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Indian medicinal plants with hypoglycemic potentials: Review Part I

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Abstract: Blood glucose lowering activity of aqueous extract in normal and glucose loaded rats. Antihyperglycemic activity of the extract in streptozotocin-diabetic rats along with reduction in the increased plasma thiobarbituric acid reactive substance and blood urea. 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.

Keywords: Plant, Hypoglycemia, Blood level, Glucose, Family

Introduction: Indian medicinal plants with hypoglycemic activity:

1. Acacia Arabica

Common name: Indian Gum Arabic tree

Family: Leguminosae

Activity with route of administration/dosage:

- i. Hypoglycaemic activity of 94% seed diet in normal rats orally with no blood sugar lowering activity in alloxanized rats at the same dose level.¹
- ii. Hypoglycemic effect of powdered seeds in normal rabbits (2, 3 and 4 mg/kg) administered orally.²

Reported mechanism of action:

Acts through release of insulin from pancreatic beta cells, which accounts for the hypoglycemic activity.^{1,2}

2. Aegle marmelos (L.)

Common name: Holy Fruit Tree

Family: Rutaceae

Activity with route of administration/dosage:

- i. Hypoglycemic effect of aqueous decoction of the plant root bark (1 ml/100 mg) in normal fasted rats.³
- ii. Antihyperglycemic activity of aqueous leaf extract in alloxanized rats.⁴
- iii. Antihyperglycemic activity of aqueous leaf extract in streptozotocin induced diabetic rats.^{5,6}
- iv. Hypoglycemic and antioxidant activity of leaves in diabetic male albino rats.⁷
- v. Antihyperglycemic and antioxidant activity of the plant in alloxanized rats.⁸
- vi. Antihyperglycemic activity of the leaves in glucose induced hyperglycemic rat at an oral dose equivalent to 250 mg/kg.⁹
- vii. Antihyperglycemic activity of aqueous fruit extract (250 mg/kg, twice daily for 1 month) in streptozotocin induced female albino Wistar diabetic rats.¹⁰
- viii. Hypoglycaemic activity of water extract of fruits in streptozotocin-induced diabetic Wistar rats (125 and 250 mg/kg) twice a day for 4 weeks, orally.¹¹
- ix. Antioxidant activity of the aqueous extract of fruits in streptozotocin diabetic rats (125 and 250 mg/kg), orally for 30 days.¹²

Reported mechanism of action:

Increases utilization of glucose; either by direct stimulation of glucose uptake or via the mediation of enhanced insulin secretion⁹ and also decreases the elevated glucose and glycosylated hemoglobin levels.¹⁰

3. Allium cepa L.

Common name: Onion

Family: Liliaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of ether soluble fraction of onion (0.25 mg/kg p.o.) in normal rabbits.¹³
- ii. Hypoglycemic activity of the bulb in rabbits in an oral glucose tolerance test at 2 g/kg.¹⁴
- iii. Antihyperglycemic, antioxidant and hypolipidemic activity of a diet containing 3% freeze dried onion powder upon prolonged administration in STZ diabetic rats.¹⁵

Reported mechanism of action:

Lowers blood glucose level and has potent antioxidant activity, which may account for the hypoglycemic potential.¹³

4. Allium sativum L.

Common name: Garlic

Family: Alliaceae

Activity with route of administration/dosage:

- i. Antihyperglycemic activity of ethanol, petroleum ether and ethyl acetate extract in alloxanized rabbits at a dose of 0.25 mg/kg, orally.¹⁶
- ii. Antioxidant activity of allicin, isolated from garlic.¹⁷

Reported mechanism of action:

Has strong antioxidant activity and rapid reactivity with thiol containing proteins responsible for the hypoglycemic property.¹⁷

5. Aloe vera (L.)

Common name: Aloe

Family: Aloaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of the plant (200 and 300 mg/kg p.o.) on normal fasted rats, oral glucose-loaded rats and streptozotocin-induced diabetic rats.¹⁸
- ii. Hypoglycaemic activity of leaf pulp extracts in type I and type II diabetic rats.¹⁹

- iii. Hypoglycemic effect of aloe and its bitter principle in alloxanized mice.²⁰
- iv. Antihyperglycemic activity of dried sap in five non-insulin-dependent diabetic patients and in alloxanized Swiss albino mice.²¹

Reported mechanism of action:

Maintains glucose homeostasis by controlling the carbohydrate metabolizing enzymes and stimulates insulin release from pancreatic beta cells.²⁰

6. Artemisia pallens

Common name: Davana

Family: Compositae

Activity with route of administration/dosage:

- i. Antihyperglycemic activity of aerial parts (100 mg/kg, orally) in glucose-fed hyperglycaemic and alloxan-induced diabetic rats. Moderate hypoglycaemic effect (1000 mg/kg) in fasted normal rats.²²

Reported mechanism of action:

Inhibits glucose re-absorption or increase in peripheral glucose utilization.²²

7. Annona squamosa L.

Common name: Sugar apple

Family: Annonaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of aqueous leaf extracts in streptozotocin-nicotinamide induced diabetic rats.²³
- ii. Hypoglycemic and antihyperglycemic activities of ethanolic leaf-extract (350 mg/kg, orally) in normal, streptozotocin (STZ)-diabetic rats and alloxanized rabbit.²⁴

Reported mechanism of action:

Lowers blood glucose level.²³

8. Andrographis paniculata

Common name: King of Bitter

Family: Acanthaceae

Activity with route of administration/dosage:

- i. Hypoglycemic and antihyperglycemic activity of *Andrographis paniculata* and andrographolide in normal and streptozotocin induced diabetic rats, orally.²⁵

Reported mechanism of action:

Prevents glucose absorption from gut.²⁵

9. Azadirachta indica

Common name: Neem

Family: Meliaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of hydro alcoholic plant extract in normal rats and hypoglycemic activity in glucose fed and streptozotocin induced diabetic rats.²⁶
- ii. Hypoglycemic and antihyperglycemic activities of leaf extract in normal and streptozotocin-induced diabetic rat.²⁷
- iii. Hypoglycemic activity of crude ethanolic extract of the plant in alloxan diabetic albino rats.²⁸

Reported mechanism of action:

Inhibits action of epinephrine on glucose metabolism, resulting in increased utilization of peripheral glucose²⁶ and exhibits hypoglycaemic activity without altering the serum cortisol concentration.^{27, 28}

10. Biophytum sensitivum (L.)

Common name: Life Plant

Family: Oxalidaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of the plant leaf extract in alloxan diabetic male rabbits.²⁹
- ii. Hypoglycemic activity of the plant on glucose homeostasis in rabbits.³⁰

Reported mechanism of action:

Stimulates pancreatic beta cells to release insulin.²⁹

11. Beta vulgaris L.

Common name: Garden beet

Family: Chenopodiaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of Betavulgarosides II–IV, isolated from the root of Beta vulgaris L. in an oral glucose tolerance test in rats.³¹

Reported mechanism of action:

Lowers blood glucose level.³¹

12. Brassica juncea (L.)

Common name: Brown Mustard

Family: Brassicaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of Brassica juncea diet (10%, w/w) in normal rats upon oral administration for 60 days.³²

Reported mechanism of action:

Increases the concentration of hepatic glycogen and glycogenesis and suppressed the activity of glycogen phosphorylase and

gluconeogenic enzymes, lead to reduction in glycogenolysis and gluconeogenesis.³²

13. Boerhavia diffusa L.

Common name: Tar vine

Family: Nyctaginaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of aqueous leaf extract at a dose of 100, 200 and 400 mg/kg in alloxan induced diabetic rats.³³
- ii. Hypoglycemic and antihyperglycemic activity of aqueous leaf extract (200 mg/kg p.o., daily for 4 weeks) in normal and alloxan induced diabetic rats.^{34, 35}

Reported mechanism of action:

Increases plasma insulin levels and improves glucosentolerance, produced significant antioxidant activity.^{34, 35}

14. Cassia auriculata L.

Common name: Tanner's

Family: Leguminosae

Activity with route of administration/dosage:

- i. Antihyperglycemic and antihyperlipidemic activity of aqueous flower extract in streptozotocin-induced diabetic rats upon oral administration at different doses for 30 days.^{36,37}
- ii. Antioxidant activity of aqueous flower extract in the brain of streptozotocin diabetic rats.^{38,39}

Reported mechanism of action:

Suppresses enhanced gluconeogenesis during diabetes and enhance utilization of glucose through increased glycolysis^{36, 37} in addition to pronounced alpha-glucosidase inhibitory actions resulting in a significant and potent lowering of blood glycemic response.^{38,39}

15. Caesalpinia bonducella (L.)

Common name: Chinese Cinnamon

Family: Caesalpinaceae

Activity with route of administration/dosage:

- i. Hypoglycemic and antihyperglycemic activities of the aqueous and 50% ethanolic seed extracts in normal and streptozotocin-diabetic rats.⁴⁰
- ii. Antihyperglycemic activity of the seed extracts in type II diabetic Long Evans rat.⁴¹
- iii. Hypoglycemic activity of aqueous and ethanolic extracts in chronic type II diabetic model with an increase in secretion of insulin from isolated islets.⁴²

Reported mechanism of action:

Increases the release of insulin from pancreatic cells.⁴⁰

16. Cajanus cajan (L.)

Common name: Pigeon pea

Family: Fabaceae

Activity with route of administration/dosage:

- i. Glucose tolerance enhancing activity of aqueous leaf and stem extract in oral glucose tolerance test.⁴³
- ii. Hypoglycemic activity of cooked diet in healthy human volunteers.⁴⁴

Reported mechanism of action:

Lower plasma glucose level.⁴⁵

17. Citrullus colocynthis (L.)

Common name: Bitter apple

Family: Cucurbitaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of aqueous extract (300 mg/kg), glycosidic and saponin extract (50 mg/kg), orally in normal rabbits.^{46, 47}
- ii. Blood glucose lowering activity of aqueous seed extract in normal and streptozotocin (STZ)-induced diabetic rats upon daily oral administration for 2 weeks.⁴⁸

Reported mechanism of action:

Exerts an insulinotropic effect.^{46, 47}

18. Coccinia indica

Common name: Ivy gourd

Family: Cucurbitaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of alcoholic leaf extract in normoglycemic guinea pig.⁴⁹
- ii. Hypoglycemic activity of the leaves in alloxanized dogs upon oral administration.⁵⁰
- iii. Hypoglycemic and antihyperglycemic activity of the ethanolic root extract in fasted and glucose-loaded animal models.⁵¹
- iv. Hypoglycemic effect of 95% ethanol extract of the leaves in normal fed and 48 h starved rats.⁵²
- v. Blood glucose lowering activity of 60% ethanol leaf extract (200 mg/kg, orally).⁵³

- vi. Hypoglycemic activity of the leaf extract in a double blind control trial in human subjects.^{54,55}
- vii. Antihyperglycemic activity of dried extract (500 mg/kg p.o., for 6 weeks) in 30 diabetic patients.⁵⁶

Reported mechanism of action:

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.⁵² Also has an insulin secretagogue effect^{54, 55} and acts like insulin by correcting elevated enzymes in glycolytic pathway and restoring LPL activity in lipolytic pathway with control of hyperglycemia in diabetes.⁵⁶

19. Casearia esculenta Roxb.

Common name: Carilla

Family: Flacourtiaceae

Activity with route of administration/dosage:

- i. Antihyperglycaemic activity of root extract (300 mg/kg p.o. for 45 days) in normal and streptozotocin-induced diabetic rats.⁵⁷
- ii. Blood glucose lowering activity of aqueous extract in normal and glucose loaded rats. Antihyperglycemic activity of the extract in streptozotocin-diabetic rats along with reduction in the increased plasma thiobarbituric acid reactive substance and blood urea.⁵⁸

Reported mechanism of action:

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.⁵⁷

20. Catharanthus roseus (L.)

Common name: Madagascar periwinkle

Family: Apocynaceae

Activity with route of administration/dosage:

- i. Hypoglycemic activity of ethanolic leaf extract in normal rats upon oral administration at graded dose. Hypoglycemic activity of the extract (500 mg/kg) in streptozotocin rats and in oral glucose tolerance test.⁵⁹
- ii. The hypoglycemic activity of dichloromethane: methanol nextract of leaves and twigs in streptozotocin (STZ) induced diabetic rat (500 mg/kg p.o., for 7 and 15 days).⁶⁰
- iii. Hypoglycemic and antihyperglycemic activity of leaf juice or water decoction of the plant in normal and alloxan-induced diabetic rabbits.⁶¹

Reported mechanism of action:

Increases metabolization of glucose⁶⁰ and enhances secretion of insulin either from the beta cells of Langerhans or through extrapancreatic mechanism.⁶¹

21. Camellia sinensis

Common name: Green tea

Family: Theaceae

Activity with route of administration/dosage:

- i. Antihyperglycemic activity of hot water extract of green tea in streptozotocin (STZ)-diabetic rats.^{62, 63}

Reported mechanism of action:

Epigallocatechin gallate, present in tea increases insulin activity and prevent oxidative damages, responsible for the hypoglycemic activity.^{62, 63}

Conclusion:

From the above work it is clear that number of medicinal plants used to treat hyperglycemia.

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