

PHYTOCHEMISTRY AND PHARMACOLOGICAL ACTIVITIES OF *PTEROCARPUS MARSUPIUM*– A REVIEW

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ABSTRACT

Pterocarpus marsupium Roxb. (Fabaceae) commonly known as Bijasal or Indian Kino is important plant used traditionally for medicinal purposes. Several chemical constituents like pterostilbene, epicatechin, pterosupin, marsupsin, etc., have been identified and isolated. *Pterocarpus marsupium* extract shows promising results in cataract and hypertriglyceridaemia. This plant has various pharmacological activities like antifungal, antioxidant, analgesic, anti-inflammatory, hepatoprotective etc. This paper explains the evidence-based information regarding the phytochemistry and pharmacological activity of the plant which helps the researchers for more qualitative research.

KEYWORDS: Pterostilbene, Epicatechin, Ptersupin, Cataract, Hypertriglyceridaemia

INTRODUCTION

Pterocarpus marsupium Roxb. (Fabaceae) commonly known as Bijasal or Indian Kino, is one of the most valuable multipurpose forest trees that yields excellent timber for the international trade market¹. Indian kino, is a medium to large deciduous tree that can grow up to 30 meters height². The plant species is native to India, Sri Lanka and Nepal. It is particularly found in certain areas of the Western Ghats, in the Karnataka-Kerala region, in the states of Gujrat, Madhya Pradesh, Bihar and Orissa³. The herb is known by different name in different regions such as Venga(Malayalam), Vengai(Tamil), Asanahm Asana, Beejaka, Bandhukavriksha (Sanskrit), Red Kino tree, Malabar Kino Tree (English), Bijasal, Bila(hindi), Vengai(Tamil), Yegi (Telgu), Piasal (in Orrisa), Malabar, Benga and Bijiyaasal (in western Nepal) and so on⁴. *Pterocarpus marsupium* Roxb. is a plant drug belonging to the group called rasayana in ayurvedic system of medicine⁵. The flowers are used in fever, the gum is used in leucorrhoea and passive haemorrhage⁶. *Pterocarpus marsupium* Roxb. (Fabaceae) is a deciduous tree about 90 ft or more high. Leaves are 3 to 5 inch long, have 5-7 leaflets, oblong, margin wavy and obtuse. The petioles are round, smooth and waved from leaflet to leaflet, 5 or 6 inches long and there are no stipules. Flower about 1.5 cm long, very numerous, white, with a small tinge of yellow. The heartwood of this tree is golden yellow. Tree bark yields a reddish gum. Stamens are 10, united near the base, but soon dividing into two parcels of 5 each; anthers are globose and 2-lobed. The legume, which is borne on a long petiole, is three-fourths orbicular, the upper remainder, which extends from the pedicel to the remainder of the style, is straight, the whole surrounded with a waved, veiny, downy, membranous ing, swelled, rugose, woody in the center, where the seed is lodged and not opening^{7,8}.

Traditional uses

The bark and resin decoction is an astringent for severe diarrhea, dysentery, for the treatment of tumors of the gland, urethral discharges, used on ringworm of the scalp and chronic ulcers, abortifacient⁹. The heart wood is astringent, bitter acrid, anti inflammatory, anthelmintic, anodyne¹⁰. It is

good for elephantiasis, leucoderma, diarrhoea, rectalgia, cough and greyness of hair¹¹. It is safe and effective in wounds, fever, stomachache, diabetes, jaundice, antiulcer¹².

Chemical constituents

The plant contains protein, pentosan, pterosupin, pseudobaptigenin, liquiritigenin, isoliquiritigenin, garbanzol, 5-de-oxykaempferol, p-hydroxybenzaldehyde, b-eudesmol, erythrodiol-3-monoacetate, pterostilbene, l-epicatechin, marsupol, carpusin, propterol, propterol B, marsupinol, irisolidone-7-O- α -L-rhamnopyranoside, have been obtained mainly from the heartwood and root¹³. Aqueous extract of the heartwood of *Pterocarpus marsupium* contains five new flavonoid C-glucosides namely 6-hydroxy-2-(4-hydroxybenzyl)-benzofuran-7-C- β -D-glucopyranoside, 3-(α -methoxy-4-hydroxybenzylidene)-6-hydroxybenzo-2(3H)-furanone-7-C- β -D-glucopyranoside, 2-hydroxy-2-*p*-hydroxybenzyl-3(2H)-6-hydroxybenzofuranone-7-C- β -D-glucopyranoside, 8-(C- β -D-glucopyranosyl)-7,3',4'-trihydroxyflavone and 1,2-bis(2,4-dihydroxy-3-C-glucopyranosyl)¹⁴. Ether extract of the roots of *Pterocarpus marsupium* consist of a new flavonol glycoside 6-hydroxy-3,5,7,4'-tetramethoxyflavone-6-O-rhamnopyranoside, a benzofuranone derivative¹⁵, 2,4'6-trihydroxy-4-methoxybenzo(b)furan-3(2H)one designated carpusin¹⁶, 1,3-bis(4-hydroxyphenyl)propan-2-ol, designated propterol¹⁷, 1-(2,4-dihydroxyphenyl)-3-(4-hydroxyphenyl)propan-2-ol designated propterol¹⁸, 6-hydroxy-7-O-methyl-3-(3-hydroxy-4-O-methyl benzyl) chroman-4-one¹⁹.

Pharmacological activities

CNS activity

(-)-Epicatechin has been isolated from the bark of *Pterocarpus Marsupium*. This flavonoid compound was tested for its activity on central nervous system of frog, rats and mice. Preliminary acute toxicity studies were also carried out. It was observed that (-)-epicatechin did not have any effect on central nervous system of rats and mice, (-)-epicatechin had shown both positive chronotropic and inotropic effects on frog hearts, the effect of which is blocked by propranolol. The compound in higher doses caused hyperglycemia in rats and this effect is also blocked by propranolol, showing adrenergic type of activity. (-)-Epicatechin was found to have no untoward effect even in higher doses²⁰.

Antidiabetic activity

Aqueous extract of *Pterocarpus marsupium* at both doses, i.e., 100 and 200 mg/kg, decreased the fasting and postprandial blood glucose in type 2 diabetic rats. The 200 mg/kg had more effect on postprandial hyperglycemia. The drug also improved the body weight of diabetic animals. Cytokine TNF- α was found to be elevated in untreated diabetic rats due to chronic systemic inflammation. The aqueous extract at both doses significantly ($P < 0.001$) decreased the elevated TNF- α level in type 2 diabetic rats^{21, 22}.

Hepatoprotective activity

Methanol extract of the stem bark of *P. marsupium* possesses hepatoprotective activity. In methanol extract-treated animals, the toxic effect of CCl₄ was controlled significantly by restoration of the levels of serum bilirubin, protein and enzymes as compared to the normal and the standard drug silymarin-treated groups. Histology of the liver sections of the animals treated with the extracts showed the presence of normal hepatic cords, absence of necrosis and fatty infiltration, which further evidenced the hepatoprotective activity²³.

Anti-inflammatory and antioxidant activity

In human peripheral blood, *Pterocarpus marsupium* extract was shown to decrease prostaglandin E₂ levels possibly through inhibition of the inflammatory mediator cyclooxygenase-2²⁴.

Antihyperglycemic activity

Glucose levels in rats with hyperglycemia induced by streptozotocin were determined after i.p administration of marsupsin (1), pterosupin (2), and pterostilbene (3), three important phenolic constituents of the heartwood of *Pterocarpus marsupium*. Marsupsin and pterostilbene significantly lowered the blood glucose level of hyperglycemic rat^{25,26}.

Cardiotonic activity

Cardiotonic effect of aqueous extract of *Pterocarpus marsupium* heartwood was studied by using isolated frog heart perfusion. Calcium free ringer solution was used as vehicle for administration of

aqueous extract of *Pterocarpus marsupium* as test extract and digoxin as standard. A significant increase in height of force of contraction (positive inotropic effect) and decrease in heart rate (negative chronotropic effect) at a very low concentration (0.25mg/ml) was observed with test extract as compared to same dose of Standard digoxin. The present result indicates that a significant increase in height of force of contraction with decrease in heart rate was observed as test dose increases²⁷.

Antianalgesic and antioxidant activity

Use of the hot-plate method to study central analgesic activity of the bark extract in mice indicated that the bark extract of *Pterocarpus marsupium* possesses the ability to significantly reduce pain threshold and also increase the response latency period to thermal stimuli in mice, similar to the reference drug pentazocine. The reaction time of mice was significantly increased to 2 hr with 500 mg mL⁻¹ of bark extract, whereas pentazocine also increased reaction time to 2 hr with 5 mg kg⁻¹. The in vitro antioxidant activity of the bark extract was evaluated using the 1, 1-diphenyl-2-picrylhydrazyl assay, and the results were expressed as IC₅₀. Ascorbic acid, used as a standard, had an IC₅₀ = 34.0 µg mL⁻¹, whereas the bark extract of *Pterocarpus marsupium* had an IC₅₀ = 53.0 µg mL⁻¹.

Antimicrobial activity

The antimicrobial activity of *Pterocarpus marsupium* was evaluated against pathogenic bacteria *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia* in an *in vitro* condition. The aqueous extract of *Pterocarpus Marsupium* inhibited growth of bacteria with the minimal inhibitory concentration ranging from 0.04 mg to 0.08 mg and extracts of *F. bengalensis* and *H. indicus* showed inhibition at the range of 0.04 mg to 0.1 mg against the bacteria tested. The susceptibility of bacterial pathogens was in the order of *S. aureus*, *K. pneumoniae* and *P. aeruginosa*^{29,30}.

Anti-hyperglycemic and hypoglycemic activity

The hypoglycemic effect of the aqueous extract of the bark of *Pterocarpus marsupium* was investigated in both normal and alloxan-induced diabetic rats. The Aqueous extract of *Pterocarpus marsupium* reduced the blood sugar levels from 72.32±5.62 to 61.35±1.2 mg% 2 h after oral administration of the extract and also significantly lowered the blood glucose in alloxan diabetic rats from 202.91±5.44 to 85.22±11.28 mg% 21 days after daily oral administration of the extract ($P<0.001$)^{31,32}.

Cytotoxic, Antiproliferative and anti-inflammatory activity

Pterostilbene, a dimethyl ester derivative act as a cytotoxic and hence used as an anti-cancer agent. Pterostilbene was found to inhibit the cell proliferating factors like Akt, Bcl-2 and induced the mitochondrial apoptotic signals like Bax, and the series of caspases. It also inhibited Matrix metalloproteinase 9 (MMP9) and α -methylacyl-CoA racemase (AMACR), two very well known metastasis inducers. In conclusion, pterostilbene has multiple target sites to induce apoptosis. Hence, it can be used as a potential agent for the cure of breast and prostate cancer³³.

COX-2 Inhibition

Pterocarpus marsupium extract decreases PGE₂ production indicating COX-2 specific inhibition^{34,35}.

Anti-hyperinsulinaemic and anti-hypertriglyceridaemic activity

The aqueous extract of *Pterocarpus marsupium* bark substantially prevented insulin resistance (hyperinsulinaemia) and hypertriglyceridaemia. The ethyl acetate extract of heartwood of *Pterocarpus marsupium* was given to rats for 14 consecutive days. The results proved that there is a significant reduction of serum triglyceride, total cholesterol, LDL- and VLDL- cholesterol without any significant effect on the level of HDL- cholesterol^{36,37}.

Anti-cataract activity

Anti-cataract activity was demonstrated on the aqueous extract of *Pterocarpus marsupium* bark. This was evident from the decreased opacity index in the alloxan induced diabetic rats³⁸.

Genotoxic assessment

Since the plant is used as an antidiabetic agent for a longer duration, studies were undertaken to evaluate the genotoxicity of this extract using both somatic cells and germ cells. Results obtained clearly demonstrate that the extract by itself is not genotoxic. Additionally it reduced the genotoxic effect of cyclophosphamide in a dose dependent manner which was comparable to a known antimutagen, vitamin

C. Thus this data clearly demonstrates that there are no genotoxic effects after administration of this drug in mice³⁹.

Antifungal Activity

The usefulness of this drug as a topical agent against *T. cruris* and *T. corporis* was. The drug yielded good response within 3 days of the first application⁴⁰.

CONCLUSION

The history of herbal medicine is as old as human civilization. The wealth of India is stored in the enormous natural flora which has been gifted to her. Endowed with a wide diversity of agro-climatic conditions, India is virtually herbarium of the world. The importance of medicinal and aromatic plants has been emphasized from time to time. It is believed that the drugs of natural origin shall play an important role in healthcare particularly in the rural areas of India. *Pterocarpus marsupium* is important herbal drug of various pharmacological properties and it requires further exploitation.

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