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Review Article

Medicinal Flowers in the Management of Diabetes Mellitus: A Review

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Abstract
Diabetes mellitus is regarded as a noncurable but controllable disease. The disease necessitates constant reassessment of glycaemic control in people with diabetes and appropriate adjustment of therapeutic regimens. For several centuries medical practitioners have long been acknowledged the therapeutic properties of certain flowers. The medicinal properties of flowers are evaluated from the aspect of potential health benefits concerning mainly the influence of color, odour and flavour components in relation to antioxidant activity, and scavenging activity of reactive oxygen radicals. Though many flowers available in our surroundings have medicinal uses and are widely used in indigenous system, there is a scarce data about the medicinal uses of flowers. This review highlights therapeutic utility of medicinal flowers and enriches our knowledge regarding pharmacological aspects of the flowers used in managing diabetes.

Keywords: diabetes, medicinal flowers, hypoglycemic activity.

INTRODUCTION

Diabetes mellitus (DM) is a chronic endocrine disorder resulting from defects in pancreas insulin production and secretion and/or insulin resistance in peripheral tissues, leading to abnormalities in carbohydrate, lipid and protein metabolism. Lifestyle changes in modern society, such as diminished physical activity and increased ingestion of high-energy foods have explained the high incidence of DM, which is reaching epidemic proportions worldwide[1]. In 2013, more than 382 million people had diabetes, with estimation to rise to 592 million worldwide by 2035[2]. Progressive nature of the disease necessitates constant reassessment of glycaemic control in people with diabetes and appropriate adjustment of therapeutic regimens[3]. Thus, the management of diabetes without any side effects is still a challenge.

Diet therapy along with insulin or oral hypoglycemic agent forms an important way of treatment in diabetes and its complications though it has several demerits. To successfully cope with this challenging situation, there is an urgent need to search for more treatment options that are readily available, safe and cost-effective[4]. Especially the antioxidant effects of phytochemicals such as polyphenols or carotenoids have been studied extensively, but less is known about mechanisms linking medicinal flowers to the management of diabetes mellitus.

Flowers the sexual reproductive parts of the plants are matchless ornaments to the nature Queen. They are an integral part of our lives and are associated with the most poignant moments of human experiences like celebrations or grieving. They are used not just for their aesthetic sense but also for nutritive and medicinal properties also. For several centuries medical practitioners have long been acknowledged the therapeutic properties of certain flowers. The kingdom of flowers is very vast and can categorize them in general into four main classes depending upon the purpose for which they are grown, i.e. ornamental, commercial, medicinal and vegetable or edible flowers[5].

Out of the total 4, 22,000 flowering plants reported from the world, more than 50,000 plants are used for medicinal purposes. In India, more than 43% of the total flowering plants are reported to be of medicinal importance[6]. India has a very rich flora with nearly 17,500 flowering plants which constitutes 12% of the recorded world flora. Flowers are directly eaten as petals or made as juice decoction, tincture or mixing them with some other ingredients and then administered. Different formulations of flowers are used as Juice, Powder, Syrup, *Arka* (Distilled extract), scents, soups etc[7].

The medicinal properties of flowers are evaluated from the aspect of potential health benefits concerning mainly the influence of color, odour and flavour components in relation to antioxidant activity, and scavenging activity of reactive oxygen radicals.

In present day concrete jungle life most of the people are suffering with so many lifestyle diseases especially diabetes. There is need of fast and correct method of diagnosis, less expensive treatment with least or no side effects and permanent solution, is the need of the hour to the present day society[8]. Though many flowers available in our surroundings are having medicinal uses and are widely used in indigenous system, there is a scarce data about the medicinal uses of flowers. This review highlights therapeutic utility of medicinal flowers and enriches our knowledge regarding pharmacological aspects of the flowers used in managing diabetes.

Cocos nucifera flowers

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Oral administration of *Cocos nucifera* flowers extract to diabetic group of rats reduced the formation of glycosylated haemoglobin by virtue of its normoglycemic activity. It is indicated that *Cocos nucifera* flowers extract possess antidiabetic as well as antioxidant properties. Phytochemical screening indicated the presence of pharmacologically active ingredients in the flowers and nontoxic. The level of glycogen content, the activities of glycogen synthase and glycogen phosphorylase has been shown to be improved upon treatment with the extract[9]. Administration of the methanol extract of coconut inflorescence to the diabetic rats showed dose dependent reduction in hyperglycemia. The cytoprotective property of coconut inflorescence was evidenced from the acute toxicological evaluation. The levels of serum aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase were significantly decreased in the diabetic rats treated with inflorescence when compared with the diabetic control rats[10].

Catharanthus roseus flowers

Oral administration of aqueous extract of *Catharanthus roseus* flowers to diabetic rats resulted in significant reduction in blood glucose, reduction in lipid profile and also prevented a decrease in body weight. Supplementation with *Catharanthus roseus* flowers to diabetic rats significantly reduced the fatty changes and inflammatory cell infiltrates. The aqueous flower extract had synergetic hyperglycemia effect revealed by increased serum insulin levels, decreased serum lipid levels and therefore attribute to therapeutic value of the aqueous flower

extract of *Catharanthus roseus* to combat the diabetic condition in rats[11].

Psidium guajava flowers

Oral administration of aqueous extract of *Psidium guajava* flowers to diabetic rats resulted in significantly reduction in plasma glucose, creatinine, urea, AST, ALT, ACP, ALP, LPO, glucose-6-phosphatase and fructose1,6 bisphosphatase and increased level of serum insulin, protein, CAT, SOD, glycogen synthase and hexokinase. Flowers of *Psidium guajava* exhibit hypoglycaemic activity in alloxan induced diabetic rats. The aqueous extract of *Psidium guajava* flower extract possesses good glycaemic control properties in alloxan induced experimental rats[12].

Cassia auriculata flowers

Oral administration of aqueous extract of *Cassia auriculata* flowers extract to alloxan-induced diabetic group of rats showed significant antidiabetic activity as observed from serum glucose level in diabetic rats. It is revealed that, the aqueous extract of *Cassia auriculata* flowers is worthwhile to develop the bioactive principle for diabetes mellitus[13]. Treatment with aqueous extract of *Cassia auriculata* flowers restored the blood glucose and plasma insulin significantly in diabetic animals[14].

Pterospermum acerifolium (L.) Wild flowers

Diabetic animals treated with *Pterospermum acerifolium* (L.) wild flowers reduced the levels of fasting blood glucose, significantly compared to that of diabetic control animals. HPLC analysis of *Pterospermum acerifolium* (L.) Wild flowers extract revealed the presence of quercetin and apigenin as major constituents and both inhibiting the glycogen phosphorylase enzyme in molecular modelling studies. The study have evidenced strongly that the probable glucose lowering mechanism of action of the *Pterospermum acerifolium* (L.) wild flowers was by increasing the glucose uptake in peripheral tissues and by inhibiting gluconeogenesis[15].

Chamomile recutita flowers

Daily oral consumption of ethanolic extract of *Chamomile recutita* flowers exhibited a pronounced hypoglycemic effect and reduced the lipid peroxidation process with enhanced antioxidant defence system in the diabetic rats[16]. chamomile tea possess a glucose lowering effect and able to reduce the fasting and post prandial blood sugar levels progressively and lower the level of hemoglobin A1c (HbA1c) significantly[17].

Citrullus colocynthis Linn. flowers

Oral administration of the Streptozotocin induced diabetic mice with the flower extract of *Citrullus colocynthis Linn.* resulted in significant reduction of blood glucose level, serum cholesterol and increased in liver glycogen. The antidiabetic effect of *Citrullus colocynthis Linn.* flower could be due to the presence of various phytoconstituents detected in the phytochemical screening imparting therapeutic effect[18].

Clitoria ternatea Linn. flowers

The aqueous extract of *Clitoria ternatea* flowers significantly reduced serum glucose, glycosylated hemoglobin and the activities of gluconeogenic enzyme, glucose-6- phosphatase, and increased the serum insulin, liver and skeletal muscle glycogen and the activity of the glycolytic enzyme, glucokinase. Flower extracts of *Clitoria ternatea* are reported to increase insulin secretion and enhance glycogenesis process. The extracts were effective in regulating the glycogen content and the activity of glucokinase and glucose-6-phosphatase[19]. The probable mechanism by which *Clitoria ternatea* flower petal extract exerts antiglycation and antioxidant activity may be in association with the phytochemical compounds in the extract. Antiglycation and antioxidant activity of *Clitoria ternatea* flower petal extract may be responsible for their usefulness in the management and prevention of AGE mediated diabetic complication[20].

Musa sapientum flowers

Intragastric administration of a fresh flower decoction of *M. sapientum* flowers to hyperglycemic rabbits was reported to significantly decrease the hyperglycemic peak and/or the area under the glucose tolerance curve. Oral administration of various doses of chloroform extract of *M. sapientum* flowers significantly reduced blood glucose and glycosylated hemoglobin and increased total hemoglobin in alloxanized rats[21].

Punica granatum flowers

The flowers of the plant *Punica granatum* are used as anti-diabetic in Unani medicine called Gulnarfarsi. Oral administration of extract led to significant blood glucose lowering effect in glucose fed hyperglycemic and alloxanized diabetic rats. The methanolic extract of the flowering part of *Punica granatum* in diabetic fatty rats

markedly reduced plasma glucose levels by interferring with transit, digestion or absorption of sugars in the small intestine. *Punica granatum* was shown to inhibit intestinal α-glucosidase activity, leading to hyperglycemic property[22]. The flower extracts of *Punica granatum* possess significant hypoglycemic activity, which may be partly due to their stimulatory action on insulin release and may in part be due to its antioxidant activity[23].

Tectona grandis flowers

Oral administration of methonolic extract of *Tectona grandis* flowers among streptozotocin-nicotinamide induced diabetic rats significantly improved body weight and reduced blood glucose, in diabetic rats. Methonolic extract of *Tectona grandis* flowers showed the presence of polyphenolic active constituents, such as gallic acid, quercetin, rutin, ellagic acid, ferulic acid, and kaempferol, which was confirmed by HPLC. Polyphenolic active constituents present in methonolic extract of *Tectona grandis* flowers are possibly responsible for the blood glucose-lowering effect in diabetic rats via an insulin-sensitizing action, as well as inhibition of α-amylase and α-glucosidase activity[24].

Nymphaea stellata flowers

Administration of *Nymphaea stellata* flower extract to alloxan induced diabetic rats showed more promising results with regard to fasting blood glucose (FBG), plasma insulin levels, haemoglobin counts and urine sugar levels[25]. *Nymphaea stellata* flowers show therapeutic promise as a protective agent against the development and progression of atherosclerosis and possible related cardiovascular complications in diabetes mellitus[26].

Moringa oleifera flowers

Administration of ethanolic extract of *Moringa oleifera* flowers orally exhibited improved lipid metabolism, glucose-lowering potential and beneficial in preventing diabetic complications as a result of lipid peroxidation and oxidative systems in streptozotocin-induced diabetic rats. Oral administration of ethanolic extract of *Moringa oleifera* flower significantly reduced the levels of blood glucose, serum lipids and lipid peroxidation when compared with the controls[27]. *Moringa oleifera* flower could be employed therapeutically in managing diabetes mellitus.

Caesalpinia pulcherrima flowers

Adminisrtration of the *Caesalpinia pulcherrima* flower extract significantly decreased blood glucose levels in diabetic rats confirmed by the histopathological study with better regeneration of β cells[28].

Hibiscus tiliaceus flowers

The methanolic *Hibiscus tiliaceus* flower extract showed significant antidiabetic activity with significant improvement in body weight among streptozotocin induced diabetic wistar rats. Daily oral treatment with the extract resulted in significantly reduction in blood glucose serum cholesterol and triglycerides. Antidiabetic properties of *Hibiscus tiliaceus* flower extract might be due to antioxidant effect of the plant[29].

Borassus flabellifer flowers

Oral administration of *Borassus flabellifer flower extract* significantly decreased blood glucose among the experimental rats. It is conceivable that antioxidant/ free radical scavenging activity of *Borassus flabellifer* flowers ethanol extract is one of the mechanism associated with anti-diabetic effect. The other mechanism is regeneration and moderate expansion of cellular population and size of islet of Langerhans and β cells by ethanol extracts of *Borassus flabellifer* flowers. The anti-diabetic activity of extract may be due to the presence of flavonoids and tri-terpenoids. It is reported that flavonoids constitute the active biological principles of most medicinal plants with hypoglycemic and anti-diabetic properties[30].

Saraca asoca flowers

Administration of aqueous ethanolic extract of *Saraca asoca* to diabetic rats showed a moderate decrease in the levels of blood glucose. The possible may be by increasing either the pancreatic secretion of insulin from the existing beta cells or by its release from the bound form. It is also evidenced by histopathological examination of pancreas showing expansion of islet cells, which cause more insulin secretion[31].

Nelumbo nucifera flowers

The *Nelumbo nucifera* flower extract has been reported to decrease fasting blood glucose and increase serum insulin and WBC counts in experimental diabetic rats. *Nelumbo nucifera* flower extract possesses immunomodulatory effects and hypoglycemic activities by virtue of flavonoids from flowers. In-vitro studies revealed the improvement of glucose tolerance by increased peripheral glucose utilisation caused by increased sensitivity of skeletal muscle to endogenous insulin[33]. Methanol extract from *Nelumbo nucifera* stamens revealed inhibitory activity against rat lens aldose reductase, the key enzyme of the polyol pathway[34].

Kigelia pinnata flowers

Oral administration of *Kigelia pinnata* flowers extracts decreased the blood glucose level significantly and showed the hypolipidemic effect. The hypolipidemic effect may be due to inhibition of fatty acid synthesis. The extract also showed improvement in lipid profile and body weight[35].

Tabernaemontana divaricata (L.) flowers

Administration of methanolic extract of *Tabernaemontana divaricata* flowers has considerable effect in lowering fasting blood glucose level in alloxan induced diabetic mice. The flowers extract has considerable hypoglycemic activity considering the blood sugar level in standard and diabetic control[36].

Combretum lanceolatum flowers

Oral administration of with ethanolic extract of *Combretum lanceolatum* flowers to diabetic rats presented reduction in glycemia, glycosuria and urinary urea levels, and increase in liver glycogen content. HPLC chromatogram showed that quercetin as the major compound in the extract. The extract appears to act through the inhibition of gluconeogenesis, since urinary urea was reduced and skeletal muscle mass was increased[37]. Antihyperglycaemic effect of flowers is related to the reduction of the hepatic glucose output, and

its reduced production in liver of diabetic rats treated with *Combretum lanceolatum flowers*[38].

Calotropis gigantea Linn. flowers

The *Calotropis gigantea* Linn. flowers possess marked hypoglycemic activity that resulted in improvement of oral glucose tolerance and lowering of the serum glucose levels in diabetic rats. The presence of flavonol glycosides may be responsible for the observed anti-diabetic activity, increased glucose uptake, suppression of the gluconeogenic enzymes such as glucose-6-phosphatase[39].

Rhododendron arboreum flowers

Ethanol extract of *Rhododendron arboreum* flowers showed maximum antihyperglycemic activity by bringing down the blood glucose levels. Administration of the *Rhododendron arboreum* flower extract to diabetic rats enhanced the hepatic hexokinase activity and promoted glycolysis and glucose utilization for energy production. The increased insulin levels may be due to the significant reduction in the activities of gluconeogenic enzymes. And hence decrease concentration of glucose in blood[40].

Pterospermum acerifolium flowers

Ethyl acetate fraction of *Pterospermum acerifolium* flowers was found act as the potential *α*-amylase inhibitor. Inhibition of this enzyme activity in the digestive tract of humans is considered to be effective to control diabetes by diminishing the absorption of glucose decomposed from starch by this enzyme. The probable glucose lowering mechanism of action of active ethyl acetate fraction of *Pterospermum acerifolium* flowers is by increasing the glucose uptake in peripheral tissues and by inhibition of gluconeogenesis[41].

Diplotaxis simplex flowers

The oral administration of *Diplotaxis simplex* flowers extract restored the glycemia, α-amylase activity, and serum lipid profile and antioxidant enzymes. The flowers extract exhibited a renal protective role by decreasing the urea and creatinine levels in diabetic rats' serum. *Diplotaxis simplex* flowers contain bioactive compounds such as rhamnetin, isorhamnetin, quercetin and kaempferol responsible for antioxidant and hypoglycemic properties[42].

Coreopsis tinctoria flowers

The extract of *Coreopsis tinctoria* flowers lowered blood glucose levels through the inhibition of *α*-glycosidase activity. The flavonoids from *Coreopsis tinctoria* flowers displayed antioxidant activities and showed to prevent the increase of blood glucose levels. The hypoglycemic effects of the extracts may be exerted through the inhibition of *α*-glucosidase activity. *Coreopsis tinctoria* flower may be used as a nutriceutical or potential source of drug for diabetes[43].

Crocus sativus Linn

The *Crocus sativus* Linn extract ameliorated blood glucose, cognitive deficit, lipid profile, reduced oxidative stress, nitric oxide, and TNF-*α* in the diabetic rats. The principle mechanisms involved in the antidiabetic and neuroprotective effect of saffron are its strong antioxidant and anti-inflammatory potential. It can be recommended in diabetic subjects as herbal drug after randomized clinical trials[44].

Azadirachta indica flowers

Decrease in blood glucose concentration after *Azadirachta indica* flower administration may be produced by several mechanisms including decreased synthesis or release of glucose by the liver or increased release of insulin or increased peripheral glucose utilization. It may be suggested that, the hypoglycemic action of Azadirachta indica flower may be due to its direct effect on the tissue. Azadirachta indica flower possess active hypoglycemic constituents[45].

CONCLUSION

Diabetes milletus is a chronic disease which leads to various complications on long standing. Allopathic medicines are not effective in treating the disease leading to various adverse effects. Flowers which are used as popular remedies are rich source of biologically active secondary metabolites. It is very essential to have a proper documentation of medicinal flowers and their potential for the improvement of health and hygiene through an ecofriendly system. This review enriches our knowledge regarding the chemical constituents and pharmacological properties of flowers. Activity guided fractionation could isolate and characterize many compounds. Hence medicinal flowers are the best alternative for the treatment of diabetes mellitus. Discovery of novel compounds can be developed through extensive research work on bioactivity of various constituents.

REFERENCES

1. Siqueira JT, Batistela E, Pereira MP, Da Silva VC, De Sousa PT, Andrade CMB. *Combretum lanceolatum* flowers ethanol extract inhibits hepatic gluconeogenesis: an in vivo mechanism study. Pharmaceutical Biology 2016; 54: 1671-1679.
2. Guariguata L, Whiting DR, Hamnleton I, Beagley J, Linnenkamp U, Shaw JE. Global Estimates of Diabetes Prevalence for 2013 and Projections for 2035. Diabetes Res. Clin. Pract. 2014; 103:137-149.
3. Ziyabrj AH, Mohammad A, Maclean E, Behbehani K, Carballo M. Diabetes: A Fast Evolving Epidemic, Kuwait Medical Journal 2015; 47: 291-301.
4. Shubhashree MN, Shantha TR, Ramarao V, Prathapareddy M, Venkateshawarulu G. A review on therapeutic uses of flowers as depicted in classical texts of Ayurveda and Siddha. J. Res. Educ. Indian Med 2015:82: 1-14.
5. Varadhan KP. Introduction to pushpa ayurveda. Ancient science of life 1985; 4:153-157.
6. Reddy MP, Rao V, Shantha TR, Kumar KR, Venkateshwarlu G, Rahmathulla. Therapeutic uses of Flowers - Leads from Traditional System of Medicine.International Journal of Herbal Medicine 2015; 3: 12-20.
7. Hussain SA, Marouf BH. Flavonoids as alternatives in treatment of type 2 diabetes mellitus. Academia Journal of Medicinal Plants 2013; 1: 031-036.

8. Uniyal SK, Singh KN, Jamwal P, Lal B. Traditional use of medicinal plants among the tribal communities of Chhota Bhangal- Western Himalaya. Journal of Ethnobiology and Ethnomedicine 2006; 2:14-21.
9. Saranya S, Pradeepa S, Subramanian S. Biochemical Evaluation of Antidiabetic Activity of *Cocos nucifera* Flowers in STZ Induced Diabetic Rats. Int J Pharm Sci Rev Res 2014; 26:67-75.
10. Renjith RS, Chikku AM, Rajamohan T. Cytoprotective, antihyperglycemic and phytochemical properties of Cocos nucifera (L.) inflorescence. Asian Pac J Trop Med. 2013; 6:804-810.
11. Natarajan A, Ahmed KSZ, Sundaresan S, Sivaraj A, Devi K, Senthil Kumar B. Effect of Aqueous Flower Extract of *Catharanthus roseus* on Alloxan Induced Diabetes in Male Albino Rats. International Journal of Pharmaceutical Sciences and Drug Research 2012; 4(2): 150-153.
12. Priyadharshini G, Anuradha R. Hypoglycaemic activity of *Psidium guajava* linn. Flowers against alloxan induced diabetes in male albino rats. Bulletin of Pharmaceutical and Medical Sciences 2014:2(1):2118-2126.
13. Hatapakki BC, Suresh HM, Bhoomannavar V, Shivkumar SI. Effect of *Cassia auriculata* Linn flowers against alloxan-induced diabetes in rats. Journal of Natural Remedies 2005; 5:132 – 136.
14. Hakkim FL, Girija S, Kumar RS, Jalaludeen MD. Effect of aqueous and ethanol extracts of *Cassia auriculata* L. flowers on diabetes using alloxan induced diabetic rats. Int J Diabetes & Metabolism 2007; 15: 100-106.
15. Paramaguru R, Mazumder PM, Sasmal D, Jayaprakash V. Antidiabetic Activity of *Pterospermum acerifolium* Flowers and Glucose Uptake Potential of Bioactive Fraction in L6 Muscle Cell Lines with Its HPLC Fingerprint. BioMed Research International 2014;1-11.
16. Al-Musa H, AL-Hashem F. Hypoglycemic, Hepato-Renal and Antioxidant Potential Effects of *Chamomile* Recutita Flowers Ethanolic Extract in Streptozotocin-Diabetic Rats. American Journal of Pharmacology and Toxicology 2014; 69: 1-12**.**
17. Kelleni MT. Chamomile Tea Potentials in Prevention and Amelioration of Type 2 Diabetes Mellitus. J Diabetes Metab 2016;7: 649-654.
18. Nigam V, Mishra MK, Biswal PK. Steptozotocin induced diabetic mice model for antihyperglycaemic activity of *Citrullus colocynthis* linn. flowers. World Journal of Pharmacy and Pharmaceutical Sciences 2014; 3: 949-959.
19. Daisy P, Rajathi M. Hypoglycemic Effects of *Clitoria ternatea* Linn. (Fabaceae) in Alloxan-induced diabetes in rats. Tropical Journal of Pharmaceutical Research 2009; 8: 393-398.
20. Chayaratanasin P, Barbieri MA, Suanpairintr N, Adisakwattana S. Inhibitory effect of *Clitoria ternatea* flower petal extract on fructose-induced protein glycation and oxidation-dependent damages to albumin *in vitro*, BMC Complementary and Alternative Medicine 2015; 15:27-32.
21. Makwana AR, Sameja KD, Rao SK. Review on Medicinal Plants of Gujarat with Anti-diabetic Potential. International Journal of Pharmacognosy and Phytochemical Research 2016; 8: 167-173.
22. Li Y , Wen S, Kota BP, Peng G, Li GQ, Yamahara J, Roufogalis BD. Punica granatum flower extract, a potent glucosidase inhibitor, improves postprandial hyperglycemia in Zucker diabetic fatty rats. Journal of Ethnopharmacology 2005; 99: 239–244.
23. Bhaskar A, Kumar A. Antihyperglycemic, antioxidant and hypolipidemic effect of Punica granatum L flower extract in streptozotocin induced diabetic rats. Asian Pacific Journal of Tropical Biomedicine 2012; S1764-S1769.
24. Ramachandran S, Rajasekaran A. Blood glucose-lowering effect of Tectona grandis flowers in type 2 diabetic rats: a study on identification of active constituents and mechanisms for antidiabetic action. J Diabetes 2014; 6:427-37.
25. Rajagopal K, Sasikala K. Antihyperglycaemic and antihyperlipidaemic effects of Nymphaea stellata in alloxan-induced diabetic rats. Singapore Med J 2008; 49: 137-141.
26. Rajagopal K, Sasikala K, Ragavan B. Hypoglycemic and Antihyperglycemic Activity of Nymphaea stellata Flowers in Normal and Alloxan Diabetic Rats. Pharmaceutical Biology 2008; 46: 654-659.
27. Arise RO, Aburo OR, Farohunbi ST, Adewale AA. Antidiabetic and Antioxidant Activities of Ethanolic Extract of Dried Flowers of Moringa oleifera in Streptozotocin-induced Diabetic Rats. Acta facultatismedicae Naissensis 2016;33(4):259-272.
28. Balasubramanian V, Seetaram P, Gayasuddin M, Venkataiah G. Demonstration of β-cell regeneration and anti-diabetic activity of Caesalpinia Pulcherrima flower extract in alloxan induced diabetic rats . Der Pharmacia Lettre, 2012; 4 :1692-1697.
29. Kumar S, Kumar V, Om Prakash. Antidiabetic and hypolipidemic activities of hibiscus tiliaceus (l.) Flowers extract in streptozotocin induced diabetic rats. Pharmacology online 2010; 2: 1037-1044.
30. Kavatagimath SA, Jalalpure SS, Hiremath RD. Screening of Ethanolic Extract of *Borassus flabellifer* flowers for its antidiabetic and antioxidant Potential. Journal of Natural Remedies 2016; 16:22-32.
31. Mishra SB, Vijayakumar M. Anti-Hyperglycemic and Antioxidant Effect of Saraca asoca (Roxb. DeWild) Flowers in Streptozotocin-Nicotinamide Induced Diabetic Rats: A Therapeutic Study. J Bioanal Biomed 2014; 12;1-5.
32. Sakuljaitrong S, Chomko S, Talubmook C, Buddhakala N. Effect of Flower Extract from Lotus (Nelumbo nucifera) on Haematological Values and Blood Cell Characteristics in Streptozotocin-induced Diabetic Rats. ARPN Journal of Science and Technology 2012; 2:1049-1054.

33. Sakuljaitrong S, Buddhakala N, Chomko S, Talubmook C. Effects of Flower Extract from Lotus (*Nelumbo nucifera*) on Hypoglycemic and Hypolipidemic in Streptozotocin-induced Diabetic Rats. International Journal of Scientific & Engineering Research 2013; 4:1441-1446.
34. Paudel KR, Panth N. Phytochemical Profile and Biological Activity of Nelumbo nucifera . Evidence-based Complementary and Alternative Medicine. 2015;2015:1-16.
35. Kumar S, Kumar V, Prakash OM. Antidiabetic and hypolipidemic activities of Kigelia pinnata flowers extract in streptozotocin induced diabetic rats. Asian Pac J Trop Biomed 2012; 2: 543-546.
36. Rahman MM, Islam MS, Ali MS, Islam MR, Hossain MZ. Antidiabetic and Cytotoxic Activities of Methanolic Extract of Tabernaemontana divaricata (L.) Flowers. Int. J. Drug Dev. & Res., 2011, 3: 270-276.
37. Dechandt CRP, Siqueira JT, De Souza DLP, Araujo LCJ, Da Silva VC, De Sousa PT. *Combretum lanceolatum* flowers extract shows antidiabetic activity through activation of AMPK by quercetin. Brazilian Journal of Pharmacognosy 2013; 23: 291-300.
38. Siqueira JT, Batistela E Pereira, MP, Silva VC, Sousa PT, Andrade CMB. *Combretum lanceolatum* flowers ethanol extract inhibits hepatic gluconeogenesis: an in vivo mechanism study.Pharmaceutical Biology 2016;54: 1671-1679.
39. Rathod NR, Chitme HR, Irchhaiya R, Chandra R. Hypoglycemic Effect of *Calotropis gigantea* Linn. Leaves and Flowers in Streptozotocin-Induced Diabetic Rats. Oman Medical Journal 2011; 26: 104-108.
40. Verma N, Amresh G, Sahu PK, Rao CV, Singh AP. Antihyperglycemic and antihyperlipidemic activity of ethyl acetate fraction of *Rhododendron arboreum* Smith flowers in streptozotocin induced diabetic rats and its role in regulating carbohydrate metabolism. Asian Pac J Trop Biomed 2012; 2: 696-701.
41. Paramaguru R, Mazumder PM, Sasmal D, Jayaprakash V. Antidiabetic Activity of *Pterospermum acerifolium* Flowers and Glucose Uptake Potential of Bioactive Fraction in L6 Muscle Cell Lines with Its HPLC Fingerprint. Biomed Res Int 2014;1-10.
42. Jdir H, Kolsi RBA, Zouari S, Hamden K, Zouari N, Fakhfakh N. The cruciferous Diplotaxis simplex: Phytochemistry analysis and its protective effect on liver and kidney toxicities, and lipid profile disorders in alloxan-induced diabetic rats. Lipids Health Dis. 2017; 16:100-104.
43. Cai W, Yu L, Zhang Y, Feng L, Kong S, Tan H. Extracts of *Coreopsis tinctoria* Nutt. Flower Exhibit Antidiabetic Effects via the Inhibition of α-Glucosidase Activity. Journal of Diabetes Research 2016; 9-13.
44. Samarghandian S, Azimi-Nezhadand M, Samini F. Ameliorative Effect of Saffron Aqueous Extract on Hyperglycemia, Hyperlipidemia, and Oxidative Stress on Diabetic Encephalopathy in Streptozotocin Induced Experimental Diabetes Mellitus. BioMed Research International 2014; 12:1-6.
45. Purohit A, Dixit VP. Hypoglycemic Effect of Neem Bark and Flower on Streptozotocin – Induced Diabetes in Mice. Ancient Science of Life 1991; 1: 28 – 30.