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Pterocarpus marsupium Roxb. - A Comprehensive Review

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ABSTRACT
The *Pterocarpus marsupium* belong to family Fabaceae and is widely distributed in central, western and southern regions of India. The role of *Pterocarpus marsupium* as anti-diabetic has been very well established. Its extract has been prepared using many methods like infusion, maceration, decoction and percolation. Several chemical constituents like pterostilbene, (-)-epicatechin, pterosupin, marsupsin, *etc.,* have been identified and isolated. *Pterocarpus marsupium* extract also shows promising results in cataract and hypertriglyceridaemia. This plant also finds its use as cardiotonic and hepatoprotective agent. Studies have also been reported to demonstrate its ability as a specific COX- 2 inhibitor. The present review explores its description, traditional uses, extraction methods, chemical constituents, pharmacological activity and commercial importance so that its potential as a multipurpose medicinal agent can be understood and appreciated.
KEY WORDS: Extraction methods, Pharmacological activities, *Pterocarpus marsupium.*
Abbreviations: COX- 2: cyclooxygenase- 2, LDL: low desity lipoprotein, VLDL: very low density lipoprotein, HDL: high desity lipoprotein, PGE_2: prostaglandin E_2

INTRODUCTION

Plants are indispensable to man for his life. All phyta of plants *viz.* Thallophyta, Bryophyta, Pteridophyta and Spermatophyta, contain species that yield official and unofficial products of medicinal importance. 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 (1). *Pterocarpus marsupium* Roxb is grown in deciduous and evergreen forests of central, western and southern regions of India. It is found mostly in the states of Gujrat, Madhya Pradesh, Bihar and Orissa (2-3).

TAXONOMICAL CLASSIFICATION

Domain	: Eukaryota
Kingdom	: Plantae
Subkingdom	:Viridaeplantae
Phylum	: Magnoliophyta
Subphylum	: Euphyllophytina
Infraphylum	: Radiatopsis
Class	: Magnoliopsida
Subclass	: Rosidae
Superorder	: Fabanae
Order	: Fabales
Family	: Fabaceae
Genus	: *Pterocarpus*
Species	: *marsupium* (4).

BOTANICAL DESCRIPTION

It is of moderate size to large tree. The height ranges from 15 to 30 meters. The stem is stout and crooked with widely spreading branches. The bark is thick and dark brown to grey in colour. Leaves are compound and imparipinnate. Leaflets are 5-7, coriaceous, oblong, obtuse, emarginated or even bilobed at the apex and glabrous on both surfaces. The petioles are round, smooth and waved from leaflet to leaflet, 5 or 6 inches long and there are no stipules. Panicles are terminal and very large; ramifications are bifarious, like the leaves. Peduncles and pedicals are round and a little downy. Bracts are small, caduceus, solitary below each division and subdivision of the panicle. The flowers are very numerous, white, with a small tinge of yellow. Vexillum is with a long, slender claw, very broad; sides reflexed, waved, curled and veined; keel is two pettled, adhering slightly for a little way near the middle, waved, *etc.*, same as the vexillum. Stamens are 10, united near the base, but soon dividing into two parcels of 5 each; anthers are globose and 2-lobed. Ovary is oblong, pedicelled, hairy, generally 2-celled; cells are transverse and 1-seeded. Style is ascending. 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, membraneous wing, swelled, rugose, woody in the center, where the seed is lodged and not opening; generally one but sometimes 2-celled. Seeds are single and reniform (3, 5).

DESCRIPTION OF DRUG

Drug consists of heartwood of *Pterocarpus marsupium.* It consists of irregular pieces of variable size and thickness. It is golden yellowish- brown in colour with darker streaks. It is very hard and brittle. In water it gives yellow coloured solution with blue fluorescence. Transverse section shows alternating bands of larger and smaller polygonal cells consisting of tracheids, fibre tracheids, xylem parenchyma and transversed by xylem rays. Xylem vessels are throughout distributed.

Tyloses filled with tannins are present. Tracheids are long, thick walled with tapering ends and simple pits. Xylem parenchyma cells are rectangular with simple pits and xylem rays are uni-to-biseriate. The calcium oxalate crystals are present and the starch is absent (2).

SYNONYMS

Sanskrit	: Bījaka, Pītāsara, Asanaka, Bījasāra
Assamese	: Aajar
Bengali	: Piyasala, Pitasala
English	: Indian Kino Tree
Gujrati	: Biyo
Hindi	: Vijyasara, Bija
Kannada	: Bijasara, Asana
Kashmiri	: Lal Chandeur
Malayalam	: Venga
Marathi	: Bibala
Orissi	: Piashala
Punjabi	: Chandan Lal, Channanlal
Tamil	: Vengai
Telugu	: Yegi, Vegisa
Urdu	: Bijasar (2).

ETHNOMEDICAL USES

The genus is widely distributed on the Earth and the astringent drug from this genus is known as 'kino'. The phloem of stem contains red astringent fluid present in secretory cell which exudes after given incision. Kino is odourless but has astringent taste and sticks in the teeth, colouring the saliva red in colour (6). As astringent it is used in diarrhoea, dysentery, *etc.* Bruised leaves are applied on skin diseases, sores and boils. Wood is useful in treating diabetes (7-8).

EXTRACTION METHODS

i) Infusion : The *Pterocarpus marsupium* heartwood has been used since ages to treat diabetes. The beakers made from heartwood are filled with water and allowed to stand overnight to give 'Beeja Wood Water' (8). Mohire *et al.* prepared the aqueous extract of dried heartwood of *Pterocarpus marsupium* by keeping in a beaker containing 100 ml. distilled water for 12 hours. The brown coloured aqueous extract with light blue shade on surface was collected in the morning and concentrated on the water bath. The product was dried using rotary evaporator, finally dried under sunlight and powdered (9). Bose and Sepaha used central hard wood which was dried and crushed into coarse powder. The aqueous extract was prepared using 24 hours infusion in the strength of 1:8 which was prepared daily and consumed. They also prepared 7 days infusion in the same strength (10). Gupta prepared the aqueous infusion of *Pterocarpus marsupium* by soaking 50 grams of saw dust of the wood in 500 ml. distilled water for overnight at room temperature. The supernatant liquid was collected and the final volume was adjusted so that 10 ml of infusion represented 1 gram of the crude drug. The infusion was stored in a sealed container in refrigerator at 4 °C for subsequent use (11). Vats *et al.* grinded the dried bark into fine powder and soaked in equal volume of water, stirred occasionally and left overnight. The pulp obtained was filtered, the filtrate dried at reduced temperature and then after lyophilization the aqueous extract was collected (12). Grover *et al.* and Vats *et al.* grinded the bark of *Pterocarpus marsupium* in an electric grinder. The powder was soaked in equal amount of water and stirred intermittently and then left overnight. The pulp was then filtered through a coarse sieve and the filtrate was dried at reduced temperature (13-14). Grover *et al.* prepared the aqueous extract by grinding the bark of *Pterocarpus marsupium* to coarse powder in an electric grinder and the powder obtained was soaked in 1500 ml of distilled water and stirred intermittently and then left stationary. After 36 hours, the mixture was filtered through a sieve lined with muslin cloth and the filtrate obtained was completely lyophilized to dry powder. This dry powder was stored at low temperature (15).

ii) Decoction : The Ayurvedic Pharmacopoeia (1990) recommends 50-100 grams of the drug for decoction (2). In one study, dried heartwood of *Pterocarpus marsupium* was pulverized, boiled with distilled water until the volume was reduced to less than 100 ml, and filtered, and the volume was adjusted to 100 ml in order to obtain an extract, 1ml of which corresponds to 1 gram of the drug (16). Suri *et al.* prepared the decoction of powdered *Pterocarpus marsupium* heartwood in boiling water and then spray dried it (17).

iii) Maceration : Ahmed *et al.* chopped the wood of *Pterocarpus marsupium* into small pieces and extracted in absolute ethanol for 1 week (18). Joshi *et al.* collected the heartwood and cut it into very small pieces. Maceration with methanol was done for 7 days. The extract was vacuum dried and stored in a refrigerator until further use (19). In one study, the alcohol extract of the bark of *Pterocarpus marsupium* was prepared by cold double maceration. The extract obtained was concentrated using a rotary flash evaporator and then dried in a desiccator (20).

iv) Percolation : Sepaha and Bose used central heartwood, dried and crushed into coarse powder. The extract was prepared with the addition of 95 % alcohol in a percolator in the strength of 1:6 (10). Chakravarthy and Gode cut the fresh bark into very fine chips and extracted with petroleum ether (60-80 °C) in a Soxhlet apparatus for 24 hours (21).

v) Hot Water Extraction : Maurya *et al.* and Handa *et al.* powdered heartwood (5 Kg) and exhaustively extracted with hot water (4x16 ml). The concentrated extract (500 g) was suspended in water (2.0 litre) and successively partitioned with ethyl acetate and n-butyl alcohol (22-23).

PHYTOCHEMISTRY

The ethyl acetate extract of powdered dried heartwood of *Pterocarpus marsupium* revealed the presence of following constituents: pterostilbene, (2S)-7-hydroxyflavanone, isoliquiritigenin, liquiritigenin, 7,4'-dihydroxyflavone, marsupsin, pterosupin, p-hydroxybenzaldehyde, (2R)-3-(p-hydroxyphenyl)-lactic acid and pm-33 (24). Tripathi and Joshi isolated three compounds from the ethyl acetate fraction of *Pterocarpus marsupium*, retusin-8-O-α-L-arabinopyranoside, naringenin, lupeol (25). The resolution of ethyl acetate extract of the aqueous decoction of dried heartwood of *Pterocarpus marsupium* yielded pterocarpol among other compounds (16). Handa *et al.* isolated and identified an isoaurone C- glucoside

named as pterocarposide (23). Suri *et al.* isolated a novel C-glucoside, 1-(2', 6'-dihydroxyphenyl)-β-D-glucopyranoside from the aqueous decoction of powdered dried heartwood of *Pterocarpus marsupium* (17). Maurya *et al.* prepared the aqueous extract of heartwood of *Pterocarpus marsupium* and isolated five new flavanoid C-glucosides: pteroside, pteroisoauroside, marsuposide, flavon C-glucoside, vijayosin and two known compounds, C-β-D-glucopyranosyl-2,6-dihydroxyl benzene and sesquiterpene (22). In another study, the bark of *Pterocarpus marsupium* was extracted with ethanol in a percolator and the phenolic constituent was identified as (-)-epicatechin. Two sterols, sitosterol and stigmasterol were also isolated (21). Tripathi and Joshi isolated two new flavonoid glycosides from the roots of *Pterocarpus marsupium*, 7-Hydroxy-6, 8-dimethyl flavanone-7-O-alpha-L-arabinopyranoside and 7,8,4'-trihydroxy-3', 5'-dimethoxy flavanone-4'-O-beta-D-glucopyranoside (26). The structures of some of the important constituents are shown in **Figure 1-10** (27-36).

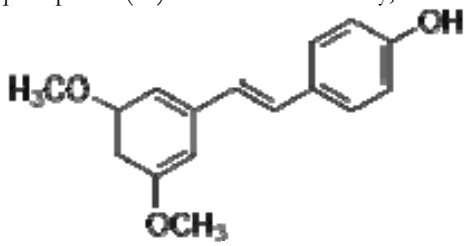

Figure 1: Pterostilbene

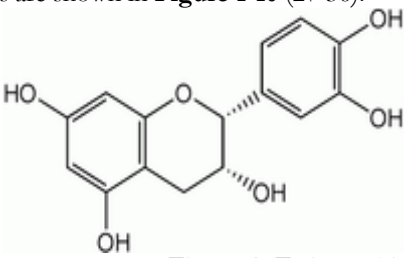

Figure 2: Epicatechin

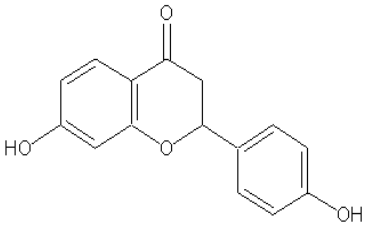

Figure 3: Liquiritigenin

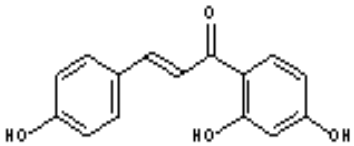

Figure 4: Isoliquiritigenin

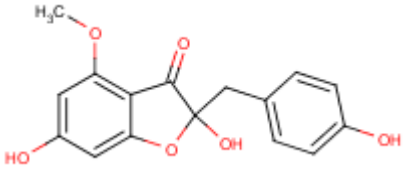

Figure 5: Marsupsin

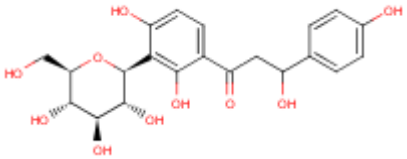

Figure 6: Pterosupin

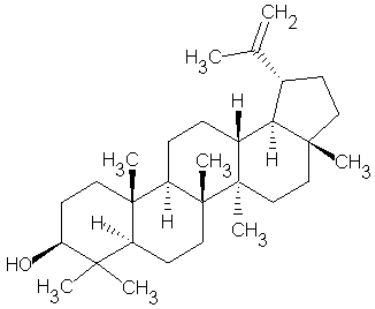

Figure 7: Lupeol

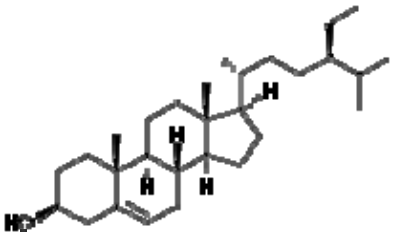

Figure 8: Sitosterol

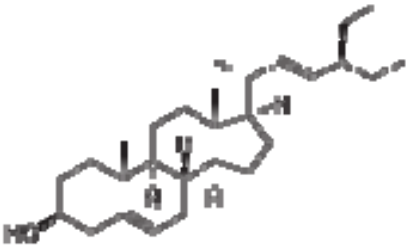

Figure 9: Stigmasterol

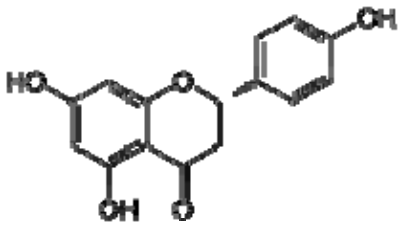

Figure 10: Naringenin

PHARMACOLOGY

i) Antidiabetic/Antihyperglycaemic/Hypoglycaemic activity

Grover et al. reviewed the medicinal plants having anti diabetic potential and found *Pterocarpus marsupium* to be one of the promising plants (37). Dhanabal *et al.* prepared the alcoholic extract of the bark of *Pterocarpus marsupium* and successively extracted with toluene, chloroform, ethyl acetate and butanol. These fractions were found to have beneficial effects on blood glucose levels (20). A flexible dose double blind multicenter randomized controlled trial undertaken from October 1995 till January 1998 concluded that vijayasar is an effective blood glucose lowering agent, its glycaemic effect being comparable to that of tolbutamide in treatment of naïve patients with Type 2 diabetes (38). In another study, an aqueous extract of *Pterocarpus marsupium* wood was screened for hypoglycemic activity on alloxan induced diabetic rats and the results were found to be statistically significant (39). Vats *et al.* extracted the bark of *Pterocarpus marsupium* and assessed the anti-hyperglycemic and hypoglycemic effect of *Pterocarpus marsupium* in normal and alloxanized diabetic rats. This study showed that the extract exhibited a small but significant hypoglycemic effect in normal rats and a significant and clear dose dependent anti-hyperglycemic effect (14). Manickam *et al.* evaluated the anti-hyperglycemic activity of phenolics from *Pterocarpus marsupium*. Marsupsin and pterostilbene significantly lowered the blood glucose level of hyperglycemic rats (40). A clinical study was conducted on potent hypoglycaemic plants and the result indicated that *Pterocarpus marsupium* is useful for treating non-obese diabetes (41). Ahmad *et al.* extracted the wood of *Pterocarpus marsupium* with absolute ethanol and then took the ethyl acetate soluble fractions which when tested upon alloxan-diabetic rats significantly lowered the blood sugar level with a corresponding increase in blood insulin level (18).

(ii)Anti-hyperinsulinaemic and anti-hyper triglyceridaemic activity

The aqueous extract of *Pterocarpus marsupium* bark substantially prevented insulin resistance (hyperinsulinaemia) and hypertriglyceridaemia (15). In another study, Jahromi and Ray administered the ethyl acetate extract of heartwood of *Pterocarpus marsupium* in 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 (16).

iii) Cardiotonic activity

In one study, it was observed that at a very high dilution the aqueous extract of heartwood of *Pterocarpus marsupium* produced negative chronotropic and positive inotropic effects in frogs. The results showed that the aqueous extract of *Pterocarpus marsupium* possesses an excellent cardiotonic activity (9). In another study, (-)- epicatechin extracted from the bark of *Pterocarpus marsupium* was studied and it showed cardiac stimulant activity in perfused frog hearts producing increase in force along with increase in rate. Thus (-)-epicatechin showed a cardiac stimulant property (21).

iv) Anti-cataract activity

Vats *et al.* demonstrated the anti-cataract activity of the aqueous extract of *Pterocarpus marsupium* bark. This was evident from the decreased opacity index in the alloxan induced diabetic rats (12).

v) COX-2 Inhibition

Hougee *et al.* performed a study in which a PGE_2 inhibitory effect of a commercially available extract of *Pterocarpus marsupium*, characterized by pterostilbene, was demonstrated. *Pterocarpus marsupium* extract decreases PGE_2 production indicating COX-2 specific inhibition (42).

vi) Hepatoprotective activity

In one study, it was demonstrated that the methanol extract of stem bark of *Pterocarpus marsupium* possesses hepatoprotective activity (43).

ANTIDIABETIC PREPARATIONS IN INDIA CONTAINING *PTEROCARPUS MARSUPIUM*

Some of the popular anti diabetic preparations, marketed in India, containing *Pterocarpus marsupium* among other ingredients are given in **Table 1.**

Brand name	Manufacturer
D-Fit cap.	Shree Dhanwantri Herbals, Solan.
Diabecon tab	Himalaya Drug Company, Karnataka.
Hyponidd tab.	Charak Pharma Pvt. Ltd., Solan.
Madhumehari granules and tab.	Shree Baidyanath Ayurved Bhawan Pvt. Ltd., Jhansi.

Table 1: Antidiabetic preparations containing Pterocarpus marsupium

CONCLUSION

In developing countries, providing modern healthcare facilities is still in infancy. Due to economic constraint, it is prudent to look for options in herbal medicines. *Pterocarpus marsupium* has been used as anti-diabetic since time immemorial. The beakers made from heartwood are filled with water and are allowed to stand overnight to give "Beeja Wood Water". *Pterocarpus marsupium* is being used commercially in pharmaceutical

preparations. This paper also reveals that the *Pterocarpus marsupium* has been extracted using variety of methods like infusion, decoction, maceration and percolation. In the *Pterocarpus marsupium* extract many chemical constituents like pterostilbene, marsupsin, pterosupin, (-)-epicatechin *etc.* have been identified and isolated. The literature review revealed that *Pterocarpus marsupium* can be used in variety of pharmacological disorders, however more investigations must be carried out to evaluate the mechanism of action of its active principles so that it's potential can be fully utilized.

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