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Review Article

A Review of the Ethnomedicinal Uses, Phytochemistry and Pharmacological Activities of *Terminalia mollis* M.A. Lawson (Combretaceae)

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Abstract

A comprehensive review of published information on ethnomedicinal uses, phytochemical and pharmacological properties of *Terminalia mollis* M.A. Lawson, a medium-sized to large deciduous tree, is presented. This study revealed that *T. mollis* is used as ethnoveterinary medicine and traditional medicine against sexually transmitted infections, respiratory infections, gastrointestinal problems, bilharzia, malaria, haemorrhoids, abdominal pains, measles, jaundice, cryptococcal meningitis and back pain. Phytochemical research identified flavonoids, polyphenols, ellagitannin, pentacyclic triterpenoids, trihydroxybenzoic acid, tannins, steroids, saponins, anthraquinones, cardiac glycosides and anthocyanins from leaves and root bark of *T. mollis*. Ethnopharmacological research revealed that the phytochemical compounds isolated from *T. mollis* and crude extracts of the species showed antibacterial, antimycobacterial, antimycoplasmal, antifungal, antiviral, anticonvulsant, antileishmanial, antioxidant, antiplasmodial, antitrypanosomal and cytotoxicity activities. Since *T. mollis* extracts are widely used as sources of traditional medicines, there is a need for extensive phytochemical, pharmacological, toxicological evaluations, *in vivo* and clinical studies.

Key words: Combretaceae, indigenous knowledge, materia medica, *Terminalia mollis*, traditional medicine

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

INTRODUCTION

Terminalia mollis M.A. Lawson (Fig. 1) has a long history of medicinal use in tropical Africa. Use of plants as traditional medicines is a popular practice among communities in developing countries¹. Uses of medicinal plants and associated traditional ecological knowledge, skills and practices play a crucial role in preventing, treating and managing human and animal diseases and illnesses throughout the world¹. This tremendous biological diversity and associated traditional ecological knowledge have remained poorly explored from a scientific and commercial perspective². Medicinal plants have long been used as sources of pharmaceutical products throughout the world, with more than 70-80% of the world's population still relying upon medicinal plants for primary health care³⁻⁶. Moreover, about 25% of the pharmaceutical prescriptions in use today are directly or indirectly derived from medicinal plants³. The majority of people in developing countries continue to use traditional medicines for their primary healthcare needs due to the accessibility, affordability and cultural acceptability of traditional or herbal medicines^{7,8}. There is increased interest in investigating the effectiveness of traditional medicines and incorporating this practice into biomedical healthcare facilities since traditional medical practices serve a larger patient population than biomedical healthcare facilities, especially in peri-urban, rural and marginalized areas in developing countries⁹⁻¹². However, traditional medicine is often disregarded or ignored in favour of biomedical healthcare treatments, despite its potential

benefits. Recent research shows that traditional medicine is associated with tremendous biological diversity and traditional ecological knowledge and skills accumulated over many generations, but often remains poorly explored from a scientific and commercial perspective³.

Medicinal plants, therefore, represent an important source of natural products offering new opportunities for the development of innovative new pharmaceutical products^{13,14}. Medicinal plants are used as crude extracts, poultices, herbal concoctions of different plant species, ointments, infusions of herbal teas or tinctures, component mixtures in porridges or soups, pharmaceutical drugs or prescription medicines^{3,15}. But many medicinal plants are scientifically poorly known and in need of detailed phytochemical and pharmacological research. The future of medicinal plant usage in tropical Africa is determined by the recognition and integration of traditional medicine into conventional medicine and advanced ethnopharmacological research of medicinal plants used as phytomedicines, functional foods and dietary supplements¹⁶. Recent research shows that the quality of herbal or traditional medicines is often compromised due to their production and also the presence of contaminants emanating from either natural or anthropogenic sources⁸. Therefore, issues about safety and toxicological properties of medicinal plants lead to ethnopharmacological research focusing on phytochemical analyses, pharmacological properties, clinical research and quality control of medicinal plants¹⁷. It is therefore, within this context, that the current study was undertaken, aimed at reviewing the medicinal uses, phytochemical and pharmacological properties of *T. mollis*.

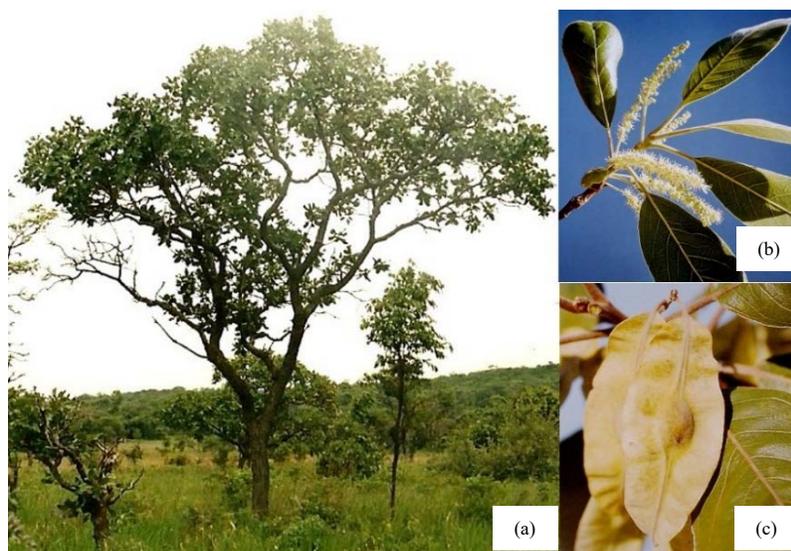


Fig. 1(a-c): *Terminalia mollis*, (a) Entire plant, (b) Branch showing leaves and flowers and (c) Branch showing leaves and fruits (photos: M Bingham)

MATERIALS AND METHODS

The literature search for medicinal uses, phytochemistry and pharmacological properties of *T. mollis* was conducted from August to December, 2024 using online search databases used including Web of Science, Scopus®, SpringerLink®, Google Scholar, SciELO, PubMed® and ScienceDirect®. The pre-electronic sources, which included books, book chapters, journal articles, dissertations and thesis obtained from the University library, were also used. The scientific reports published in English were considered for inclusion in this review. The keywords used in the search included "*Terminalia mollis*", its synonyms and the English common name "large-leaved terminalia". An additional search was also conducted using the keywords "Biological activities of *Terminalia mollis*", "Pharmacological properties of *Terminalia mollis*", "Ethnobotany of *Terminalia mollis*", "Medicinal uses of *Terminalia mollis*", "Phytochemistry of *Terminalia mollis*" and "Traditional uses of *Terminalia mollis*". The literature search covered publications from 1972 to 2025, a long period to capture literature on the medicinal uses, phytochemical and pharmacological properties of *T. mollis*.

Taxonomy and morphological description of *Terminalia mollis*. 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 Australia¹⁸⁻²⁴. 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^{19,20,25}. The leaves of some *Terminalia* species are petiolate or sessile, usually entire but occasionally subcrenate, often with some pellucid dots or glands on either side of the leaf near the base or on the petiole²⁶. The flowers are bisexual or male or female on the same or different trees, usually borne in lax spikes²⁵. The flowers are small, lacking petals and the fruit is one-seeded with two wings that are joined at the top and bottom²⁵. The bark, leaf and fruit characters are widely used to differentiate and identify the *Terminalia* species^{27,28}. The genus name *Terminalia* is derived from the Latin word "*terminus*" which means "end", about the leaves that are borne in whorls close to the ends of the shoots, branchlets and branches^{25,29}. The specific name "*mollis*" means "smooth" or "soft" about the texture of the leaves³⁰. The synonyms of *T. mollis* include *Myrobalanus mollis* (M.A. Lawson) Kuntze, *Pteleopsis*

kerstingii Gilg ex Engl., *T. dewevrei* De Wild. and *T. Durand*, *T. glandulosa* De Wild., *T. kerstingii* Engl., *T. mildbraedii* Gilg ex Mildbr., *T. reticulata* Engl., *T. spekei* Rolfe, *T. suberosa* R.E. Fr. and *T. torulosa* F. Hoffm³¹. The English common name of *T. mollis* is "large-leaved terminalia"³².

Terminalia mollis is a medium-sized to large deciduous and well-shaped tree growing to 20 m in height. *Terminalia mollis* has an intense shade, dense foliage, a crown tapering to an oval shape, no layered appearance and rarely with a straight trunk (Fig. 1a)³³. The bark of *T. mollis* is grey to black in colour, rough, deeply fissured and lighter grey in the fissures. The branchlets are corky with conspicuous leaf scars. The leaves are spread out along the branchlets or closely clustered at the ends of the stems. The leaves are large, broadly elliptic to oblong in shape, semi-leathery, with short soft hairs on the upper surface, most of which are lost by maturity and undersurface densely covered with pale to slightly brownish matted hairs. The leaf midrib is raised near the base of the leaf and becomes indented towards the apex. The leaf apex is broadly tapering to rounded and the leaf base is rounded to shallowly lobed. The leaf margin is entire, often with a conspicuous fringe of long hairs. The flowers are greenish white, occur in axillary spikes (Fig. 1b), are strongly scented and occur in October to December. The fruits are large (Fig. 1c), velvety, with a stout wing, ribbed and waxy, hanging in heavy, conspicuous masses, yellowish-green in colour, occasionally pink-tinged and becoming pale brown at maturity. *Terminalia mollis* has been recorded at medium altitudes in savanna, open woodland, wooded grassland, rocky hillsides, seasonally inundated floodplain, on edges of vleis in sandy and heavy soils and often left in agricultural fields and cultivated land at an altitude ranging from 140 to 2170 m above sea level. *Terminalia mollis* has been recorded in Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Democratic Republic of Congo (DRC), Ghana, Guinea, Ivory Coast, Kenya, Mali, Mozambique, Namibia, Nigeria, Rwanda, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe (Fig. 2)³⁴⁻³⁹. *Terminalia mollis* resembles *T. stenostachya* Engl. and Diels but differs from the latter in having leaves that are not curling backwards and spread out around the stem and velvety fruits which are yellowish green and occasionally tinged with pink.

Ethnobotanical uses of *Terminalia mollis*. *Terminalia mollis* is an important fodder species in Eastern and Southern Africa, with its leaves and shoots being palatable and browsed by livestock and game, particularly during the dry periods^{33,37}. The roots of *T. mollis* produce red-brown dye, which darkens with time and is used to dye leather and clothes³³. *Terminalia mollis*



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

is an attractive tree that has potential as an ornamental and/or shade plant in private gardens, tolerating fire, termites, frost and moderate drought and can also be cultivated to fill large open spaces. *Terminalia mollis* has abundant litter fall and good mulch quality and is widely used for soil improvement. Therefore, *T. mollis* grows well with several crops and is highly appreciated as a tree for intercropping purposes. *Terminalia mollis* is propagated by seeds and wildlings. In East Africa, the wildlings of *T. mollis* are often collected in grazing and cultivated land³³. The wood of *T. mollis* is considered to be one of the most important and best quality firewoods in eastern and Southern Africa, as it burns slowly with intense heat, little smoke and makes good charcoal³³. The wood of *T. mollis* is yellowish grey in colour, hard, heavy, strong, compact, lustrous and termite and borer-proof and makes a useful general-purpose timber^{33,37}. Therefore, *T. mollis* is used throughout its distributional range as a source of building materials for houses, livestock enclosures, fencing posts and handles of agricultural implements^{33,37}.

Medicinal uses of *Terminalia mollis*: *Terminalia mollis* is used as a source of traditional medicines in Benin, Cameroon, DRC, Kenya, Mozambique, Namibia, Nigeria, Rwanda, Tanzania, Uganda and Zambia, that is, 45.8% of the countries where

the species is indigenous (Table 1). In the DRC, the roots of *T. mollis* are sold in informal herbal medicine markets as sources of traditional medicines³⁸⁻⁴⁰. In tropical Africa, the bark, leaves, roots, stems, root bark, or stem bark of *T. mollis* are used as traditional medicines to treat or manage 46 human and animal diseases or ailments. The ethnobotanical data on medicinal applications of *T. mollis* have been reported in DRC and Tanzania (Table 2). The main ailments and diseases treated by *T. mollis* extracts (Fig. 3) include its use as ethnoveterinary medicine and traditional medicine for sexually transmitted infections, respiratory infections, gastrointestinal problems, bilharzia, malaria, haemorrhoids, abdominal pains, measles, jaundice, cryptococcal meningitis and back pain. Other medicinal applications of *T. mollis* that are supported by at least two references include the use of leaf or root decoction or maceration as a remedy for diabetes⁴¹⁻⁴³. In the DRC, the root bark decoction of *T. mollis* is taken orally as traditional medicine for erectile dysfunction^{44,45} while the bark, leaf or root decoction is applied topically against wounds⁴⁵⁻⁴⁷. In Tanzania, the leaf or root decoction of *T. mollis* is taken orally as a Human Immunodeficiency Virus (HIV) therapy or treatment supplement⁴⁸⁻⁵⁰. In Tanzania, the bark or roots of *T. mollis* are used in combination with those of *Erythrina* spp., as traditional medicines for yellow fever⁵¹.

Table 1: Medicinal uses of *Terminalia mollis*

Medicinal use	Part used	Country	References
Mono-therapeutic applications			
Abdominal pain	Bark, leaf or root powder decoction taken orally	DRC and Nigeria	Mutombo <i>et al.</i> ⁴⁰ , Kingo <i>et al.</i> ⁵¹ and Valentin <i>et al.</i> ⁵²
Amoebiasis	Root bark decoction taken orally	DRC	François <i>et al.</i> ⁴⁵
Ascariasis	Root bark decoction taken orally	DRC	François <i>et al.</i> ⁴⁵
Back pain	Root or root powder decoction taken orally	DRC and Nigeria	Mutombo <i>et al.</i> ⁴⁰ and Kingo <i>et al.</i> ⁵¹
Bilharzia	Leaf or root decoction taken orally	DRC and Tanzania	Kasali <i>et al.</i> ⁴²
Colic	Leaf decoction taken orally	DRC	Valentin <i>et al.</i> ⁵²
Cryptococcal meningitis	Bark or root decoction taken orally	Namibia and Tanzania	Kisangau <i>et al.</i> ⁵³ and Chinsemu <i>et al.</i> ⁵⁴
Diabetes	Leaf or root decoction or maceration taken orally	DRC	Amuri <i>et al.</i> ⁴¹ , Kasali <i>et al.</i> ⁴² and Valentin <i>et al.</i> ⁴³
Epilepsy	Not specified	Cameroon	Ngo <i>et al.</i> ⁵⁵
Erectile dysfunction	Root bark decoction taken orally	DRC	Valentin <i>et al.</i> ⁴⁴ and François <i>et al.</i> ⁴⁵
Eye infection	Stem bark decoction applied as eye drops	Tanzania	Maregesi <i>et al.</i> ⁵⁶
Gastro-intestinal problems (cholera, constipation, diarrhoea, dysentery and stomach ache)	Bark, leaf, root or root bark decoction or maceration taken orally	DRC, Kenya, Namibia, Nigeria, Tanzania and Zambia	Amuri <i>et al.</i> ⁴¹ , Kasali <i>et al.</i> ⁴² , Valentin <i>et al.</i> ⁴³ , Valentin <i>et al.</i> ⁴⁴ , François <i>et al.</i> ⁴⁵ , Neuwinger ⁴⁶ , Valentin <i>et al.</i> ⁴⁷ , Burkill ⁴⁸ , Moshi <i>et al.</i> ⁴⁹ , Mouozong <i>et al.</i> ⁵⁰ , Valentin <i>et al.</i> ⁵² , Maregesi <i>et al.</i> ⁵⁶ , Fowler ⁵⁷ , Mosh ⁵⁸ , Nyunja <i>et al.</i> ⁵⁹ , Chinsemu <i>et al.</i> ⁶⁰ , Mutie <i>et al.</i> ⁶¹ and Ilunga <i>et al.</i> ⁶²
Haemorrhoids	Bark, leaf or root decoction taken orally	DRC and Nigeria	Mutombo <i>et al.</i> ⁴⁰ , Neuwinger ⁴⁶ and Valentin <i>et al.</i> ⁵²
Heart problems	Stem bark decoction taken orally	Tanzania	Peter <i>et al.</i> ⁶³
Hernia	Leaf decoction taken orally	DRC	Ilunga <i>et al.</i> ⁶²
Human Immunodeficiency Virus (HIV) therapy or treatment supplement	Leaf or root decoction taken orally	Tanzania	Burkill ⁴⁸ , Moshi <i>et al.</i> ⁴⁹ and Mouozong <i>et al.</i> ⁵⁰
Jaundice	Stem bark decoction taken orally	DRC and Tanzania	Kasali <i>et al.</i> ⁴² and Maregesi <i>et al.</i> ⁵⁶
Kidney problems and urine-blockage	Root decoction taken orally	Tanzania	Maregesi <i>et al.</i> ⁵⁶
Malaria	Leaf, root bark or stem bark decoction taken orally	DRC, Rwanda and Tanzania	François <i>et al.</i> ⁴⁵ , Burkill ⁴⁸ , Moshi <i>et al.</i> ⁴⁹ , Mouozong <i>et al.</i> ⁵⁰ , Mosh ⁵⁸ and Muganga <i>et al.</i> ⁶⁴
Measles	Leaf or root decoction or maceration applied topically	DRC and Tanzania	Valentin <i>et al.</i> ⁴³
Respiratory infections (asthma, catarrh, cough, sore throat and tuberculosis)	Bark, leaf or root decoction or maceration taken orally	DRC, Mozambique, Namibia, Nigeria, Tanzania, Uganda and Zambia	Valentin <i>et al.</i> ⁴³ , François <i>et al.</i> ⁴⁵ , Chinsemu and Hedimbi ⁵⁴ , Fowler ⁵⁷ , Mosh ⁵⁸ , Chinsemu <i>et al.</i> ⁶⁰ , Ilunga <i>et al.</i> ⁶² , Bruschi <i>et al.</i> ⁶⁵ , Ibrahim <i>et al.</i> ⁶⁶ , Masters <i>et al.</i> ⁶⁷ , Razão <i>et al.</i> ⁶⁸ and Siteo and van Wyk ⁶⁹
Sexually transmitted infections (gonorrhoea and syphilis)	Leaf, root or stem bark decoction taken orally	DRC and Tanzania	Amuri <i>et al.</i> ⁴¹ , Kasali <i>et al.</i> ⁴² , François <i>et al.</i> ⁴⁵ , Burkill ⁴⁸ , Moshi <i>et al.</i> ⁴⁹ , Mouozong <i>et al.</i> ⁵⁰ and Mosh <i>et al.</i> ⁵⁸
Tooth decay	Leaf decoction applied topically	DRC	François <i>et al.</i> ⁴⁵
Ulcers	Leaf maceration taken orally	DRC	Valentin <i>et al.</i> ⁴³
Wounds	Bark, leaf or root decoction applied topically	DRC	François <i>et al.</i> ⁴⁵ , Neuwinger ⁴⁶ and Valentin <i>et al.</i> ⁴⁷
Yellow fever	Bark or root decoction taken orally	Tanzania	Kingo and Maregesi ⁵¹
Ethnoveterinary medicine (abortion, diarrhoea, fever, otitis, rinderpest, ticks, foot and mouth disease)	Bark, roots or stems	Benin and Kenya	Wanzala <i>et al.</i> ⁷⁰ and Dassou <i>et al.</i> ⁷¹
Used in combination with other species			
Yellow fever	Bark or roots used in combination with <i>Erythrina</i> spp.	Tanzania	Kingo <i>et al.</i> ⁵¹

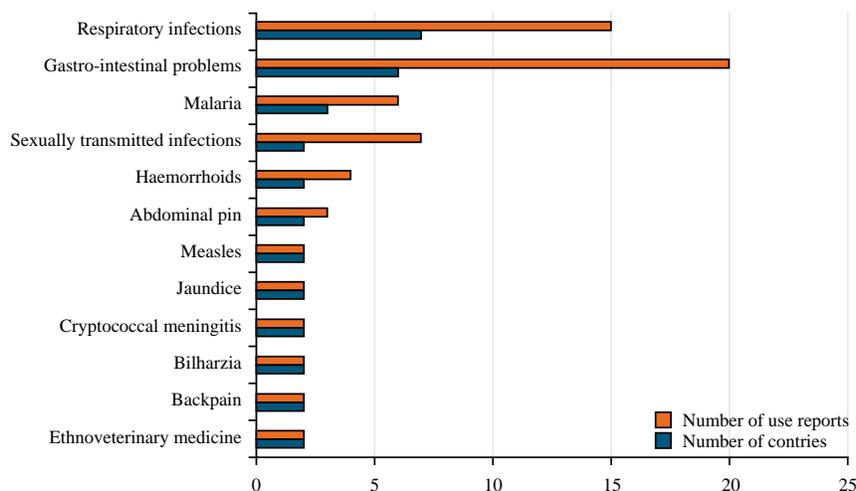


Fig. 3: Main ethnomedicinal uses of *Terminalia mollis* in tropical Africa

Table 2: Countries where *Terminalia mollis* is used for ethnomedicinal purposes, medicinal use reports and the number of literature sources

Country	Number of medicinal uses	Number of references
DRC	24	9
Tanzania	15	8
Nigeria	8	2
Benin	6	1
Kenya	3	3
Namibia	3	2
Zambia	2	1
Mozambique	1	3
Cameroon	1	1
Rwanda	1	1
Uganda	1	1

Table 3: Phytochemical compounds isolated from the leaves of *Terminalia mollis*

Phytochemical compound	Formula	Part	References
2 ⁿ -O-galloyl vitexin	C ₂₈ H ₂₄ O ₁₄	Leaves	Liu <i>et al.</i> ⁷²
2α,3β,23-trihydroxy-urs-12-en-28-oic acid	C ₃₀ H ₄₈ O ₆	Leaves	Liu <i>et al.</i> ⁷²
2α-hydroxyursolic acid	C ₃₀ H ₄₈ O ₄	Leaves	Liu <i>et al.</i> ⁷²
3-O-methylellagic acid 4'-O-α-rhamnopyranoside	C ₂₁ H ₁₈ O ₁₂	Leaves	Liu <i>et al.</i> ⁷²
Arjunolic acid	C ₃₀ H ₄₈ O ₅	Leaves	Liu <i>et al.</i> ⁷²
Catechin	C ₁₅ H ₁₄ O ₆	Leaves	Liu <i>et al.</i> ⁷²
Chebulanin	C ₂₇ H ₂₄ O ₁₉	Leaves	Liu <i>et al.</i> ⁷²
Ellagic acid	C ₁₄ H ₆ O ₈	Root bark	Muganga <i>et al.</i> ⁷³
Epicatechin	C ₁₅ H ₁₄ O ₆	Leaves	Liu <i>et al.</i> ⁷²
Epigallocatechin	C ₂₂ H ₁₈ O ₁₁	Leaves	Liu <i>et al.</i> ⁷²
Friedelin	C ₃₀ H ₅₀ O	Leaves	Liu <i>et al.</i> ⁷²
Gallic acid	C ₇ H ₆ O ₅	Leaves	Liu <i>et al.</i> ⁷²
Galocatechin	C ₁₅ H ₁₄ O ₇	Leaves	Liu <i>et al.</i> ⁷²

Phytochemical and pharmacological properties of *Terminalia mollis*. Liu *et al.*⁷² and Muganga *et al.*⁷³ isolated flavonoids, polyphenols, ellagitannin, pentacyclic triterpenoids, flavan-3-ol, ellagic acid glycoside, flavones and trihydroxybenzoic acid from the leaves and root bark of *T. mollis* (Table 3). Similarly, the qualitative phytochemical evaluations of *T. mollis* stem bark revealed varying amounts

of tannins, phenols, flavonoids, steroids, saponins, anthraquinones, cardiac glycosides and anthocyanins⁷⁴. Some of the phytochemical compounds isolated from *T. mollis* and its crude extracts exhibited antibacterial, antimycobacterial, antimycoplasmal, antifungal, antiviral, anticonvulsant, antileishmanial, antioxidant, antiplasmodial, antitrypanosomal and cytotoxicity activities.

Antibacterial activities: Moshi *et al.*⁴⁹ evaluated the antibacterial activities of ethanol, petroleum ether, butanol, ethyl acetate and dichloromethane extracts of *T. mollis* leaves, roots and stem wood against *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Vibrio cholera*, *Bacillus anthracis* and *Salmonella typhi* using the disc diffusion method with ampicillin and gentamicin as positive controls. The extracts demonstrated activities against the tested pathogens exhibiting zone of inhibition ranging from 4.7 to 20.0 mm⁴⁹. Ibrahim *et al.*⁷⁵ evaluated the antibacterial activities of aqueous and ethanol extracts of *T. mollis* bark and wood against *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* using the agar diffusion method. The extracts demonstrated activities against the tested pathogens exhibiting zone of inhibition ranging from 15.5 to 30.0 mm⁷⁵. Maregesi *et al.*⁷⁶ evaluated the antibacterial activities of methanol and aqueous extracts of *T. mollis* root and stem bark against *Staphylococcus aureus*, *Bacillus cereus* and *Klebsiella pneumoniae* using the microdilution method with ampicillin rifampicin as a positive control. The extracts showed activities against the tested pathogens exhibiting minimum inhibitory concentration (MIC) values ranging from 500.0 to 1000.0 µg/mL⁷⁶. Anokwuru *et al.*⁷⁷ evaluated the antibacterial activities of methanol extracts of *T. mollis* leaves against *Staphylococcus aureus*, *Bacillus cereus*, *Staphylococcus epidermidis*, *Klebsiella pneumoniae*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Salmonella typhimurium* and *Shigella sonnei* using the microdilution assay with ciprofloxacin as a positive control. The extracts exhibited activities against the tested pathogens with MIC values ranging from 0.63 to 3.0 mg/mL⁷⁷. Mouozong *et al.*⁵⁰ evaluated the antibacterial activities of ethanol extracts of *T. mollis* leaves against multidrug-resistant *Pseudomonas aeruginosa* using the broth microdilution method. The extract demonstrated activities against the tested pathogen, exhibiting MIC values ranging from 512.0 to 2048.0 µg/mL⁵⁰.

Antimycobacterial activities: Ilunga *et al.*⁶² evaluated the antimycobacterial activities of the methanol extract of *T. mollis* against mycobacterium smegmatis using a microdilution assay with ofloxacin as a positive control. The extract demonstrated activities exhibiting MIC and MBC values of 89.0 and 143.0 µg/mL, respectively⁶².

Antimycoplasmal activities: Muraina *et al.*⁷⁸ evaluated the antimycoplasmal activities of acetone extracts of *T. mollis* leaves against *Mycoplasma mycoides* subsp., *mycoides* (T1/44 strains) using the two-fold serial microplate dilution.

The extract demonstrated activities against the pathogen, exhibiting MIC value of 160.0 µg/mL⁷⁸.

Antifungal activities: Moshi *et al.*⁴⁹ evaluated the antifungal activities of ethanol, petroleum ether, butanol, ethyl acetate and dichloromethane extracts of *T. mollis* leaves, roots and stem bark against *Candida albicans*, *Cryptococcus neoformans* and *Aspergillus flavus* using the disc diffusion method with clotrimazole as a positive control. The extracts demonstrated activities against the tested pathogens, exhibiting zone of inhibition ranging from 1.3 to 16.0 mm⁴⁹. Ibrahim *et al.*⁷⁵ evaluated the antifungal activities of aqueous and ethanol extracts of *T. mollis* bark and wood against *Candida albicans* using the agar diffusion method. The extracts exhibited activities against the tested pathogens, exhibiting zone of inhibition ranging from 15.5 to 27.5 mm⁷⁵. Liu *et al.*⁷² evaluated the antifungal activities of the phytochemical compounds arjunolic acid, 2α,3β,23-trihydroxy-urs-12-en-28-oic acid, 2α-hydroxyursolic acid and gallic acid isolated from *T. mollis* leaves against *Candida krusei*, *Candida albicans* and *Candida parapsilosis* using the colorimetric broth microdilution assay with itraconazole as a positive control. The phytochemical compounds demonstrated activities against the tested pathogens, exhibiting MIC values ranging from 50.0 to 200.0 µg/mL⁷². Baba-Moussa *et al.*⁷⁹ evaluated the antifungal activities of aqueous extracts of *T. mollis* leaves and root bark against *Microsporum gypseum*, *Epidermophyton floccosum*, *Trichophyton rubrum* and *Trichophyton mentagrophytes* using the microdilution method with amphotericin B as a positive control. The extract showed activities against the tested pathogens exhibiting MIC values ranging from 0.25 to 1.0 mg/mL⁷⁹. Masoko and Eloff⁸⁰ and Masoko *et al.*⁸¹ evaluated the antifungal activities of acetone, hexane, dichloromethane and methanol extracts of *T. mollis* leaves against *Candida albicans*, *Cryptococcus neoformans*, *Aspergillus fumigatus*, *Microsporum canis* and *Sporothrix schenckii* using the microdilution assay with amphotericin B as a positive control. The extracts exhibited activities against the tested pathogens, exhibiting MIC values ranging from 0.02 to 2.5 mg/mL^{80,81}.

Antiviral activities: Maregesi *et al.*⁷⁶ evaluated the antiviral activities of methanol and aqueous extracts of *T. mollis* root and stem bark against the herpes simplex virus type 1, Semliki forest A7 and vesicular stomatitis virus T2 using the end point titration technique (50% EPPT) with acyclovir as a positive control. The extract showed antiviral activities with reduction factor (RF) values ranging from 10¹ and 10⁴ at concentrations of 50.0 to 100.0 µg/mL⁷⁶. Maregesi *et al.*⁸² evaluated the

antiviral activities of aqueous and 80% methanol extracts of *T. mollis* root and stem bark against Human Immunodeficiency Virus type 1 (HIV-1, IIB strain) and type 2 (HIV-2, ROD strain) using the micro dilution assay with azidothymidine as a positive control. The extracts demonstrated activities against the tested pathogens, exhibiting Half Maximal Inhibitory Concentration (IC₅₀) values ranging from 4.4 to 67.5 µg/mL⁸².

Anticonvulsant activities: Ngo *et al.*⁵⁵ evaluated the *in vivo* anticonvulsant activities of aqueous extracts of *T. mollis* roots by conducting the strychnine (STR), pentylenetetrazol (PTZ), diazepam or sodium thiopental-induced sleep in mice. The extracts demonstrated activities by exhibiting activities against PTZ-induced convulsions, protecting mice against STR-induced convulsions and increasing in a dose-dependent manner the sleeping time induced by diazepam or sodium thiopental⁵⁵.

Antileishmanial activities: Wafula *et al.*⁸³ evaluated the *in vivo* antileishmanial activities of ethanol extracts of *T. mollis* stem bark using female Balb mice infected with *Leishmania major* promastigotes. The extract showed activities by inhibiting promastigote and amastigote growth and exhibiting Median Lethal Concentration (LC₅₀) values ranging from 96.4 to 103.0 µg/mL⁸³.

Antioxidant activities: Masoko and Eloff⁸⁴ evaluated the antioxidant activities of acetone, hexane and methanol extracts of *T. mollis* leaves using 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay with ascorbic acid as a positive control. The extract exhibited strong antioxidant activities⁸⁴. Muganga *et al.*⁸⁵ evaluated the antioxidant activities of methanol extracts of *T. mollis* roots using 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid (ABTS⁺) free radical scavenging assay with punicalagin as a positive control. The extract demonstrated activities exhibiting an IC₅₀ value of 4.2 µg/mL⁸⁵. Wafula *et al.*⁸⁶ evaluated the antioxidant activities of methanol extracts of *T. mollis* roots using the DPPH free radical scavenging assay with ascorbic acid as a positive control. The extract demonstrated activities exhibiting an IC₅₀ value of 175.3 µg/mL⁸⁶. These preliminary *in vitro* antioxidant evaluation findings could imply that *T. mollis* extracts have the potential to protect human body cells from harmful damage caused by free radicals.

Antiplasmodial activities: Maregesi *et al.*⁸² evaluated the antiplasmodial activities of aqueous and 80% methanol

extracts of *T. mollis* root and stem bark against *Plasmodium falciparum* using the twofold serial dilution assay with chloroquine as a positive control. The extracts demonstrated activities against the tested pathogens exhibiting IC₅₀ values ranging from 125.0 to 250.0 µg/mL and MIC value of 250.0 µg/mL⁸². Muganga *et al.*⁶⁴ evaluated the antiplasmodial activities of methanol and aqueous extracts of *T. mollis* root bark against chloroquine-sensitive *Plasmodium falciparum* strain (3D7) by measuring the lactate dehydrogenase activities. The methanol and aqueous extracts demonstrated activities exhibiting IC₅₀ values of 11.7 and 33.5 µg/mL, respectively⁶⁴. Muganga *et al.*⁷³ evaluated the antiplasmodial activities of aqueous and methanol extracts of *T. mollis* root bark and the phytochemical compound ellagic acid isolated from the species against *Plasmodium falciparum* strains 3D7 and F32 with artemisinin and chloroquine as positive controls by measuring the lactate dehydrogenase activities. The extracts and the phytochemical compound demonstrated activities against the tested strains, exhibiting IC₅₀ values ranging from 0.1 to 12.3 µg/mL⁷³. Muganga *et al.*⁷³ also evaluated the *in vivo* antiplasmodial activities of the aqueous extract of *T. mollis* using the classical 4 days suppressive test on *Plasmodium berghei* infected mice by measuring the percentage of parasitemia reduction and the survival of the experimental animals. The level of parasitemia reduction on day 4 post-infection was 44.0% after oral administration of the aqueous extract of *T. mollis*⁷³.

Antitrypanosomal activities: Muganga *et al.*⁸⁵ evaluated the *in vitro* antitrypanosomal activities of aqueous and methanol extracts of *T. mollis* roots against *Trypanosoma brucei brucei* (strain 427) using the Alamar Blue assay with suramin as a positive control. The methanol and aqueous extracts demonstrated activities exhibiting IC₅₀ values of 4.5 and 6.1 µg/mL, respectively⁸⁵.

Cytotoxicity activities: Moshi *et al.*⁴⁹ evaluated the cytotoxicity activities of ethanol, petroleum ether, butanol, ethyl acetate and dichloromethane extracts of *T. mollis* leaves, roots and stem wood using the brine shrimp lethality test. The extracts demonstrated activities exhibiting LC₅₀ values ranging from 10.4 to 101.3 µg/mL⁴⁹. Maregesi *et al.*⁸² evaluated the cytotoxicity activities of aqueous and 80% methanol extracts of *T. mollis* root and stem bark on MT-4 cells. The extracts demonstrated activities exhibiting Median Cytotoxic Concentration (CC₅₀) values ranging from 53.3 to 72.7 µg/mL⁸².

CONCLUSION

As outlined in the present review, *T. mollis* is an important medicinal plant species characterized by several uses in traditional medicine in tropical Africa. While extensive evaluations of the biological activities of the crude extracts of the species have been undertaken, the ethnopharmacological knowledge and properties of the species have not been properly studied. Given the traditional and current uses of the species, there is no doubt that *T. mollis* is a promising materia medica in African traditional pharmacopoeia. To realize the full potential of *T. mollis*, future studies should explore additional active phytochemical compounds using various *in vitro* and *in vivo* models. Such extensive research can make a valuable contribution to growing knowledge about *T. mollis* and its active ingredients and this could potentially lead to the commercial development of pharmaceutical products. There is a need for detailed studies focusing on phytochemical and pharmacological properties, toxicity and safety, mechanisms of action *in vivo* and clinical research of the species aimed at corroborating the ethnomedicinal applications of *T. mollis*. There is also a need to evaluate the combinational therapy involving *T. mollis* and other species, such as *Erythrina* species.

SIGNIFICANCE STATEMENT

The current study contributes to the existing traditional knowledge about medicinal uses, phytochemistry and pharmacological properties of *T. mollis*. This study reviews the ethnopharmacological properties of *T. mollis* from a global perspective based on policies and strategies of the World Health Organization about usage of traditional medicinal plants. The results of this study provides basic data on pharmacological screening of *T. mollis*, isolation and identification of pharmacologically active phytochemical compounds, toxicological properties of the crude extracts and active constituents and clinical studies of the species, which is likely to be an important medicinal plant species needed for the comprehensive primary health care system in tropical Africa. However, future research should also address the need for standardized quality control procedures for herbal medicinal products.

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