



INDIGENOUS REMEDIES FOR DIABETES MELLITUS

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ABSTRACT

Diabetes mellitus (DM), a global public health problem, is now emerging as an epidemic world over. According to a widely accepted estimation, the number of diabetic patients would reach 366 million by the year 2030. India now has the world's largest diabetic population, encompassing an estimated 35 million people out of an overall population of 1 billion. In just over 20 years (i.e. 2025) the country will have almost 200 million people (approximately 15% of the population) affected by diabetes or its precursor. In India, indigenous remedies have been used in the treatment of DM since the time of Charaka and Sushruta (6th century BC). The ethnobotanical information reports about 800 plants that may possess anti-diabetic potential. Several such herbs have shown anti-diabetic activity when assessed using presently available experimental techniques. The present review, deals with some selective Indian medicinal plants having pharmacologically established hypoglycemic potential.

Keywords: Diabetes mellitus, indigenous remedies

INTRODUCTION

Diabetes mellitus (DM), a global public health problem, is now emerging as an epidemic world over. According to a widely accepted estimation, the number of diabetic patients would reach 366 million by the year 2030. India now has the world's largest diabetic population, encompassing an estimated 35 million people out of an overall population of 1 billion. In just over 20 years (i.e. 2025) the country will have almost 200 million people (approximately 15% of the population) affected by diabetes or its precursor¹. Diabetes mellitus is group of syndrome characterized by hyperglycemia altered metabolism of lipids, carbohydrates and proteins with an increase risk complications from vascular disease². It was reported that there is a higher incidence of retinopathy, neuropathy, nephropathy etc. together with diabetes. A wide spread pathological change is thickening of capillary membrane, increase in vessel wall matrix and cellular proliferation resulting in vascular complication like lumen narrowing, early atherosclerosis, sclerosis of glomerular capillaries, retinopathy, neuropathy and vascular insufficiency.

It may affect the disruption of carbohydrate and fat metabolism³. Diabetes is a metabolic disorder where in human body does not produce or properly uses insulin, a hormone that is required to convert sugar, starches, and other food into energy⁴. Human body has to maintain the blood glucose level at a very narrow range, which is done with insulin and glucagon. The function of glucagon is causing the liver to release glucose from its cells into the blood, for the production of energy. The condition may be multifactorial origin in which heredity, age, sex, pregnancy, obesity, autoimmune, infections and emotional disturbances may be important. It may precipitated by pancreatic disorders, hormonal disorders (e.g. acromegaly and cushing syndrome), or by administration of drugs (corticosteroids or diuretic, especially thiazides)⁵. There are mainly two types of diabetes—Type 1 and Type 2. In Type 1 diabetes, in the absence of pancreatic b-cells the hormone insulin is not produced while Type 2 diabetes mellitus (T2DM), is characterized by a progressive impairment of insulin secretion by pancreatic b-cells

and by a relative decreased sensitivity of target tissues to the action of this hormone⁶. Gestation diabetes mellitus (GDM) is glucose intolerance being recognized during pregnancy. It can complicate pregnancy leading to prenatal morbidity and mortality, so clinical detection important. In India, indigenous remedies have been used in the treatment of DM since the time of Charaka and Sushruta (6th century BC). Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. The ethnobotanical information reports about 800 plants that may possess anti-diabetic potential⁷. Several such herbs have shown anti-diabetic activity when assessed using presently available experimental techniques⁸. Although, oral hypoglycemic agents/insulin is the mainstay of treatment of diabetes and is effective in controlling hyperglycemia, they have prominent side effects and fail to significantly alter the course of diabetic complications⁹. As the knowledge of heterogeneity of this disorder increases, there is needed to look for more efficacious agents with lesser side effects. Though development of modern medicine resulted in the advent of modern pharmacotherapeutics including insulin, biguanides, sulfonylureas and thiazolidinediones, there is still a need to look for new drugs as no drug (except strict glycemic control with insulin) has been shown to modify the course of diabetic complications¹⁰. Apart from currently available therapeutic options, many herbal medicines have been recommended for the treatment of diabetes. Traditional plant medicines are used throughout the world for a range of diabetic presentations. Herbal drugs are prescribed widely because of their effectiveness, less side effects and relatively low cost. Therefore, investigation on such agents from traditional medicinal plants has become more important. India has a rich history of using various potent herbs and herbal components for treating diabetes. Many Indian plants have been investigated for their beneficial use in different types of diabetes and reported in numerous scientific journals. The present review, deals with some selective Indian medicinal plants having pharmacologically established hypoglycemic potential¹¹.

Table 1: Selected Indian Medicinal Plants With Hypoglycemic Potential^{10,11}

Sr. No	Name Of Plant	Part Used	Model Used	Reported Mechanism of Action	Reference
1	<i>Acacia arabica</i> (Lam.) Muhl. ex Willd. Common name: Indian Gum Arabic tree [Family: Leguminosae]	Seed, powdered seed (2, 3 and 4 mg/kg)	Normal rats, alloxan rats, rabbits	Acts through release of insulin from pancreatic beta cells.	12,13
2	<i>Aegle marmelos</i> (L.) Correa ex Roxb. Common name: Holy Fruit Tree [Family: Rutaceae]	root bark (1 ml/100mg), aqueous leaf extract	Normal fasted rats,	Increases utilization of glucose	14-16

3	<i>Allium cepa L.</i> Common name: Onion [Family:Liliaceae]	ether soluble fraction of onion (0.25 mg/kg p.o.),	STZ rats	Lowers blood glucose level	17-19
4	<i>Allium sativum L.</i> Commonname: Garlic [Family: Alliaceae]	ethanol, petroleum ether and ethyl acetate extract (0.25 mg/kg)	Alloxan rabbits	Has strong antioxidant activity and rapid reactivity with thiol containing proteins responsible for the hypoglycemic property.	20-21
5	<i>Aloe vera (L.) Burm.f.</i> Common name: Aloe [Family: Aloaceae]	leaf pulp extracts	STZ rats	Maintains glucose homeostasis by controlling the carbohydrate metabolizing enzymes and stimulates insulin release from pancreatic beta cells.	22-24
6	<i>Artemisia pallens Wall</i> Common Name: Davana [Family:Compositae]	aerial parts (100 mg/kg, orally)	Alloxan rats	Inhibits glucose re-absorption or increase in peripheral glucose utilization	25
7	<i>Annona squamosa L.</i> Common name: Sugar apple [Family:Annonaceae]	ethanolic leaf-extract (350 mg/kg, orally)	STZ rats and alloxan rabbits	Lowers blood glucose level	26-27
8	<i>Andrographis paniculata</i> Nees Common name: King of Bitter [Family:Acanthaceae]	Andrographis paniculata extract	STZ rats	Prevents glucose absorption from gut.	28-30
9	<i>Azadirachta indica A.Juss.</i> Common name: Neem [Family: Meliaceae]	Hydro alcoholic plant extract, crude ethanolic extract of the plant	STZ rats, alloxan albino rats	Inhibits action of epinephrine on glucose metabolism, resulting in increased utilization of peripheral glucose	31-34
10	<i>Amaranthus esculents</i> [Family: Amaranthaceae]	whole plant , oil fraction	STZ rats	☒Glucose; ☒insulin	35
11	<i>Biophytum sensitivum (L.)</i> Common name: Life Plant [Family: Oxalidaceae]	plant leaf extract	Alloxan rabbits	Stimulates pancreatic beta cells to release insulin	36
12	<i>Boerhavia diffusa L.</i> Common name: Tar vine [Family:Nyctaginaceae]	aqueous leaf extract (100, 200 and 400 mg/kg)	Alloxan rats	Increases plasma insulin levels and improves glucose tolerance	37-38
13	<i>Cassia auriculata L.</i> Common name: Tanner's Cassia [Family:Leguminosae]	aqueous flower extract	STZ rats	Suppresses enhanced gluconeogenesis during diabetes and enhance utilization of glucose through increased glycolysis. in addition to pronounced alpha-glucosidase inhibitory actions resulting in a significant and potent lowering of blood glycemic response	39
14	<i>Caesalpinia bonducella (L.)Roxb.</i> Common name: Chinese Cinnamon [Family: Caesalpinaceae]	aqueous and 50% ethanolic seed extracts	STZ rats	Increases the release of insulin from pancreatic cells	40
15	<i>Citrullus colocynthis (L.)Schrud.</i> Common name: Bitter apple [Family: Cucurbitaceae]	aqueous extract (300 mg/kg)	Normal rabbits, STZ rats	Exerts an insulinotropic effect	41-42
16	<i>Coccoloba indica Wight & Arn.</i> Common name: Ivy gourd [Family: Cucurbitaceae]	alcoholic leaf extract	Guinea pig, Alloxan dogs	Suppresses glucose synthesis, through depression of the key gluconeogenic enzymes glucose-6-phosphatase and fructose-1,6-bisphosphatase and enhances glucose oxidation by shunt pathway through activation of its principal enzyme glucose-6-phosphate dehydrogenase. Also has an insulin secretagogue effect and acts like insulin by correcting elevated enzymes in glycolytic pathway and restoring LPL activity in lipolytic pathway with control of hyperglycemia in diabetes	43-48
17	<i>Casearia esculenta Roxb.</i> Common name: Carilla Fruit [Family:Flacourtiaceae]	root extracts (300 mg/kg p.o.)	STZ rats	Exhibits significant reduction in blood glucose level, a decrease in the activities of glucose-6-phosphatase and fructose-1,6-bisphosphatase and an increase in the activity of liver hexokinase, resulting in potent hypoglycemic activity	49
18	<i>Catharanthus roseus (L.) G.</i>	ethanolic leaf	STZ rats	Increases metabolism of glucose and	50-52

	<i>Don</i> Common name: Madagascarperiwinkle [Family: Apocynaceae]	extract (500mg/kg), dichloromethane: methanol extract of leaves and twigs((500 mg/kg p.o., for 7 and 15 days)		enhances secretion of insulin either from the beta cells of Langerhans or through extrapancreatic mechanism	
19	<i>Camellia sinensis Kuntze</i> Common name: Green tea [Family: Theaceae]	hot water extract of green tea	STZ rats	increases insulin activity	53-54
20	<i>Chamaemelum nobile</i> [Family: Asteraceae]	aqueous extract of leaves	STZ rats	☑Glucose	55
21	<i>Coscinium fenestratum</i> [Family: Menispermaceae]	alcoholic extract/steam barks	STZ rats	☑Glucose, ☑glycosylated hemoglobin, ☑glycogen, ☑lipids, ☑oxidative stress	56
22	<i>Enicostemma littorale Blume</i> [Family: Gentianeaceae]	aqueous extract of plant	Alloxan rats	Enhances glucose-induced insulin release from isolated rat pancreatic islets, mediated through K (+)-ATP channel-dependent pathway	57-58
23	<i>Eugenia jambolana Lam.</i> Common name: Indian black berry [Family: Myrtaceae]	pulp extract of the fruits, alcoholic extract (100 mg/kg p.o.)	STZ rats, alloxan rats	May be mediated through an insulin release mechanism or due to alteration in hepatic and skeletal muscle glycogen content and hepatic glucokinase, hexokinase, glucose-6-phosphate and phosphofructokinase levels in diabetic mice. It also enhances serum insulin act and exhibits normoglycemia and better glucose tolerance	59-64
24	<i>Egyptian Morus alba</i> [Family: Moraceae]	alcoholic extract	STZ rat	☑Glucose, ☑lipid peroxidation, ☑insulin	65
25	<i>Ficus bengalensis L.</i> Common name: Banyan tree [Family: Moraceae]	bark extract	STZ rats, alloxan rats	Stimulates insulin secretion from beta cells of islets of Langerhans and inhibits insulin degradative process.	66-70
26	<i>Hibiscus rosa sinensis L.</i> Common name: China Rose [Family: Malvaceae]	ethanol extract of the plant, alcoholic leaf extract (250 mg/kg p.o. for seven days consecutive)	STZ rats	Stimulates insulin secretion from pancreatic beta cells and increases utilization of glucose, either by direct stimulation of glucose uptake or via the mediation of enhanced insulin secretion	71-72
27	<i>Helicteres isora L.</i> Common name: Screw tree [Family: Sterculiaceae]	ethanolic root extract (300 mg/kg, after 9 days of administration	Mice	Acts through insulin-sensitizing activity	73-74
28	<i>Hintonia standleyan</i> [Family: Rubiaceae]	methanolic extract	STZ rat	☑Glucose	75-76
29	<i>Hypoxis hemerocallidea</i> [Family: Hypoxodaceae]	Aqueous extract/fruits	STZ mice , rat	☑Glucose	77
30	<i>Leonotis leonurus</i> [Family: Lamiaceae]	Aqueous extract/leaves	STZ mice , rat	☑Glucose	78
31	<i>Lepidium sativum</i> [Family: Brassiaceae]	Aqueous extract/leaves	STZ rat	☑Glucose	79
32	<i>Lycium barbarum</i> [Family: Solanaceae]	Isolated compounds /fruits	STZ rat	☑Glucose, ☑oxidative stress, ☑GLUT4, ☑insulin	80-81
33	<i>Mangifera indica L.</i> Common name: Mango [Family:Anacardiaceae]	Aqueous leaf extracts (1 g/kg p.o.)	STZ rats	Possibly acts through intestinal reduction of the absorption of glucose as well as pancreatic and extrapancreatic mechanisms	82-83
34	<i>Momordica cymbalaria</i> Fenzl [Family: Cucurbitaceae]	fruit powder, aqueous fruit extract (0.5 g/kg dose for 6 weeks)	Alloxan rats	May act by increasing hepatic glycogen	84-85
35	<i>Mucuna pruriens (L.)</i> Common name: Velvet bean [Family: Leguminosae]	powdered seeds (0.5, 1 and 2 g/kg), plant extract (200 mg/kg), alcohol extract of the plant (100, 200 and 400	Alloxan rabbits, STZ mice	Possibly acts through stimulation of the release of insulin and/or by a direct insulin-like action due to the presence of trace elements like manganese, zinc, etc.	86-88

36	<i>Morus alba L.</i> Common name: White mulberry [Family: Moraceae]	mg/kg/day) aqueous extract of leaves(200mg/kg)	Mice	Acts by increasing glucose uptake	89
37	<i>Murraya koenigii (L.) Spreng.</i> Common name: curry-leaf tree [Family: Rutaceae]	leaf-powder	Normal rats	Increases glycogenesis and decreases glycogenolysis and gluconeogenesis	90-91
38	<i>Malmea depressa</i> [Family: Annonaceae]	aqueous extract, ethanolic extract , n-butenol fraction/roots	STZ rats	☑Glucose	92
39	<i>Mangifera indica</i> [Family: Anacardiaceae]	aqueous extract/stem barks	STZ rats	☑Glucose	93
40	<i>Momordica charnita</i> [Family: Cucurbitaceae]	methanolic extract, isolated compounds /gourd Aqueous extract/leaves	STZ rats, STZ mice Alloxan-rat	☑Glucose	94-95
41	<i>Ocimum sanctum L.</i> Common name: Holy Basil [Family: Lamiaceae]	ethanolic leaf extract, plant extract (200 mg/kg for 30 days)	STZ rat	Acts by cortisol inhibiting potency	96-98
42	<i>Punica granatum L.</i> Common name: Pomegranate [Family: Punicaceae]	ethanolic flower extract, plant extract (200 mg/kg for 30 days)	STZ rat	Inhibits intestinal alpha-glucosidase activity, leading to antihyperglycemic property	99-100
43	<i>Piper betle</i> [Family: Piperaceae]	aqueous extract, ethanolic extract/leaves	STZ rat	☑Glucose, ☑glycosylated hemoglobin	101-102
44	<i>Psidium guajava Linn.</i> [Family: Myrtaceae]	aqueous extract/whole plant	STZ rat	☑Glucose, ☑lipids, ☑insulin	103
45	<i>Raphanus sativus</i> (Brassicaceae)	aqueous extract /whole plant	STZ rat, mice	☑Glucose, ☑lipids, ☑insulin	104
46	<i>Retama raetam</i> [Family: Fabaceae]	aqueous extract/whole plant	STZ rat	☑Glucose	105
47	<i>Strobilanthes crispus</i> [Family: Acanthaceae]	aqueous extract/leaves	STZ rat	☑Glucose	106
48	<i>Syzygium cordatum</i> [Family: Myrtaceae]	aqueous extract/leaves	STZ rat	☑Glucose, ☑hepatic glycogen	107
49	<i>Salacia reticulata Wight.</i> Common name: Salacia [Family: Celastaceae]	aqueous decoction	STZ rat	Inhibits alpha-glucosidase activity	108
50	<i>Salacia Oblonga Wall.</i> [Family: Celastaceae]	aqueous methanolic extract, aqueous methanolic extract	Zucker rat (OZR)	Acts through inhibition of alpha-glucosidase activity	109
51	<i>Sida cordifolia L.</i> [Family: Malvaceae]	methanolic extract/root	STZ rat	☑Glucose	110
52	<i>Swertia chirayita (Roxb. Ex Fleming) H. Karst.</i> Common name: Indian Gentian [Family: Gentianaceae]	ethanol extract (250 mg/kg)	STZ rat	Stimulates insulin release from islets of Langerhans by depleting aldehyde-fuchsin stained beta-granules and immunostained insulin	111-112
53	<i>Syzygium alternifolium</i> Walp. [Family: Myrtaceae]	Aqueous Extract/seed	Alloxan rats	☑Glucose	113
54	<i>Scoparia dulcis L.</i> Common name: Sweet Broomweed [Family: Scrophulariaceae]	aqueous leaf extract (0.15, 0.30 and 0.45 g/kg body weight for 45	STZ rat , mice	Suppresses glucose influx into the polyol pathway leading to increased activities of antioxidant enzymes and plasma insulin and decreases activity of sorbitol dehydrogenase	114-115

		days p.o.), plant extracts		Also potentiates insulin release from Blood glucose, sorbitol dehydrogenase, glycosylated pancreatic islets.	
55	<i>Taxus yunnanensis</i> [Family: Taxaceae]	aqueous extract, methenolic extract, isolated compounds/ woods	STZ rat	☒Glucose	116
56	<i>Terminalia catappa L.</i> [Family: Combretaceae]	Pet-ether, Methanol, aqueous extract/fruit	Alloxan rats	☒Glucose	117
57	<i>Terminalia chebula</i> [Family: Combretaceae]	chloroform exreacr /seeds	STZ rat	☒Glucose	118
58	<i>Terminalia superb</i> [Family: Combretaceae]	methenolic extract, methylene chloride extract/steam barks	STZ rat	☒Glucose	119
59	<i>Trema orientalis</i> [Family: Ulmaceae]	aqueous extract/steam bark	STZ rat	☒Glucose	120
60	<i>Tremella mesenteric</i> [Family: Combretaceae]	isolated compounds/fruits	STZ rat	☒Glucose	121
61	<i>Triticum repens</i> P.Beauv. [Family: Gramineae]	aqueous extract/rhizomes	STZ rat	☒Glucose	122
62	<i>Viscum album L.</i> [Family: Llorenthaceae]	aqueous extract, ethanolic extract/whole plant	STZ rat	☒Glucose, ☒lipidic Peroxidation	123
63	<i>Zizyphus spina-christi</i> [Family: Rhamnaceae]	n-butenol fraction, isolated compounds/l eaves	STZ rat	☒Glucose, ☒insulin	124
64	<i>Smilax chinensis (L.)</i> [Family:Liliaceae]	ethanolic extract, dried rhizomes	Alloxan rats	Reduces blood glucose level	125
65	<i>Abelmoschus esculentus</i> Linn [Family: Malvaceae]	aqueous extract, fruit	Alloxan mice	Reduces blood glucose level	126

CONCLUSION

The incidences of modern lifestyle diseases like Type 2 diabetes widely prevalent in industrialized countries are on the rise in developing countries. The burden of T2DM is enormous when the costs of diagnosis and treatment are considered. Due to economic constraints, providing modern medical healthcare in developing countries such as India is still a far-reaching goal. Out of an estimated 250000 higher plants, less than 1% has been screened pharmacologically and very few in regard to DM. Therefore, it is prudent to look for options in herbal medicine for diabetes as well. The goals of medicine no matter to which group it belongs, are the same i.e. the welfare of the patient. One can look towards a future of integrated medicine and hope that research in alternative medicine will help identify what is safe and effective rather than marginalizing, unorthodox medical claims and findings.

REFERENCES

- Geetanjali Kaushik et.al., Commonly consumed Indian plant food materials in the management of diabetes mellitus, Diabetes & Metabolic Syndrome: Clinical Research & Reviews 4 (2010) 21-40
- Goodman and Gilman's, "The Pharmacological Basis of Therapeutics", McGraw-Hill, 5th Edition, New York, 1996, 1286-89.
- Tripathi K. D., 'An Essentials of Medical Pharmacology', Jaypee Publication, 5th Edition, New Delhi, 2006, 235-236.
- Liggett P., David T., Choudhari N., 'Diabetic Retinopathy' Enlarged Text New England Retina, Vol. 12(2), 2006,52-62.
- Harman R., 'Health Care Disease and Patient Advice' The Pharmaceutical Press, Vol. 17, 1990, 45-49.
- Burcelin R, Rolland E, Dolci W, Germain S, Carrel V, Thorens B. Encapsulated, genetically engineered cells, secreting glucagon-like peptide-1 for the treatment of non-insulin-dependent diabetes mellitus. Ann N Y Acad Sci 1999; 875(June (18)):277-85.
- Alarcon-Aguilara, F.J., Roman-Ramos, R., Perez-Gutierrez, S., Aguilar- Contreras, A., Contreras-Weber, C.C., Flores-Saenz, J.L. 1998. Study of the anti-hyperglycemic effect of plants used as antidiabetics. Journal of Ethnopharmacology 61 (2), 101-/110.
- Saifi, A.Q., Shinde, S., Kavishwar, W.K., Gupta, S.R. 1971. Some aspects of phytochemistry and hypoglycemic actions of Pterocarpus marsupium. Journal of Research in Indian Medicine 6 (2), 205-207.
- Rang, H.P., Dale, M.M. 1991. The Endocrine System Pharmacology, Second ed. Longman Group Ltd, UK, pp. 504-508.
- J.K. Grover, S. Yadav, V. Vats., Medicinal plants of India with anti-diabetic potential, Journal of Ethnopharmacology 81 (2002) 81-100
- Pulok K. Mukherjee, Kuntal Maiti , Kakali Mukherjee , Peter J. Houghton., Leads from Indian medicinal plants with hypoglycemic potentials Journal of Ethnopharmacology 106 (2006) 1-28
- Singh, K.N., Chandra, V., Barthwal, K.C., 1975. Letter to the editor: hypoglycemic

13. activity of *Acacia arabica*, *Acacia benthami* and *Acacia modesta* leguminous seed diets in normal young albino rats. *Indian Journal of Physiology and Pharmacology* 19, 167-168.
14. Wadood, A., Wadood, N., Shah, S.A., 1989. Effects of *Acacia arabica* and *Caralluma edulis* on blood glucose levels of normal and alloxan diabetic rabbits. *Journal of Pakistan Medical Association* 39, 208-212.
15. Karunanayake, E.H., Welihinda, J., Sirimanne, S.R., Sinnadorai, G., 1984. Oral hypoglycemic activity of some medicinal plants of Sri Lanka. *Journal of Ethnopharmacology* 11, 223-231.
16. Ponnachan, P.T., Paulose, C.S., Panikkar, K.R., 1993. Effect of leaf extract of *Aegle marmelose* in diabetic rats. *Indian Journal of Experimental Biology* 31, 345-347.
17. Kamalakkannan, N., Rajadurai, M., Prince, P.S., 2003. Effect of *Aegle marmelos* fruits on normal and streptozotocin-diabetic Wistar rats. *Journal of Medicinal Food* 6, 93-98.
18. Augusti, K.T., 1973. Studies on the effects of a hypoglycemic principle from *Allium Cepa* Linn. *Indian Journal of Medical Research* 61, 1066-1071.
19. Gupta, R.K., Gupta, S., Samuel, K.C., 1977. Blood sugar lowering effect of various fractions of onion. *Indian Journal of Experimental Biology* 15, 313-314.
20. Babu, P.S., Srinivasan, K., 1997. Influence of dietary capsaicin and onion on the metabolic abnormalities associated with streptozotocin induced diabetes mellitus. *Molecular and Cellular Biochemistry* 175, 49-57.
21. Jain, R.C., Vyas, C.R., 1975. Garlic in alloxan-induced diabetic rabbits. *American Journal of Clinical Nutrition* 28, 684-685.
22. Rabinkov, A., Miron, T., Konstantinovski, L., Wilchek, M., Mirelman, D., Weiner, L., 1998. The mode of action of allixin: trapping of radicals and interaction with thiol containing proteins. *Biochimica et Biophysica Acta* 1379, 233-244.
23. Rajasekaran, S., Sivagnanam, K., Ravi, K., Subramanian, S., 2004. Hypoglycemic effect of *Aloe vera* gel on streptozotocin-induced diabetes in experimental rats. *Journal of Medicinal Food* 7, 61-66.
24. Okyar, A., Can, A., Akev, N., Baktir, G., Sutlupinar, N., 2001. Effect of *Aloe vera* leaves on blood glucose level in type I and type II diabetic rat models. *Phytotherapy Research* 15, 157-161.
25. Ajabnoor, M.A., 1990. Effect of aloes on blood glucose levels in normal and alloxan diabetic mice. *Journal of Ethnopharmacology* 28, 215-220.
26. Subramoniam, A., Pushpangadan, P., Rajasekharan, S., Evans, D.A., Latha, P.G., Valsaraj, R., 1996. Effects of *Artemisia pallens* Wall. on blood glucose levels in normal and alloxan-induced diabetic rats. *Journal of Ethnopharmacology* 50, 13-17.
27. Shirwaikar, A., Rajendran, K., Dinesh Kumar, C., Bodla, R., 2004. Hypoglycemic activity of aqueous leaf extracts of *Annona squamosa* in streptozotocin-nicotinamide type 2 diabetic rats. *Journal of Ethnopharmacology* 91, 171-175.
28. Gupta, R.K., Kesari, A.N., Murthy, P.S., Chandra, R., Tandon, V., Watal, G., 2005. Hypoglycemic and hypoglycemic effect of ethanolic extract of leaves of *Annona squamosa* L. in experimental animals. *Journal of Ethnopharmacology* 99, 75-81.
29. Borhanuddin, M., Shamsuzzoha, M., Hussain, A.H., 1994. Hypoglycaemic effects of *Andrographis paniculata* Nees on non-diabetic rabbits. *Bangladesh Medical Research Council Bulletin* 20, 24-26.
30. Yu, B.C., Hung, C.R., Chen, W.C., Cheng, J.T., 2003. Antihyperglycemic effect of andrographolide in streptozotocin-induced diabetic rats. *Planta Medica* 69, 1075-1079.
31. Zhang, X.F., Tan, B.K., 2000a. Anti-diabetic property of ethanolic extract of *Andrographis paniculata* in streptozotocin-diabetic rats. *Acta Pharmacologica Sinica* 21, 1157-1164.
32. Chattopadhyay, R.R., Chattopadhyay, R.N., Nandy, A.K., Poddar, G., Maitra, S.K., 1987a. Preliminary report on antihyperglycemic effect of a fraction of fresh leaves of *Azadirachta indica* (Beng. Neem). *Bulletin of the Calcutta School of Tropical Medicine* 35, 29-33.
33. Chattopadhyay, R.R., 1996. Possible mechanism of antihyperglycemic effect of *Azadirachta indica* leaf extract, part IV. *General Pharmacology* 27, 431-434.
34. Chattopadhyay, R.R., 1999. A comparative evaluation of some blood sugar lowering agents of plant origin. *Journal of Ethnopharmacology* 67, 367-372.
35. Gholap, S., Kar, A., 2004. Hypoglycaemic effects of some plant extracts are possibly mediated through inhibition in corticosteroid concentration. *Pharmazie* 59, 876-878.
36. Kim, H.K., Kim, M.J., et al, 2006. Antioxidative and anti-diabetic effects of amaranth (*Amaranthus esculentus*) in streptozotocin-diabetic rats. *Cell Biochemistry and function* 24, 195-199.
37. Puri, D., Baral, N., 1998. Hypoglycemic effect of *Biophytum sensitivum* in the alloxan diabetic rabbits. *Indian Journal of Physiology and Pharmacology* 42, 401-406.
38. Chude, M.A., Orisakwe, O.E., Afonne, O.J., Gamaniel, K.S., Vongtau, O.H., Obi, E., 2001. Hypoglycaemic effect of the aqueous extract of *Boerhavia diffusa* leaves. *Indian Journal of Pharmacology* 33, 215-216.
39. Pari, L., Amarnath Satheesh, M., 2004. Hypoglycemic activity of *Boerhaavia diffusa* L.: effect on hepatic key enzymes in experimental diabetes. *Journal of Ethnopharmacology* 91, 109-113.
40. Pari, L., Latha, M., 2002. Effect of *Cassia auriculata* flowers on blood sugar levels, serum and tissue lipids in streptozotocin diabetic rats. *Singapore Medical Journal* 43, 617- 621.
41. Sharma, S.R., Dwivedi, S.K., Swarup, D., 1997. Hypoglycemic, antihyperglycemic and hypolipidemic activities of *Caesalpinia bonducella* seeds in rats. *Journal of Ethnopharmacology* 58, 39-44.
42. Abdel-Hassan, I.A., Abdel-Barry, J.A., Tariq Mohammeda, S., 2000. The hypoglycemic and antihyperglycemic effect of *Citrullus colocynthis* fruit aqueous extract in normal and alloxan diabetic rabbits. *Journal of Ethnopharmacology* 71, 325-330.
43. Al-Ghaithi, F., El-Ridi, M.R., Adeghate, E., Amiri, M.H., 2004. Biochemical effects of *Citrullus colocynthis* in normal and diabetic rats. *Molecular and Cellular Biochemistry* 261, 143-149.
44. Mukherjee, K., Ghosh, N.C., Datta, T., 1972. *Coccinia indica* Linn. as potential hypoglycemic agent. *Indian Journal of Experimental Biology* 10, 347-349.
45. Singh, N., Singh, S.P., Vrat, S., Misra, N., Dixit, K.S., Kohli, R.P., 1985. A study on the anti-diabetic activity of *Coccinia indica* in dogs. *Indian Journal of Medical Science* 39, 27-29.
46. Shibib, B.A., Khan, L.A., Rahman, R., 1993. Hypoglycemic activity of *Coccinia indica* and *Momordica charantia* in diabetic rats: depression of the hepatic glucosylating enzymes glucose-6-phosphatase and fructose-1,6- bisphosphatase and elevation of both liver and red-cell shunt enzyme glucose-6-phosphate dehydrogenase. *Biochemistry Journal* 292, 267- 270.
47. Azad Khan, A.K., Akhtar, S., Mahtab, H., 1979. *Coccinia indica* in the treatment of patients with diabetes mellitus. *Bangladesh Medical Research Council Bulletin* 5, 60-66.
48. Babu, P.S., Srinivasan, K., 1997. Influence of dietary capsaicin and onion on the metabolic abnormalities associated with streptozotocin induced diabetes mellitus. *Molecular and Cellular Biochemistry* 175, 49-57.
49. Kamble, S.M., Kamlakar, P.L., Vaidya, S., Bambole, V.D., 1998. Influence of *Coccinia indica* on certain enzymes in glycolytic and lipolytic pathway in human diabetes. *Indian Journal of Medical Science* 52, 143-146.
50. Prakasam, A., Sethupathy, S., Pugalendi, K.V., 2002. Antihyperglycaemic effect of *Casearia esculenta* root extracts in streptozotocin-induced diabetic rats. *Pharmazie* 57, 758-760.
51. Chattopadhyay, R.R., Sarkar, S.K., Ganguly, S., Banerjee, R.N., Basu, T.K., 1991. Hypoglycemic and antihyperglycemic effect of leaves of *Vinca rosea* Linn. *Indian Journal of Physiology and Pharmacology* 35, 145- 151.
52. Singh, S.N., Vats, P., Suri, S., Shyam, R., Kumria, M.M., Ranganathan, S., Sridharan, K., 2001. Effect of a hypoglycemic extract of *Catharanthus roseus* on enzymic activities in streptozotocin induced diabetic rats. *Journal of Ethnopharmacology* 76, 269-277.
53. Nammi, S., Boini, M.K., Lodagala, S.D., Behara, R.B., 2003. The juice of fresh leaves of *Catharanthus roseus* Linn. reduces blood glucose in normal and alloxan diabetic rabbits. *BMC Complementary and Alternative Medicine* 3, 4.
54. Gomes, A., Vedasiromoni, J.R., Das, M., Sharma, R.M., Ganguly, D.K., 1995. Anti-hyperglycemic effect of black tea (*Camellia sinensis*) in rat. *Journal of Ethnopharmacology* 45, 223-226.

55. Anderson, R.A., Polansky, M.M., 2002. Tea enhances insulin activity. *Journal of Agricultural and Food Chemistry* 50, 7182-7186
56. Eddouks, M., Lemhadri, A., Zeggwagh, N.A., Michel, J.B., 2005a. Potent hypoglycemic activity of the aqueous extract of *Chamaemelum nobile* in normal and streptozotocin-induced diabetic rats. *Diabetes Research and Clinical Practices* 67, 189-195
57. Shirwaikar, A., Rajendran, K., Punitha, I.S., 2005. Antidiabetic activity of alcoholic stem extract of *Coscinium fenestratum* in streptozotocin-nicotinamide induced type 2 diabetic rats. *Journal of Ethnopharmacology* 97, 369-374.
58. Vijayvargia, R., Kumar, M., Gupta, S., 2000. Hypoglycemic effect of aqueous extract of *Encicostemma littorale* Blume (chhota chirayata) on alloxan induced diabetes mellitus in rats. *Indian Journal of Experimental Biology* 38, 781-784
59. Maroo, J., Vasu, V.T., Aalinkeel, R., Gupta, S., 2002. Glucose lowering effect of aqueous extract of *Encicostemma littorale* Blume in diabetes: a possible mechanism of action. *Journal of Ethnopharmacology* 81, 317-320.
60. Achrekar, S., Kaklij, G.S., Pote, M.S., Kelkar, S.M., 1991. Hypoglycemic activity of *Eugenia jambolana* and *Ficus bengalensis*: mechanism of action. *In Vivo* 5, 143-147
61. Prince, P.S., Menon, V.P., Pari, L., 1998. Hypoglycemic activity of *Syzygium cumini* seeds: effect on lipid peroxidation in alloxan diabetic rats. *Journal of Ethnopharmacology* 61, 1-7.
62. Prince, P.S., Kamalakkannan, N., Menon, V.P., 2004a. Hypoglycemic and antihyperlipidaemic effect of alcoholic *Syzygium cumini* seeds in alloxan induced diabetic albino rats. *Journal of Ethnopharmacology* 91, 209-213.
63. Grover, J.K., Vats, V., Rathi, S.S., 2000. Anti-hyperglycemic effect of *Eugenia jambolana* and *Tinospora cordifolia* in experimental diabetes and their effects on key metabolic enzymes involved in carbohydrate metabolism. *Journal of Ethnopharmacology* 73, 461-470.
64. Sharma, S.B., Nasir, A., Prabhu, K.M., Murthy, P.S., Dev, G., 2003. Hypoglycaemic and hypolipidemic effect of ethanolic extract of seeds of *Eugenia jambolana* in alloxan-induced diabetic rabbits. *Journal of Ethnopharmacology* 85, 201-206.
65. Ravi, K., Ramachandran, B., Subramanian, S., 2004a. Protective effect of *Eugenia jambolana* seed kernel on tissue antioxidants in streptozotocin-induced diabetic rats. *Biological and Pharmaceutical Bulletin* 27, 1212-1217.
66. Singap, A.N., El-Beshbishy, H.A., Yonekawa, M., Nomura, T., Fukai, T., 2005. Hypoglycemic effect of Egyptian *Morus alba* root bark extract: effect on diabetes and lipid peroxidation of streptozotocin-induced diabetic rats. *Journal of Ethnopharmacology* 100, 333-338.
67. Augusti, K.T., 1975. Hypoglycemic action of bengalensin, a glucoside isolated from *Ficus bengalensis* Linn. in normal and alloxan diabetic rabbits. *Indian Journal of Physiology and Pharmacology* 19, 218-220
68. Achrekar, S., Kaklij, G.S., Pote, M.S., Kelkar, S.M., 1991. Hypoglycemic activity of *Eugenia jambolana* and *Ficus bengalensis*: mechanism of action. *In Vivo* 5, 143-147.
69. Cherian, S., Kumar, R.V., Augusti, K.T., Kidwai, J.R., 1992. Hypoglycemic effect of a glycoside of pelargonidin isolated from the bark of *Ficus bengalensis* Linn. *Indian Journal of Biochemistry and Biophysics* 29, 380-382.
70. Augusti, K.T., Daniel, R.S., Cherian, S., Sheela, C.G., Nair, C.R., 1994. Effect of leucopelargonin derivative from *Ficus bengalensis* Linn. on diabetic dogs. *Indian Journal of Medical Research* 99, 82-86
71. Kumar, R.V., Augusti, K.T., 1989. Hypoglycemic effect of a leucocyanidin derivative isolated from the bark of *Ficus bengalensis* Linn. *Indian Journal of Biochemistry and Biophysics* 26, 400-404.
72. Sachdewa, A., Khemani, L.D., 1999. A preliminary investigation of the possible hypoglycemic activity of *Hibiscus rosa-sinensis*. *Biomedical and Environmental Sciences* 12, 222-226.
73. Sachdewa, A., Raina, D., Srivastava, A.K., Khemani, L.D., 2001a. Effect of *Aegle marmelos* and *Hibiscus rosa sinensis* leaf extract on glucose tolerance in glucose induced hyperglycemic rats (Charles foster). *Journal of Environmental Biology* 22, 53-57.
74. Chakrabarti, R., Vikramadithyan, R.K., Mullangi, R., Sharma, V.M., Jagadheshan, H., Rao, Y.N., Sairam, P., Rajagopalan, R., 2002. Hypoglycemic and hypolipidemic activity of *Helicteres isora* in animal models. *Journal of Ethnopharmacology* 81, 343-349.
75. Venkatesh, S., Dayanand Reddy, G., Reddy, Y.S., Sathyavathy, D., Madhava Reddy, B., 2004. Effect of *Helicteres isora* root extracts on glucose tolerance in glucose-induced hyperglycemic rats. *Fitoterapia* 75, 364-367.
76. Guerrero-Analco, J.A., Hersch-Martinez, P., Pedraza-Chaverri, J., Navarrete, A., Mata, R., 2005. Antihyperglycemic effect of constituents from *Hintonia standleyana* in streptozotocin-induced diabetic rats. *Planta Medica* 71, 1099-1105
77. Navarrete, A., Mata, R., 2005. Antihyperglycemic effect of constituents from *Hintonia standleyana* in streptozotocin-induced diabetic rats. *Planta Medica* 71, 1099-1105
78. Ojewole, J.A., 2006. Antinociceptive, anti-inflammatory and antidiabetic properties of *Hypoxis hemerocallidea* Fisch. and *C.A.Mey.* (Hypoxidaceae) corm [African Potato] aqueous extract in mice and rats. *Journal of Ethnopharmacology* 103, 126-134.
79. Ojewole, J.A., 2005b. Antinociceptive, anti-inflammatory and antidiabetic effects of *Leonotis leonurus* (L.) R. BR. [Lamiaceae] leaf aqueous extract in mice and rats. *Methods and Findings in Experimental and Clinical Pharmacology* 27, 257-264
80. Eddouks, M., Maghrani, M., Zeggwagh, N.A., Michel, J.B., 2005c. Study of the hypoglycaemic activity of *Lepidium sativum* L. aqueous extract in normal and diabetic rats. *Journal of Ethnopharmacology* 97, 391-395.
81. Zhao, Y.F., Keating, D.J., Hernandez, M., Feng, D.D., Zhu, Y., Chen, C., 2005a. Long-term inhibition of protein tyrosine kinase impairs electrophysiologic activity and a rapid component of exocytosis in pancreatic β cells. *Journal of Molecular Endocrinology* 35, 49-59.
82. Wu, H., Guo, H., Zhao, R., 2006. Effect of *Lycium barbarum* polysaccharide on the improvement of antioxidant ability and DNA damage in NIDDM rats. *Yakugaku Zasshi: Journal of the Pharmaceutical Society of Japan* 126, 365-3671
83. Aderibigbe, A.O., Emudianughe, T.S., Lawal, B.A., 1999. Antihyperglycaemic effect of *Mangifera indica* in rat. *Phytotherapy Research* 13, 504-507
84. Muruganandan, S., Srinivasan, K., Gupta, S., Gupta, P.K., Lal, J., 2005. Effect of mangiferin on hyperglycemia and atherogenicity in streptozotocin diabetic rats. *Journal of Ethnopharmacology* 97, 497-501.
85. Rao, B.K., Kesavulu, M.M., Giri, R., Appa Rao, C., 1999. Hypoglycemic and hypolipidemic effects of *Momordica cymbalaria* Hook. fruit powder in alloxan-diabetic rats. *Journal of Ethnopharmacology* 67, 103-109
86. Kameswara Rao, B., Kesavulu, M., Apparao, C., 2003a. Evaluation of hypoglycemic effect of *Momordica cymbalaria* fruit in alloxan-diabetic rats. *Fitoterapia* 74, 7-13.
87. Akhtar, M.S., Qureshi, A.Q., Iqbal, J., 1990. Hypoglycemic evaluation of *Mucuna pruriens* Linn. Seeds. *Journal of Pakistan Medical Association* 40, 147-150.
88. Grover, J.K., Vats, V., Rathi, S.S., Dawar, R., 2001. Traditional Indian antidiabetic plants attenuate renal hypertrophy, urine volume and albuminuria in streptozotocin induced diabetic mice. *Journal of Ethnopharmacology* 76, 233-238.
89. Rathi, S.S., Grover, J.K., Vats, V., 2002. The effect of *Momordica charantia* and *Mucuna pruriens* in experimental diabetes and their effect on key metabolic enzymes involved in carbohydrate metabolism. *Phytotherapy Research* 16, 236-243.
90. Chen, F., Nakashima, N., Kimura, I., Kimura, M., 1995. Hypoglycemic activity and mechanisms of extracts from mulberry leaves (*Folium mori*) and cortex *mori radidis* in streptozotocin-induced diabetic mice. *Yakugaku Zasshi* 115, 476-482.
91. Iyer, U.M., Mani, U.V., 1990. Studies on the effect of curry leaves supplementation (*Murraya koeingii*) on lipid profile, glycosylated proteins and amino acids in non-insulin-dependent diabetic patients. *Plant Foods and Human Nutrition* 40, 275-282.
92. Khan, B.A., Abraham, A., Leelamma, S., 1995. Hypoglycemic action of *Murraya koeingii* (curry leaf) and *Brassica juncea* (mustard): mechanism of action. *Indian Journal of Biochemistry and Biophysics* 32, 106-108.
93. Andrade-Cetto, A., Martinez-Zurita, E., Wiedenfeld, H., 2005. Hypoglycemic effect of *Malmea depressa* root on

- streptozotocin diabetic rats. *Journal of Ethnopharmacology* 100, 319-322
95. Ojewole, J.A., 2005c. Antiinflammatory, analgesic and hypoglycemic effects of *Mangifera indica* Linn. (Anacardiaceae) stem-bark aqueous extract. *Methods and Findings in Experimental and Clinical Pharmacology* 27, 547-554
 96. Shetty, A.K., Kumar, G.S., Sambaiah, K., Salimath, P.V., 2005. Effect of bitter gourd (*Momordica charantia*) on glycaemic status in streptozotocin induced diabetic rats. *Plant Foods for Human Nutrition* 60, 109-112.
 97. Harinantenaina, L., Tanaka, M., Takaoka, S., Oda, M., Mogami, O., Uchida, M., Asakawa, Y., 2006. *Momordica charantia* constituents and antidiabetic screening of the isolated major compounds. *Chemical and Pharmaceutical Bulletin* 54, 1017-1021. 100
 98. Chattopadhyay, R.R., 1993. Hypoglycemic effect of *Ocimum sanctum* leaf extract in normal and streptozotocin diabetic rats. *Indian Journal of Experimental Biology* 31, 891-893.
 99. Vats, V., Yadav, S.P., Grover, J.K., 2004a. Ethanolic extract of *Ocimum sanctum* leaves partially attenuates streptozotocin-induced alterations in glycogen content and carbohydrate metabolism in rats. *Journal of Ethnopharmacology* 90, 155-160.
 100. Gholap, S., Kar, A., 2004. Hypoglycaemic effects of some plant extracts are possibly mediated through inhibition in corticosteroid concentration. *Pharmazie* 59, 876-878.
 101. Jafri, M.A., Aslam, M., Javed, K., Singh, S., 2000. Effect of *Punica granatum* Linn. (Flowers) on blood glucose level in normal and alloxan-induced diabetic rats. *Journal of Ethnopharmacology* 70, 309-314.
 102. Das, A.K., Mandal, S.C., Banerjee, S.K., Sinha, S., Saha, B.P., Pal, M., 2001. Studies on the hypoglycaemic activity of *Punica granatum* seed in streptozotocin induced diabetic rats. *Phytotherapy Research* 15, 628-629.
 103. Arambewela, L.S., Arawwawala, L.D., Ratnasooriya, W.D., 2005. An antidiabetic activity of aqueous and ethanolic extracts of *Piper betle* leaves in rats. *Journal of Ethnopharmacology* 102, 239-245.
 104. Santhakumari, P., Prakasam, A., Pugalendi, K.V., 2006. Antihyperglycemic activity of *Piper betle* leaf on streptozotocin-induced diabetic rats. *Journal of Medicinal Food* 9, 108-112.
 105. Ojewole, J.A., 2005d. Hypoglycemic and hypotensive effects of *Psidium guajava* Linn. (Myrtaceae) leaf aqueous extract. *Methods and Findings in Experimental and Clinical Pharmacology* 27, 689-695.
 106. Taniguchi, H., Kobayashi-Hattori, K., Tenmyo, C., Kamei, T., Uda, Y., Sugita-Konishi, Y., Oishi, Y., Takita, T., 2006. Effect of Japanese radish (*Raphanus sativus*) sprout (Kaiware-daikon) on carbohydrate and lipid metabolisms in normal and streptozotocin-induced diabetic rats. *Phytotherapy Research* 20, 274-278.
 107. Maghrani, M., Michel, J.B., Eddouks, M., 2005. Hypoglycaemic activity of *Retama raetam* in rats. *Phytotherapy Research* 19, 125-128.
 108. Fadzelly, A.B., Asmah, R., Fauziah, O., 2006. Effects of *Strobilanthes crispus* tea aqueous extracts on glucose and lipid profile in normal and streptozotocin-induced hyperglycemic rats. *Plant Foods for Human Nutrition* 61, 7-12
 109. Musabayane, C.T., Mahlalela, N., Shode, F.O., Ojewole, J.A., 2005. Effects of *Syzygium cordatum* (Hochst.) [Myrtaceae] leaf extract on plasma glucose and hepatic glycogen in streptozotocin-induced diabetic rats. *Journal of Ethnopharmacology* 97, 485-490.
 110. Yoshikawa, M., Murakami, T., Yashiro, K., Matsuda, H., 1998. Kotalanol, a potent alpha-glucosidase inhibitor with thiosugar sulfonium sulfate structure, from hypoglycemic Ayurvedic medicine *Salacia reticulata*. *Chemical and Pharmaceutical Bulletin (Tokyo)* 46, 1339-1340
 111. Li, Y., Peng, G., Li, Q., Wen, S., Huang, T.H., Roufogalis, B.D., Yamahara, J., 2004. *Salacia oblonga* improves cardiac fibrosis and inhibits postprandial hyperglycemia in obese Zucker rats. *Life Science* 75, 1735-1746.
 112. Kanth, V.R., Diwan, P.V., 1999. Analgesic, antiinflammatory and hypoglycaemic activities of *Sida cordifolia*. *Phytotherapy Research* 13, 75-77.
 113. Sekar, B.C., Mukherjee, B., Chakravarti, R.B., Mukherjee, S.K., 1987. Effect of different fractions of *Swertia chirayita* on the blood sugar level of albino rats. *Journal of Ethnopharmacology* 21, 175-181.
 114. Saxena, A.M., Bajpai, M.B., Murthy, P.S., Mukherjee, S.K., 1993. Mechanism of blood sugar lowering by a *Swertia chirayita*-containing hexane fraction (SWI) of *Swertia chirayita*. *Indian Journal of Experimental Biology* 31, 178-181
 115. Rao, B.K., Rao, C.H., 2001. Hypoglycemic and antihyperglycemic activity of *Syzygium alternifolium* (Wt.) Walp. seed extracts in normal and diabetic rats. *Phytomedicine* 8, 88-93.
 116. Pari, L., Venkateswaran, S., 2002. Hypoglycaemic activity of *Scoparia dulcis* L. extract in alloxan induced hyperglycaemic rats. *Phytotherapy Research* 16, 662-664.
 117. Latha, M., Pari, L., Sitasawad, S., Bhone, R., 2004b. *Scoparia dulcis*, a traditional hypoglycemic plant, protects against streptozotocin induced oxidative stress and apoptosis in vitro and in vivo. *Journal of Biochemical and Molecular Toxicology* 18, 261-272.
 118. Banskota, N.T., Nguyen, Y., Tezuka, T., Nobukawa, S., Kadota, S., 2006. Hypoglycemic effects of the wood of *Taxus yunnanensis* on streptozotocin-induced diabetic rats and its active components. *Phytomedicine* 13, 109-114
 119. Nagappa, A.N., Thakurdesai, P.A., Venkat Rao, N., Singh, J., 2003. Hypoglycemic activity of *Terminalia catappa* Linn. fruits. *Journal of Ethnopharmacology* 88, 45-50.
 120. Rao, N.K., Nammi, S., 2006. Antidiabetic and renoprotective effects of the chloroform extract of *Terminalia chebula* Retz seeds in streptozotocin-induced diabetic rats. *BMC Complementary and Alternative Medicine* 6, 17.
 121. Kamtchouing, P., Kahpui, S.M., Dzeufiet, P.D., Tedong, L., Asongalem, E.A., Dimo, T., 2005. Anti-diabetic activity of methanol/methylene chloridestem bark extracts of *Terminalia superba* and *Canarium schweinfurthii* on streptozotocin-induced diabetic rats. *Journal of Ethnopharmacology* 104, 306-309
 122. Dimo, T., Nguemou, F.T., Kamtchouing, P., Dongo, E., Tan, P.V., 2006. Glucose lowering efficacy of the aqueous stem bark extracts of *Trema orientalis* (Linn) Blume in normal and streptozotocin diabetic rats. *Die Pharmazie* 61, 233-236
 123. Lo, H.C., Tsai, F.A., Wasser, S.P., Yang, J.G., Huang, B.M., 2006. Effects of ingested fruiting bodies, submerged culture biomass, and acidic polysaccharide lucuronoxylomannan of *Tremella mesenterica* Retz: Fr. on glycaemic responses in normal and diabetic rats. *Journal of Life Science* 78, 1957-1966.
 124. Eddouks, M., Maghrani, M., Michel, J.B., 2005b. Hypoglycaemic effect of *Triticum repens* P. Beauv in normal and diabetic rats. *Journal of Ethnopharmacology* 102, 228-232.
 125. Orhan, D.D., Aslan, M., Sendogdu, N., Ergun, F., Yesilada, E., 2005. Evaluation of the hypoglycemic effect and antioxidant activity of three *Viscum album* subspecies (European mistletoe) in streptozotocin-diabetic rats. *Journal of Ethnopharmacology* 98, 95-102.
 126. Abdel-Zaher, A.O., Salim, S.Y., Assaf, M.H., Abdel-Hady, R.H., 2005. Antidiabetic activity and toxicity of *Zizyphus spinachristi* leaves. *Journal of Ethnopharmacology* 101, 129-138
 127. Venkidesh R., Subhash C. Mandal, Dilipkumar Pal, Mohana Lakshmi S., Saravanakumar A., Antidiabetic Activity Of *Smilax Chinesis* (L.) In Alloxan Induced Diabetic Rats, *International Journal of Pharmacy and Pharmaceutical Sciences*, Vol 2, Suppl 2, 2010, 51-54
 128. Dibyajyoti Saha, Bindu Jain, Vibhor K. Jain., *Phytochemical Evaluation And Characterization of Hypoglycemic Activity Of Various Extracts Of Abelmoschus Esculentus* Linn. Fruit. *International Journal of Pharmacy and Pharmaceutical Sciences*, Vol 3, Suppl 2, 2011, 183-185.