A REVIEW ON MEDICINAL PLANTS OF RAJASTHAN HAVING ANTIDIABETIC ACTIVITY

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INTRODUCTION

Diabetes mellitus (DM) is the most common metabolic disorder characterized by irregulation of carbohydrate, protein, and fat metabolism. It leads to high blood glucose concentration or hyperglycemia and secondary to an absolute or relative lack of the hormone insulin [1]. Insulin unavailability may be due to degenerative changes in β-cells in the pancreatic islets, reduced effectiveness of the hormones due to the formation of anti-insulin antibodies or inactive complexes, immune-mediated islet cytotoxicity, or inappropriate secretion of hormones by neoplasm in other endocrine organs [2]. Deficiency or insensitivity causes glucose to accumulate in the blood, leading to various complications. Polypidiasia, polyphagia, and excessive weight loss occurred due to this. Classification of DM is based on its etiology and clinical presentation. There are four types of DM such as type 1 diabetes, type 2 diabetes, gestational diabetes, and other specific types [3]. Type 1 diabetes, often referred to as juvenile diabetes, is insulin dependent and known to affect only 5% of the diabetic population. Type 1 diabetes is said to account for only a minor portion of the total burden of diabetes in a population although it is the major type of diabetes in younger age groups at majority of well-to-do countries. The incidence of type 1 diabetes is increasing in both rich and poor countries. Type 2 DM accounts for over 85% of DM worldwide and is associated with a high incidence of morbidity and mortality. It is estimated that 143 million people worldwide suffering from this disease. It has been predicted that the number may probably double by 2030. With an estimated 50.8 million people living with diabetes, India has the world’s largest diabetes population, followed by China with 43.2 million. In 2011, it was reported that one person died from diabetes-related causes every 7 s. Annual global health-care spending on diabetes was up to US $465 billion in 2011 (International Diabetes Federation, 2011a). In the management of type 2 DM, lifestyle modification (exercise, weight control, and nutrition) is crucial [4].

At present, available therapy for diabetes includes insulin and a range of oral hypoglycemic agents such as sulphonylureas, metformin, glucokinase inhibitors, and troglitazone. However, these are reported to produce serious adverse side effects such as liver problems, lactic acidosis, and diarrhea [5].

Plants have their chemical compounds which demonstrate alternative and safe effects on DM. The majority of plants contain various phytoconstituents, namely glycosides, alkaloids, terpenoids, flavonoids, carotenoids, etc., that is, frequently implicated as having antidiabetic effect [6]. To date, hundreds of herbs and traditional medicine formulas have been reported to have been used for the treatment of DM. In the past decade, research has been focused on scientific evaluation and justification of traditional drugs of plant origin and screening of more effective and safe antidiabetic potentials has continued to be an important area.

ANTIDIABETIC ACTIVITY OF MEDICINAL PLANTS OF RAJASTHAN

Rajasthan, the largest state of India exhibits variety in physiognomy, climate, and soil, therefore, the vegetation including a wide variety of medicinal plants. The tribal people of remote areas of Rajasthan are totally dependent on indigenous system of medicine for their health as it is difficult for them to get modern medical facilities for their day-to-day health problems. The traditional healers of Rajasthan are having a commendable knowledge of the medicinal intrinsic worth of plants that grow around them [7]. Various ethno-botanical studies carried out in Rajasthan indicate that some plants are being used for their antidiabetic potential by most of the tribals.

Acacia nilotica (Family - Mimosaceae, Local name - Babul, Kikar)
It is a moderate-sized tree with a spreading crown. It is indigenous to the Indian subcontinent as also in Tropical Africa, Burma, Sri Lanka, Saudi Arabia, and Egypt, and in West and East Sudan. In India, natural babul forests are generally found in Rajasthan. It contains catechin, gallloylated flavan-3, 4-diol, robandidiol, androstene steroid, Δ-9-pinitol carbohydrate, catechin-5-galloyl ester, and gallic, m-digallic, and chlorogenic acids; the plants in the Middle East are also rich in potassium, phosphorus, magnesium, iron, and manganese [8]. A study shows that the leaves extract of this plant has significant hypoglycemic, antioxidant, and hypolipidemic effect. This potential activity of A. nilotica leaf might be due to the presence of its phytochemicals or the collective action of many active ingredients (Fig. 1).

Argemone mexicana L. (Family - Papaveraceae, Local name - Pili kateli/Satayanas)
It is commonly known as prickly poppy and is an indigenous herb used as a medicinal plant in several parts of Rajasthan. The plant consists of alkaloids, namely berberine, protope, sargurnarine, optinsine, chelerythrine, etc. Medicinal plants being the effective source of both traditional and modern...
medicines are genuinely useful for primary health care. Hypoglycemic and antidiabetic activity of ethanolic and aqueous extracts of whole plants have been reported in normoglycemic and alloxan-induced hyperglycemic rats by single-dose and multi-dose treatment [9] (Fig. 2).

**Capparis decidua** (Family - Capparidaceae, Local name - Kair)

*C. decidua* is the native plant of Thar desert. The plant is xerophytic and drought resistant; belongs to family Capparidaceae. The genus *Capparis* comprises 250 species including trees, shrubs, and woody climbers, but in India, only 26 species of the genus are reported [10,11] commonly known as teent in Rajasthan. The plant is rich in nutrient, used for nutraceutical purposes by local people. Young berries are used to make pickle and vegetable [12]. The plant is an important component of desert ecosystem. Various phytoconstituents have been isolated from *C. decidua*. Various phytoconstituents have been isolated from *C. decidua* such as β-sitosterol, spermidine alkaloid, isocodonocarpine, Capparine, Capparine, Capparine are isolated from root [10,13]. Ethanol extract of aerial part of the plant showed anti-inflammatory and analgesic activity. Fruits have antidiabetic, hypolipidemic, anti-atherosclerotic, and antiinflammatory activities. Alcoholic extract obtained from bark, flower, and fruit showed hypolipidemic activity in model rat (Fig. 3).

**Catharanthus roseus** (Family - Apocynaceae, Local name - Rose periwinkle)

*Catharanthus* is commonly used in most of the herbal preparations for diabetes. It has been reported to consist of anticancer activity [14], antidiabetic activity (flowers and leaves) [15], hypolipidemic activity [16], and antioxidant activity [17]. The main phytoconstituents present in this plant are alkaloids [14], flavonoids [18], and steroids [19]. It has been used effectively in various traditional systems of medicines for the treatment of diabetes. Catharanthine is the major active phytoconstituents in *C. roseus* that shows antidiabetic activity (Fig. 4).

**Datura inoxia** Mill. (Family - Solanaceae, Local name - Dhatura)

It is a low growing, spreading perennial with hairy 2–5 in. leaves, white flowers, and a spiny fruit plant. This plant conquers a very special place in Ayurveda since all plant parts, namely flowers, leaves, root, stem, fruit, and seeds, have been meritoriously employed for a range of treatments such as insanity, rabies, and leprosy. *D. inoxia* includes atropine, scopoline, hycyanine, with an olides (lactones) and other tropanes. Leaf extracts show flavonoids, phenolic compounds, cardiac glycosides, and sugars, and the formation of the Fe3+ nanoparticles was first monitored using UV-Vis absorption spectroscopy typical surface plasma absorption maxima at 270–290 nm. Seed extracts of *D. inoxia* have the strongest antioxidant potential [20] (Fig. 5).

**Morus alba** (Family - Moraceae, Local name - White mulberry)

It is usually a short-lived plant native to north China. Moracin M, steppogenin-4′-O-β-D-glucoside, and mulberroside A were isolated from the root bark of *M. alba* L. These all produced hypoglycemic effects [21]. Hypolipidemic and antioxidant effects from freeze-dried powder of mulberry (*M. alba* L.) fruit are also investigated [22]. Mulberroside A, a glycosylated stilbenoid, can be useful in the treatment of hyperuricemia and gout [23,24]. An ethanolic extract of mulberry leaf has antihyperglycemic, antioxidant, and antiglycation effects in chronic diabetic rats [25] (Fig. 6).

**Pterocarpus marsupium** (Family - Fabaceae, Local name - Indian Kino Tree)

*Pterocarpus* is a genus of pantropical trees. The diseases commonly treated by *Pterocarpus* in the Ayurveda system are diabetes, inflammation, and bleeding. The bark of plant is also useful for bleeding and toothaches. The leaves are often applied externally as a remedy for skin diseases ethyl acetate extract of root contains benzofuranone, marusupium stilbene, pterostilbene, etc., marusupium and pterostilbene significantly lower the blood glucose levels useful in diabetic rats while pterostilbene acts as hypolipidemic, hypoglycemic, significant reduction in glycosylated Hb, and increase in total Hb level. The wooden glass made up of heartwood of *P. marsupium* is being used for drinking water to control blood sugar and strong antidiabetic in Ayurvedic system of medicine. Heartwood of *P. marsupium* has been examined clinically and found efficient in insulin-independent DM patients (type 2 DM) [26] (Fig. 7).

**Tinospora cordifolia** (Family - Menispermaceae, Local name - giloy)

*T. cordifolia* is a shrub that is native to India. Its root, stems, and leaves are used in Ayurvedic medicine. It is used for diabetes, high cholesterol, allergic rhinitis (hay fever), upset stomach, gout, lymphoma and other cancers, rheumatoid arthritis, hepatitis, peptic ulcer disease, fever, gonorrhea, syphilis, and to boost the immune system. *T. cordifolia* is the major sources of...
of tinosporine, cordifolide, tinosporide, cordifole, and columbin that regulate cholesterol synthesis and glycolysis [27-29] (Fig. 8).

**Tridax procumbens** Linn. (Family - Asteraceae, Local name - Rukhari)

It is a species of flowering plant in the daisy family. It is best known as a widespread weed and pest plant. It has been extensively used in Indian traditional medicine as anticoagulant, antifungal and insect repellent, in bronchial catarrh, diarrhea, and dysentery. Moreover, it comprises wound remedial activity and promotes hair growth. It is also diverse as Bhringraj, which is well-known Ayurvedic medicine for liver disorders [30]. Antioxidant properties [31] of this plant have also been demonstrated (Fig. 9).

**Xanthium strumarium** Linn. (Family - Asteraceae, Local name - Aadha-Shishi)

This plant is a summer annual that becomes about 2-4' tall. The aerial parts of the plant contain a mixture of unidentified alkaloids, sesquiterpene lactones, namely xanthinin, xanthatin, and xanthosine, guaianolides, germacranolides, and elemanolides, sulfated, glycoside,
## Table 1: Plants with antidiabetic activity

| S. No. | Plant name             | Family          | Part used     | Extract     | Activity                        | References |
|--------|------------------------|-----------------|---------------|-------------|---------------------------------|------------|
| 1      | Abroma augusta         | Malvaceae       | Leaves        | Methanol    | Antidiabetic                    | [35]       |
| 2      | Acacia catechu         | Leguminosae     | Hardwood      | Ethanol     | Antidiabetic and antihyperlipidemic | [36]       |
| 3      | Acacia melanoxylon     | Leguminosae     | Seeds         | Hydro-alcoholic | Antidiabetic                    | [37]       |
| 4      | Adiantum caudatum      | Polyopidadeae   | Whole plant   | Ethanol     | Hypoglycemic and antihyperlipidemic | [38]       |
| 5      | Albizia odoratissima   | Leguminosae     | Bark          | Methanol    | Hypoglycemic                    | [39]       |
| 6      | Alternanthera ficoidea | Amaranthaceae    | Stem and leaves | Ethanol    | Antidiabetic                    | [40]       |
| 7      | Andrographispaniculata | Acanthaceae     | Leaves        | Ethanol     | Antidiabetic                    | [41]       |
| 8      | Artocarpus heterophyllus | Moraceae       | Fruit         | Aqueous     | Antidiabetic, antioxidant activity | [42]       |
| 9      | Asparagus racemosus    | Asclepiadaceae  | Roots         | Ethanol     | Antidiabetic                    | [43]       |
| 10     | Azadirachta indica     | Meliaceae       | Leaves        | Ethanol     | Antidiabetic activity           | [44]       |
| 11     | Bambusa arundinacea    | Gramineae       | Leaves        | Ethanol     | Hypoglycemic                    | [45]       |
| 12     | Boerhavia diffusa      | Nyctaginaceae   | Leaves        | Aqueous     | Antihyperlipidemic              | [46]       |
| 13     | Brassica juncea        | Cruciferae      | Leaves        | Methanol    | Antihyperglycemic               | [47]       |
| 14     | Brassica oleracea      | Cruciferae      | Leaves        | Methanol    | Hypoglycemic and hypolipidemic  | [48]       |
| 15     | Calotropis procera     | Asclepiadaceae  | Leaves        | Hydroalcoholic | Antihyperglycemic               | [49]       |
| 16     | Capsicum annum         | Solanaceae      | Red chili pepper | Ethanol    | Hypoglycemic and hypocholesterol        | [50]       |
| 17     | Cassia fistula         | Leguminosae     | Bark          | Ethanol     | Antidiabetic                    | [51]       |
| 18     | Cinnamomum burmannii   | Lauraceae       | Bark          | Aqueous     | Hypoglycemic, antidiabetic      | [52]       |
| 19     | Cissampelos pareira    | Menispermacinae | Leaves        | Aqueous     | Hypoglycemic                    | [53]       |
| 20     | Citrus lemon           | Rutaceae        | Peel          | n-hexane    | Hypoglycemic                    | [54]       |
| 21     | Curcuma longa          | Zingiberaceae   | Rhizome       | Aqueous     | Hypoglycemic, hypolipidemic     | [55]       |
| 22     | Dalbergia sisso Roxb.  | Fabaceae        | Bark          | Ethanol     | Antidiabetic                    | [56]       |
| 23     | Ephedra sinica         | Gnetaceae       | Whole plant   | Hydroalcoholic | Antidiabetes, antioxidant activity | [57]       |
| 24     | Eucalyptus camaldulensis | Myrtaceae       | Leaves        | Aqueous     | Antioxidant, antidiabetic       | [58]       |
| 25     | Euphorbia hirta        | Euphorbiaceae   | Whole plant   | Petroleum ether and methanol | Antidiabetic | [59]       |
| 26     | Ficus racemosa         | Moraceae        | Stem bark     | Hexane      | Antidiabetic                    | [60]       |
| 27     | Foeniculum vulgare     | Umbelliferae    | Aerial part   | N-hexane, methanol | Antihyperglycemic               | [61]       |
| 28     | Gymnema sylvestre      | Asclepiadaceae  | Leaves        | Aqueous     | Antidiabetes                    | [62]       |
| 29     | Ipomoea batatas        | Convolvulaceae  | Leaves        | Aqueous     | Antidiabetic                    | [63]       |
| 30     | Jatropha curcas        | Euphorbiaceae   | Leaf          | Methanol    | Antihyperglycemic and hypolipidemic | [64]       |
| 31     | Moringa oleifera       | Moringaceae     | Pods          | Methanol    | Antidiabetic                    | [65]       |
| 32     | Murroya koennigii       | Rutaceae        | Leaves        | Aqueous     | Antidiabetic                    | [66]       |
| 33     | Nelumbo nucifera       | Nymphaeaceae    | Flower        | Ethanol     | Hypoglycemic                    | [67]       |
| 34     | Nerium oleander        | Apocynaceae     | Fresh shoot   | Aqueous     | Increased glucose uptake and insulin-binding activity | [68]       |
| 35     | Nyctanthes arbor-tristis | Oleaceae       | Roots         | Methanol    | Antidiabetic                    | [69]       |
| 36     | Ocimum sanctum         | Labiatae        | Leaves        | Hydroalcoholic | Antidiabetic                    | [70]       |
| 37     | Opuntia dillenii       | Cactaceae       | Cladodes      | Aqueous     | Antidiabetic                    | [71]       |
| 38     | Oryza sativa           | Gramineae       | rice bran     | Aqueous     | Antidiabetic                    | [72]       |
| 39     | Panax maximum          | Oligaceae       | Leaf          | Ethanol     | Antidiabetic                    | [73]       |
| 40     | Physalis peruviana     | Solanaceae      | fresh leaves  | Aqueous     | Antidiabetic                    | [74]       |
| 41     | Piper longum           | Piperaceae      | Fruits        | Ethanol     | Antihyperglycemic and antioxidant potential | [75]       |
| 42     | Pismum sativum         | Leguminosae     | Pods          | Aqueous     | Hypolipidemic and pancreatic lipase inhibitory activity | [76]       |
| 43     | Psidium guajava        | Myrtaceae       | Leaves        | Ethanol     | Hypoglycemic and antihyperglycemic | [77]       |
| 44     | Rauwolfia serpentina   | Apocynaceae     | Roots         | Hydro methanol | Antihyperglycemic              | [78]       |
| 45     | Syzygium polyanthus    | Myrtaceae       | Leaf          | Methanol    | Antihyperglycemic               | [79]       |
| 46     | Tamarindus indica      | Leguminosae     | Seeds         | Hydro methanol | Antidiabetic, hypolipidemic    | [80]       |
| 47     | Tectona grandis        | Verbenaceae     | Bark          | Methanol    | Antioxidant, antidiabetic       | [81]       |
| 48     | Terminalia arjuna      | Combretaceae    | Bark          | Aqueous     | Antidiabetic                    | [82]       |
| 49     | Tinospora bakis        | Menispermacinae | Seeds         | Aqueous     | Antihyperglycemic and hypolipidemic | [83]       |
| 50     | Zizyphus mauritiana    | Rhamnaceae      | Fruits        | Ethanol     | Antidiabetic                    | [84]       |
Antioxidant potentials and ajmalicine. Isolation of indole alkaloids from Edgew. J Appl results in L. In alloxan induced hyperglycaemic rats. after treatment with giberellic by rd

3. Sicree R, Shaw J, Zimmet P. The global burden. diabetes and impaired

2. Sachan NK, Kumar Y, Pushkar S, Thakur RN, Gangwar SS, Khan A, Anderson RA. Insulin potentiating factor (IPF) present in foods, species and natural products. Pak J Nutr 2003;2:254-7.

6. Malviya N, Jain S, Malviya S. Antidiabetic potential of medicinal plants. Acta Pol Pharm 2010;67:113-8.

4. Matheka DM, Alkizim FO. Complementary and alternative medicine

5. Khan A, Anderson RA. Insulin potentiating factor (IPF) present in foods, species and natural products. Pak J Nutr 2003;2:254-7.

3. Sicree R, Shaw J, Zimmet P. The global burden. diabetes and impaired

There are no conflicts of interest in the submitted review article.

AUTHORS’ CONTRIBUTION
Charruta Mathur: The main author is doing her thesis on "antidiabetic activity of methanolic crude extract of Capparis decidua in male albino rats." Dr. BS Gupta: Corresponding author is the supervisor of main author. He has been working as Associate Professor in the Department of Zoology, University of Rajasthan. He has been involved in various projects of antifertility and antidiabetic activity of various plant extracts.

CONFLICTS OF INTEREST
There are no conflicts of interest in the submitted review article.

REFERENCES
1. Okon JE, Ofeni AA. Antidiabetic effect of Dioscorea bulbifera on alloxan-induced diabetic rats. CIB Tech J Pharm Sci 2013;1:14-9.
2. Sachan NK, Kumar Y, Pushkar S, Thakur RN, Gangwar SS, Kalaiselvan VK, et al. Antidiabetic potential of alcohol and aqueous extracts of Ficus racemosa Linn. Bark in normal and alloxan-induced diabetic rats. Int J Pharm Sci Drug Res 2009;1:24-7.
3. Sicree R, Shaw J, Zimmert P. The global burden. diabetes and impaired glucose tolerance. prevalence and projections. In: Gan D, editor. Diabetes Atlas. 3rd ed. Brussels: International Diabetes Federation; 2006. p. 16-103.
4. Matheka DM, Alkizim FO. Complementary and alternative medicine for Type 2 diabetes mellitus: Role of medicinal herbs. J Diabet Endocrinol 2012;3:44-56.
5. Khan A, Anderson RA. Insulin potentiating factor (IPF) present in foods, species and natural products. Pak J Nutr 2003;2:254-7.
6. Malviya N, Jain S, Malviya S. Antidiabetic potential of medicinal plants. Acta Pol Pharm 2010;67:113-8.
7. Jain A, Katewa SS, Galav P, Nag A. Some therapeutic uses of biodiversity among the tribals of Rajasthan. Indian J Tradit Knowl 2008;7:256-62.
8. Pareek P, Choudhry M. Management of Type 2 diabetes by Indian gum Arabic (Acacia nilotica) pods powder. Int J Food Nutr Sci 2013;2:77-83.
9. Nayak P, Kar DM, Maharana L. Antidiabetic activity of aerial parts of Argemonex mexicana L. In alloxan induced hyperglycaemic rats. Pharmacol Online 2011;1:889-903.
10. Rathee S, Rathee P, Rathee D, Rathee D, Kumar V. Phytochemical and pharmacological potential of kair (Capparis decidua). Int J Phytother 2010;2:7-10.
11. Singh D, Singh RK. Kair (Capparis decidua): A potential ethnobotanical weather predictor and livelihood security shrub of the arid zone of Rajasthan and Gujarat. Indian J Tradit Knowl 2011;10:146-55.
12. Upadhyay RK. Kerela plant: A natural source of medicines and nutrients. Int J Green Pharm (IJGP) 2011;5:255-65.
13. Derna PD, Dangar RD, Shah KN, Gandhi DM, Suhagia BN. Pharmacognostical potential of Capparis decidua Ledge. J Appl Pharm Sci 2011;1:6-11.
14. Jean HR, Jean MN, Gaelle LC, Philippe T, Monique LH, Louise LM, et al. Isolation of indole alkaloids from Catharanthus roseus by centrifugal partition chromatography in the pH-zone refining mode. J Chromatogr A 1999;849:421-31.
15. Sumana G, Suryawanshi SA. Effect of Vinca rosea extracts in treatment of alloxan diabetes in male albino rat. Indian J Exp Biol 2001;39:748-59.
16. Antia BS, Okon JE. Effect of leaf juice of Catharanthus roseus Linn. On cholesterol, triglyceride and lipoproteins levels in normal rats. Indian J Pharm 2005;37:401-2.
17. Jaleel CA, Gopi R, Manivannan P, Sankar B, Kishorekumar A, Panneerselvam R, et al. Antioxidant potentials and ajmalicine accumulation in Catharanthus roseus after treatment with giberellic acid. Colloids Surf B Biointerfaces 2007;60:195-200.
18. Gilles B, Marie GD, Bruno D, Anne MM. A new flavonol glycoside from Catharanthus roseus. Phytochemistry 1999;50:167-9.
19. Akirai S. Brasiniosteroid biosynthesis. Plant Physiol Biochem 1999;37:551-61.
20. Ramadan MF, Zayed R, El-Shamy H. Screening of bioactive lipids and radical scavenging potential of some Solanaceae plants. Food Chem 2007;103:885-90.
21. Zhang M, Chen M, Zhang HQ, Sun S, Xie B, Wu FH, et al. In vivo hypoglycemic effects of phenolics from the root bark of Morus alba. Fitoterapia 2009;80:375-8.
22. Yang X, Yang L, Zheng H. Hypolipidemic and antioxidant effects of mulberry (Morus alba L.) fruit in hyperlipidaemia rats. Food Chem Toxicol 2010;48:2374-9.
23. Wang CP, Wang Y, Wang X, Zhang X, Ye JF, Hu LS, et al. Mulberryoside a possesses potent uricosuric and nephroprotective effects in hyperuricemic mice. Planta Med 2011;77:786-94.
24. Kim JK, Kim M, Cho SG, Kim MK, Kim SW, Lim YH, et al. Biotransformation of mulberryoside a from Morus alba results in enhancement of tyrosinase inhibition. J Ind Microbiol Biotechnol 2010;37:631-7.
25. Naowaboot J, Pannangpetch P, Kukongviriyapan V, Kongyingyoes B, Kukongviriyapan U. Antihyperglycemic, antioxidant and antiglycation activities of mulberry leaf extract in streptozotocin-induced chronic diabetic rats. Plant Foods Hum Nutr 2009;64:116-21.
26. Flexible Dose Open trial of Vijayasar in Cases of Newly-Diagnosed Non-insulin-Dependent Diabetes Mellitus. Indian council of medical research (ICMR), collaborating centres, New Delhi. Indian J Med Res 1999;109:24-9.
27. Hui H, Tang G, Go VL. Hypoglycemic herbs and their action mechanisms. Chin Med 2009;4:11.
28. Kar A, Choudhary BK, Bandyopadhyay NG. Comparative evaluation of hypoglycemic activity of some Indian medicinal plants in alloxan induced diabetic rats. J Ethnopharmacol 2003;84:105-8.
29. van de Venter M, Roux S, Bungu LC, Louw J, Crouch NR, Grace OM, et al. Antidiabetic screening and scoring of 11 plants traditionally used in South Africa. J Ethnopharmacol 2008;119:81-6.
30. Pathak AK, Saraf S, Dixit VK. Hepatoprotective activity of Tridax procumbens-Part I. Fitoterapia 1991;62:307-13.
31. Ravikumar V, Shivasanghapi KS, Devaki T. Effect of Tridax procumbens
on liver antioxidant defense system during lipopolysaccharide-induced hepatitis in D-galactosamine sensitised rats. Mol Cell Biochem 2005;269:131-6.

32. Jopura RN, Nayyar SL, Chopra IC. Glossary of Indian Medicinal Plants. New Delhi: Council of Scientific and Industrial Research; 1945. p. 259.

33. Moerman D. Native American Ethnobotany. Oregon. Portland: Timber Press; 1998. p. 453-9.

34. AgarwalA. Critical issues in quality control of herbal products. Pharm Times 2008;39:7-11.

35. Khanra R, Dewanjee S, K Das T, Sahu R, Gangopadhyay M, De Feo V, et al. Abroma augusta L. (Malvaceae) leaf extract attenuates diabetes induced nephropathy and cardiomyopathy via inhibition of oxidative stress and inflammatory response. J Transl Med 2015;13:6.

36. Srivastava SP, Mishra A, Bhattacharya V, Tatigoppula N, Srivastava AK. Acacia catechu hard wood: Potential anti-diabetic cum anti-dyslipidemic. Med Chem Res 2011;20:1732-9.

37. Kumar S, Chodhary M, Yadav P, Nitesh N, Budhawar V. Anti-diabetic activity of hydroalcoholic extract of Acacia melanoxylon Linn. Seeds. in streptozotocin induced diabetic rats. J Diabetes Res Ther 2016;2:3.

38. Saha D, Ghosh SK, Das T, Mishra SB. Hypoglycemic and antihyperlipidemic effects of Adiantum caudatum in alloxan induced diabetes in rats. Asian J Pharm Clin Res 2016;9:361-3.

39. Kumar D, Kumar S, Kohli S, Arya R, Gupta J. Anti-diabetic activity of methanolic extract of Ab piscosa Aiton in alloxan induced diabetic albino mice. Asian J Prod Trop Med 2014;4:900-3.

40. Rajan TS, Aanandhi VM. Anti-diabetic activity of ethanolic extract of Alternanthera ficoides Linn in streptozotocin induced diabetic rats. Int J Pharm Bio Sci 2012;3:648-53.

41. Akter R, Mahabub-U-Zaman M, Rahman MS, Khatun MA, Abdullah M, Ahmed NU, et al. Comparative studies on anti-diabetic effect with phytochemical screening of Azadirachta indica and Andrographis paniculata. IOSR J Pharm Biol Sci 2013;3:122-8.

42. Bivora A, Tamang E, Iskandar R, Khrina S, Suhartono E, Antidiabetic and antioxidant activity of jackfruit (Artocarpus heterophyllus) extract. J Med Bioeng 2015;4:318-23.

43. Hannan JM, Mareenah A, Li L, Rokeya B, Abdel-Wahab YH, et al. Evaluation of hypoglycemic and antihyperlipidemic effects of Oryza sativa L. in normoglycemic and streptozotocin-induced diabetic mice. Int J Pharmacol 2015;9:227-33.

44. Rahmatullah M, Shefa TF, Hasan L, Hossain MT, Ahmed S, et al. Antidiabetic activity of Ocimum sanctum L. against alloxan induced diabetes in wistar albino rats. J Nat Prod Plant Resour 2015;3:488-92.

45. Neto MC, de Vasconcelos CF, Thijan VN, Caldas GF, Araújo AV, Costa-Rev Bras Farmacogn 2013;23:913-9.

46. Magiidd MM, Salama NA, Ali MR. Hypoglycemic and antihypercholesterolemic effects of intragastric administration of dried chili pepper (Capsicum annum) in alloxan-induced diabetic male albino rats fed with high-fat-diet. J Food Nutr Res 2014;2:830-6.

47. Malpani SN, Manjunath KP, Sholapur H, Savadi RV, Akki KS, Darade SS, et al. Antidiabetic activity of Cassia fistula Linn. Bark in alloxan induced diabetic rats. Int J Pharm Sci 2010;2:382-5.

48. Cheng DM, Kuhn P, Poulev A, Rojo LE, Lila MA, Raskin I, et al. In vivo and in vitro antidiabetic effects of aqueous cinnamon extract and cinnamon oil on obesity, inflammation and insulin resistance in high-fat-diet fed mice. Exp Ther Med 2012;3:707-12.

49. Basak SS, Chandan F. Chemical composition and in vitro antioxidant and antidiabetic activities of Eucalyptus Camaldulensis Dehnh. Essential oil. J Iran Chem Soc 2015;12:716-21.

50. Devi S, Kumar M. In vivo antidiabetic activity of methanolic extract of Eugenia hirta L. Int J Diabetes Endocrinol 2017;2:36-9.

51. Nasution R, Marianne M, Kausar A. Antidiabetic activity of ARA (Ficus racemosa) from ACEH. Int J Chem Tech Res 2010;10:9-10.

52. Mhaidat NM, Abu-zaiton AS, Alrouhi KH, Alrouhi W, Alazab RS. Antihyperglycemic properties of Foeniculum vulgare Extract in streptozotocin-induced diabetes in rats. In J Pharmcol 2015;11:72-5.

53. El Shafey AA, El-Ezabi MM, Seliem MM, Ouda HH, Ibrahim DS. Effect of aqueous cinnamon extract on normoglycemic and streptozotocin-induced diabetes in rats. J Med Phycol Sci 2015;2:36-9.

54. Ogurinrola OO, Fajana OO, Oluaitan SN, Adey OA, Akinola MO. Anti-diabetic activity of Ipomoea batatas Leaves extract: Effects on hepatic enzymes in alloxan-induced diabetic rats. Res J Med Plant Sci 2015;9:227-33.

55. Mathur and Gupta Asian J Pharm Clin Res, Vol 11, Issue 12, 2018, 33-39
effect of methanol extract of *Syzygium polyanthum* (Wight.) leaf in streptozotocin-induced diabetic rats. Nutrients 2015;7:7764-80.
79. Al-Ahdab MA. Anti-hyperglycemic effect of *Tamarindus indica* extract in streptozotocin-induced diabetes in male rats. World Appl Sci J 2015;33:1940-8.
80. Krishnasamy R. Antioxidant and antidiabetic activity of *Tectona grandis* Linn. In alloxan induced albino rats. Asian J Pharm Clin Res 2013;6 Suppl 3:1974-7.
81. Thomson HA, Ojo OO, Flatt PR, Abdel-Wahab YH. Aqueous bark extracts of *Terminalia arjuna* stimulates insulin release, enhances insulin action and inhibits starch digestion and protein glycation *in vitro*. Austin J Endocrinol Diabetes 2014;1:1001.
82. Alamin MA, Yagi AI, Yagi SM. Evaluation of antidiabetic activity of plants used in Western Sudan. Asian Pac J Trop Biomed 2015;5:395-402.
83. Stoilova I, Trifonova D, Marchev A, Stanchev V, Angelova G, Krastanov A. Phytochemical constituents and *in vitro* anti-diabetic properties of *Ziziphus jujuba* (*Rhamnaceae*) Fruits. Int J Pharm Phytochem Res 2017;9:150-8.