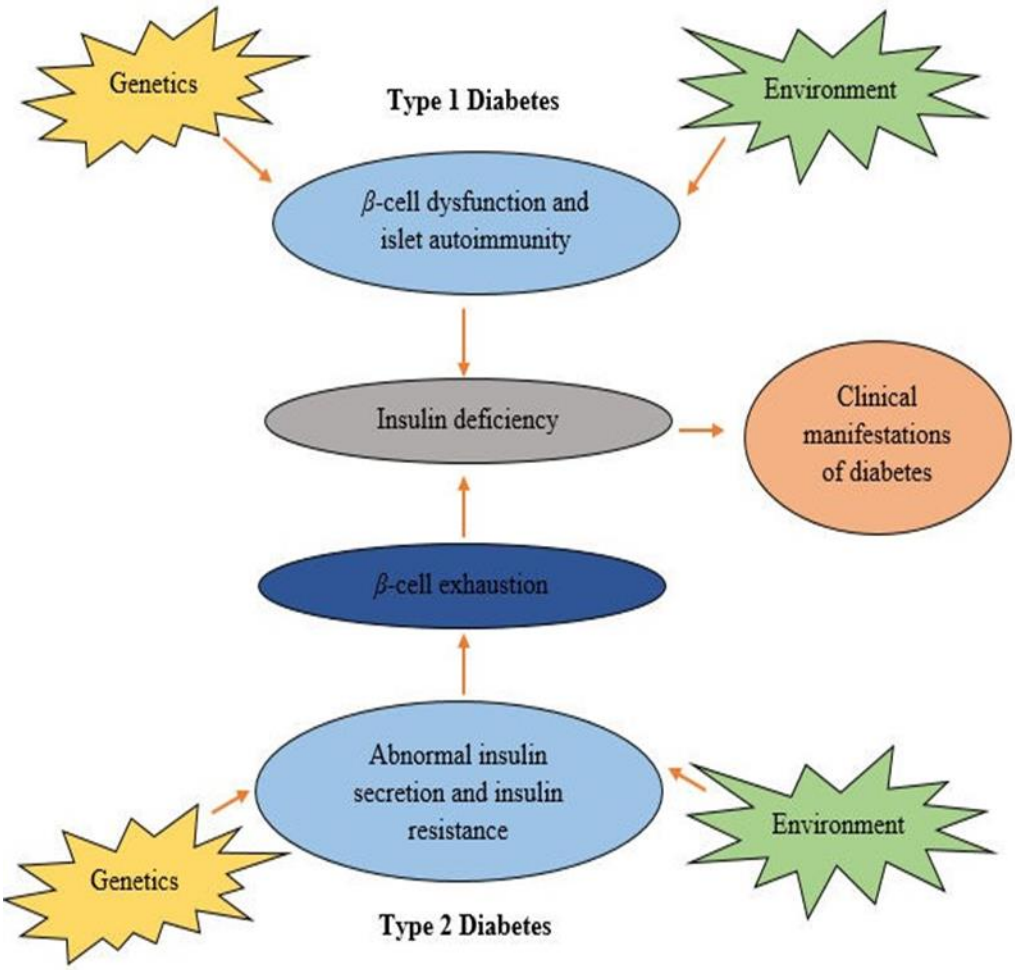

Figure 1. Mechanisms of pathophysiology diabetes type 1 and type 2.

Figure 2. The tree of *B. purpurea.*

Figure 3. The leaves of *B. purpurea.*

Figure 4. The flowers of *B. purpurea*

References

[1]. Grover SR, Mahajan AS, Patil KJ. Evaluation of anti-diabetic activities of medicinal plants. Research Articles by Budding Researchers. 2013; 1:28–32.

[2]. Gupta PP, Haider J, Yadav RP, Pal U. Preclinical evaluation of antidiabetic activity of poly herbal plant extract in streptozotocin-induced diabetic rats. The Journal of Phytopharmacology. 2016; 1:45–49.

[3]. Al Ahmed A, Khalil HE. Antidiabetic activity of Terfezia claveryi; An *in vitro* and *in vivo* study. Biomed Pharmacol J. 2019; 12:603–608.

[4]. Ramachandran A, Snehalatha C, Viswanathan V. Burden of type 2 diabetes and its complications – The Indian scenario. Curr Sci. 2002; 83:1471–1476.

[5]. Ismail, R., Ismail, N. H., Tamil, A. M., Ja'afar, M. H., Isa, Z. M., Nasir, N. M., ... & Yusof, K. H. Prevalence and factors associated with prediabetes and diabetes mellitus among adults: Baseline findings of PURE Malaysia cohort study. Clinical Epidemiology and Global Health. 2023; 21;101279.

[6]. Barrella N, Eisenberg B, Simpson SN. Hypoglycemia and severe lactic acidosis in a dog following metformin exposure. Clin Case Reports 2017;5:2097–104. https://doi.org/10.1002/ccr3.1255.

[7]. Ito H, Abe M, Mifune M, Oshikiri K, Antoku S, Takeuchi Y, et al. Hyperuricemia Is Independently Associated with Coronary Heart Disease and Renal Dysfunction in Patients with Type 2 Diabetes Mellitus. PLoS One 2011;6:1–7. https://doi.org/10.1371/journal.pone.0027817.

[8]. Prasad SK, Kulshreshtha A, Qureshi TN. Antidiabetic activity of some herbal plants in streptozotocin-induced diabetic albino rats. Pak J Nutr. 2009; 8:551–557.

[9]. Chauhan A, Sharma PK, Srivastava P, Kumar N, Dudhe R. Plants having potential antidiabetic activity: A review. Der Pharm Lett. 2010; 2:369–387.

[10]. Kumar T, Chandrashekar KS. *Bauhinia purpurea* Linn: A review of its ethnobotany, phytochemical and pharmacological profile. Res J Med Plant. 2019; 5:420–431.

[11]. Menezes FDS, Minto ABM, Ruela HS, Kuster RM, Sheridan H, Frankish N. Hypoglycemic activity of two Brazilian Bauhinia species: *Bauhinia forficata* L. and *Bauhinia monandra* Kurz. Rev Bras Farmacogn. 2007; 17:8–13.

[12]. Marimuthu K, Dhanalakshmi R. A study on phytochemicals in *Bauhinia purpurea* l. leaf and flower. Int. J. Pharm Sci Rev Res. 2014; 29:72–76.

[13]. Kumar S, Narwal S, Kumar V, Prakash O. α-glucosidase inhibitors from plants: a natural approach to treat diabetes. Pharmacog Rev. 2017; 5:19–29.

[14]. Kirtikar KR, Basu BA. Indian medicinal plants. Second edition. Periodical expert book agency. New Delhi, India. 1991; 856–860.

[15]. Zakaria ZA, Yahya F, Mamat SS, Mahmood ND, Mohtarrudin N, Taher M, Salleh MZ. Hepatoprotective action of various partitions of methanol extract of *Bauhinia purpurea* leaves against paracetamol induced liver toxicity: involvement of the antioxidant mechanisms. BMC Complement Alternat Med. 2016; 16:1–16.

[16]. Sarkar A, Tripathi VD, Sahu RK, Aboulthana WM. Evaluation of anti-inflammatory and anti-arthritis activity of isolated fractions from *Bauhinia purpurea* leaves extracts in rats. UK J Pharm Biosci. 2017; 5:47–58.

[17]. Barros IBD, Kappel MAA, Santos PMD, Veiga Junior VFD, D'Elia E, Bastos IN. The inhibitory action of *Bauhinia purpurea* extracts on the corrosion of carbon steel in sulfuric acid medium. Mater Res. 2016; 19:187–194.

[18]. Brahmachari AK, Nath S, Brahmachari G, Batabyal S, Mandal TK, Bandopadhyay SK, Sinha BP, Pandey AK. Modulatory effect of semipurified fraction of *B. purpurea* l. bark extract on oxidative stress in STZ induced diabetic rats. Explor Anim Med

Res. 2016; 6:26–36.

[19]. Asolker LV, Kakkar KK, Chakre OJ. Supplement to glossary of Indian medicinal plants. Part-I (A-K). National Institute of Science Communication. New Delhi. 2000; 116–117.

[20]. Janardhanan K, Vadivel V, Pugalenthi M. Biodiversity in Indian underexploited/ tribal pulses. In Improvement Strategies of Leguminosae Biotechnology. Springer, Dordrecht. 2003; 353–405.

[21]. Bhartiya HP, Gupta PC. A Chalcone Glycoside from The seeds of *Bauhinia purpurea*. Phytochem. 1981; 20: 2051.

[22]. Ramadan MF, Sharanabasappa G, Seetharam YN, Seshagiri M, Moersel J T. Characterisation of fatty acids and bioactive compounds of Kachnar (*Bauhinia purpurea* L.) seed oil. Food Chem 2006; 98:359–365.

[23]. Kuo YH, Yeh MH, Huang SL. A Novel 6-butyl-3-hydroxyflavanone from Heartwood of *B. purpurea*. Phytochem. 1998; 49:2529–2530.

[24]. Yadava RN, Tripathi P. A novel flavone glycoside from the stem of *Bauhinia purpurea*. Fitoterapia. 2000; 71:88–90.

[25]. Boonphong S, Puangsombat P, Baramee A, Mahidol C, Ruchirawat S, Kittakoop P. Bioactive compounds from *Bauhinia purpurea* possessing antimalarial, antimycobacterial, antifungal, anti-inflammatory, and cytotoxic activities. J Nat Prod. 2007; 70:795–801.

[26]. Salatino A, Blatt CT, Santos DYD, Vaz AM. Foliar flavonoids of nine species of Bauhinia. Braz J Bot. 1999; 22:17–20.

[27]. Gupta A, Verma S, Khatoon S, Dwivedi H, Rawat AK. High-performance thin-layer chromatographic analysis for the simultaneous quantification of four phenolics in flowers and flower buds of *Bauhinia purpurea* l., *Bauhinia variegata* l., and *Bauhinia acuminata* l. J Planar Chromatogr Mod TLC. 2015. 28:452–457.

[28]. Ragasa CY, Hofileña J, Rideout JA. Secondary metabolite from *Bauhinia purpurea.* Ind J Microbiol. 2004; 133:1–5.

[29]. Zakaria ZA, Wen LY, Rahman NIA, Ayub AHA, Sulaiman MR, Gopalan HK. Antinociceptive, anti-inflammatory and antipyretic properties of the aqueous extract of *Bauhinia purpurea* leaves in experimental animals. Med Princ Pract. 2007; 16:443–449.

[30]. Verma T, KS, C, Joshi AB. α-Amyrin caprylate-a new triterpene isolated from the leaf of *Bauhinia purpurea* Linn. Asian J Res Chem. 2009; 2:569–570.

[31]. Murugan M, Mohan VR. Evaluation of phytochemical analysis and antibacterial activity of

Bauhinia purpurea L. and *Hiptage benghalensis* L. Kurz. J App Pharm Sci. 2011; 1:157–160.

[32]. Shamala, T., Surendra, B. S., Chethana, M. V., & Shanmukhappa, S. Extraction and isolation of Isoflavonoids from stem bark of *Bauhinia purpurea* (L): Its biological antipsychotic and analgesic activities. Smart Mater Medi. 2022; 3; 179-187.

[33]. Htay, T. M., Sann, K. K., & Haini, H. Comparative study on phytochemical screening and antioxidant activity of aqueous extract from various parts of *Bauhinia purpurea*. Bioactivities. 2023; 1(1); 24-31.

[34]. Vadivel V, Biesalski HK. Antioxidant potential and health relevant functionality of *Bauhinia purpurea* L. seeds. Br Food J. 2013; 115:1025–1037.

[35]. Dej-Adisai S, Pitakbut T. Determination of α-glucosidase inhibitory activity from selected Fabaceae plants. Pak J Pharm Sci. 2015; 28:1679–1683.

[36]. Truc DTT, Phu DH, Hai NX, Mai NTT, Nhan NT. Study on α-glucosidase inhibitory activity of the medicinal plants from Phu Yen Province. Vietnam J Chem. 2017; 55:89–91.

[37]. Chaudhari MG, Joshi BB, Mistry KN. *In vitro* anti-diabetic and anti-inflammatory activity of stem bark of *Bauhinia purpurea*. BOPAMS. 2013; 1:139–150.

[38]. Singh AK, Ram H. Dipeptidyl peptidase-iv inhibition and ex-vivo antioxidant potential of phytocompounds of *Withania somnifera*, *Trigonella foenum* and *Bauhinia purpurea.* European J Biomed. 2018; 5:671–678.

[39]. Kantari, S. A. K., Biswal, R. P., Kumar, P., Dharanikota, M., & Agraharam, A. Antioxidant and Antidiabetic Activities, and UHPLC-ESI-QTOF-MS-Based Metabolite Profiling of an Endophytic Fungus *Nigrospora sphaerica* BRN 01 Isolated from *Bauhinia purpurea* L. Appl Biochem Biotechnol. 2023; 1-18.

[40]. Pahwa S, Mazumder R, Bhattacharya S. Antidiabetic activity of methanolic extract of bark of *Bauhinia purpurea*. Int J Pharm Sci Res. 2012; 3:444–1447.

[41]. Gupta R, Sharma AK. Anti-hyperglycemic activity of aqueous extracts of some medicinal plants on Wistar rats. J Diabetes Metab. 2017; 8:1–7.

[42]. Uddandrao, V. S., Parim, B., Singaravel, S., Ponnusamy, P., Ponnusamy, C., Sasikumar, V., & Saravanan, G. Polyherbal formulation ameliorates diabetic cardiomyopathy through attenuation of cardiac inflammation and oxidative stress via NF-κB/Nrf-2/HO-1 pathway in diabetic rats. J Cardiovasc Pharmacol. 2022; 79(1); e75-e86.

[43]. Benalla W, Bellahcen S, Bnouham M. Antidiabetic medicinal plants as a source of alpha

glucosidase inhibitors. Curr Diabetes Rev. 2010; 6:247–254.

[44]. Al-masri, IM, Mohammad MK, Tahaa MO. Inhibition of dipeptidyl peptidase iv (dpp iv) is one of the mechanisms explaining the hypoglycemic effect of Berberine. J Enzyme Inhib Med Chem. 2009; 24:1061–1066.

[45]. Kanstrup AB, Sams CK, Lundbeck JM, Christiansen LB, Kristiansen MUS. Patent No. 6,869,947. Washington, 2005. DC: U.S. Patent and Trademark Office.

[46]. Tesauro M, Mazzotta FA. Pathophysiology of diabetes. In Transplantation, Bioengineering, and Regeneration of the Endocrine Pancreas. Academic Press. 2020; 37–47.

[47]. Sabu MC, Kuttan R. Anti-diabetic activity of medicinal plants and its relationship with their antioxidant property. J Ethnopharm. 2002; 81:155–160.

[48]. Missoun F, Bouabdelli F, Awatif B, Amari N, Djebli N. Antidiabetic bioactive compounds from plants. Med Technol J. 2018; 2:199–214.

[49]. Bharti SK, Krishnan S, Kumar A, Kumar A Antidiabetic phytoconstituents and their mode of action on metabolic pathways. Ther Adv Endocrinol. Metab. 2018; 9:81–100.