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REVIEW ARTICLE

ETHNOBOTANICAL USES, PHYTOCHEMICAL AND PHARMACOLOGICAL PROPERTIES OF *Turraea floribunda:* A REVIEW

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ABSTRACT

Turraea floribunda Hochst. is a small to medium-sized tree used as traditional medicine in tropical Africa. This study was aimed at providing a comprehensive review of the ethnobotanical uses, phytochemistry and pharmacological properties of *T. floribunda*. This information was collected from several online databases such as PubMed®, Web of Science, ScienceDirect®, Google Scholar, SpringerLink®, Scopus® and SciELO and pre-electronic literature sources such as books, book chapters and scientific publications obtained from the university library. This study showed that *T. floribunda* is used as traditional medicine in 53.8% of the countries where the species is indigenous. The traditional medicines prepared from the bark, leaves, roots and stem bark of *T. floribunda* are used to treat and manage 20 human and livestock diseases and ailments in central, eastern and southern Africa. The phytochemical evaluation of the species revealed that it contains diterpenoids, alkanes, sesquiterpenoids, methyl esters, triterpenoids, fatty acids, esters, fatty alcohols, limonoids, sterols and hydrocarbons. Ethnopharmacological research showed that the crude extracts and phytochemical compounds isolated from *T. floribunda* have antibacterial, antifungal, anti-hypertensive, anti-inflammatory, antioxidant, antiplasmodial, antiprotozoal, cytotoxicity, insecticidal and larvicidal activities. Detailed studies focusing on toxicological evaluations, *in vivo* and clinical research aimed at corroborating the traditional medical applications of *T. floribunda* are recommended.

Keywords: Mahogany, Meliaceae, traditional medicine, tropical Africa, *Turraea floribunda.*

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INTRODUCTION

Turraea floribunda Hochst. (Figure 1) is a small to medium-sized deciduous tree belonging to the Meliaceae or the mahogany or chinaberry family. Meliaceae family has approximately 50 genera and 1400 species (Oyedeji-Amusa *et al.,* 2024) of mostly shrublets, shrubs and trees confined to the tropics and subtropics of both hemispheres (Leistner, 2000; Oyedeji-Amusa *et al.,* 2024). Meliaceae species have been recorded in diverse ecological conditions (Figure 2) ranging from rocky seashores, deserts, rain forests, mangrove swamps, seasonal, dry and wet tropical forests (Heywood *et al.,* 2007). Several species belonging to the Meliaceae family are sought after in the world as sources of commercial timbers. Such species include *Cedrela odorata* L. (Cuban or Spanish cedar), *Entandrophragma caudatum* (Sprague) Sprague (mountain mahogany), *Khaya anthotheca* (Welw.) C.DC. (red mahogany), *Khaya senegalensis* (Desr.) A.Juss. (African mahogany) and *Swietenia mahagoni* (L.) Jacq. (West Indian mahogany (Pooley, 1993; Lemmens *et al.,* 2012). Similarly, some of the species belonging to the Meliaceae family are regarded as multipurpose species used as sources of timber, herbal medicines, food, garden ornamentals, fodder, dyes, source of oil, fuels, soap, cosmetics, insecticides and fertilizer (Oyedeji-Amusa *et al.,* 2021; Tsomele *et al.,* 2021; Legesse *et al.,* 2023; Ramanan *et al.,* 2024). Recently, there has been growing interest on the phytochemical compounds isolated from some species belonging to the Meliaceae family as well as biological activities of these compounds and/or crude extracts of these species (Mouthe *et al.,* 2021; Safriansyah *et al.,* 2022; Mianda *et al.,* 2023; Riyadi *et al.,* 2023; Shewaye *et al.,* 2023; Happi and Teufel, 2024; Nguekeu *et al.,* 2024; Tatio *et al.,* 2024). Therefore, members of the Meliaceae family are used daily for different purposes, but this indigenous or traditional knowledge on plant uses is still a relatively underdeveloped discipline. Van Wyk and Gericke (2018) argued that scientific documentation of indigenous or traditional knowledge about plant utilization, availability, conservation and their characteristics is important for the application and beneficiation of this knowledge as an instrument for sustainable development. Literature studies show that utilization of natural resources such as

plants play a vital role in the socio-economic development of nations by presenting opportunities for economic growth, increased revenues, infrastructure development, job creation, improved well-being and knowledge transfer (Tian and Zhang, 2023).

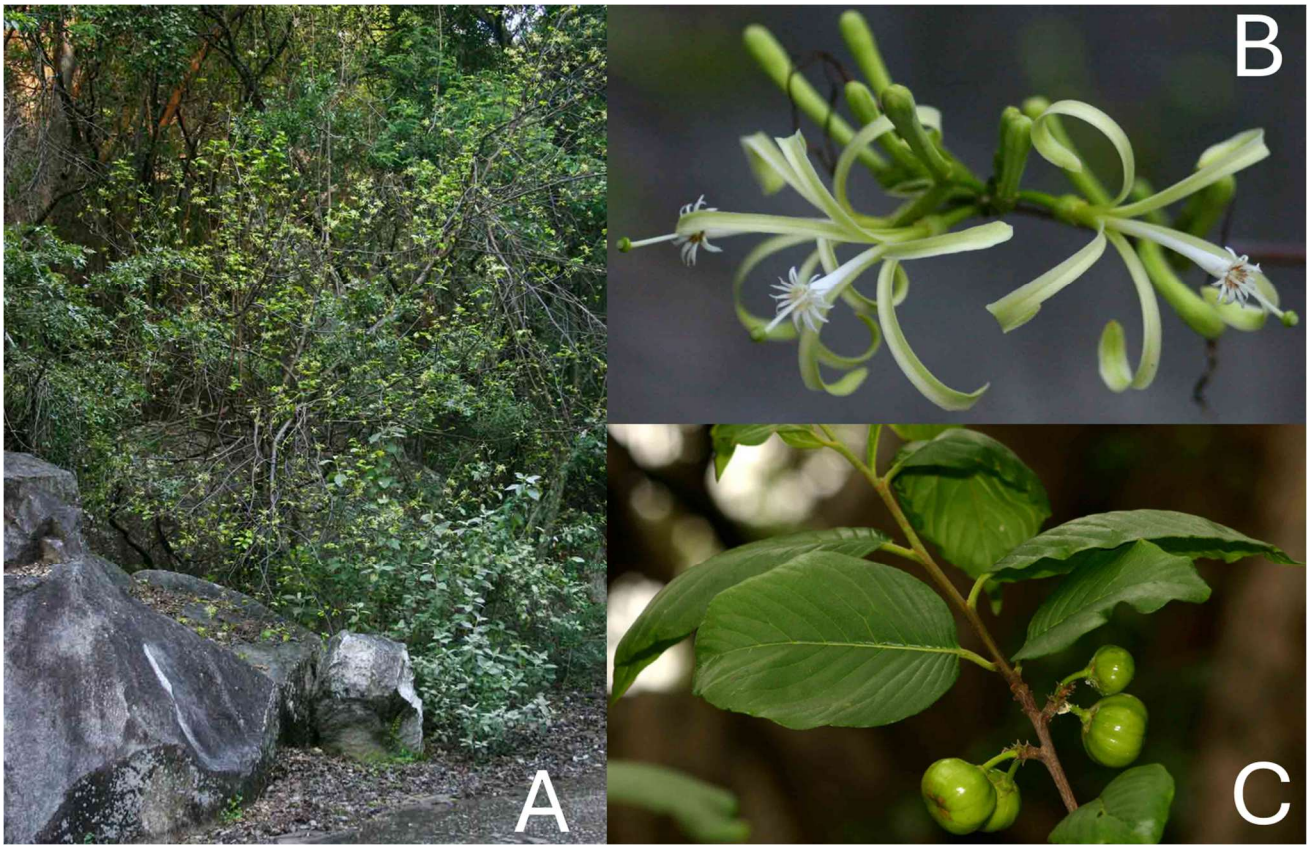

Figure 1: *Turraea floribunda*: A: general habit of the species, B: a branch showing flowers, and C: a branch showing leaves, leaf arrangement and fruits (photos: B Wursten).

Turraea floribunda plays an important role in the provision of goods and ecosystem services that are important for human survival and well-being (Oyedeji-Amusa *et al.,* 2021). For example, *T. floribunda* is one of the medicinal plants widely used as a source of traditional medicines in the KwaZulu Natal province in South Africa (Mander, 1998). Research by Mander (1998) and Mander *et al.* (2012) showed that the species potential for cultivation on a commercial scale as a medicinal plant, offering peri-urban, rural farmers and communities in marginal areas an alternative source of livelihoods. Moreover, the bark, leaves, roots and stems of *T. floribunda* are sold in informal herbal medicine markets as sources of traditional medicines in the Gauteng, KwaZulu-Natal and Mpumalanga provinces of South Africa (Cunningham, 1993; Mander, 1998; Williams *et al.,* 2001; Dold and Cocks, 2002). *Turraea floribunda* is in general a valuable medicinal plant in central, eastern and southern Africa, and the species is listed in the monograph "Medicinal and magical plants of southern Africa: An annotated checklist" as a valuable medicinal plant (Arnold *et al*., 2002). It is therefore, within this context that the current study was undertaken aimed at evaluating the medicinal, phytochemical and pharmacological properties of *T. floribunda*.

The literature search on medicinal uses, phytochemical and pharmacological properties of *Turraea floribunda* was conducted from July 2023 to April 2024. This information on these aspects was obtained using online databases such as Scopus® (http://www.scopus.com/), Web of Science (https://www.webofknowledge.com), Google Scholar (https://scholar.google.com/), Springer Link® (https://link.springer.com/), SciELO (https://search.scielo.org/), Science Direct® (https://www.sciencedirect.com/search) and PubMed® (https://pubmed.ncbi.nlm.nih.gov/). Additional information on the medicinal uses, phytochemical and pharmacological properties of *T. floribunda* was also obtained by systematic search of various resources which are not covered by electronic databases, and these included journal papers, books, dissertations, book

chapters, theses and other scientific articles obtained from the University library. The keywords used in the search included "*T. floribunda*", the synonyms of the species "*Turraea floribunda* Hochst.*"*, English common names of the species, that is, "honeysuckle-tree", "splendid honeysuckle-tree", "the many-flowered turraea" and "wild honeysuckle-tree". Additional search was also conducted using the keywords *"*biological activities of *T. floribunda*", "pharmacological properties of *T. floribunda*", "ethnobotany of *T. floribunda*", "medicinal uses of *T. floribunda*", "phytochemistry of *T. floribunda*" and "traditional uses of *T. floribunda".*

Figure 2: Distribution of *Turraea floribunda* in tropical Africa (map drawn using mapchart.net)

Taxonomy and morphological description of *Turraea floribunda:* *Turraea* L. is a genus of about 50 small to medium deciduous trees, shrubs and shrublets, usually suffruticose and occasionally scrambling (Leistner, 2000). In southern Africa, the genus is represented by eight species, namely *T. floribunda*, *T. fisheri* Gürke, *T. nilotica* Kotschy & Peyr., *T. obtusifolia* Hochst., *T. pulchella* (Harms) T.D.Penn., *T. streyi* F.White & Styles, *T. wakefieldii* Oliv. and *T. zambesica* Sprague and Hutch. (Palgrave, 2002; Germishuizen and Meyer, 2003; Oyedeji-Amusa *et al.,* 2021). These species are distinguished on the basis of leaf and petiole characters as well as geographical information (Palgrave, 2002; Germishuizen and Meyer, 2003; Oyedeji-Amusa *et al.,* 2021). Species of this genus have woody or leathery, dehiscent capsule fruits, with one or two red or black fleshy seeds covered partially or wholly by a red or

orange aril (Palgrave, 2002). These species have been recorded in Africa, Madagascar Mascarenes and the Comores, with one species widespread in the tropical Far East (Leistner, 2000). Muellner *et al.* (2006) argued that the centre of diversity of the genus *Turraea* is in the Afro-Malagasy region, a floristic centre of plant diversity characterized by several plant genera. The genus name "*Turraea*" is in honour of Giorgio della Turre (1607-1688), an Italian medical doctor and botanist, who was a Director of the Botanic Garden at Padua from 1649 to 1683, and published a catalogue of the plants in the garden in 1660 (Palmer and Pitman, 1972). The specific name "*floribunda*" is derived from Latin, meaning "flowering profusely" (Schmidt *et al.,* 2017), in reference to many flowers produced by the species. The synonyms of *T. floribunda* Hochst. include *Rutaea floribunda* (Hochst.) M.Roem., *Turraea heterophylla* Sond. and *Turraea kaessneri* Baker f. (White and Styles, 1963; White, 1986; Styles and White, 1991). The English common names of *T. floribunda* include "honeysuckle-tree", "splendid honeysuckle-tree", "the many-flowered turraea" and "wild honeysuckle-tree" (Palmer and Pitman, 1972; Palgrave, 2002; Burrows *et al.,* 2018).

Turraea floribunda is a small to medium-sized deciduous shrub or small tree with a tendency to scramble and have horizontally spreading branches (Van Wyk and Van Wyk, 2013). The species is a slender, often many stemmed or occasionally with a trunk up to 30 cm in diameter and can grow up to 13 m in height under ideal conditions (Palgrave, 2002). The bark is pale grey, grey blotched with brown or a dark red-brown in colour. The young branches are hairy, later becoming smooth and darker in colour. Leaves of *T. floribunda* are simple, alternate, ovate to lanceolate in shape, soft to the touch, toothed when very young, when mature untoothed, widely lance-shaped to egg-shaped, shortly or bluntly pointed, narrowing to the base. The leaves are hairy when young, becoming somewhat smoother, dark green above, paler green below with a network of finer veins which are prominent below. The leaves are borne on densely hairy stalks. The leaves and flowers tend to grow at the ends of short side branches. The flowers of *T. floribunda* are axillary, borne in dense clusters, green-yellow in colour, sweetly scented, appearing with the new leaves, curve backwards and with a protruding and conspicuous white staminal tube. The fruits are dark brown or black in colour, roundish, shiny, deeply ribbed and woody, star-shaped, splitting along the ribs into segments that curl back and show the small, bright orange or red shiny seeds within. *Turraea floribunda* has been recorded in Burundi, the Democratic Republic of Congo (DRC), Eswatini, Kenya, Malawi, Mozambique, Rwanda, South Africa, South Sudan, Sudan, Tanzania, Uganda and Zimbabwe (White and Styles, 1963; White, 1986; Styles and White, 1991; Fischer *et al.,* 2010; Kalema and Beentje, 2012; Darbyshire *et al.,* 2015) (Figure 2). The species has been recorded in coastal bush, coastal forest, riverine forest, lowland forest, dune forest, low-lying evergreen forest, moist forest, forest margins, secondary forest, bushveld, open woodland, wooded kloofs and on stream banks from sea level up to 915 m above sea level (Styles and White, 1991; Palgrave, 2002; Germishuizen and Meyer, 2003; Burrow *et al.,* 2018).

Ethnobotanical and traditional uses of *Turraea floribunda:* *Turraea floribunda* is a multipurpose plant species, almost all of its different parts used as sources of ecosystem services and goods such as timber, construction materials, traditional medicines, firewood, fodder and various cultural applications. *Turraea floribunda* is used as an ornamental plant in central, eastern and southern Africa in well-drained soils and where frost is not severe, particularly in small gardens (Manning, 2015). For example, in Tanzania, *T. floribunda* is preserved in or around home compounds as an ornamental plant, on roadsides to create shade, live fence, wind break and for soil conservation (Lovett *et al.,* 2006; Latham, 2008). In Tanzania, the timber and wood of *T. floribunda* is locally used for house building, fence posts, joinery, panelling, agricultural implements, utensils, tool handles, firewood and charcoal production (Lovett *et al.,* 2006). In central, eastern and southern Africa, the fresh foliage of *T. floribunda* is eaten by livestock and game (Palmer and Pitman, 1972; Van Wyk and Van Wyk, 2013). Research conducted by Palmer and Pitman (1972) showed that the butterfly known as the white-barred caraks, *Charaxes brutus natalensis*, breeds on *T. floribunda* (Palmer and Pitman, 1972). National conservation status of *T. floribunda* in Eswatini and South Africa focusing on the extent and intensity of threats being faced by the species which is currently harvested from the wild showed that the species is of Least Concern based on the IUCN Red List Categories and Criteria (Loffler and Loffler, 2005; Raimondo *et al.,* 2009; Oyedeji-Amusa *et al.,* 2024).

Turraea floribunda is used as a source of traditional medicines in South Africa, Tanzania, Eswatini, Uganda, DRC, Malawi and Kenya, that is, 53.8% of the countries where the species is indigenous (Table 1). The traditional medicines prepared from the bark, leaves, roots and stem bark of *T. floribunda* are used to treat and manage 20 human and livestock diseases and ailments in central, eastern and southern Africa. The main ailments and diseases treated by *T. floribunda* crude extracts include its use as an emetic in South Africa and Tanzania, purgative (Eswatini, South Africa and Tanzania), malaria (Kenya and Uganda) and rheumatism (Eswatini, South Africa and Tanzania) (Table 1). In South Africa, the roots of *T. floribunda* are mixed with the bark of *Strychnos henningsii* Gilg (family Loganiaceae) and boiled in two litres of water, and about 250 ml of this decoction taken orally three times a day as

traditional medicine for rheumatic fever (Hutchings *et al.,* 1996; Grace *et al.,* 2003; Fowler, 2006; Maroyi, 2021). The roots of *Canthium ciliatum* (D.Dietr.) Kuntze (family Rubiaceae) are usually used by the traditional healers in South Africa as substitute for *T. floribunda* as an emetic to induce trances before divining dances (Gerstner, 1941).

Table 1: Ethnomedicinal uses of *Turraea floribunda*

Medicinal use	Plant part used	Country	Reference
Abscesses	Root decoction applied topically	South Africa	Neuwinger, 2000
Ascites	Root maceration applied topically	South Africa	Watt and Breyer-Brandwijk, 1962; Hutchings *et al.,* 1996
Cardiac problems	Root maceration taken orally	South Africa	Boon and Pooley, 2010; Schmidt *et al.,* 2017
Cough	Leaf and root decoction taken orally	Tanzania	Latham, 2008; Kokwaro, 2009
Dropsy	Root infusion applied topically	South Africa	Heilgendorff, 1988; Palgrave, 2002
Emetic	Bark and root decoction taken orally	South Africa and Tanzania	Notten, 2007; Latham, 2008; Lye *et al.,* 2008
Heart problem	Bark, leaf and root infusion taken orally	Eswatini, South Africa and Tanzania	Loffler and Loffler, 2005; Lovett *et al.,* 2006; Manning, 2015
Malaria	Stem bark decoction taken orally	Kenya and Uganda	Kuglerova *et al.,* 2011; Muthaura *et al.,* 2015
Nervous system	Bark and root infusion taken orally	South Africa	Hutchings, 1989
Pain	Bark and root infusion orally	South Africa	Hutchings, 1989
Protection from bad dreams	Bark	South Africa	Bryant, 1966; Schmidt *et al.,* 2017
Purgative	Bark and root decoction taken orally	Malawi and Tanzania	Kokwaro, 2009; Manning, 2015; Van Wyk and Gericke, 2018
Renal	Bark and root infusion taken orally	South Africa	Hutchings, 1989
Rheumatism	Bark, leaf and root maceration taken orally	Eswatini, South Africa and Tanzania	Hutchings *et al.,* 1996; Loffler and Loffler, 2005; Lovett *et al.,* 2006
Rheumatic fever	Roots mixed with bark of *Strychnos henningsii* Gilg	South Africa	Hutchings *et al.,* 1996; Grace *et al.,* 2003; Fowler, 2006; Maroyi, 2021
To induce a state of trance	Bark infusion taken orally	South Africa	Manning, 2015; Schmidt *et al.,* 2017
Tonic	Not specified	South Africa	Mhlongo and Van Wyk, 2019
Typhoid fever	Stem bark decoction taken orally	DRC	Valentin *et al.,* 2022
Urethral infection	Bark decoction taken orally	South Africa	Bhat and Jacobs, 1995
Ethnoveterinary medicine (panacea)	Bark decoction	Uganda	Gradé *et al.,* 2009

Phytochemistry and pharmacological properties of *Turraea floribunda:* Several phytochemical compounds such as diterpenoids, alkanes, sesquiterpenoids, methyl esters, triterpenoids, fatty acids, esters, fatty alcohols, limonoids, sterols and hydrocarbons have been identified from the bark, leaves, roots, seeds and wood of *T. floribunda* (Table 2). Akinniyi *et al.* (1986) isolated limonoids from the bark of *T. floribunda*, while the same compounds have also been isolated from the roots of this species by Torto *et al.* (1995, 1996) and Ndung'u *et al.* (2004). Limonoids have also been isolated from the seeds of *T. floribunda* by Akerman (1990), Mulholland *et al.* (1992), Fraser *et al.* (1994), Mulholland *et al.* (1998) and McFarland *et al.* (2004). Akerman (1990) isolated sterols from the wood extract of *T. floribunda* while Ehawa *et al.* (2020) isolated sterols and triterpenoids from the leaves of the species. Recently, Shilaluke and Moteetee (2022) isolated diterpenoids, alkanes, sesquiterpenoids, methyl esters, triterpenoids, fatty acids, esters, fatty alcohols and hydrocarbons from the leaves of *T. floribunda*. Some of the phytochemical compounds isolated from T. floribunda and its crude extracts exhibited antibacterial,

antifungal, anti-hypertensive, anti-inflammatory, insecticidal and larvicidal activities. antioxidant, antiplasmodial, antiprotozoal, cytotoxicity,

Table 2: Phytochemical composition of *Turraea floribunda*

Chemical compound	Formula	Part	Reference
1,2-Benzisothiazol-3-amine	$C_{13}H_{20}N_2Si$	Leaves	Shilaluke and Moteetee, 2022
1,3,6,10-Cyclotetradecatetraene,3,7,11-trimethyl-14-(1-methylethyl)-[S-(E,Z,E,E)]-	$C_{20}H_{32}$	Leaves	Shilaluke and Moteetee, 2022
1,3,7,11-Cyclotetradecatetraene, 2-methyl-	$C_{15}H_{22}$	Leaves	Shilaluke and Moteetee, 2022
1,6,10,14-Hexadecatetraen-3-ol,3,7,11,15-tetramethyl-,(E,E)-	$C_{20}H_{34}O$	Leaves	Shilaluke and Moteetee, 2022
2,15-Hexadecanedione	$C_{16}H_{30}O_2$	Leaves	Shilaluke and Moteetee, 2022
2,6,10,14-Hexadecatetraen-1-ol,3,7,11,15-tetramethyl-,acetate, (E,E,E)-	$C_{22}H_{36}O_2$	Leaves	Shilaluke and Moteetee, 2022
3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	Leaves	Shilaluke and Moteetee, 2022
4,4'-bi-4H-pyran, 2,2',6,6'-tetrakis(1,1-dimethylethyl)-4,4'-dimethyl-	$C_{28}H_{46}O_2$	Leaves	Shilaluke and Moteetee, 2022
6,10-Dodecadien-1-yn-3-ol, 3,7,11-trimethyl-	$C_{15}H_{24}O$	Leaves	Shilaluke and Moteetee, 2022
9,12,15-Octadecatrienoic acid, 2,3-dihydroxypropyl ester, (Z,Z,Z)-	$C_{21}H_{36}O_4$	Leaves	Shilaluke and Moteetee, 2022
9,19-Cyclolanostan-3-ol, acetate, (3β)-	$C_{32}H_{54}O_2$	Leaves	Shilaluke and Moteetee, 2022
1α,11β-diacetoxy-4α-carbomethoxy-7α-hydroxy-12α-(2-methylpropanoyloxy)-15-oxohavanensin	$C_{35}H_{48}O_{12}$	Root bark	Ndung'u *et al.,* 2004
1α,7α,11β-triacetoxy-4α-carbomethoxy-12α-(2-methylbutanoyloxy)-14β,15β-epoxyhavanensin	$C_{32}H_{40}O_{11}$	Root bark	Ndung'u *et al.,* 2004
1α,7α-12α-triacetoxy-4α-carbomethoxy-11β-(2-methylpropanoyloxy)-14β,15β-epoxyhavanensin	$C_{38}H_{50}O_{16}$	Bark	Akinniyi *et al.,* 1986
1α,7α,11β-triacetoxy-4α-carbomethoxy-12α-(2-methylpropanoyloxy)-14β,15β-epoxyhavanensin	$C_{37}H_{50}O_{13}$	Root bark	Ndung'u *et al.,* 2004
1H-3a,7-Methanoazulene,octahydro-1,4,9,9-tetramethyl-	$C_{15}H_{26}$	Leaves	Shilaluke and Moteetee, 2022
1H-Indene, 1-ethylidene-	$C_{11}H_{10}$	Leaves	Shilaluke and Moteetee, 2022
(1R,4S,5S)-1,8-Dimethyl-4-(prop-1-en-2-yl)spiro[4.5]dec-7-ene	$C_{15}H_{24}$	Leaves	Shilaluke and Moteetee, 2022
2-Chloroethanol	C_2H_5ClO	Leaves	Shilaluke and Moteetee, 2022
2-Cyclohexen-1-one,4-(3-hydroxybutyl)-3,5,5-trimethyl-	$C_{13}H_{22}O_2$	Leaves	Shilaluke and Moteetee, 2022
2-Pentadecanone, 6,10,14-trimethyl-	$C_{18}H_{36}O$	Leaves	Shilaluke and Moteetee, 2022
2-Piperidinone, N-[4-bromo-n-butyl]-	$C_9H_{16}BrNO$	Leaves	Shilaluke and Moteetee, 2022
2-Undecanone, 6,10-dimethyl-	$C_{13}H_{26}O$	Leaves	Shilaluke and Moteetee, 2022
2(4H)-Benzofuranone,5,6,7,7a-tetrahydro-4,4,7a-trimethyl-,(R)-	$C_{11}H_{16}O_2$	Leaves	Shilaluke and Moteetee, 2022
3-Cyano-3-octyl-1,4-cyclohexadiene	$C_{15}H_{23}N$	Leaves	Shilaluke and Moteetee, 2022
((4aS,8S,8aR)-8-isopropyl-5-methyl-3,4,4a,7,8,8a-hexahydronaphthalen-2-yl)methanol	$C_{15}H_{24}O$	Leaves	Shilaluke and Moteetee, 2022
4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	$C_6H_8O_4$	Leaves	Shilaluke and Moteetee, 2022
4-Methyl-1,5-heptadiene	C_8H_{14}	Leaves	Shilaluke and Moteetee, 2022
4-Methyl-2,4-bis(p-hydroxyphenyl)pent-1-ene	$C_{24}H_{36}O_2Si_2$	Leaves	Shilaluke and Moteetee, 2022
4-tert-Octylphenol, TMS derivative	$C_{17}H_{30}OSi$	Leaves	Shilaluke and Moteetee, 2022
11-epi-21-hydroxytoonacilide	$C_{31}H_{38}O_{11}$	Leaves	Ehawa *et al.,* 2020
11*β*, 12*α*-diacetoxycedrelone	$C_{30}H_{35}O_9$	Leaves	Ehawa *et al.,* 2020
11β-acetoxy-3,7-diacetyl-4α-carbomethoxy-12α-isobutyryloxy-28-nor-1-tigloyl-havanensin	$C_{42}H_{56}O_{14}$	Roots	Torto *et al.,* 1996
18-nor-4α-carbomethoxy-11β-acetoxy-12α-(2-methylbutanoyloxy)-14,15-deoxyhavanensin-1-acetate	$C_{36}H_{50}O_{11}$	Roots	Torto *et al.,* 1995
28-nor-4α-carbomethoxy-11β-acetoxy-12α-(2-methylbutanoyloxy)-14,15-deoxyhavanensin-1,7-diacetate	$C_{38}H_{52}O_{12}$	Roots	Torto *et al.,* 1995, 1996

28-nor-4α-carbomethoxy-11β-hydroxy-12α-(2-methylbutanoyloxy)-14,15-deoxyhavanensin-1,7-diacetate	$C_{34}H_{48}O_{10}$	Roots	Torto *et al.,* 1995, 1996
28-nor-4α-carbomethoxy-11β-acetoxy-12α-(2-methylbutanoyloxy)-14,15-deoxyhavanensin-1-acetate	$C_{36}H_{50}O_{11}$	Roots	Torto *et al.,* 1995, 1996
28-nor-4α-carbomethoxy-7-deoxy-7-oxo-11β-acetoxy-12α-(2-methylbutanoyloxy)-14,15-deoxyhavanensin-1-acetate	$C_{36}H_{48}O_{11}$	Roots	Torto *et al.,* 1995, 1996
Acetic acid, hydrazide	$C_2H_6N_2O$	Leaves	Shilaluke and Moteetee, 2022
Acetic acid, hydroxy-	$C_2H_4O_3$	Leaves	Shilaluke and Moteetee, 2022
Arsenous acid, tris(trimethylsilyl) ester	$C_9H_{27}O_3Si_3$	Leaves	Shilaluke and Moteetee, 2022
Benzeneacetic acid	$C_8H_8O_2$	Leaves	Shilaluke and Moteetee, 2022
Benzeneethanamine,2-fluoro-β,3,4-trihydroxy-N-isopropyl-	$C_{11}H_{16}NO_3$	Leaves	Shilaluke and Moteetee, 2022
Betulinic acid	$C_{30}H_{49}O_3$	Leaves	Ehawa *et al.,* 2020
Butyl 6,9,12-hexadecatrienoate	$C_{20}H_{34}O_2$	Leaves	Shilaluke and Moteetee, 2022
α-Calacorene	$C_{15}H_{20}$	Leaves	Shilaluke and Moteetee, 2022
cis-5,8,11,14,17-Eicosapentaenoic acid	$C_{20}H_{30}O_2$	Leaves	Shilaluke and Moteetee, 2022
cis-Z-α-Bisabolene epoxide	$C_{15}H_{24}O$	Leaves	Shilaluke and Moteetee, 2022
Cyclotrisiloxane, hexamethyl-	$C_6H_{18}O_3Si_3$	Leaves	Shilaluke and Moteetee, 2022
n-Decanoic acid	$C_{10}H_{20}O_2$	Leaves	Shilaluke and Moteetee, 2022
dl-7-Azatryptophan	$C_{10}H_{11}N_3O_2$	Leaves	Shilaluke and Moteetee, 2022
dl-α-Tocopherol	$C_{29}H_{50}O_2$	Leaves	Shilaluke and Moteetee, 2022
(E,E,E)-3,7,11,15-tetramethylhexadeca-1,3,6,10,14-pentaene	$C_{20}H_{32}$	Leaves	Shilaluke and Moteetee, 2022
Eicosane	$C_{20}H_{42}$	Leaves	Shilaluke and Moteetee, 2022
Ergost-5-en-3-ol, acetate, (3β,24R)-	$C_{30}H_{50}O_2$	Leaves	Shilaluke and Moteetee, 2022
Fridelin	$C_{30}H_{50}O$	Leaves	Ehawa *et al.,* 2020
Geijerene	$C_{12}H_{18}$	Leaves	Shilaluke and Moteetee, 2022
Glycerin	$C_3H_8O_3$	Leaves	Shilaluke and Moteetee, 2022
Heptacosane	$C_{27}H_{56}$	Leaves	Shilaluke and Moteetee, 2022
Hexadecane	$C_{16}H_{34}$	Leaves	Shilaluke and Moteetee, 2022
n-Hexadecanoic acid	$C_{16}H_{32}O_2$	Leaves	Shilaluke and Moteetee, 2022
Hydrazine	H_4N_2	Leaves	Shilaluke and Moteetee, 2022
Hydroxylamine	H_3NO	Leaves	Shilaluke and Moteetee, 2022
Isoaromadendrene epoxide	$C_{15}H_{24}O$	Leaves	Shilaluke and Moteetee, 2022
Isophytol	$C_{20}H_{40}O$	Leaves	Shilaluke and Moteetee, 2022
Lupeol	$C_{30}H_{51}O$	Leaves	Ehawa *et al.,* 2020
Methyl 6,9,12,15,18-heneicosapentaenoate	$C_{22}H_{34}O_2$	Leaves	Shilaluke and Moteetee, 2022
Methyl 8,11,14-heptadecatrienoate	$C_{18}H_{30}O_2$	Leaves	Shilaluke and Moteetee, 2022
Methyl Alcohol	CH_4O	Leaves	Shilaluke and Moteetee, 2022
Naphthalene, 2-methyl-	$C_{11}H_{10}$	Leaves	Shilaluke and Moteetee, 2022
Neophytadiene	$C_{20}H_{38}$	Leaves	Shilaluke and Moteetee, 2022
Nonanamide	$C_9H_{19}NO$	Leaves	Shilaluke and Moteetee, 2022
Octadecanal	$C_{18}H_{36}O$	Leaves	Shilaluke and Moteetee, 2022
Phenol,2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-	$C_{23}H_{32}O_2$	Leaves	Shilaluke and Moteetee, 2022
Phenol, 2,6-bis(1,1-dimethylethyl)-	$C_{14}H_{22}O$	Leaves	Shilaluke and Moteetee, 2022
Phthalic acid, 4-cyanophenyl heptyl ester	$C_{22}H_{23}NO_4$	Leaves	Shilaluke and Moteetee, 2022
Phthalic acid, heptadecyl 2-propylpentyl ester	$C_{33}H_{56}O_4$	Leaves	Shilaluke and Moteetee, 2022
Phthalic acid, heptyl pentyl ester	$C_{20}H_{30}O_4$	Leaves	Shilaluke and Moteetee, 2022
Phytol	$C_{20}H_{40}O$	Leaves	Shilaluke and Moteetee, 2022
β-Santalol	$C_{15}H_{24}O$	Leaves	Shilaluke and Moteetee, 2022
Silane	H_4Si	Leaves	Shilaluke and Moteetee, 2022
β-sistosterol	$C_{29}H_{50}O$	Leaves, seeds	Ehawa *et al.,* 2020; Shilaluke and Moteetee, 2022
β-sistosterol-3-*O*-*β*-D-glucopyranoside	$C_{35}H_{60}O_6$	Leaves	Ehawa *et al.,* 2020
β-Sitosterol acetate	$C_{31}H_{52}O_2$	Leaves	Shilaluke and Moteetee, 2022

Stigmast-4-en-3-one	$C_{29}H_{48}O$	Leaves	Shilaluke and Moteetee, 2022
Stigmasterol	$C_{29}H_{48}O$	Leaves, seeds	Ehawa *et al.,* 2020; Shilaluke and Moteetee, 2022
Stigmasterol-3-*O*-*β*-D-glucopyranoside	$C_{35}H_{58}O_6$	Leaves	Ehawa *et al.,* 2020
Supraene	$C_{30}H_{50}$	Leaves	Shilaluke and Moteetee, 2022
Tetradecanoic acid	$C_{14}H_{28}O_2$	Leaves	Shilaluke and Moteetee, 2022
Thiophene, 2,3-dihydro-	C_4H_6S	Leaves	Shilaluke and Moteetee, 2022
α-Tocopheryl acetate	$C_{31}H_{52}O3$	Leaves	Shilaluke and Moteetee, 2022
Tridecane	$C_{13}H_{28}$	Leaves	Shilaluke and Moteetee, 2022
Tridecanoic acid, methyl ester	$C_{14}H_{28}O_2$	Leaves	Shilaluke and Moteetee, 2022
Tris(tert-butyldimethylsilyloxy)arsane	$C_{18}H_{45}O_3Si_3$	Leaves	Shilaluke and Moteetee, 2022
Turraflorin A	$C_{31}H_{38}O_8$	Seeds	Fraser *et al.,* 1994; Mulholland *et al.,* 1998
Turraflorin B	$C_{29}H_{36}O_7$	Seeds	Fraser *et al.,* 1994; Mulholland *et al.,* 1998
Turraflorin C	$C_{35}H_{44}O_{12}$	Seeds	Fraser *et al.,* 1994; Mulholland *et al.,* 1998
Undecanoic acid	$C_{11}H_{22}O_2$	Leaves	Shilaluke and Moteetee, 2022
Undecanoic acid, methyl ester	$C_{12}H_{24}O_2$	Leaves	Shilaluke and Moteetee, 2022
Ursolic acid	$C_{30}H_{48}0_3$	Leaves	Ehawa *et al.,* 2020

Antibacterial activities: Kuglerova *et al.* (2011) evaluated the antibacterial activities of crude ethanol extracts of *T. floribunda* bark against *Enterococcus faecalis* using the broth microdilution assay with ciprofloxacin as a positive control. The extract exhibited weak activities with minimum inhibitory concentration (MIC) value of 512.0 µg/ml (Kuglerova *et al.,* 2011). Similarly, Oyedeji-Amusa *et al.* (2020) also evaluated the antibacterial activities of dichloromethane and methanol extracts of *T. floribunda* leaves and bark against *Fusobacterium nucleatum* sub *nucleatum, Bacillus cereus, Pseudomonas aeruginosa, Enterococcus faecalis, Escherichia coli, Moraxella catarrhalis, Staphylococcus aureus* and *Streptococcus mutans* using the micro-plate dilution assay with ciprofloxacin as a positive control. The extracts exhibited activities against the tested pathogens exhibiting the MIC values ranging from 0.13 mg/ml to 4.0 mg/ml (Oyedeji-Amusa *et al.,* 2020). These preliminary findings somehow confirm the antibacterial potential of *T. floribunda* and its usefulness in the treatment and management of microbial infections such as skin infections.

Antifungal activities: Kuglerova *et al.* (2011) evaluated the antifungal activities of crude ethanol extracts of *T. floribunda* bark against *Candida albicans* using the broth microdilution assay with nystatin as a positive control. The extract exhibited weak activities with MIC value of 256.0 µg/ml (Kuglerova *et al.,* 2011). These research findings corroborate the traditional use of root decoctions of *T. floribunda* against skin infections such as abscesses (Neuwinger, 2000) and ascites (Watt and Breyer-Brandwijk, 1962; Hutchings *et al.,* 1996).

Anti-hypertensive activities: Duncan *et al.* (1999) evaluated the anti-hypertensive activities of aqueous extracts of *T. floribunda* leaves using the angiotensin converting enzyme assay (ACE). The extract exhibited weak inhibition of 45.0% against ACE (Duncan *et al.,* 1999), highlighting the need to corroborate the usage of *T. floribunda* bark, leaf and root infusions as herbal medicine for heart problems (Loffler and Loffler, 2005; Lovett *et al.,* 2006; Manning, 2015).

Anti-inflammatory activities: Fawole *et al.* (2010) evaluated the anti-inflammatory activities of 50% methanol extract of T. floribunda leaves against cyclooxygenase-1 and -2 (COX-1 and COX-2) enzymes with indomethacin as a positive control. The extract showed good COX-1 and COX-2 inhibitory activities of 56.3% and 87.3%, respectively (Fawole *et al.,* 2010), indicating the potential of T. floribunda leaf extracts inhibiting and suppressing inflammatory reactions and factors. These findings offer support to traditional use of the species in various inflammatory ailments and diseases ranging from microbial infections to pain and injury that usually result in cell injury and death.

Antioxidant activities: Fawole *et al.* (2010) evaluated the antioxidant activities of 50% methanol extract of *T. floribunda* leaves against 2,2-diphenyl1-picryl hydrazyl (DPPH) free radical scavenging and ferric-reducing power (FRAP) assays with ascorbic acid as a positive control. The extract exhibited activities with half maximal effective concentration (EC_{50}) value of 5.0 µg/ml in DPPH assay and dose-dependent reducing activities in FRAP assay (Fawole *et al.,* 2010). The documented *in vitro* antioxidant activities exhibited by the extracts of *T. floribunda* leaves could imply that the species has the capacity to protect human body cells from harmful damage caused by free radicals.

Antiplasmodial activities: Clarkson *et al.* (2004) evaluated the antiplasmodial activities of dichloromethane and methanol (1:1) extracts of *T. floribunda* leaves against chloroquine-sensitive strain (D10) of *Plasmodium falciparum* using the parasite lactate dehydrogenase (pLDH) assay with chloroquine diphosphate as a positive control. The extract exhibited activities with half maximal inhibitory concentration (IC_{50}) value of 8.8 µg/ml (Clarkson *et al.,* 2004). Mokoka *et al.* (2013) also evaluated the antiplasmodial activities of dichloromethane : methanol (1:1) extract of *T. floribunda* bark, leaves and roots against *Plasmodium falciparum* (NF-54 strain) using the G^3H-hypoxanthine incorporation assay with chloroquine phosphate as the positive control. The extracts exhibited activities with IC_{50} values ranging from 4.5 µg/ml to 12.7 µg/ml (Mokoka *et al.,* 2013). Muthaura *et al.* (2015) evaluated the antiplasmodial activities of methanol extract of *T. floribunda* stem bark against the chloroquine resistant *Plasmodium falciparum* using the G^3H-hypoxanthine incorporation assay with artemisinin and chloroquine phosphate as positive controls. The extract exhibited activities with IC_{50} value of 5.5 µg/ml (Muthaura *et al.,* 2015). Moyo *et al.* (2016) evaluated the antiplasmodial activities of acetone extract of *T. floribunda* leaves against the chloroquine sensitive *Plasmodium falciparum* (NF-54 strain) using the parasite lactate dehydrogenase (pLDH) assay with chloroquine phosphate as a positive control. The extract exhibited activities with IC_{50} values ranging from 4.6 µg/ml to 9.2 µg/ml (Moyo *et al.,* 2016). The traditional uses of *T. floribunda* as herbal medicine for malaria (Kuglerova *et al.,* 2011; Muthaura *et al.,* 2015) and the documented antiplasmodial activities would contribute to the search for bioactive principles and also the use of such species as antimalarial drug alternatives.

Antiprotozoal activities: Mokoka *et al.* (2013) evaluated the antiprotozoal activities of dichloromethane: methanol (1:1) extract of *T. floribunda* roots against axenically grown Leishmania donovani using the resazurin assay with miltefosine as the positive control. The extract exhibited activities with IC_{50} value of 13.1 µg/ml (Mokoka *et al.,* 2013). These antiprotozoal activities demonstrated by *T. floribunda* implies that the species may have bioactive constituents with potential in controlling protozoan parasites.

Antitrypanosomal activities: Mokoka *et al.* (2013) evaluated the antitrypanosomal activities of dichloromethane : methanol (1: 1) extract of *T. floribunda* bark, leaves and roots against *Trypanosoma brucei rhodesiense* using the serial dilution assay. The extract exhibited activities with IC_{50} values ranging from 17.1 µg/ml to 24.4 µg/ml (Mokoka *et al.,* 2013). These results could be used in the search for lead compounds required for the development of chemotherapies needed for managing trypanosomal infections in both humans and animals.

Cytotoxicity activities: Mokoka *et al.* (2013) evaluated cytotoxicity activities of dichloromethane : methanol (1:1) extracts of *T. floribunda* bark, leaves and roots against rat myoblast (L6-cells) using the Alamar Blue assay with podophyllotoxin as the positive control. The extract exhibited activities with IC_{50} values ranging from 48.3 µg/ml to 55.7 µg/ml (Mokoka *et al.,* 2013). Further cytotoxicity assessments should focus on identifying the bioactive compounds responsible for such activities.

Insecticidal activities: Ehawa *et al.* (2020) evaluated the insecticidal activities of methanolic extracts of *T. floribunda* against the second instar larvae of *Tuta absoluta* using a leaf disc painting method. The extracts exhibited activities with the median lethal dose (LD_{50}) value of 587.0 ng/µl after 24 hours of exposure (Ehawa *et al.,* 2020). The aqueous extract of *T. floribunda* leaves showed weak insecticidal activities exhibiting 49.0% and 43.0% repellence against *Spodoptera frugiperda* and *Plutella xylostella*, respectively with antifeeding deterrent coefficient of 67.0 and 44.2 against the two species (Shilaluke and Moteetee, 2022). Therefore, this species has potential to be used as a biocontrol agent against insect pests.

Larvicidal activities: Ndung'u *et al.* (2004) evaluated the larvicidal activities of the crude chloroform and methanol extracts of *T. floribunda* root bark and also the phytochemical compounds 1α,7α,11β-triacetoxy-4α-carbomethoxy-12α-(2-methylpropanoyloxy)-14β,15β-epoxyhavanensin and 1α,11β-diacetoxy-4α-carbomethoxy-7α-hydroxy-12α-(2-methylpropanoyloxy)-15-oxohavanensin isolated from the root bark of *T. floribunda* against the third-instar larvae of *Anopheles gambiae sensu stricto* using the larvicidal bioassay with azadirachtin as a positive control. The chloroform and methanol extracts, and the phytochemical compounds exhibited activities with LD_{50} values ranging from 3.6 ppm to 107.8 ppm, which were comparable to LD_{50} value of 57.1 ppm exhibited by the positive control (Ndung'u *et al.,* 2004). Therefore, the potent larvicidal activities demonstrated by *T. floribunda* implies that the havanensinoids isolated from the species may be the bioactive constituents responsible for the larvicidal activities exhibited by the species.

Conclusion: The current study provides a summary of ethnobotanical uses, medicinal applications, phytochemical and pharmacological properties of *T. floribunda.* Such evaluations are needed considering that *T. floribunda* is widely used as traditional medicine throughout its distributional range in central, eastern and southern Africa, and it is clear that the full therapeutic potential of the species has not yet been realized. Literature studies show that there is growing demand for

medicinal plants such as *T. floribunda* which are used as traditional medicines, sources of complementary and alternative treatments. This is usually the case with medicinal plants that are characterized by bioactive components such as flavonoids, phenolics and terpenoids which are beneficial to human health. Therefore, future studies should focus on detailed ethnopharmacological evaluations of the species, emphasizing phytochemical, pharmacological, toxicological, *in vivo* and clinical research aimed at corroborating the traditional medicinal applications of the species. This study contributes to the existing medicinal uses, phytochemical and pharmacological properties of *T. floribunda* that could be useful in bio-prospecting for new health-promoting and pharmaceutical products. Compilation of ethnopharmacological properties of *T. floribunda* is an important step towards identification of knowledge gaps required to protect consumers from non-standardized herbal medicine usage of plant species used as sources of traditional medicines.

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