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Plant Review

A Review on "Anjan" *Hardwickia binata* Roxb.: Its Phytochemical Studies, Traditional Uses and Pharmacological Activities

SP Shingade*, RB Kakde

ABSTRACT

Hardwickia binata commonly known as "Anjan" belonging to the family *Caesalpiniaceae* is a handsome medium or large deciduous ornament tree with graceful drooping branch lets is represented by a single species *Hardwickia binata* Roxb. It is used in folklore medicines for various ailments including diarrhea, leprosy, worm's infection, indigestion, leucorrhoea, chronic cystitis, gonorrhea, cancer, gram negative and gram positive bacteria and fungi. The parts of plant used as roots, leaves, bark, seed, wood, Husk. The review describes therapeutic efficacy of the leaves, seed, root, husk and its extracts and isolated compounds in different aliments such as antimicrobial, analgesic, antifungal, antibacterial, cardio protective, anti-inflammatory, antitumor and DNA polymerase β inhibition properties of *Hardwickia binata* were reported. A preliminary Phytochemical screening show that it comprises mainly phenolic compound, saponins, flavonoids, glycosides and tannins, carbohydrate, protein, amino acids, steroids, lipids, quinones, volatile oil, fats and fixed oil. Bioactivity-guided fractionation of an active methyl ethyl ketone extract of *Hardwickia binata* reported to the isolation of a potent inhibitor, named as Harbinaticacid, a novel diterpenoid and its potency as DNA polymerase β inhibitor. Root bark exudates has been traditionally used to cure breast cancer by Malayali tribes of Chitteri hills. The ethanolic leaf extracts of *Hardwickia binata* Roxb (Caesalpinaceae) showed a broad-spectrum of activity against both gram-positive and gram-negative bacteria and were screened for antibacterial activity. This systematic review aims to provide information regarding distribution, Morphology, Phytochemical Constituents, Traditional uses and also describes various pharmacological activities reported on the plant *Hardwickia binata* which may help in future research to improve human health care.

Key words: *Hardwickia binata* Roxb., Anticancer, Antibacterial, Antifungal, DNA polymerase β inhibitor, GC-MS, FTIR.

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INTRODUCTION

Hardwickia binata Roxb. is a native species of India that grows up to 25 - 30 m high, girth 1.8-3 m with a clean cylindrical bole up to 12-15 m, moderate-sized to large tree with drooping branches and dark grey, rough with deep crack bark contain tannins.[1-3] It is monotypic genus of flowering plant synonyms are *Hardwickia trapeziformis R. Grah.* and *Harongana madagascariensis* Chois. Subfamily Detarioideae of the legumes. This plant genus name *Hardwickia binata* as named to the plant after Thomas *Hardwickia* by William Roxburgh.[4] It is medicinally as well as economically important plant.[5,6] The tree yields an extremely hard, heavy, durable and a good quality timber that produces an excellent fuel. The trees make excellent firewood, good quality charcoal. The wood is extremely durable, hard and heavy makes excellent piles for bridge foundations, agricultural implements, carts and wheel work. It is also the source of a fiber, a resin and balsam, oleo-resin which has local medicinal uses.

TOXONOMICAL CLASSIFICATION

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonae
Order: Fabales
Family: *Fabaceae*/*Caesalpiniaceae*
Subfamily: Caesalpinioideae
Genus: *Hardwickia* Roxb.

COMMON NAME

Hindi: Anjan
Telegu: Yepi
Marathi: Kamara
Malayalam: Aacha
Tamil: Acha
Nepali: Papri

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DISTRIBUTION AND HABITAT

Hardwickia binata is a characteristics tree of the dry and hot climate and can grow mainly in dry to moist lowland tropics and subtropics, characterized by long period of drought, required scant to moderate rainfall. It is a native species of tropical South-Southeast Asia, Afghanistan, Bangladesh, Brunei, Cambodia, India, Indonesia, Iran, Laos, Malaysia, Myanmar, Nepal, Pakistan, Papua, New Guinea, Philippines, Thailand and Vietnam. In India, it is mainly found in the dry open forests of Central and South India[7] and some parts of U.P. and Bihar, western Himalayas up to 1500m.[8] In South India, it is found in Kadapa, Nellore and ceded districts and in valleys of Cauvery and Bhavani rivers.[9] The tree occur up to an altitude of 0-300m, The minimum temperature in its habitat 1 -10°C and maximum temperature varies from 43- 47°C, mean annual temperature 22 -34°C, mean annual rainfall the range from 500-1000mm but tolerates 250-1500mm. The tree growson sandstone, conglomerate, quartzite, granite, overlying soil of sandy ioam, shallow, gravely soils. It tolerates acidic to neutral soils, pH in the range 5.5-7.5, tolerating 4.5- 8.

MORPHOLOGY

It is a moderate to large sized deciduous ornamental tree with graceful, drooping slender branches crown conical in initial stage. The bark of tree is silvery white and smooth, changing to dark gray when tree get solder with rough, irregular vertical cracks, 1.2-2.5 cm tick, exfoliating in narrow flakes. Leaves are small alternate, pinnate, bifoliolate with two leaflets which are joined at the base. Leaflets are 2-6 cm long and 2-3 cm wide, sessile obliquely ovate, obtuse, glabrous, kidney shaped grayish green in color and coriaceous. Leave are drop in April and new leaves are appear in early May. Flowers are yellowish green in slender axillary racemes and terminal lax panicled appear from July to September. Sepals are on long, obtuse, whitish or yellowish green, petaloid. Stamens 10, ovaryoblong, stigma pellate.[3]

FRUIT AND SEED DESCRIPTION

The fruit is a samaroid pod, stap shaped, narrowed at both ends, glabrous, 5.7-6. cm long and 1-1.5 cm wide, oblong lanceolate, coriaceous, narrowed at both ends. Fruit appear after the flowering season and remain till May. The seed is exalbuminous, flat, about 2 cm long and 0.75 cm wide, in sub-reniform, slightly bended, pointed at one end and rounded at the other, there are fairly hard testa.

TRADITIONAL USES

The leaves extract showed a broad-spectrum activity against both gram positive and gram negative bacteria and fungi.[10] The resin obtained from the tree is used as a diuretics.[11] Bark contains tannins and astringent used in the treatment of diarrhea, worms, indigestion and leprosy, also produces an appetizer.[12] A balsam resin, combined with cubebs and sandal is used in the treatment of sexually transmitted diseases like leucorrhoea, chronic cystitis and gonorrhea.[13] Seed used for dysentery. The natives of Chhattisgarh region used leave for headache.[14] The native of kanker region used leave for purgative and constipation.

OTHER USES

Bark is used for making ropes, paper, cordage and sails.[15,16] *Hardwickia binata* yield heavy and hard timber which is used for making cart wheel, oil mill, pest and plous.[17] The wood is used for beam, mine, props, bride house construction. Leave issued for manures and mulch, cattle fodder.[18] The wood is hardest and heaviest in India. Resin yield from heartwood is used for dressings the sore of elephants.[19] Oleo-resin from heartwood is used in manufacture of varnishes.[20] The *Hardwickia binata* bark have a good sorption capacity for mercury and useful for removal of most of the mercury from water under certain condition.[21]

PHYTOCHEMISTRY

The Root bark exudates of *Hardwickia binata* are reported phytoconstituents of carbohydrates, glycosides, fixed oils and fats, proteins and amino acids, saponins, tannins, phytosterols, alkaloids, phenolic compounds, flavonoids while gums and mucilage are absents.[22] The heartwood contain β-sitosterol, (+)-taxifolin, eriodictyol, (+)-catechin,(+)-epicatechin and (+)- mopanol.[23] Leaves and seed contain Phenol, Flavonoids, saponin, glycosides, Tannins. Glycosides and Tannins.[24]

PHARMACOLOGICAL ACTIVITY

ANTIBACTERIAL ACTIVITY

Gunaselvi and Kulasekaren[25] have studied *in vitro*, screening of antibacterial activity of petroleum ether, chloroform, ethanolic leaves extract of *Hardwickia binata* Roxb. from 8 human pathogens such as *Bacillus subtilis, E. coli, P. aeruoinosa, S. typi, S. aureus, S. neeumonia, P. vularis and V. vulnificus*. Extract efficacy was evaluated using the agar well diffusion methods. The petroleum ether extract showed highest zone of inhibitions diameter of 22mm to 23mm against *P. vularis, S. aureus* and *V. vulnificus.* It's showed moderate zone of inhibition of diameter 20mm to 21mm against *B. subtilis, E. coli* and *S. typhi*. and lowest zone of inhibition of diameter 17 to 18mm against *P. aeuroinosa* and *S. pneumonia*. The chloroform extract showed the activity against *B. subtilis, E. coli, P. aeuroinosa* and *S. pneumonia, V. vulnificus.* The chloroform extract not produced the activity against *S. typhi* and *P. vularis.* It's showed the highest zone of inhibition diameter of 22mm against *S. aureus*. Moderate zone of inhibition against *B. subtillis* and *E. coli* with diameter 17-19mm. It's showed lowest zone of inhibition diameter of 16mm against *P. aeuroinosa* and S. *pneumonia, V. vulnificus*. The ethanol extract showed the high range of activity against all tested organism when compared to pet. Ether and chloroform extract.

Saranabasappa and Mallikharjuna[26] have studied antibacterial activity of ethanolic leaf extract of *Hardwickia binata* against gram positive *Bacillus cereus* and *Staphylococcus aureus* and gram negative, *Escherichia coli, Proteus vularis* and *Pseudomonas aeruinosa* bacteria using agar well diffusion assay at the 4mg/ml concentration in comparison with the streptomycin sulphate showed significant antibacterial activity.

ANTIFUNGAL ACTIVITY

Gunaselvi and Kulasekaren[25] studied *in vitro*, antifungal activities of petroleum ether, chloroform, etanolic leaves extract of *Hardwickia binata* robx from 4 human pathogens such as *Aspergillus niger, Aspergillus flavus, C. albicans* and *A. fumiatus* fungus using agar well diffusion method. Pet. Ether extract produced the activity against all tested fungus strains with zone of inhibition of diameter 15 mm to 19 mm at concentration of 100mg/ml. Chloroform extract produced the activity against all tested fungus strains with zone of inhibition of diameter 14 mm to 18 mm at concentration of 100mg/ml.

ANALGESIC ACTIVITY

Sharanbasappa and Mallikharjuna[26] studies on ethanolic leaf extracts of *Hardwicka binata* of the family leguminosae were screened for analgesic activity. It showed significant activity at the dose of 200mg/kg body weight after 90 min and up to 120 min in comparison with standard analgin.

ANTICANCER ACTIVITY

Prabakaran and Senthil Kumar were studies *in vitro* cytotoxicity assay methods against animal cell lines and human cancer cell lines. *In vitro*, crude extracts of root bark exudates of *Hardwickia binata* in petroleum ether, ethyl acetate, chloroform, methanol and water were tested for cytotoxic activity in African green monkey kidney Epithelial cells, (Vero), human Cervical Cancer Cell line (HeLa) and human Breast Cancer Cells (MCF 7) by MTT assay in concentration ranging from 32.25 µ/ml to 1000µ /ml. The cytotoxicity activity was found to increase with the polarity of the solvent, i.e. .petroleum ether > ethyl acetate > chloroform > methanol > water. Petroleum ether, ethyl acetate and methanol showed higher degree of inhibition against human Breast cancer cell line (MCF 7) human Cervical Cancer Cell Line (HeLa). The aqueous extract sowed week activity against the cell line tested.

DNA POLYMERASE β INHIBITOR

JineZen and Selley[27] studies on bioassay- guided fractionation of an active methyl ethyl ketone extract of *Hardwickia binata* using an assay sensitivity to DNA polymerase β inhibition, resulted in the isolation of novel diterpenoid named Harbinatic acid was established as3α-O-transpcoumaroyl-7-labden-15-oic acid from spectroscopic analysis compare with published data. *Hardwickia binata* showed potent inhibition of DNA polymerase β with an $IC_{50}$of 4.7 µM in the presence of bovin serum albumin and 2.9 µM in the absence of bovin serum albumin.

GC-MS ANALYSIS

Prabakaran and Senthil Kumar[22] studied on GC-MS showed the presence of 22 organic compounds out of which 18 compounds reported to possess various activities and five compounds possess anticancer activity. Components identified in the root bark exudates of *Hardwickia binata* Roxbs are Methyoxydi (-1pyrrolidiny) phosphine, 1-tert-Butyl-3-(3-metoxypenyl)-bicycle(1.1.1)pentan, Limonene dioxide, 2-(3-Cycloexylaminopropylamino) ethylthioposphate, Pentanoic acid,2-(2-hydroxy-2- methyl- 4- phenyl but-3-ynyl)amino-4- methyl, Decanoicacid, ethyl ester, cis-9-Hexadecenal, 4-Octadecenal, N-{3-(6-Hydroxyhexylexyl)aminopropyl}aziridine,9,12,15-Octadecatrienoic acid, methyl ester,(Z,Z,Z), 9,12-Octadecadienoyl chloride,(Z,Z),Octadecanoic acid, ethyl ester, 4-Hexenoic acid, 2-amino-6-hydroxy-4-methyl,9,12,15-Octadecatrienoic acid, ethyl ester,(Z,Z,Z), 8,11,14-Eicostrienoic acid,(Z,Z,Z), 5,8,11,14-Eicosatertraenoic acid, ethyl ester, {all-Z}, 2H-pyran-3-ol, 2-ethoxy-3,4-dihydro acetate, 3-{N-(2-Diethylaminoethyl}-1-cyclopentenylamino}propionitrile, Deoxyspergualin, 1H-3a,7-Methanozulene,octahydro-1,4,9,9-tetramethyl, Benzoic acid,4-nitro-1-methylethyl ester, Squalene. Most of the compounds have been reported to have antimicrobial, Hepato protective, Cardio protective while some have anti-inflammatory activity. Among the various bioactive compounds present, five have been reported as anticancer properties. They are 9,12,15-Octadecatrienoic acid, ethyl ester,(Z,Z,Z), 8,11,14-Eicostrienoic acid,(Z,Z,Z), 5,8,11,14-Eicosatertraenoic acid, ethyl ester, {all-Z},Squalene.

FTIR, GC-MS ANALYSIS

Deshmukh and Ghanawat[28] has worked on FTIR and GC-MS analysis of shade dried powdered leaves , seed and husk of *Hardwickia binata*. Ethanolic extract was analyzed using GC-MS confirmed 10 different compounds 1,1-dethoxy-ethan, tetradecamethyl-cycloheptasiloxane, linoleic acid, ethyl ester, ethyl oleate in leaves, seed and husk; hexadecanoic acid and ethyl ester found in only leaves and seed; 1-methyl-4-(1-methylethyl)-Benzene, 2-methyl-5-{1-methylethyl}-phenol,3,7,11,15-tetramethyl-2-hexadecen-1-ol are found only leaves; dodecamethyl-cyclohexasiloxane only in seed; thymol only in husk. These compounds showed anti-microbial, antifungal, anti-inflammatory, analgesic, cancer preventive, antioxidant antispasmodic. Crude powder of plant used for FTIR analysis and it showed the presences of alcohol, phenols, amines, amides, carboxylic acids, aromatics, alkenes, alkanes, aliphatic amines, esters, ethers alkynes, alkyl halides in leaves, seed and husk, saturated aliphatic found in only seed and aldehydes only in husk.

CONCLUSION

The plants of this genus possess anticancer, Analgesic, Antibacterial, Antifungal activities and DNA polymerase β inhibitor. The leaves extracts of *Hardwickia binata* Roxb. (Caesalpinaceae) showed a broad spectrum of activity against both gram-positive and gram-negative bacteria and fungi. Bioactive substances from this plant can therefore be employed in the formulation of antimicrobial agents for the treatment of various bacterial and fungal infections including gonorrhea, pneumonia, eye infections and mycotic infections. Isolation, identification and purification of these phytoconstituents and determination of their respective antimicrobial potencies and toxicological evaluation with the view to formulating novel chemotherapeutic agents should be the future direction for investigation. The ethnolic leaf extracts of *Hardwickia binata* of the family Leguminosae were screened for antibacterial and analgesic activities. The antimicrobial activity of petroleum ether, chloroform and ethanolic leaves extracts of *Hardwickia binata* Roxb. (Caesalpinaceae) possessed potential antibacterial and Anti-fungal activities. *Hardwickia binata* Roxb. (Fabaceae) root bark exudates have been traditionally used by tribes of Chitteri hills to cure breast cancer. This study also opens avenues for pharmaceutical researchers to develop a potential anticancer drug.

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CONFLICT OF INTEREST

The authors declare no Conflict of interest.

ABBREVIATIONS

GC-MS: Gas Chromatography Mass Spectroscopy; **FTIR:** Fourier Transform Infrared Spectroscopy.

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