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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

OPEN ACCESS Pakistan Journal of Biological Sciences

ISSN 1028-8880
DOI: 10.3923/pjbs.2025.677.684

Review Article
Ecology, Botany and Medicinal Properties of *Terminalia myrtifolia* (M.A.Lawson) Gere & Boatwr. (Combretaceae)

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Abstract

Terminalia myrtifolia (M.A.Lawson) Gere & Boatwr. has a long history of medicinal use in tropical Africa. The primary purpose of this study was to review the ecology, botany and medicinal properties of *T. myrtifolia*. A search for available information on the ecology, medicinal uses and ethnopharmacological properties of *T. myrtifolia* was conducted by systematically searching the scientific databases such as ScienceDirect®, PubMed®, Web of Science, SpringerLink®, Google Scholar, Scopus® and SciELO, as well as pre-electronic literature sources such as book chapters, books and other scientific publications obtained from the university library. This study showed that the bark, fruits, leaves, roots or stem bark of *T. myrtifolia* are used as traditional medicines for menstrual problems, dysentery, fever, infertility or sterility, swellings of the stomach, venereal diseases, sores and wounds. The ethnopharmacological evaluations showed that the crude extracts and phytochemical compounds isolated from the species have antibacterial, antifungal and antiproliferative activities. To realize the full potential of *T. myrtifolia* as an herbal medicine, future studies should focus on conducting detailed phytochemical, pharmacological and toxicological evaluations, *in vivo* and clinical research.

Key words: Combretaceae, materia medica, myrtle bushwillow, terminalia myrtifolia, tropical Africa

Citation: Maroyi, A., 2025. Ecology, botany and medicinal properties of *Terminalia myrtifolia* (M.A.Lawson) Gere & Boatwr. (Combretaceae). Pak. J. Biol. Sci., 28: 677-684.

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Competing Interest: The authors has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Terminalia myrtifolia (M.A.Lawson) Gere & Boatwr. Fig. 1(a-c). It is a plant species known for its crucial role in maintaining and enhancing environmental quality[1]. This species is also an important non-timber forest product (NTFP) in tropical Africa, valuable as food, fodder, traditional medicine and a source of raw materials for various uses[1-6]. Throughout the human history, NTFPs have been used for a variety of purposes like domestic materials, soap, detergents, food, dyes, fodder, resins, fibre, medicinal and aromatic plants, agricultural amenities, spices, construction materials, paper and many of them are associated with different cultures and rituals of local communities[7-14]. Literature studies show that various NTFPs are also known to satisfy household, commercial, socio-economic and environmental values of local communities and/or generate substantial income for the households and communities[7,13,15,16]. The livelihood security of rural people in many developing countries depend greatly on the status and condition of the natural resources such as NTFPs[7,15]. They have the potential for livelihood support, poverty alleviation, biodiversity conservation and economic growth of rural and peri-urban communities worldwide[17,18]. The growing commercial trade of some NTFPs, in particular herbal or traditional medicines, crafts and construction materials, has resulted in an increase in the harvest volumes from the wild areas where most NTFPs are collected or harvested from, leading to over-exploitation of many of these species[15]. The NTFPs are also threatened by the fragmentation of the species' habitats and also conversion and degradation of such habitats[19]. Over the last 30 years, the management of NTFPs has been receiving increasing attention from researchers, resource users and development agencies. Research by Shrestha *et al.*[16] showed that sustainable exploitation of NTFPs and commercialization of these natural resources is important for socio-economic development, livelihood enhancement and poverty reduction in many developing countries. It is therefore, within this context that the current study was undertaken to review the ecology, botany and medicinal properties of *T. myrtifolia*. With this in mind, the traditional uses of *T. myrtifolia* and the recent pharmacological studies of the species are discussed.

MATERIALS AND METHODS

The literature search for the ecological, medicinal and ethnopharmacological properties of *T. myrtifolia* was conducted from July to December, 2024 using online search databases used including Scopus®, ScienceDirect®, Web of Science, SpringerLink®, SciELO, Google Scholar and PubMed®. The pre-electronic sources which included books, book chapters, journal articles, dissertations and theses obtained from the university library, were also used. The keywords used in the search included "*Terminalia myrtifolia*", its synonym "*Pteleopsis myrtifolia*" and English common names "Myrtle bushwillow", "Myrtle-leaved pteleopsis", "Pteleopsis", "Stink bushwillow", "Two-winged pteleopsis", "Two-winged stinkbush", "Two-winged stink bushwillow" and "Variable bushwillow". An additional search was also conducted using the keywords "Biological activities of *Terminalia myrtifolia*", "Ecology of *Terminalia myrtifolia*", "Pharmacological properties of *Terminalia myrtifolia*", "Ethnobotany of *Terminalia myrtifolia*", "Medicinal uses of *Terminalia myrtifolia*", "phytochemistry of *Terminalia myrtifolia*" and "traditional uses of *Terminalia myrtifolia".*

RESULTS AND DISCUSSION

Taxonomy and morphological description of *Terminalia myrtifolia*: The genus *Terminalia* consists of approximately 190 species and is fairly cosmopolitan in distribution, recorded across the tropical areas of Asia, Africa, America and extending into the subtropical regions of the Pacific Islands and Australia[20-26]. The genus *Terminalia* comprises trees, shrubs and lianas, characterized by the leaves which are simple, without scales, that are alternate, spirally arranged or sometimes opposite or nearly opposite and are usually terminal or crowded towards the ends of the branches and sometimes on short shoots[21-24,27]. The leaves of some *Terminalia* species are petiolate or subsessile, usually entire but occasionally subcrenata, often with some pellucid dots or glands on either side of the leaf near the base or on the petiole[28]. The flowers are bisexual or male or female on the same or different trees, usually borne in lax spikes[27]. The flowers are small, lacking petals and the fruit is one-seeded with two wings which are joined at the top and bottom[27]. The bark, leaf and fruit characters are widely used to differentiate and identify the *Terminalia* species[26,29,30]. The genus name *Terminalia* is derived from the Latin word "*Terminus*" which means "end", in reference to the leaves that are borne in whorls close to the ends of the shoots, branchlets and branches[2]. The specific name "*Myrtifolia*" means "with leaves resembling the myrtle, that is, *Myrtus communis* L. (family Myrtaceae), a species known to have small and diamond-shaped leaves"[27]. The pharmacological and medicinal literature often cites the name *Pteleopsis myrtifolia* (M.A.Lawson) Engl. & Diels. Other synonyms of *T. myrtifolia* include *Combretum myrtifolium* M.A.Lawson,

Fig. 1(a-c): *Terminalia myrtifolia*: (a) Entire plant, (b) Branch showing flowers and (c) Branch showing leaves and fruits (photos: BT Wursten)

Pteleopsis myrtifolia Engl. & Diels., *P. obovata* Hutch., *P. stenocarpa* Engl. & Diels. and *P. variifolia* Engl. The English common names of *T. myrtifolia* include "Myrtle bushwillow", "Myrtle-leaved pteleopsis", "Pteleopsis", "Stink bushwillow", "Two-winged pteleopsis", "Two-winged stinkbush", "Two-winged stink bushwillow" and "Variable bushwillow"[27,31-33].

Terminalia myrtifolia is a deciduous shrub or small tree that grows up to 25 m in height[27,31-34]. The tree has a wide spreading, fairly dense, drooping and round crown (Fig. 1a). The stems are numerous, thin, upright, long, thin, flexible, but meandering with light or dark grey or brown trunk cracked longitudinally. The leaves are simple, opposite to sub-opposite, or sometimes alternate and borne on short and slender stalks. The leaves are elliptic to obovate in shape with entire margins, hairy when young, shiny and silvery green above but dull green below. The leaf apex and base are usually pointed, the base is usually narrowed or occasionally rounded and smooth with spreading veins. *Terminalia myrtifolia* flowers from November to April, producing flowers which are small and creamy-white to pale yellow in colour (Fig. 1b), have a strong and an unpleasant scent, appearing before or with new leaves, occurring in racemes and in the axils of the leaves. The flowers are bisexual, with male flowers in the same raceme and visited by several insects, which in turn attract insect-eating birds. The fruits are borne in clusters in great abundance (Fig. 1c), are oval in shape with papery wings, pale green in colour when young and pink to brown in colour when older. The fruits of *T. myrtifolia* resemble fruits of *Hymenocardia ulmoides* Oliv. (Phyllanthaceae family)[27]. However, the fruits of *H. ulmoides* are rounder, quite flat and a single wing, whereas the *T. myrtifolia* fruits have a small, hard, raised bump in the middle. The branches and twigs of *T. myrtifolia* are much more flexible than those of *H. ulmoides*[27]. *Terminalia myrtifolia* is closely related and often confused with *Terminalia anisoptera* (Welw. ex M.A.Lawson) Gere & Boatwr. (synonym *Pteleopsis anisoptera* (Welw. ex M.A.Lawson) Engl. & Diels,[35,36] which has small, square, usually four-winged fruits and leaves with more steeply angled veins and leaf apex that has a more or less drawn-out point[27]. Both species are dense, multi-stemmed shrubs or small trees recorded in overlapping geographical areas, with *T. anisoptera* recorded in Angola, the Democratic Republic of Congo, Mozambique, Tanzania, Zambia and Zimbabwe[31,36]. But *T. myrtifolia* grows in dry bushveld, woodland, wooded grassland, riverine fringes, thicket and forest in sandy soils. *Terminalia myrtifolia* has been recorded in Angola, Botswana, Kenya, South Africa, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe at an altitude ranging from sea level to 1600 m above sea level[27,31-34,36-41] (Fig. 2).

Traditional uses of *Terminalia myrtifolia*: *Terminalia myrtifolia* is one of tropical Africa's most versatile plants, providing food, fibre, traditional medicines, wood and construction material. The leaves and fruits of *T. myrtifolia* are considered edible as vegetables[33,42]. The leaves of *T. myrtifolia* are also eaten by edible caterpillars *Imbrasia lucida*, which occur in large numbers on the species[2]. In South Africa, the wood of *T. myrtifolia* is used for smoking edible *Strychnos madagascariensis* Poir. (Loganiaceae family) fruit pulp[27]. The leaves and branches of *T. myrtifolia* are browsed by game and livestock[4,27,43] and the species demonstrated adequate levels of crude protein (13.89%), fibre (21.94%), phosphorus (0.19%), calcium (0.41%) and magnesium (0.32%) required to support the growth and maintenance of livestock species[1]. *Terminalia myrtifolia* is an important source of fibre in South Africa[44] and the stems of the species are strong and pliable and therefore, often used to make fishing baskets[27]. *Terminalia myrtifolia* is widely used throughout its distributional range as a source of building materials for livestock enclosures, houses, walking sticks, craft work and fencing posts[44]. *Terminalia myrtifolia* is an important source of firewood and charcoal throughout the distributional range of the species, with its wood burning slowly with intense heat[45-49]. The wood of *T. myrtifolia* is hard, heavy, strong and durable and therefore, useful as general-purpose timber for handles of agricultural implements and furniture[45]. In East Africa, *T. myrtifolia* is regarded as excellent for bee forage, mulch and green manure, shade, ornamental and windbreak[33].

Fig. 2: Distribution of *Terminalia myrtifolia* in tropical Africa

Medicinal uses of *Terminalia myrtifolia*: The leaves and roots of *T. myrtifolia* are only sold in local informal herbal medicine markets as sources of traditional medicine in tropical Africa[2,42]. The traditional medicines prepared from the bark, fruits, leaves, roots, or stem bark of *T. myrtifolia* are used to treat and manage 22 human diseases and ailments (Table 1). The main ailments and diseases treated by *T. myrtifolia* extracts (Fig. 3) include menstrual problems, dysentery, fever, infertility or sterility, swellings of the stomach, venereal diseases, sores and wounds. Other medicinal applications of *T. myrtifolia* that are supported by at least two references include its uses as traditional medicine for diarrhoea[42,51,52], intestinal worms[33,42], malaria[42,51,53], muscle pain[42,51,52] and tuberculosis[51,54]. In Tanzania, the leaf sap or root decoction of *T. myrtifolia* is taken orally mixed with the leaf sap and root decoction of *Diospyros zombensis* (B.L.Burtt) F.White (Ebenaceae family) as a remedy for dysentery[2,42,55,56].

Pharmacological properties of *Terminalia myrtifolia*: The phytochemical compound taraxerol isolated from *T. myrtifolia* leaves and the crude extracts of the species exhibited antibacterial, antifungal and antiproliferative activities

Antibacterial activities: Eloff *et al.*[62] evaluated the antibacterial activities of the phytochemical compound taraxerol isolated from *T. myrtifolia* leaves against *Staphylococcus aureus*, *Enterococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* using the microdilution assay. The phytochemical compound demonstrated activities against the tested pathogens, exhibiting minimum inhibitory concentration (MIC) values ranging from 16.0 to 630.0 µg/mL[62]. Anokwuru *et al.*[63] evaluated the antibacterial activities of methanol extracts of *T. myrtifolia* leaves against *Staphylococcus aureus*, *Bacillus cereus*, *Staphylococcus epidermidis*, *Klebsiella pneumoniae*, *Enterococcus faecalis*,

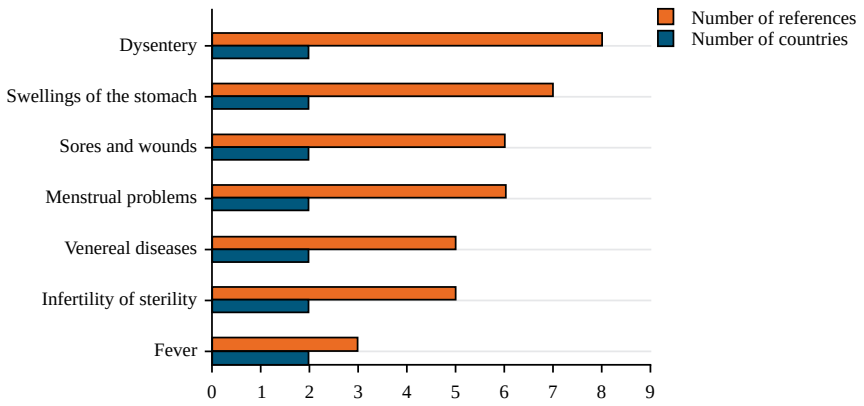

Fig. 3: Main ethnomedicinal applications of *Terminalia myrtifolia* in tropical Africa

Table 1: Medicinal uses of *Terminalia myrtifolia*

Medicinal use	Part used	Country	References
Mono-therapeutic applications			
Antiabortifacient	Leaf juice taken orally	Tanzania	Quattrocchi[2]
Chest pains	Bark or leaf decoction taken orally	Tanzania	Luoga *et al.*[47]
Diarrhoea	Leaf, root or stem bark decoction taken orally	Mozambique	Silen *et al.*[42], Manuel *et al.*[50], Razão *et al.*[51] and Sitoe and van Wyk[52]
Drive away evil spirits	Leaves	Not specified	Quattrocchi[2]
Dysentery	Fruit, leaf or root decoction taken orally	Mozambique and Tanzania	Quattrocchi[2], Dharani[33], Silen *et al.*[42], Hedberg *et al.*[55], Fyhrquist *et al.*[57], Fyhrquist *et al.*[58] and Nicosia *et al.*[59]
Fever	Root decoction taken orally	Mozambique and Tanzania	Dharani[33], Silen *et al.*[42], Ribeiro *et al.*[53]
Infertility or sterility	Root decoction taken orally	Mozambique and Tanzania	Quattrocchi[2], Silen *et al.*[42], Ribeiro *et al.*[53], Hedberg *et al.*[55] and Kacholi *et al.*[60]
Intestinal worms	Root decoction taken orally	Tanzania	Dharani[33] and Silen *et al.*[42]
Madness	Root decoction taken orally	Mozambique	Ribeiro *et al.*[53]
Malaria	Root decoction taken orally	Mozambique	Silen *et al.*[42], Razão *et al.*[51], Ribeiro *et al.*[53]
Menstrual problems	Fruit, leaf or root decoction taken orally	Mozambique and Tanzania	Silen *et al.*[42], Hedberg *et al.*[55], Fyhrquist *et al.*[57], Fyhrquist *et al.*[58], Nicosia *et al.*[59] and Kacholi *et al.*[60]
Muscle pain	Leaf, root or stem bark decoction applied topically	Mozambique	Silen *et al.*[42], Manuel *et al.*[50], Sitoe and Van Wyk[52]
Postpartum and prepartum care	Fruit, leaf or root decoction taken orally	Mozambique	Nicosia *et al.*[59]
Sexual dysfunctions	Fruit, leaf or root decoction taken orally	Mozambique	Nicosia *et al.*[59]
Sores and wounds	Fruit, leaf or root decoction applied topically	Mozambique and Tanzania	Quattrocchi[2], Silen *et al.*[42], Hedberg *et al.*[55], Fyhrquist *et al.*[57], Fyhrquist *et al.*[58] and
Swellings of the stomach	Leaf or root decoction taken orally	Mozambique and Tanzania	Nicosia *et al.*[59] Quattrocchi[2], Dharani[33], Silen *et al.*[42], Razão *et al.*[51], Hedberg *et al.*[55], Fyhrquist *et al.*[57] and Fyhrquist *et al.*[58]
Tuberculosis	Root decoction taken orally	Mozambique	Razão *et al.*[51] and Aparicio *et al.*[54]
Uterine complaints	Fruit, leaf or root decoction taken orally	Mozambique	Nicosia *et al.*[59]
Venereal diseases	Fruit, leaf or root decoction taken orally	Mozambique and Tanzania	Quattrocchi[2], Kokwaro[56], Fyhrquist *et al.*[57], Nicosia *et al.*[59] and Kamuhabwa *et al.*[61]
Used in combination with other species			
Dysentery	Leaf sap or root decoction taken orally mixed with leaf sap and root decoction of *Diospyros zombensis* (B.L.Burtt) F.White (Ebenaceae family)	Tanzania	Quattrocchi[2], Silen *et al.*[42], Hedberg *et al.*[55] and Kokwaro[56]

Pseudomonas aeruginosa, Escherichia coli, *Salmonella typhimurium* and *Shigella sonnei* using the microdilution assay with ciprofloxacin as positive control. The extracts exhibited activities against the tested pathogens with MIC values ranging from 0.63 to 3.0 mg/mL[63].

Antifungal activities: Fyhrquist *et al.*[57] evaluated the antifungal activities of methanol extracts of *T. myrtifolia* roots against *Candida glabrata, Cryptococcus neoformans, Candida albicans, Candida parapsilosis, Candida tropicalis* and *Candida krusei* using the agar diffusion method with

amphotericin B and itraconazole as positive controls. The extracts demonstrated activities against the tested pathogens exhibiting zone of inhibition ranging from 16.9 to 21.2 mm[57].

Antiproliferative activities: Kamuhabwa *et al.*[61] evaluated the antiproliferative activities of the methanolic extracts of *T. myrtifolia* roots against three human cell lines, that is, HT29 (colon adenocarcinoma), HeLa (cervical carcinoma) and A431 (skin carcinoma). The extract exhibited pronounced cytotoxic activities against A431 and H29 cancer cell lines and weak cytotoxic activities against HeLa cancer cell lines[61]. Fyhrquist *et al.*[58] evaluated the antiproliferative activities of methanolic extract of *T. myrtifolia* roots against T 24 (bladder carcinoma), HeLa (cervical carcinoma) and MCF 7 breast cancer cell lines using the Alamar Blue assay. The extract exhibited strong activities against T 24, moderate activities against HeLa and weak activities against MCF 7, with inhibition percentage ranging from 40.9 to 77.7%[58].

CONCLUSION

The present review provides a summary of the ecological, botanical, medicinal and pharmacological properties of *T. myrtifolia* in tropical Africa. To realize the full potential of *T. myrtifolia* as a medicinal plant species, there is a need for detailed evaluations of the phytochemical, pharmacological and toxicological properties of the species. There is also a need for ethnopharmacological studies aimed at examining the combined effects of *T. myrtifolia* extracts with other plant species such as *D. zombensis*.

SIGNIFICANCE STATEMENT

This review provides existing information on the ecological, botanical, medicinal and pharmacological properties of *T. myrtifolia* that could be useful in future research aimed at developing new health-promoting and pharmaceutical products. Such research results could provide baseline data required in the identification of knowledge gaps needed to correlate ethnopharmacological properties of the species. Future research on *T. myrtifolia* should focus on advanced phytochemical and pharmacological evaluation of the species, including its toxicological properties, *in vivo* and clinical studies.

ACKNOWLEDGMENT

This research was funded by the University of Fort Hare, South Africa, grant number R188.

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