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Medicinal uses and pharmacological properties of *Terminalia kaiserana* F.Hoffm. (Combretaceae family).

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Abstract

Background
Terminalia kaiserana F.Hoffm. is a deciduous shrub or small tree widely used in traditional medicine in tropical Africa. This study was aimed at reviewing the medicinal uses and ethnopharmacological properties of *T. kaiserana*.

Methods
A search for available information on the medicinal uses and ethnopharmacological properties of *T. kaiserana* was conducted by searching the scientific databases such as SpringerLink®, PubMed®, Scopus®, Web of Science, Google Scholar, ScienceDirect®, and SciELO, as well as pre-electronic literature sources such as books, book chapters, and other publications obtained from the university library.

Results
Results from this research showed that the *T. kaiserana* is used as a diuretic and traditional medicine against HIV/AIDs opportunistic infections, skin diseases, backache, cardiac problems, headache, diuretic, vomiting, cough, bilharzia, diarrhoea, and gonorrhoea. The phytochemical assessment of *T. kaiserana* revealed that it contains castalagin, ellagic acid glycosides, ellagic acid rhamnoside, ellagitannin, gallic acid, gallotannins, punicalagin, punicalin, tannins, terchebulin, and terflavin-A. The crude extracts of *T. kaiserana* and phytochemical compounds isolated from the species exhibited antibacterial, antimycobacterial, antifungal, and antiproliferative activities.

Conclusion
Results of this study contribute to the existing traditional ecological knowledge about ethnomedicinal applications and ethnopharmacological properties of *T. kaiserana* that could be useful in bio-prospecting for new health-promoting and pharmaceutical products.

Recommendations
Future research on *T. kaiserana* should focus on detailed phytochemical, pharmacological, and toxicological evaluations, as well as *in vivo* and clinical studies.

Keywords: Bush willow family, Combretaceae, materia medica, Terminalia kaiserana, traditional ecological knowledge
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Introduction

Terminalia kaiserana F.Hoffm. is a deciduous shrub and sometimes a small tree which is widely used in traditional medicine in tropical Africa (Kokwaro, 2009; Iwu, 2014). *Terminalia kaiserana* is a member of the Combretaceae

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family, commonly known as the white mangrove, Indian almond, or bush willow family. The Combretaceae family consists of approximately 530 species distributed in ten genera, including *Terminalia* L., *Combretum* Loefl., *Dansiea* Bymes, *Conocarpus* L., *Getonia* Roxb., *Laguncularia* C.F.Gaertn., *Guiera* Adans. ex Juss., *Lumnitzera* Willd., *Strephonema* Hook.f., and *Macropteranthes* F.Muell. (Maurin et al., 2010, 2017; Christenhusz and Byng, 2016). The majority of the plants belonging to the Combretaceae family are woody, mostly trees, shrubs, or lianes (Leistner, 2000; Stace, 2002, 2007). The socio-economic, medicinal, and cultural importance of the *Terminalia* genus throughout the world has been recorded in several studies (Cock, 2015; Zhang et al., 2019; Das et al., 2020; Waly et al., 2020; Tali et al., 2023; Taia et al., 2024). Some of the *Terminalia* species that are used as sources of traditional medicines include *T. arjuna* (Roxb. ex DC.) Wight & Arn., *T. avicennioides* Guill. & Perr., *T. bellirica* (Gaertn.) Roxb., *T. bentzoë* (L.) L.f., *T. brachystemma* Welw. ex Hiern, *T. brownii* Fresen., *T. chebula* Retz., *T. laxiflora* Engl. & Diels, *T. macroptera* Guill. & Perr., *T. phanerophlebia* Engl. & Diels, *T. schimperiana* Hochst. and *T. spinosa* Engl. (Irvine, 1961; Watt and Breyer-Brandwijk, 1962; Burkill, 1994; Schmelzer and Gurib-Fakim, 2013; Zhang et al., 2019).

The World Health Organization (WHO, 2013) defined traditional medicine as "health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral-based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to maintain well-being, as well as to treat, diagnose or prevent illness". According to the WHO, 65–80% of the world's healthcare practices involve the use of traditional medicines, which include a wide array of medicinal plants, traditional practices, and therapies that vary from culture to culture and region to region (Pan et al., 2014). For example, in South Africa, medicinal plants are an important aspect of the daily lives of many people in the country and an important part of the local people's cultural heritage (Van Wyk et al., 2013). Current research shows an upsurge in the use of traditional medicines throughout the world, and this is attributed to improvement in regulation, analytical and quality control tools as well as advances in clinical research showing great value of traditional medicines in primary health-care and management of various diseases and ailments in which conventional medicines have not done too well (Chauhan et al., 2013; Siraj et al., 2020). Similarly, medicinal plants and plant-derived medicines are widely used in traditional cultures all over the world and they are becoming increasingly popular in modern society as natural alternatives to synthetic chemicals (Van Wyk and Wink, 2012), and also in the context of modern pharmaceuticals focusing on ethnopharmacological properties of traditional medicines (Li and Weng, 2017; Mamun and Khan, 2020; Tadesse et al., 2025). Developing pharmaceutical drugs using plant-based pharmaceutical techniques and biotechnology offers an efficient, cost-effective, and alternative to conventional therapy or treatment (Veeresham, 2012; Subramoniam, 2014; Sam, 2019; Chaachouay and Zidane, 2024). Recent research showed that plant-made pharmaceuticals are increasingly being used to fight life-threatening ailments and diseases such as diabetes mellitus, asthma, tuberculosis, influenza, coronary artery disease, and gastrointestinal infections (Chaachouay and Zidane, 2024). Similarly, researchers attribute medicinal properties of the *Terminalia* species to various active constituents such as tannins, triterpenes, phenols, glycosides, steroids, polyols, esters, styrenes, saponins, anthraquinones, flavonoids, and lignans (Das et al., 2020; Waly et al., 2020; Tali et al., 2023; Taia et al., 2024).

Therefore, traditional medicines and associated ecological knowledge increasingly continue to form the basis of primary health care needs in many parts of the world (Ahmed, 2016; Asiimwe et al., 2021). It is, therefore, within this context that the evaluation of medicinal and ethnopharmacological properties of *T. kaiserana* was undertaken. Medicinal plants in general have been used over the years as sources of phytochemical compounds that act directly or indirectly to prevent or treat disease or ailment, and maintain health (Wink and Van Wyk, 2008; Van Wyk and Wink, 2015). These different active ingredients, phytochemical compounds, or natural products have inspired the design, discovery, and development of new pharmaceutical drugs (Chaachouay and Zidane, 2024). Therefore, ethnopharmacological research focusing on active ingredients, phytochemical compounds, or natural products of medicinal plants will play a vital part in the search for the design, discovery, and development of new pharmaceutical drugs in the future, as well as the exploration of global biodiversity as a possible source of new pharmaceutical drugs and health products. This is part of an initiative to document baseline data for future phytochemical and pharmacological evaluations of the

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species, which can be used for pharmaceutical drugs and health-promoting research purposes. Such research is important as it contributes to the conservation and preservation of medicinal plants and associated traditional ecological knowledge.

Materials and methods

Eligibility criteria

Literature sources excluded from this review are those articles that are partially accessed, that is, accessed as abstracts only, and also published or unpublished ethnopharmacological surveys lacking information on medicinal uses and ethnopharmacological properties of *T. kaiserana* (Figure 1). The search covered publications from 1961 to 2025, a long period to capture literature on the medicinal uses and ethnopharmacological properties of *T. kaiserana*.

Information sources

A search for available information on the medicinal uses and ethnopharmacological properties of *T. kaiserana* was conducted by systematically searching the scientific databases such as PubMed® (https://pubmed.ncbi.nlm.nih.gov/), ScienceDirect® (https://www.sciencedirect.com/search), Web of Science (https://www.webofknowledge.com), Google Scholar (https://scholar.google.com/), SpringerLink® (https://link.springer. com/), SciELO (https://search.scielo.org/) and Scopus® (http://www.scopus.com/), as well as pre-electronic literature sources such as book chapters, books and other scientific publications obtained from the university library. Investigating medicinal plants as possible sources of active ingredients, phytochemical compounds, or natural products has inspired the design, discovery, and development of new pharmaceutical drugs, which requires a multidisciplinary approach and hence the need to review the medicinal uses and pharmacological properties of *T. kaiserana,* a plant species widely used in traditional medicine in tropical Africa.

Search strategy

The search was conducted from January to May 2025 using the following keywords: "*Terminalia kaiserana*", "biological activities of *Terminalia kaiserana*", "pharmacological properties of *Terminalia kaiserana*", "ethnobotany of *Terminalia kaiserana*", "medicinal uses of *Terminalia kaiserana*", "phytochemistry of *Terminalia kaiserana*", and "traditional uses of *Terminalia kaiserana*"

Selection process

The selection process was designed to include a wide range of scientific publications focusing on the medicinal uses and ethnopharmacological properties of *T. kaiserana*. In the selection process, no limitations were applied regarding the year, region, or country of publication, thus allowing for a comprehensive and unrestricted assessment of the scientific articles.

Data collection process

The majority of studies (n = 27; 87.1%) were case studies, while four were review papers. A variety of sampling techniques were used, which included random and convenience sampling, such as purposive and snowball sampling. Criteria employed to select participants or respondents also varied across the studies. But the participants or respondents included traditional healers, herbalists, local leaders, farmers, hunters, plant gatherers, community members, extension officers, government and non-governmental representatives with interest and knowledge about plant resources, particularly *T. kaiserana*. Most of the articles relied on qualitative data (n = 18; 58.1%), while (n = 9; 29.0%) studies used quantitative data, and the remainder used both quantitative and qualitative data. Qualitative data were collected through face-to-face interviews, observations made during field work, focus group discussions, data generated through questionnaires, and published data analysis. Other studies were based on field studies, laboratory analysis of field data, and molecular analysis of biological samples. About a third of the studies employed thematic analysis, ecological and ethnobotanical indices such as the Jaccard index, informant consensus factor, use value, and relative importance index.

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Data items

This search string was designed to identify articles with the botanical description of *T. Kaiserana,* its origin, and geographical distribution. This review also identified articles that provided medicinal uses of *T. kaiserana,* plant parts used, mode of administration, dosage, active ingredients, biological activities of crude extracts, and phytochemical compounds isolated from the species.

Synthesis methods

In this review, narrative synthesis, which involved analyzing, summarizing, and interpreting both qualitative and quantitative data, was used. Microsoft Excel was used to organize and analyze the data. Generated data were used to formulate the text, tables, map, and graph presented in this review.

Reporting bias assessment

One major limitation of this research was over-reliance on studies undertaken by Fyhrquist (n = 7; 22.6%), that is, Fyhrquist et al. (2002, 2004, 2006, 2013, 2014a,b) and Fyhrquist (2007). But other studies by Chhabra et al. (1989), Moshi et al. (2006), Lye et al. (2008), Kokwaro (2009), Hilonga et al. (2019), Huffman (2022), Kacholi and Amir (2022) documented useful information on medicinal applications, phytochemical, and biological activities of *T. kaiserana.*

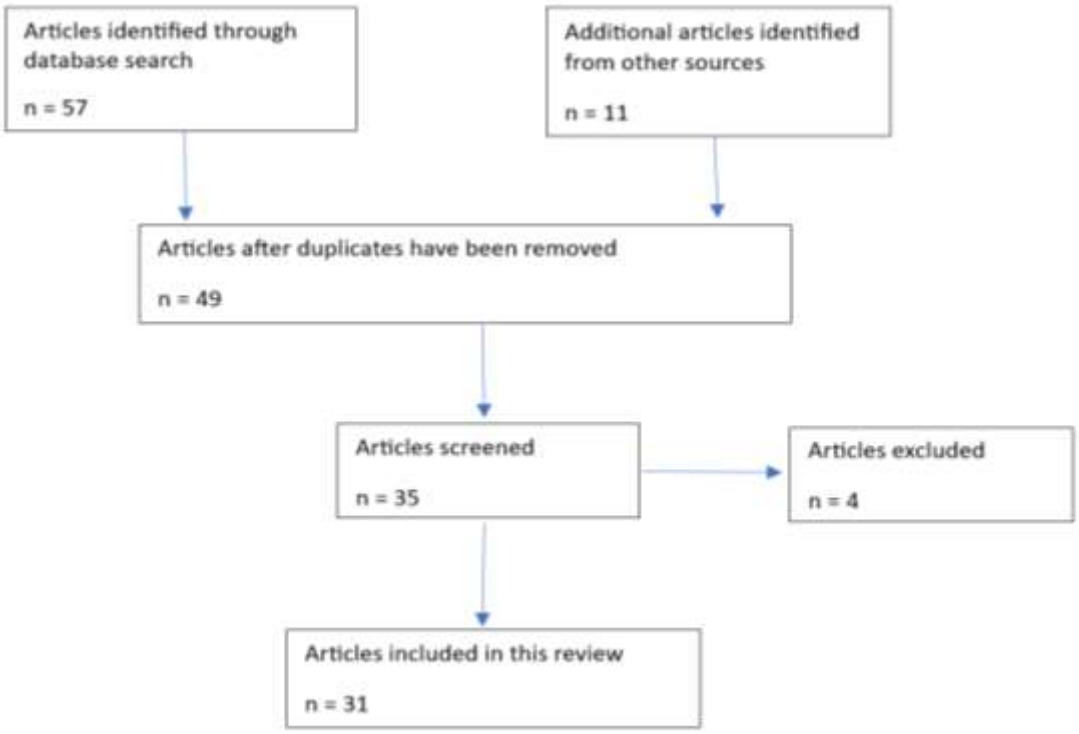

Figure 1: Flow diagram showing identification and screening of articles used in this review.

Results and discussion

Study selection

The systematic review identified 31 articles that were relevant to the botany, medicinal uses, and ethnopharmacological properties of *T. kaiserana* (Table 1). Several articles were excluded because they did not address

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medicinal uses of *T. kaiserana* or ethnopharmacological properties of the species. Such examples include Lawton and Dimbleby (1963), who recorded *T. kaiserana* in northern Zambia, while Banda et al. (2008), Mganga and Lyaruu (2016), Mganga et al. (2017), and Amir and Manoko (2019) recorded the species in western Tanzania. Another study not included in this systematic review is the documentation of vernacular names of *T. kaiserana* in western Tanzania, which was undertaken by Nishida and Uehara (1981) without including any information on medicinal uses and ethnopharmacological properties of the species. Research focusing on the botany, medicinal uses, phytochemistry, and biological activities of *T. kaiserana* has been conducted in many studies since 1962 (Table 1).

Table 1: List of studies used in this review

Author(s)	Year	Information about *Terminalia*	Details of medicinal uses of *T. kaiserana*	Details of the phytochemistry of *T. kaiserana*	Details of the biological activities of *T. kaiserana*
Chhabra et al.	1989	Yes	Yes	No	No
Exell	1978	Yes	No	No	No
Burkill	1994	Yes	No	No	No
Fyhrquist	2007	Yes	Yes	Yes	Yes
Fyhrquist et al.	2002	Yes	Yes	No	No
Fyhrquist et al.	2004	Yes	Yes	No	No
Fyhrquist et al.	2006	Yes	No	No	Yes
Fyhrquist et al.	2013	Yes	Yes	No	No
Fyhrquist et al.	2014a	Yes	Yes	Yes	Yes
Fyhrquist et al.	2014b	No	No	Yes	No
Cock	2015	Yes	No	No	No
Hilonga et al.	2019	Yes	Yes	No	No
Huffman	2022	Yes	Yes	No	No
Iwu	2014	Yes	Yes	Yes	Yes
Kacholi and Amir	2022	Yes	Yes	No	No
Kokwaro	2009	Yes	Yes	No	No
Lemmens	2012	Yes	No	No	No
Lye et al.	2014	Yes	Yes	No	No
Maurin et al.	2010	Yes	No	No	No
Moshi et al.	2006	Yes	Yes	No	No
Palgrave	2002	Yes	No	No	No
Palmer and Pitman	1972	Yes	No	No	No
Quattrocchi	2012	Yes	Yes	No	Yes
Schmidt et al.	2017	Yes	No	No	No
Stace	2002	Yes	No	No	No
Stace	2007	Yes	No	No	No
Van Wyk and Van Wyk	2013	Yes	No	No	No
Van Wyk et al.	2013	Yes	No	No	No
Watt and Breyer-Brandwijk, Wickens	1962 1973	Yes	No	No	No

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Zhang et al.	2019	Yes	Yes	Yes	Yes

Taxonomy and morphological description of *Terminalia kaiserana*

The genus *Terminalia* L. consists of about 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 (Stace, 2007; Maurin et al., 2010, 2017). The genus *Terminalia* comprises trees, shrubs, and lianas, which are characterized by simple leaves, 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 (Leistner, 2000; Stace, 2007). The leaves of some *Terminalia* species are petiolate or subsessile, usually entire but occasionally subcrenate, often with some pellucid dots or glands on either side of the leaf near the base or on the petiole (Palmer and Pitman, 1972; Schmidt et al., 2017). The flowers are bisexual or male or female on the same or different trees, usually borne in lax spikes (Palmer and Pitman, 1972; Van Wyk and Van Wyk, 2013). The flowers are small, lacking petals, and the fruit is one-seeded with two wings that are joined at the top and bottom (Palgrave, 2002). The bark, leaf, and fruit characters are often used to differentiate and identify the different *Terminalia* species (Chakrabarty et al., 2019; Rayane et al., 2022).

Terminalia kaiserana is a deciduous shrub or small tree that grows to about 10 metres in height (Wickens, 1973; Exell, 1978). The bole is characterized by low-branching, crown flat or rounded crown, with spreading branches, densely shady with somewhat drooping foliage. The bark surface is rough and fissured, purplish brown or black, peeling off in strips to reveal the inner bark, which is thick, fibrous, and light brown in colour. The twigs of *T. kaiserana* are initially hairy and become glabrous with age. The leaves are spirally arranged, simple with entire margins, and crowded at the ends of branches. The leaves are elliptic to obovate in shape, base rounded to cuneate, apex obtuse to acute, sometimes slightly acuminate. The inflorescence of *T. kaiserana* is short, occurring in axillary spikes, whitish or creamy in colour. The fruit is an ellipsoid winged nut, glabrous, purplish brown in colour, and indehiscent with a single seed. *Terminalia kaiserana* has been recorded in Burundi, Malawi, Tanzania, and Zambia (Figure 2) in bushland, wooded grassland, and woodland at an altitude ranging from 400 m to 1800 m above sea level (Wickens, 1973; Exell, 1978). In Tanzania, *T. kaiserana* has been recorded in degraded and highly disturbed coastal forests (Mligo, 2018). Research conducted by Wickens (1978) and Lemmens (2012) showed that in eastern Tanzania, *T. kaiserana* hybridizes with *T. sericea* Burch. ex DC.

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Figure 2. Distribution of *Terminalia kaiserana* in tropical Africa

Medicinal uses of *Terminalia kaiserana*

Terminalia kaiserana is an important source of traditional medicines in tropical Africa; its bark and roots are sold in informal herbal medicine markets as sources of traditional medicine in Tanzania (Hilonga et al., 2019). Similarly, its leaf, root, or stem bark decoctions are used to treat and manage 18 human ailments and diseases (Table 2). The main ailments and diseases treated by *T. kaiserana* crude extracts include its use as a diuretic and traditional medicine against HIV/AIDs opportunistic infections, skin diseases, backache, cardiac problems, headache, vomiting, cough, bilharzia, diarrhoea, and gonorrhoea (Figure 3). Other medicinal applications of the species include its use as an aphrodisiac (Chhabra et al., 1989; Fyhrquist et al., 2004) and traditional medicine against cholera (Huffman, 2022), dysentery (Quattrocchi, 2012), fever (Quattrocchi, 2012), and malaria (Hilonga et al., 2019; Huffman, 2022). *Terminalia kaiserana* is also taken as traditional medicine mixed with *Bridelia cathartica* G.Bertol. (Phyllanthaceae family), *Combretum molle* R.Br. ex G.Don (Combretaceae family) and *Dalbergiella nyasae* Baker f. (Fabaceae family) (Fyhrquist, 2007; Quattrocchi, 2012).

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Table 2: Medicinal uses of *Terminalia kaiserana* in Tropical Africa

Medicinal use	Part used and administration	Reference
Mono-therapeutic applications		
Aphrodisiac	Leaf or root decoction taken orally	Chhabra et al., 1989; Fyhrquist et al., 2004
Backache	Leaf or root decoction taken orally	Chhabra et al., 1989; Fyhrquist et al., 2004, 2014a; Kokwaro, 2009
Bilharzia	Leaf, root, or stem bark decoction taken orally	Chhabra et al., 1989; Fyhrquist et al., 2004, 2014a; Fyhrquist, 2007; Lye et al., 2008; Kokwaro, 2009; Quattrocchi, 2012; Iwu, 2014; Huffman, 2022
Cardiac problems	Not specified	Chhabra et al., 1989; Fyhrquist, 2007; Fyhrquist et al., 2014a; Kokwaro, 2009
Cholera	Bark or root decoction taken orally or used as an enema	Huffman, 2022
Cough	Leaf, root, or stem bark decoction taken orally	Chhabra et al., 1989; Fyhrquist, 2007; Kokwaro, 2009; Fyhrqvist et al., 2013, 2014a; Huffman, 2022
Diarrhoea	Bark, leaf, root, or stem bark decoction taken orally or used as an enema	Chhabra et al., 1989; Fyhrquist et al., 2002, 2004, 2013, 2014a; Moshi et al., 2006; Fyhrquist, 2007; Quattrocchi, 2012; Zhang et al., 2019; Huffman, 2022
Diuretic	Root decoction taken orally.	Chhabra et al., 1989; Fyhrquist, 2007; Lye et al., 2008; Kokwaro, 2009; Fyhrquist et al., 2014a
Dysentery	Root decoction taken orally	Quattrocchi, 2012
Fever	Root decoction taken orally	Quattrocchi, 2012
Gonorrhea	Leaf, root, or stem bark decoction taken orally	Chhabra et al., 1989; Fyhrquist et al., 2002, 2004, 2014a; Fyhrquist, 2007; Lye et al., 2008; Kokwaro, 2009; Quattrocchi, 2012; Iwu, 2014; Zhang et al., 2019; Huffman, 2022; Kacholi and Amir, 2022
Headache	Leaf or root decoction taken orally	Chhabra et al., 1989; Fyhrquist et al., 2004, 2014a; Kokwaro, 2009
HIV/AIDs opportunistic infections	Root decoction taken orally	Fyhrquist et al., 2002, 2004; Moshi et al., 2006
Malaria	Leaf, root, or stem bark decoction taken orally	Hilonga et al., 2019; Huffman, 2022
Skin diseases	Leaf, root, or stem bark decoction taken orally	Fyhrquist, 2007; Hilonga et al., 2019; Huffman, 2022
Vomiting	Leaf, root, or stem bark decoction taken orally	Fyhrquist et al., 2002, 2014a; Fyhrquist, 2007; Quattrocchi, 2012; Zhang et al., 2019
Used in combination with other species		
Diabetes mellitus	Roots mixed with those of *Combretum molle* R.Br. ex G.Don (Combretaceae family)	Fyhrquist, 2007; Quattrocchi, 2012

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Diarrhea	Roots mixed with those of *C. molle*	Fyhrquist, 2007
Kidney pains	Roots mixed with those of *Bridelia cathartica* G.Bertol. (Phyllanthaceae family) and *Dalbergiella nyasae* Baker f. (Fabaceae family)	Fyhrquist, 2007

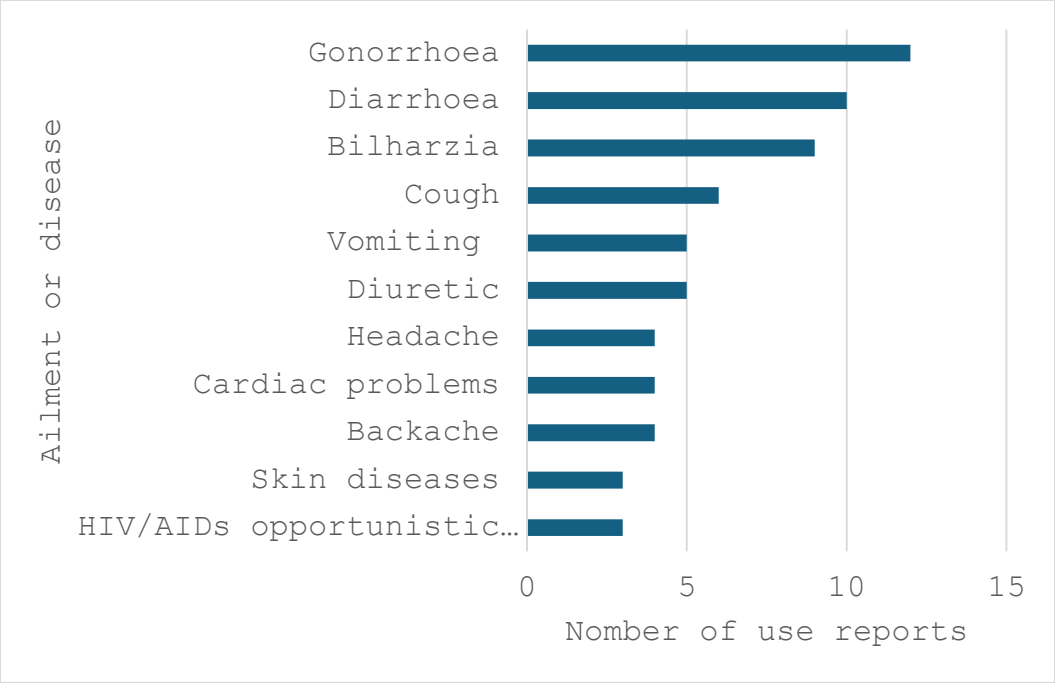

Figure 3. Main diseases and ailments treated and managed by *Terminalia kaiserana* in tropical Africa

Ethnopharmacological properties of *Terminalia kaiserana*

Qualitative and quantitative phytochemical analyses of *T. kaiserana* roots revealed the presence of castalagin, ellagic acid glycosides, ellagic acid rhamnoside, ellagitannin, gallic acid, gallotannins, punicalagin, punicalin, tannins, terchebulin, and terflavin-A (Table 3). Some of the phytochemical compounds isolated from *T. kaiserana* and its crude extracts exhibited antibacterial (Fyhrquist et al., 2002, 2013), antimycobacterial (Fyhrquist et al., 2014a), antifungal (Fyhrquist et al., 2002, 2004), antiproliferative (Fyhrquist et al., 2006), and toxicity (Moshi et al., 2006) activities.

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Table 3: Phytochemical composition of *Terminalia kaiserana* roots

Phytochemical compound	Reference
Castalagin	Fyhrquist et al., 2014b
Ellagic acid glycosides	Fyhrquist et al., 2014a,b
Ellagic acid rhamnoside	Fyhrquist et al., 2013
Ellagitannin	Fyhrquist et al., 2013, 2014a,b
Gallic acid	Fyhrquist et al., 2014a
Gallotannins	Fyhrquist et al., 2014a
Punicalagin	Fyhrquist et al., 2013, 2014b
Punicalin	Fyhrquist et al., 2013, 2014b
Tannins	Fyhrquist et al., 2014a
Terchebulin	Fyhrquist et al., 2013, 2014b
Terflavin-A	Fyhrquist et al., 2014b

Antibacterial activities

Fyhrquist *et al.* (2002) assessed the antibacterial properties of methanol extracts of *T. kaiserana* leaves and roots against *Sarcina* spp., *Staphylococcus epidermidis, Escherichia coli, Enterobacter aerogenes, Staphylococcus aureus, Bacillus subtilis,* and *Micrococcus luteus* using the agar diffusion method with ampicillin and streptomycin as positive controls. The extract exhibited activities against the tested pathogens, exhibiting inhibition zones ranging from 21.0 mm to 38.0 mm (Fyhrquist *et al.,* 2002). Fyhrqvist et al. (2013) assessed the antibacterial activities of butanol and water extracts of *T. kaiserana* roots and the phytochemical compound ellagitannin against *Staphylococcus aureus* using the microdilution method. The extracts of the species and its phytochemical compound ellagitannin showed activities against the tested pathogen, exhibiting the minimum inhibition concentration (MIC) values which ranged from 250.0 µg/ml to 625.0 µg/ml (Fyhrqvist et al., 2013).

Antimycobacterial activities

Fyhrquist et al. (2014a) evaluated the antimycobacterial activities of water, chloroform, butanol, and methanol extracts of *T. kaiserana* roots against Mycobacterium smegmatis using agar diffusion and microdilution with rifampicin as a positive control. The extracts exhibited activities against the tested pathogens, exhibiting MIC values ranging from 1250.0 µg/ml to 1562.0 µg/ml (Fyhrquist et al., 2014a)

Antifungal activities

Fyhrquist et al. (2002) assessed the antifungal properties of methanol extracts of *T. kaiserana* roots against *Candida albicans* using the agar diffusion method with amphotericin B as a positive control. The extract exhibited activities against the tested pathogen, exhibiting an inhibition zone of 28.0 mm (Fyhrquist et al., 2002). Fyhrquist et al. (2004) evaluated the antifungal activities of methanol extracts of *T. kaiserana* roots against *Candida glabrata* and *Cryptococcus neoformans* using the agar diffusion method with amphotericin B and itraconazole as positive controls. The extracts exhibited activities against the tested pathogens, exhibiting MIC values of 1.6 mg/ml (Fyhrquist et al., 2004)

Antiproliferative activities

Fyhrquist et al. (2006) evaluated the antiproliferative activities of the methanolic extract of *T. kaiserana* roots against HeLa (cervical carcinoma) and T 24 (bladder carcinoma) cancer cell lines using the Alamar Blue assay. The extract exhibited activities against HeLa and T 24, exhibiting inhibition of 23.6% and 33.7%, respectively (Fyhrquist et al., 2006)

Toxicity activities

Moshi et al. (2006) evaluated the toxicity activities of ethanol extract of *T. kaiserana* roots using the brine shrimp lethality test with cyclophosphamide as a positive control. The extract was toxic with a median lethal concentration (LC_{50}) value of 15.7 µg/ml, which was lower than the LC_{50}

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value of 16.3 µg/ml exhibited by the positive control (Moshi et al., 2006).

Conclusion

As outlined in the present review, *T. kaiserana* is a shrub or tree with great potential as a medicinal plant characterized by several uses in traditional medicine in tropical Africa. No extensive evaluations of the biological activities of the crude extracts of the species have been undertaken, nor has the identification of the active ingredients or phytochemical compounds of the species been undertaken. Therefore, 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. kaiserana* is a promising *materia medica* in African traditional pharmacopoeia. To realize the full potential of *T. kaiserana*, 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. kaiserana* 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. kaiserana*. There is also a need to evaluate the combinational therapy involving *T. kaiserana* and other species such as *B. cathartica*, *C. molle,* and *D. nyasae*.

Limitations

Identification and access to relevant literature focusing on the botany, medicinal uses, and ethnopharmacological properties of *T. kaiserana* were a major challenge. This is partly due to the restricted geographical distribution of the species. Therefore, this probably resulted in publication bias, as it caused subjectivity in the interpretation and synthesis of the research findings. This challenge is also associated with limitations such as the quality of literature sources and experimental techniques used in some of the easily accessible scientific studies.

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Author contributions

I am solely responsible for the conception and design of the research work, data collection, analysis, interpretation of the data, and writing of the manuscript.

Registration and protocol

The review was not registered, and a protocol was not prepared.

Competing interests

The author declares that there is no conflict of interest associated with this research.

List of abbreviations

HIV/AIDs - Human Immunodeficiency Virus/acquired Immunodeficiency Syndrome
LC_{50} - Median Lethal Concentration
MIC - Minimum Inhibition Concentration
WHO - World Health Organization

Availability of data, code, and other materials

All data generated or analyzed during this study are included in this article.

Author biography

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