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Review Article

Maytenus emarginata: A Folklore Ethnomedicinal Plant of Rajasthan

Khichar Mukesh Kumar*, Sharma Manoj and Agrawal R.D.

Plant Pathology and Mycology Lab, Dept. Of Botany, University of Rajasthan, Jaipur, Rajasthan (India), 302004

ABSTRACT

Tribal or folk medicines system is based on use of herbal medicines by tribal communities, which includes utilization of crude extract from local medicinal plants by medicine-men of community. The tribal communities dominated in various parts of Rajasthan harbors a vast diversity of vegetation. The surrounding plants form an integral part of culture of tribal people and the medicinal knowledge of plants is passed on from generation to generation through oral folklore and mythical stories. Ethno-botany is the study of plants and their practical uses through traditional knowledge by local inhabitants of a region. *Maytenus emarginata* Ding Hou is a Celastraceae family plant. It is locally known as 'Kankero' in hindi and Thorny staff tree in English. Various parts of this plant were used traditionally in folk culture for the treatment of various ailments. This review article includes therapeutic uses of crude extract of various parts of plant *Maytenus emarginata* and its phyto-chemical constituents. In this review article, we studied about anti-microbial, anti-oxidant, anti-cancer, hepato-protective, anti-ulcerogenic activities of this plant.

Keywords: folk medicines, medicine-men, folklore, anti-cancer, hepato-protective.

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*Address for Correspondence:

Khichar Mukesh Kumar, Plant Pathology and Mycology Lab, Dept. Of Botany, University of Rajasthan, Jaipur, Rajasthan (India), 302004

INTRODUCTION

Herbalism or Herbology include study of various types of medicinal plants, which are used for many purposes, including medical purpose. The medicinal properties of herbs lie in secondary metabolites with *in situ* functions including growth regulation, inter and intra-specific interactions, and defense against predators and infections.

Plants have been used for medicinal purposes long before prehistoric period due to their medicinal value but the factor responsible for that particular medicinal value is unknown to them. Among which Unani Hakims, Indian Vaidis and European and Mediterranean cultures are the first and foremost to start using plant as medicine. Among ancient civilizations, India has been known to be rich repository of medicinal plants among which Ayurveda, Unani, Sidha and Folk (tribal) medicines are the major systems of indigenous medicines.

Tribal or folk medicines system is use of herbal medicines by tribal communities, which includes distinct socio-cultural practices, religious beliefs, support of traditional ability and services of traditional medicine provided by various people having good knowledge of medicinal plants. The tribal communities dominated in various parts of Rajasthan harbors a vast diversity of vegetation which includes

subtropical evergreen forest of *Boswellia serratta*, *Diospyras melanxylon*, *Dendro calamusstricus*, *Maytenus emarginata*, *Bombax cieba*, *Madhuca indica*, *Tectona grandis*, *Anogeisus latifolia* and *Balanites aegyptiaca*. The surrounding plants communities form an integral part of culture of tribal people and the medicinal knowledge of plants is passed on from generation to generation through oral folklore and mythical stories¹.

Historical prospective

Historically plants were the major source of medicine from very early time as long as 2000 BC. The oldest written evidence of medicinal plants uses for the preparation of drugs has been found on a Sumerian clay slab from Nagpur, approximately 5000 years old². The Chinese book "Pen T Sao" by Emperor Shen Nung circa 2500 BC, includes 365 drugs from the dried parts of medicinal plants^{3,4}. The Indian holly book Vedas, include medicinal properties of plants.

The Ebers Papyrus, written in 1550 BC includes a collection of 700 medicinal plants and drugs for therapeutic uses^{5,6}. The excellent work of Hippocrates (459-370 BC) classified 300 medicinal plants on the basis of their physiological action; Common Centaury plant (*Centaureum umbellatum*) against fever, Garlic against intestine parasites, Opium and Henbane as narcotics, Asparagus as diuretics and, Oak and

Pomegranates as astringents^{7,8}. Theophrastus (371-287 BC) founded the botanical science with his books "De Causis Plantarum" named as Plant Etiology in English and "De Historia Plantarum"- named as Plant History in English both of which combinedly includes more than 500 medicinal plants^{9,10}. Celsus (25 BC-50 AD) presents medicinal uses of herbs work in his book "De re Medica"¹¹. "De Materia Medica" the classical book on medicinal importance of plants is written by Dioscorides (the father of pharmacognosy)¹². While the peoples of ancient time used medicinal plants primarily as simple pharmaceutical forms such as infusions, decoctions and macerations, but in later time the demand for compound drugs increased (A drug which have composition from both plant and animal origin).

Distribution and Habitat of plant

Maytenus emarginata ; - *Maytenus emarginata* Ding Hou is a Celastraceae family plant. It is locally known as 'Kankero' in hindi and Thorny staff tree in English. It is a sacred plant for environment-friendly Bishnoi community in Rajasthan. It is believed that Lord Jambheshwar (Jambhoji) had realization under the tree of *Maytenus emarginata*¹³.

The species of *Maytenus* found mainly in deciduous scrub forests from plains to 1000 meter elevations. Worldwide it is mainly distributed in India, Sri Lanka, South-West Asia and South-East Asia. In India, *Maytenus* genus is distributed in drier parts of central, north-western and south-western India. It is mainly found in Madhya Pradesh, Uttar Pradesh, Punjab, Delhi, Bihar, Rajasthan, Gujarat, Maharashtra and Tamilnadu. In Rajasthan it is growing as a xerophytic plant, it grows in moderately fertile, moist but well drained soil, mostly confined to Aravali hills and western semi drier part.

Maytenus emarginata is a small spiny tree or shrub which grows up to 6 meter in height. It is mostly growing at high elevations from near sea level and abundant at the edges of mangrove forests or secondary forests, hillsides and in patches of saline water in desert.

Botanical classification and botanical description:

Botanical classification

Kingdom : Plantae
Phylum : Magnoliophyta
Class : Magnoliopsida
Order : Celastrales
Family : Celastraceae
Genus : *Maytenus*

Botanical name: *Maytenus emarginata* (Willd.) Ding Hou

Synonyms:

- *Celastrus emarginatus* Willd.
- *Gymnosporia emarginata* (Willd.) Thw.
- *Gymnosporia Montana* (Roth.) Benth.

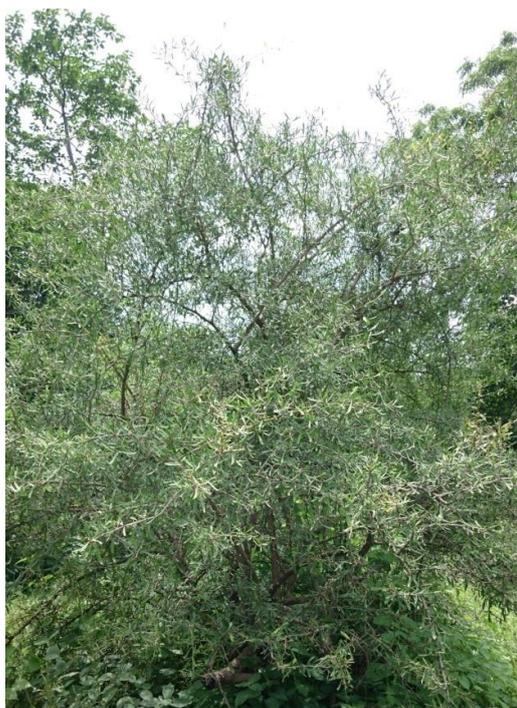
Botanical description:-

The members of Celastraceae family generally grow as trees or shrubs and include about 50 genera and 850 species. All the botanical descriptive characters of *Maytenus emarginata* are listed below:

Plant type: - Evergreen, Dioecious tree, Very hard plant.

Growing requirements: - Light- full Sun with middy shade, soil- sandy soil and lime soil, best growing season- monsoon, drought tolerance- various types of stresses of desert.

- Bark: Pale brown, smooth, cracked.
- Leaf: Thick, coriaceous and usually longer than 40mm, apex rounded, alternate on young branches, fasciculate on older ones.



(A)



(B)

Maytenus emarginata (A. Plant; B. Bark)



(C)



(D)

Maytenus emarginata (C. Leaves; D. Fruits)

THERAPEUTIC USES AND PHYTOCHEMISTRY

Secondary plant extracts of the Celastraceae family have been used from centuries throughout the South America, China and India, as insect repellents and insecticides in traditional agriculture and, also for the treatment of a plethora of medical ailments from stomach complaints and fever to rheumatoid arthritis and cancer. In some recent studies, Hussein *et al.*, found that biomolecules from

Maytenus species has been active against HIV-protease. Similar studies were done by Tin-wa *et al.*, against carcinoma and leukemia. Biochemical from *Maytenus emarginata* have been reported to be active against ulcers and MDR (Spivey *et al.*, 2002)¹⁴.

Various parts of this plant were used traditionally in folk culture for the treatment of various ailments, which are mentioned in table no 1.

table no 1: Various parts of *Maytenus emarginata* plant were used traditionally in folk culture for the treatment of various ailments

Plant part	Uses	Reference
Leaf		
Pulverized leaves + milk	As a vermifuge	Kothari <i>et al</i> , 2000 ¹⁵
Decotion of leafy twigs	As mouthwash	
Burnt leaves + ghee	To heal sores	Pullaiah <i>et al</i> , 2006 ¹⁶
Ash of leaves	For wound healing	
Tender leaves	In jaundice	
Stem		
Tender shoots	Treatment of mouth ulcers	Spivey <i>et al</i> , 2002
Stem bark + mustard oil	Kill lice in hairs	Pullaiah <i>et al</i> , 2006
Decotion of stem + black pepper	In pneumonia and cold fever	Kapoor and Kishor, 2013 ¹⁷
Fruits		
Fruit in powder form	Used for purify blood	Agarwal and Nag ¹⁸
Roots	In gastrointestinal troubles especially in dysentery	Spivey <i>et al</i> , 2002

Phytochemical constituents:-

Phytochemicals are chemical compounds that occur naturally in plants. The term is generally used to refer to those chemicals that may have biological significance, such as antioxidants, but are not established as essential nutrients. Phytochemicals are natural occurring biochemical in plants that give plants to their color, flavor, smell and texture. These biochemical were traditionally used as pharmaceutical biochemical, fragrances, food colors and flavors (Leung)¹⁹.

Many plant groups are recognized for their ability to produce secondary metabolites and many of these were used for centuries to treat a variety of diseases. Most of natural products from plants have been shown to present interesting biological and pharmacological activities and are used as chemotherapeutic agents or serve as the starting point in the development of modern medicine systems (Kamplé and Pradhan, 1988²⁰ and Harborne,1998²¹). Plant secondary metabolites provide unlimited opportunities for new drug development, because of the unmatched availability of chemical diversity and are either used as pure compound or as standardized plant extracts. In plants, various types of secondary metabolites such as alkaloids, terpenes, flavonoids, phytosterols, saponins, terpenoids, carotenoids, anthocyanins, xanthophylls are found.

Mathur and Goswami²² studied phytosterol composition of *Maytenus emarginata* fruit, leaves, flowers, stem and unorganized tissues and found that β -sitosterol, stigmasterol and total sterol content were found maximum in leaves and minimum in fruits. Stem showed amount of total sterol and individual sterols higher than fruit, but less than flower and leaves. Furthermore, unorganized tissue showed very little amount of sterols. Among all sterols, β -sitosterol showed higher % abundance as compared to stigmasterol. Materiya *et al.*,²³ worked on leaf and stem of *Maytenus emarginata* for

estimation of phytochemicals and determined phenolic and flavonoid content by using folin-ciocalteu assay and aluminium chloride colorimetric method respectively. In this study, they found that leaf has maximum amount of flavonoids content followed by tannins, steroids, triterpens and cardiac glycosides. Stem has maximum amount of tannins, followed by flavonoid, triterpens and alkaloids which are present only in trace amount. Phytocompounds from stem, leaf, root and fruit of *Maytenus emarginata* were also evaluated by Dhawale and Ghyare²⁴ and concluded that flavonoids were present in methenolic extract of fruit and aqueous extract of leaves. While tannin and phenolic compounds present in all plant extracts.

Estimation of flavonoid content from *Maytenus emarginata* was done by using Subramanian and Nagarjan, 1969²⁵ method. In this study, the maximum amount of flavonoids (Luteolin, Kaempferol, Quercetin) and total flavonoid content was found in flowers and minimum in leaves. Among all flavonoids, luteolin found in maximum amount, while quercetin found in minimum amount. Quantitative estimation of all the identified flavonoids was done by using colorimetric method of Kariyon *et al*, 1953 and Naghski *et al*, 1975²⁶, in case of quercetin is done by Mabry *et al*, 1970²⁷, in case of luteolin and kaempferol by Mathur and Goswami, 2012²⁸. Sagwan *et al*, 2011²⁹ investigated total phenolic content of root, stem, leaf and fruits of *Maytenus emarginata*, and found that total polyphenols were higher in roots (0.72_{+0.01} mg/g dw) and lower in stem (0.32_{-0.03} mg/g dw). Harshchandra *et al.*,³⁰ studied phytochemical constituents of *Maytenus emarginata*. They found that cardiac glycosides were present in higher amount followed by alkaloids, steroids, triterpens, flavonoids and saponins. In similar studies on *Maytenus*, Sagwan *et al*, 2010³¹ evaluated primary metabolites in different solvents and found maximum extractive value (4.230%) in water extract among all test solvents.

Table 2: Various Phytochemical constituents reported in *Maytenus emarginata* plant

Nature of metabolite	Identified phytochemical
Flavonoids	Luteolin, Kaempferol, Quercetin
Phytosterol	β -sitosterol, Stigmasterol, Cholesterol, α -Amyrin acetate
Triterpenoid	Lupeol, Valemol
Alkaloid	Evonine
Triterpene	Squalene, Betulin, Friedelin, Lupenyl acetate, α -Caryophyllene, Isovellerdial, Germacrene A
Triterpene glycoside	Methyl commate C, Methyl commate A
Alkane hydrocarbon	Tridecane, Dodecane
Alcohol	Glycerin
Aromatic compounds	Myoinositol
Fatty compounds	Myristic acid, Pentadecanoic acid, Palmitoleic acid, Eicosanoic acid, α -Monostearin, n-Hexadecenoic acid, 9-Hexadecenoic acid, Octadecanoic acid, Linoleic acid

PHARMACOLOGY:

Maytenus plant has many pharmacological role in herbal medicine system used by tribal peoples. A lot of pharmacological investigations have been carried out by researchers, based on phytochemical ingredients in this plant. Other than these findings, much pharmacological work still be explored. In this section, some important pharmacological activities summarizes below.

Antimicrobial activities

Extensive use of synthetic antibiotics in day to day life increases incidence of resistant in pathogenic microbes. This fact proves that current antimicrobial agents are not sufficient to control antibiotic resistant bacterial infection (Riffel *et al*, 2012³²). Phytochemicals present in traditional medicinal plant have received significant attention because they may lead to new drug discoveries (Amor, 2009³³).

Scientists working in field of phytochemistry have main aim to isolate and characterize active phytochemicals from plants, because these chemicals provide high activity profile drugs (Vaghiasya, 2011³⁴).

Practically, antimicrobial activity of various plant extracts was checked by different methods, such as agar-well method, disc-diffusion method. Dhawale and Ghyare, 2016 evaluate antimicrobial activity by using agar disc diffusion method³⁵. In this they conclude that methanol extracts were showing better results as compare to acetone and aqueous extracts. Methanolic extracts from different plant parts were showing higher zone of inhibition against *S. aureus* bacterial strain. Two fungal strains were also screened by Dhawale and Ghyare against various solvent (aqueous, methanol, acetone) extracts. *F. oxysporum* gives maximum zone of inhibition against methanolic extract of fruit, while *F. proliferafum* gives maximum zone of inhibition against methanolic extract of root.

Similar work was done by Pooja et al (2014) using agar-well diffusion method against four gram negative and four gram positive pathogenic bacteria. In this study the stem of *Maytenus emerginata* were showing best antibacterial activity against gram positive bacteria in acetone solvent. In *Maytenus emerginata* there was a direct correlation between total phenolic compound and antibacterial activity. Acetone extract of stem had maximum TPC and this is why it was showing maximum inhibitory activity. Plant secondary extracts were rich in phenolic compound such as flavonoids and tanins have better antibacterial effects³⁶⁻³⁸.

Sagwan et al (2012)³⁹ work on comparative analysis on MIC of *Maytenus emerginata* against gram positive and gram negative bacterial and fungal strains. In this study maximum inhibitory activities found in root extracts against *P. aeruginosa* and *F. oxisporum*, while leaf extracts were showing maximum antimicrobial activity against *P. aeruginosa* and *A. flavus*.

Antioxidant activity

Methanolic extract of leaves of *Maytenus emerginata* have a significant amount of total phenolic content (10.69mg calg). Due to higher amount of phenolic compounds these extracts were showing remarkable activities to scavenge ROS. This high antioxidant activity (scavenge of ROS) compared to standrad antioxidant (Ascorbic acid) could be due to high phenolic content^{40,41}. Many biological processes and metabolic reactions produce reactive oxygen species, such as singlet oxygen ($1O_2$), hydrogen peroxide (H_2O_2), superoxide anion (O_2^-) and hydroxyl ($OH\cdot$) radicals. These ROS creates homeostatic imbalance in body, which finally leads to an oxidative stress, cell death and tissue injury⁴². So, there is a great interest for new discovery of natural antioxidants for treatment of oxidative stress or damage related diseases⁴³. Dhanasree and Nizamuddin, 2015⁴⁴ evaluated *Maytenus emarginata* leaves extracts for determination of reducing antioxidant power⁴⁵, for DPPH radical scavenging activity⁴⁶, for nitric oxide radical scavenging⁴⁷, for hydroxyl radical scavenging activity⁴⁸, for super oxide radical scavenging activity⁴⁹ and also evaluation of x-glucosidase activity⁵⁰. In this study Dhanasree & Nizamuddin found antioxidant activity ranges from 5.65 to 24.54 mg AAE/g dw in the leaf extracts. Highest activity was found in Hexane extract. Alcoholic and aqueous extract showing Ic 50 of 173.47 and 286.66 ug/ml x-glucosidase activity respectively.

In similar studies, Gupta & Sharma, 2011⁵¹ investigated methanolic extracts of leaves of *Maytenus emerginata* for screening of antioxidant activity by using DPPH free radical assay and Iron chelating activity assay. Phenolic compounds

are natural antioxidants which act as free radical terminators, reducing agents, hydrogen donors and singlet oxygen quenchers. Sagwan et al, 2011⁵² studied antioxidant activity of methanolic extracts of different parts of *Maytenus emerginata* by using DPPH free radical assay described by Hatano et al, 1988⁵³. DPPH (1,1-Diphenyl-2-picrylhydrazyl) is a free radical and is widely used in determining radical scavenging activity of a compound or a plant extract. In these method different concentrations of extract produces Calibration Curves, used in determining IC 50 (inhibitory concentration 50%) value, which denotes 50% scavenging of DPPH free radicals⁵⁴. In present study, Sagwan et al found highest free radical scavenging activity in methanolic root extract with IC 50= 49.32 ug/ml. Free radical scavenging activity showing by different parts *Maytenus emerginata* are roots > leaf > fruit > stem.

Anticancer activities:

Anticancer activity of plant products was due to the presence of chemotherapeutic agents. Chemotherapeutic drugs can be divided into alkylating agents, antimetabolites, anthracyclins, plant alkaloids, topoisomerase inhibitor and other antitumor agents⁵⁵. Nagveni et al,⁵⁶ screened methenolic extracts from leaves and stem of *Maytenus emarginata* for antimitotic activity by using *Allium cepa* method^{57,58}, for seed germination assay by using Green gram seed⁵⁹ and for Brine shrimp lethality test using *Artemia salina* eggs⁶⁰. In this study methotrexate was used as standard anticancer drug. They demonstrate leaves are potent as than stem. Methanolic extracts from *Maytenus emarginata* were tested against human cell lines (Hep3b; Hepatocellular carcinoma, Hela; Cervical epithelial cancer and A549; Human lung adrenal cancer) for anticancer activity. The plant crude extracts were significantly affect cancer cell lines in two ways:- by anti-proliferation effect (decreasing metabolically active cells) and by cytotoxicity effect (decreasing number of live cells) (Harshchandra et al.,

Many anticancer bioactive compounds such as maytansinoids with antitumor activity⁶¹, quinoid triterpenes^{62,63} and triterpene dimers^{64,65} with cytotoxic activity, sesquiterpene polyesters with anti tumor activity⁶⁶ are reported from the genus *Maytenus* from the celestraceae family. Some dilactone bridged dihydroagarofuran structure compounds were isolated from the stems and branches of *Maytenus emerginata*. These compounds including Emarginate A, Emarginate B, Emarginate E, Emarginate F, and Emarginatinine and Emarginate G have *in vitro* cytotoxicity effect against Human epidermoid carcinoma⁶⁷, Human colon adenocarcinoma, Human medulla-blastoma and murine lymphocytic leukemia cell lines⁶⁸ (Sagwan 2011).

Hepatoprotective Activity

Liver disorders and its related diseases are serious problems and a satisfactory allelopathy remedy is yet to discover. But in folk culture, without knowing the actual process of action, *Maytenus emerginata* is used widely as a hepatoprotective agent, so there is a need to do chemotaxonomy of compounds, which is hepatoprotective in nature. Pathan et al., 2014⁶⁹ investigates hepatoprotective activity of ethanolic extract of *Maytenus emerginata* against paracetamol induced toxicity in male wistar rats. Paracetamol injury increases the amount of biochemical marker enzymes ALP, ALT and AST in serum with decrease in serum albumin⁷⁰⁻⁷⁶. Researchers found that 150 mg/kg B.W. of ethanolic extract of *Maytenus emerginata* significantly decrease the amount of marker enzymes and increase the albumin in serum. Ethanolic extract of *Maytenus* showing results comparable with standard drug silymarin.

Antiulcerogenic Effect

Peptic ulcer is the common gastro-intestinal trouble in clinical practices. Prolonged use of synthetic anti-ulcer drugs leads to adverse drug reactions including arrhythmia's impotence and hematopoietic changes⁷⁷ on human health. So there is a need to search for new anti-ulcer agents from Herbal medicine that retain therapeutic efficacy. Poonia & Singh, 2013⁷⁸ studied anti-ulcer activity in alcoholic extracts of leaves of *Maytenus emarginata*. In this study they use aspirin induced gastric ulcer pyloric ligation model⁷⁹. Orally administered alcoholic extract from *Maytenus* plant significantly decrease the volume of gastric acid secretion, free acidity and ulcer index and increases PH in aspirin induced wistar albino rats.

CONCLUSION

This review article revealed ethnomedicinal importance of *Maytenus emarginata*. The extensive survey of literature on *Maytenus* plant revealed that it has various important pharmacologically and medicinally phytochemicals. The plant has also been widely studied for its many pharmacological activities such as antimicrobial, antioxidant, anticancer, hepatoprotective and antiulcerogenic. *Maytenus emarginata* has been used for many years by the local tribal communities for the treatment of common diseases. Although this plant is the venerable plant of the environment friendly Vishnoi community, yet the number of this plant is decreasing continuously in Rajasthan. Therefore, there is a need to increase awareness about this plant. This review article has focused on several types of medicinal properties of plant, which suggests that further research is needed on this plant.

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