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REVIEW ARTICLE ON MANILKARA HEXANDRA (KHIRNI)

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ABSTRACT

Manilkara hexandra commonly known as Rayan and Khirni is an evergreen tree species with a long history of traditional medicinal uses in South Asia chiefly in western and central India, belongs to family Sapotaceae. The genus Manilkara includes 135 plants that are distributed Worldwide. Sapotaceae family consists of 58 genus and just about 1250 species with morphological variation, ranging from shrubs to medium and giant trees. Brazil comprises of 11 genera, and 231 species, covering 1 endemic genus, and 104 endemic species. The plant has been famous for its curative properties and has been put to use for treatment of various ailments suchlike ulcer, bronchitis, jaundice, fever, hyper dyspepsia, arthritis and alimentary disorders. A record of the literature show extracts and metabolites from this plant having pharmacological properties such as anti–inflammatory, antiulcer, aphrodisiac, alexipharmic, anthelmintic, antibacterial, and free radical scavenging activity. Apart from medicinal uses, plant has high scale value because of its edible and nutritive fruit, useful wood, latex and bark and contributes substantial livelihood support to local inhabitants.

KEYWORDS: Khirni, Manilkara hexandra, Sapotaceae, Rayan, Pharmacological properties.

INTRODUCTION

Khirni (*Manilkara hexandra* Roxb.) Dubard syn. (*Mimusops hexandra* Roxb.) belongs to the family Sapotaceae. It is believed to be originated in India (Steward J.L. *et al*., 1992). It occurs naturally in forests and common lands particularly Central and Deccan Peninsular India (Machakanoor *et al*., 2018). It is cultivated in greater part of India as ornamental and wild sown near villages, common in wastelands and hedges, in plains, gregarious in patches in Saurashtra and also for the sweet edible fruits. Wastelands can be utilized by growing it. Khirni is commonly grown in laterite soil. It is mainly propagated by seeds. It is drought hardy and slow growing species. It has no improved varieties (Panchal G.P. *et al*., 2014).

The tree is long lived, small to medium size, with a spreading crown, straight growing and massive hole. Flowering occurs in the month of October–November–December and fruit ripens during May–June (Dwivedi *et al.*, 1974). Ripe fruits are eaten fresh or after dehydration, they are sweet but astringent. The seed contains 24.6% of edible oil. (Machakanoor *et al*., 2018).

It is an evergreen tree, 50–60 ft. Tall, with blackish gray and deeply furrowed bark; leaves are 7-10 cm long, elliptic, obovate or oblong, flowers are bisexual, white, calyx 6-lobed, corolla 16 or 24-lobed, stamens 6, ovary is hairy and multi–locular with axile placentation, fruit is berry, one seeded shining yellow with ovoid shape and seeds are endospermic and oily (Dwivedi and Bajpai, 1974). *M. Hexandra* give useful wood and latex which are important source of nutritional and livelihood support for tribal population (Peter, 1999).

Figure 1

Figure 2

Figure 3

Fig 1: Riped fruit of plant. Fig 2: Tegmen obtained by removal of seed coat from seeds. Fig 3: Seeds of plant Manilkara hexandra.

Although the fruits and plants have immense importance and potential, the commercial cultivation of khirni is restricted due to lack of healthy planting material. The work on vegetative methods of propagating khirni is very meagre, so new plants are prepared by raising seedlings only. The hard seed coat mess dormancy or 'hardseededness' and recalcitrant nature of khirni seeds results in low germination. . The tough seed coat hinders the imbibition of water and limits the gaseous exchange. The short viability of seeds prevents long term storage which further reduces bulk availability of planting material. In addition, the slow growth rate of khirni seedlings is also a disadvantage in its instant and mass multiplication. (Rai *et al.,* 2018).

LITERATURE REVIEW

Sapotaceae family accommodate 58 genus, and approximately 1250 species with morphological differences, ranging from shrubs to medium and giant trees. Brazil comprises of 11 genera and 231 species, including 1 endemic genus and 104 endemic species. This family has the following: synapomorphies, well-developed, elongate laticifers with white latex; 2-branched hairs, brownish, T-shaped; berry fruits, seeds usually with a hard shiny testa, and large hilum. The genus *Manilkara* Adans is constituted by 30 species in the neotropics, approximately 20 species found in Africa, and 12 species found in Asia and Pacific. Brazil has 18 species, from which 15 are endemic to this country. The genus *Manilkara* is characterized by calyx of 2 whorls or 3 sepals, presence of staminodes and hilum shape seed. Due to this genus circumscription, some species of the genera *Achras*, and *Mimusops* were included in *Manilkara*.

***Manilkara Subsericea* (Mart.) Dubard (**Frequently recognized as "maçaranduba", "maçarandubinha", and "guracica").

It is a widespread species from Brazilian Atlantic Rain Forest. Being employed as food, and timber (Fernandes *et al.,* 2015) Analysis of the chromatogram obtained from the hexanic extract from fruits of M. subsericea indicated the elution of 20 compounds. Substances with retention time (min) of 16.84, 16.99, 18.71, and 18.94 corresponded, respectively, to palmitic acid (5.41%), palmitic acid ethyl ester (3.57%), (E)-9-octadecenoic acid ethyl ester (3.95%), and unsaturated fatty acid ethyl ester (1.45%). These compounds were identified by comparison of their MS fragmentation pattern with NIST mass spectra.

The recent analysis designates the detection of a high-level percentage of drugs from the hexane extract of edible fruits of *Manilkara subsericea*, during which beta- and alpha- amyrin, caproates and caprylates are testified for the first time from this species. Our outcomes indicate that this hexane extract from fruits and ethanolic unrefined extract from leaves and stems mounted antimicrobial activity con to *S. aureus* ATCC25923. Furthermore, these extracts had minimal cytotoxicity on Vero cells, within the equivalent concentration which inhibited *S. aureus* progress. Quite a few biological reports are allotted for mixtures of beta- and alpha-amyrin type triterpenes (Pinto Holanda *et al.,* 2008; Aragão *et al.,* 2006; Soldi *et al.,* 2008), ever since their separation by conventional chromatographic methods is somewhat difficult (Dias, Hamerski and Pinto, 2011).

The inhibitory aptitude of ethanol, hexane, esters, or dichloromethane extracts and portions from stem and leaves of Manilkara subsericea contrary to in vivo (hemorrhagic and edema) and in vitro (clotting, hemolysis, and proteolysis) actions triggered by Lachesis muta venom. The complete confirmed activities were entirely or a minimum of somewhat reduced by M. subsericea. Although, when L. muta venom was injected into mice 15 min first or after the materials, hemorrhage and edema weren't inhibited. Thus, M. subsericea might be used as antivenom in snakebites of L. muta. And, this work also highlights Brazilian flora as an upscale source of molecules with antivenom properties (Oliveira *et al.,* 2014).

Manilkara Zapota (L.): (Also known as the **sapodilla**)
It is one amongst the most important crops in India, Southern Mexico, Caribbean and Central America likewise as in South East Asia. *M. zapota* fruit is incredibly popular in Malaysia, Thailand, Singapore, Cambodia and Indonesia with a pleasing sweet flavor which is sometimes utilized in the beverage industry. Fruit are often a decent source of nutrient, containing bioactive polyphenolic compounds (Shafii *et al.,* 2017).

Leaves and seeds of *M. zapota* contain D-quercitol, myricetin-3-O-α-L-rhamnoside, sapotin, sapotinine and saccharose (Pingale and Dash, 2015). Methyl chlorogenate, quercetin, (+)-catechin, (+)-gallocatechin, myricitrin, (–)-epicatechin, polyphenol oxidase, and β-carotene are the phytoconstituents which were identified in all told parts of the plant i.e. leaves, flowers, fruits, stem and therefore the roots (Rhourri-Frih *et al.,* 2103; Gomathy et al., 2013; Khan, 2016**)**. Arginine and lysine were also found to be present in the roots of *M. zapota* (Paul SR and Hakim, 2015).

Both methanol and ethanol extracts of *M. zapota* have good antioxidant activity (Kaneria *et al.,* 2009). The leaves, fruits and stem of sapodilla are reported to own analgesic, anti-inflammatory (Khalek *et al.,* 2015) and antidiarrheal activities. The ester and aqueous extracts of leaves of *M. zapota* have antifungal activity against *Alternaria alternate*, *Aspergillus Niger*, *Candida albicans*, *Curvularia lunata*, *Fusarium eumartii*, *Mucor hiemalis*, *Penicillum chrysogenum*, *Rhizopus stolonifera* and *Baker's yeast*. Methanolic extract of *M. zapota* showed best antibacterial activity against *Pseudomonas aeruginosa*, *Salmonella typhimurium* and *Enterobacter aerogenes*. The ester extract of leaves fruits and stem

bark of the *M. zapota* was reported against EAC cell lines. Methanolic extract of the plant showed cytotoxic activity against EAC, NAML-6, MCF7, K-562 and T47D neoplastic cell lines (Garg *et al*., 2018).

The hypoglycemic activity of petroleum ether extracts of leaves and methanol extracts of seeds of *Sapodilla* was evaluated within the study. The oral glucose tolerance test was performed in mice treated with 2 mg/kg glucose solution and therefore the blood glucose level makeup my mind after 15, 30, 60, 90 and 120 min of administration. Alloxan (70 mg/kg) was injected intravenously to induce diabetes. The hypoglycemic study was applied for 7 days. In glucose tolerance test all extracts achieved significant values ($p<0.0001$) at 60, 90 and 120 min compared to the glucose control. In hypoglycemic study all extracts began to reduce the glucose level rapidly even ranging from the 2nd day of treatment and significant values ($p<0.0001$) were achieved (Paul SR and Hakim, 2015).

Manilkara Littoralis: (Common name: Andaman Bullet-Wood, Sea Mohua, Tengevaka) Uses: Leaves, fruits and bark are used in fever and women's parturation problems (Sharma *et al.*, 2018)

Mimusops Elengi **Linn** (**English**: Spanish-Cherry, American Medlar, and Bullet Wood. **Ayurvedic**: Bakula, Keshara, Simhakeshara, Sthiraa, Sthirapushpa, Vishaarada, Dhanvi, Madhupushpa, Madhugandha, Chirpushpa, Maulsiri. Unani Molsari. Siddha Magilam.).

It is cultivated in North India, Western Peninsula and South India.

Pulp of ripe fruit is astringent and utilized in chronic dysentery. Flowers, fruit and bark are astringent. Bark is given for promoting fertility in women. Seeds are purgative. The leaves contain sterols, reducing sugars and tannins; roots, a steroidal saponin; stem bark, spinasterol and taraxerol; flowers, D-mannitol, beta-sitosterol and beta-sitosterol, D-glycoside; seeds, pentacyclic triterpene acids, Mimusopic and Mimusopsic acids.

Essential oil obtained from the plant is reported to be mycotoxin. Antimicrobial activity of the root extract has been reported. Saponins isolated from the seeds are found to affect the cardiovascular activity in dogs and hemolytic activity in humans. Spasmolytic activity in isolated ileum of guinea-pigs has also been recorded. Saponins from seeds also showed spermicidal activity (Khare, 2007).

Manilkara Chicle

It is a tropical evergreen tree native to Maxico and Central America. The tree ranges from Veracruz in Maxico south to Atlantico in Colombia. It produces a natural gum commonly identified as chicle, conventionally applied in manufacturing chewing gum and other products. (Wikipedia.org).

Chicle gum is obtained from oblique cuts or slashes made within the trunk of the tree during the rainy months. From these cuts they issue milky latex which is coagulated by heat, and is then formed into solid blocks for export. The heartwood is reddish-brown; it's distinctly demarcated from the yellowish or cream-colored sapwood. It's used for railroad ties, house building, and other purposes (Standley and Steyermark, 1946-1976).

The tree yields a considerable quantity of latex, which is declared to be difficult to coagulate, but is put to use as an adulterant of sapote gum (Manilkara zapote).The gum is engrossed in transmission belts, dentistry, and as a substitute for gutta-percha, a coagulum of the latex of Palaquium spp (World Agroforestry Centre).

Manilkara Jaimiqui: (Commonly stated to as wild dill (Natural resources conservation service)).

It is native to tropical regions of North America, where it's found within the Archipelago and South Florida. Its natural habitat is areas of Coastal hammocks and Pine Rockland's (Wild Dilly). This species is split into four well-marked subspecies, which show little geographic overlap. They are:

M. jaimiqui ssp. emarginata - The Bahamas and South Florida (Arthur, 1945)

M. jaimiqui ssp. haitensis - State and Haiti (IUCN Red List)

M. jaimiqui ssp. Jaimiqui - Cuba and Jamaica (IUCN Red List)

M. jaimiqui ssp. wrightiana - Cuba (IUCN Red List)

Manilkara Kauki

In Java, the plant is understood as **Sawo kacik**, and is accompanied with the royal Javanese ritual. Throughout the planet it's known generally by the name **caqui** but in Australia it's called **wongi** It takes place in tropical Asia from Indo-China (Cambodia, Myanmar, Thailand and Vietnam) to Malesia (Indonesia, Malaysia and Papua New Guinea); and also in northern Queensland in Australia (Agricultural Research Service, 2009).

All parts gave taraxerol, a triterpene ketone, alpha-and beta-amyrin, cinnamates, alpha-sitosterol, beta-sitosterol and its beta-D-glucoside, quercitol, quercetin and its dihydroderivatives, and ursolic acid. The bark contains 10% tannins.

Root and bark is astringent and given in infantile diarrhea. Seed are febrifuge, anthelmintic, antileprotic. Leaf used as poultice for tumors. Seeds contain about 16% of fixed oil and 1% saponin. For reforestation purposes, M. kauki could be a beneficial graft stock for M. zapota, and parts of the plant are utilized in herbal medicine (Agricultural Research Service, 2009). The

fruit is reported to be very tasty, and is traditionally eaten by sound Islanders, who travel from Island to Island to reap the crop.

Manilkara timber is employed for heavy construction, also up-to-date with the bottom or exposed to the weather: for house and bridge building, railway sleepers and telephone poles. It's also used for flooring and furniture. The wood of M. kauki incorporates a good reputation in Indonesia to be used in furniture and fine carving (particularly in Bali). The timber is additionally suitable for turnery, and has been used particularly for mills. The wood shows excellent properties for the assembly of charcoal.

The fruits of plant are edible but without much flavor. Fruits of M. duplicata Dubard yet M. hexandra are edible as well. M. kauki is additionally used successfully as rootstock for sapodilla fruit trees, and flowers and seeds of this species are applied in local medicine.

Trees of M. kauki are planted near palaces and temples, often during ceremonial events. (Uses.plantnet-project.org)

SYNONYMS

M. Hexandra is commonly known as

Obtuse Leaved Mimusops	English
Khirni and Rayan	Hindi
Rajadanah	Sanskrit
Ulakkaippalai and Palai	Tamil
Patla, Pola and Kirni	Telgu
Krini and Palamunpala	Malayalam
Hale and Hannu	Kannada (Warrier, 1995)

Plant Profile

Kingdom	Plantae (plants)
Sub kingdom	Tracheobionta (vascular plants)
Super division	Spermatophyta (seed plants)
Division	Magnoliophyta (flowering plants)
Class	Magnoliopsida (dicotyledanae)
Sub class	Dilleniidae
Order	Ebenales
Family	Sapotaceae
Genus	*Manilkara* Adans. (Manilkara)
Species	*M. hexandra* (Roxb.)

Traditional Uses

Generally, it's utilized in remedial herbal medicine to recover various ailments like jaundice, ulitis, odontopathy, fever, colic dyspepsia, helminthiasis, hyper dyspepsia and burning sensation (Joshi, 2000). It purifies the blood and beneficial in swelling, abdominal colic, gout, rheumatism and toxicosis (Rao, 1985). It consists of mixture of constituents which bear various biological properties such as anti–inflammatory, diuretic, antiurolithiatic, analgesic, antipyretic and antimicrobial activity. (Khare, 2007).

M. hexandra provide eatable fruit, appropriate wood and latex which are important source of nutritional and livelihood medium for ancestral population (Peter, 1999). The bark of this species is astringent, refrigerant, febrifuge, sweet, tonic and is used consistently to cure a wide spectrum of gastrointestinal ailments (Shah *et al.*, 2004). Oil of seeds of M. hexandra is demulcent and emollient (Anjaria, 1997).

The seed's oil is used as cooking oil by the natives. The Koli tribe uses the decoction of the bark in diarrhea for children. The stem bark is also recommended for fever, jaundice, helminthiasis, flatulence, stomach disorder etc. The seeds are studied for its pharmacognosy but, there are no reports on stem bark of the said plant (Gopalkrishnan et al., 2014).

Seeds are used as Cardiac Tonic and used in the treatment of Anorexia (Herbpathy.com). Also it increases muscle weight and cause Obesity. (easyayurveda.com)

Phytochemistry

The presence of sterols and volatile oil was observed in leaves of *M. hexandra* by phytochemical examination and significant chemical tests of aqueous and alcoholic extracts of leaves. Lead acetate test of leaf extracts also shows the presence of tannins (Madhak *et al.*, 2013).Cinnamic acid, hentriacontane , taraxerol and quercitol were isolated from leaves of *M. hexandra.* (Misra and Mitra, 1968).

The lipids, proteins, carbohydrates and moisture content of fresh fruits of *M. hexandra* through chemical examination is about 2.6%, 3.53%, 22% and 71.87% respectively (Daripkar and Jadhav, 2010). The fatty acid esters of common triterpene alcohols were present in its fruit pulps (Misra *et al.*, 1974).

Three bidesmosidic saponins that is to say saponin 1, 2 and 3 carrying protobassic acids and 16-hydroxy protobassic acid as aglycons and also three phenolic compounds just as gallic acid, myrecetin, and quercetin were isolated through chromatographic separation of acetone precipitate of seeds of *M. hexandra*. (Eskander *et al.*, 2013) The unsaponifiable lipid constituents were also isolated (Saeecd *et al.*, 1991).

Saponins and tannins in bark of *M. hexandra* through physiochemical, histochemical test and Thin Layer Chromatography of alcoholic, chloroform and water extracts of *M. hexandra* bark, were separated. A triterpenoid saponin, 1β 2α, 3β, 19α–tetrahydroxyursolic acid, 28–O–β–D–glucopyranoside and β–sitosterol have been set apart from the stem bark of *M. hexandra* (Shrivastav and Singh, 1994).

The cinnamic acid esters of α– and β–amyrins, α–spinasterol, taraxerol and quercitol from its roots have been separated. (Misra and Mitra ,1968).

The presence of starch, proteins, anthraquinone glycoside, terpenoids, cardiac glycoside, tannins and saponins in bark of *M. hexandra* through physiochemical, histochemical examination and Thin Layer Chromatography (TLC) of alcoholic, chloroform and water extracts its bark was achieved (Gopalkrishnan *et al.,* 2014).

Pharmacology

Antiulcer Activity: Antiulcer effects of acetone extract and its different divisions specifically diethyl ether, ethyl acetate and aqueous fractions of stem bark of *M. hexandra* have been for the occurrence of preliminary phytoconstituents and were investigated for their antiulcer potential opposing experimental gastro–duodenal ulcers. The antiulcer activity was shown by ethyl acetate extract as it decreases gastric acid secretary activity along with strengthening of mucosal defensive mechanisms. (Modi *et al.,* 2012) and (Shah *et al.,* 2004).

Immuno-Stimulant: Polysaccharides extracted from its bark considerably stimulate the immune system by intensifying macrophage function. (Gomathi, 2012). Acetone fraction of plant carrying the crude saponin mixture possessing momentous anti–inflammatory activity. (Eskander *et al.,* 2013).

Antidiabetic Activity: Methanolic extract of plant lessens the blood glucose level and shows considerable hypoglycemic effect. Their study indicates that it can be use in the management or control of type II diabetes.(Nimbekar *et al.,* 2013).

Antioxidant Activity: Methanol leaf extracts of plant showed strong 2, 2–diphenyl picryl hydrazyl (DPPH) radical scavenging activity. (Kumar *et al.,* 2010).

Antibacterial Activity: Antibacterial activity of aqueous, petroleum and alcoholic extracts of *M. hexandra* was examined using the agar disc diffusion and agar well diffusion methods and realized that ethanol or methanol extracts are affective against six bacterial strains belonging to *Enterobacteriaceae* and various infectious diseases.(Parekh and Chanda, 2007; 2010) The antimicrobial action of root extracts of plant formulated in different solvents were screened through agar well diffusion method, zone of inhibition was precised as an asset of antimicrobial activity and it was observed that methanol root extracts of *M. hexandra* demonstrated good antibacterial activity opposite to *Staphylococcus aureus, Micrococcus leutius, Salmonella paratyphi, Serratia marcescens and Klebsiella pneumonia*.(Bharwad *et al.,* 2011) Extract of plant illustrate antibacterial activity against multi drug resistant bacteria species i.e. *Salmonella typhy, S. paratyphe, Staphylococcus aurius and S. epidermis* which are coupled with skin, respiratory diseases and enteric fever. (Mahida *et al.,* 2007)

CONCLUSION

Mimusops hexandra is a well–known traditionally medicinal and commercially important evergreen tree species and widely used as herbal drug and as a source of livelihood support by local tribal population.

Histochemical and preliminary phytochemical analyses are useful in determining the biochemical constituents present in the plant drug. This report confirmed the presence of the rich variety of bioactive compounds in the species, Manilkara hexandra and it could lead for the development of the new pharmaceuticals that address hither to unmet therapeutic needs.

The phytochemical studies conducted on M. hexandra indicate presence of various phytoconstituents such as sterols, tannin, saponins, unsaponifialble lipids, triterpene alcohols, terpenoids and phenolic compounds such as gallic acid and quercetin etc.in different parts of the plant. Plant extracts of M. hexandra exhibit diverse categories of pharmacological activities such as antiinflammatory, antiulcer, antidiabetic, antibacterial and free radical scavenging activity etc.

For further study, with the help of developing analytical method pure active chemical compound should be isolated and identified on the basis of reference standards.

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