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Review Article
Turraea nilotica Kotschy & Peyr. (Meliaceae Family): Evaluation of Medicinal, Chemical and Pharmacological Properties

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Abstract

Turraea nilotica is an important medicinal plant species in Tropical Africa. The present review compiles existing information on medicinal uses and chemical and pharmacological properties of *T. nilotica*. Multiple searches on existing literature on the traditional, medicinal, phytochemistry and pharmacological properties of *T. nilotica* were conducted in online Databases such as Scopus®, Google Scholar, SpringerLink®, SciELO, ScienceDirect®, PubMed® and Web of Science, as well as additional pre-electronic scientific data obtained from the university library. *Turraea nilotica* is used as traditional medicine against animal and human diseases or ailments in five countries in tropical Africa. The phytochemical assessments of *T. nilotica* showed that cardiac glycosides, limonoids, protolimonoids, saponins and sterols characterize the species. The pharmacological evaluations of *T. nilotica* revealed that the crude extracts and phytochemical compounds isolated from the species exhibited antimicrobial, antiplasmodial, antifeedant and cytotoxicity activities. Detailed studies focusing on toxicity and safety, mechanisms of action, *in vivo* and clinical research aimed at corroborating the traditional medical applications of *T. nilotica* are recommended.

Key words: Developing countries, ethnopharmacology, indigenous pharmacopeia, primary heathcare, *Turraea nilotica*

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

INTRODUCTION

Turraea nilotica Kotschy & Peyr. is an important medicinal plant species in Tropical Africa (Fig. 1a-c). *Turraea nilotica*, commonly known as small mahogany, lowveld honeysuckle tree and miombo honeysuckle tree belongs to the Meliaceae or the mahogany family. Meliaceae family has approximately 50 genera and 1400 species[1] of mostly shrublets, shrubs and trees confined to the tropics and subtropics of both hemispheres[1,2]. Some phytochemical compounds such as alkaloids, sesquiterpenoids, flavaglines, triterpenoids, diterpenoids, sterols, lignins and limonoids[3-5] that have been isolated from members of Meliaceae family are characterized by ethnopharmacological properties which are of interest in the development of pharmaceutical health products. Some of the species belonging to the Meliaceae family with the potential to be developed into commercial phytomedicines, sources of pharmaceutical extracts and chemical entities include *Azadirachta indica* A. Juss., *Carapa procera* DC., *Neobeguea mahafalensis* J.-F.Leroy and *Trichilia emetica* Vahl[6,7]. *Azadirachta indica* is popular as an antifertility agent and herbal medicine for malaria in Asia, Chad, Kenya, Madagascar, Niger, South Sudan and Tanzania[8]. The seed oil of *C. procera* is widely used for cosmetic purposes, while seeds, leaves and bark are used as traditional medicines for fever, digestive and respiratory problems in Senegal, Congo, Mali, Cameroon, Ivory Coast and Gabon[6-8]. The bark of *N. mahafalensis* is widely used for erectile dysfunction and traditional medicine for asthenia and rheumatism in Madagascar[6-8]. Similarly, the bark and seeds of *T. emetica* are valued for cosmetic purposes and as traditional medicines for stomach and intestinal problems, dysentery, kidney problems, indigestion, fever and skin infections in countries such as South Africa, Ethiopia, Zimbabwe and Mozambique[8,9]. In developing countries, medicinal plants play an important role in primary health care needs[10-14] with several people utilizing traditional health care services including medicinal plants such as *T. nilotica* as sources of herbal medicines. *Turraea nilotica* has been incorporated into the traditional materia medica in Southern, Central, Eastern and Western Africa, characterized by a wide range of medicinal applications throughout its distributional range[15]. It is therefore, within this context that the current study was undertaken aimed at compiling the medicinal, chemical and pharmacological properties of *T. nilotica*.

MATERIALS AND METHODS

The literature search on medicinal uses and chemical and pharmacological properties of *Turraea nilotica* was conducted from August, 2023 to May, 2024. This information on these aspects was obtained using online Databases such as Scopus®, Google Scholar, SpringerLink®, SciELO, ScienceDirect®, PubMed® and Web of Science. Additional information on the medicinal uses and chemical and pharmacological properties of *Turraea nilotica* 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, thesis and other scientific articles obtained from the university library. The keywords used in the search included "*T. nilotica*", the synonyms of the species "*Turraea nilotica* Kotschy & Peyr.", English common names "small mahogany", "lowveld honeysuckle-tree" and "miombo honeysuckle-tree". Additional search was also conducted using the keywords "Biological activities of *Turraea nilotica*", "Pharmacological properties of

Fig. 1(a-c): Flowers, fruits and leaves of *Turraea nilotica*

Turraea nilotica", "Ethnobotany of *Turraea nilotica*", "Medicinal uses of *Turraea nilotica*", "Phytochemistry of *Turraea nilotica*" and "Traditional uses of *Turraea nilotica*".

RESULTS AND DISCUSSION

Morphological description and taxonomy of the species: *Turraea* L. is a genus of about 50 small to medium deciduous trees, shrubs and shrublets, usually suffruticose and occasionally scrambling[2]. 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[2]. These species have been recorded in Africa, Madagascar Mascarenes and the Comores, with one species widespread in the Tropical Far East[2]. Muellner *et al.*[16] 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. Research by White[17] showed that *T. nilotica* is closely related to *T. robusta* Gürke (which is found in Cameroon, the Democratic Republic of Congo (DRC), Kenya, Malawi, Tanzania, Uganda and Zambia) and *T. zambesica* Sprague & Hutch. recorded in Botswana, Mozambique, Namibia, Zambia and Zimbabwe.

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[18]. The specific name "*nilotica*" means "of the Nile lands" "from the Nile River" or "from the valley of the Nile"[18]. The synonyms associated with the name *T. nilotica* Kotschy & Peyr. include *T. nilotica* var. *glabrata* Fiori, *T. randii* Bak.f. and *T. tubulifera* C.DC.[19]. The English common names of *T. nilotica* include "small mahogany", "lowveld honeysuckle-tree" and "miombo honeysuckle-tree"[18].

Turraea nilotica is a deciduous shrub, a small to medium slender tree growing up to 10 m in height[20]. The main stem is a single, rough, fissured pale grey or grey-brown stem and branches that, when young are covered with tawny hairs and on maturity develop a corky bark[20]. White lenticels maybe present on younger twigs[20]. The leaves are simple, alternate, elliptic to oblong with rounded or notched tips and somewhat narrowed bases, densely velvety when young, particularly on the under-surface, but becoming smoother later. The leaves are dark green above and paler below, with a thick midrib and secondary veins prominent below. The leaves have somewhat waxy, untoothed margins and are borne on short sturdy stalks[20]. The flowers appear on bare branches in the axils of the fallen leaves and have narrow, greenish petals which become yellow with age and curl backward. The fruit is a greenish-yellow woody capsule, spherical, splitting into several valves to show black seeds that are partially covered by the red aril. *Turraea nilotica* has corky, fire-resistant bark and occurs in rocky and gravelly ground in open wooded grassland and bushveld, savanna woodland, rocky ridges, termite mounds and on rocky or sandy soils[17]. The species has been recorded in six regional phytochoria, that is, Zambezian, East Africa, Southern Africa, Ethiopian, Somalian and Sudanian[20]. *Turraea nilotica* occurs in Botswana, Burundi, Ethiopia, Eswatini, Kenya, Malawi, Mozambique, Somalia, South Africa, Sudan, Uganda, Tanzania, Zambia and Zimbabwe (Fig. 2) at an altitude ranging from 425 to 1065 m above sea level[19,21].

Ethnomedicinal and traditional uses: *Turraea nilotica* provides numerous ecosystem services and goods which include food, construction materials, traditional medicines, fodder and various cultural applications. The leaves of *T. nilotica* are edible when fresh[22], fruits are eaten by children[22] and roots are cooked as food[23]. The fresh foliage of *T. nilotica* is eaten by livestock and game[18] and branches and stems of the species are used as handicrafts[24]. *Turraea nilotica* is currently harvested from the wild and the species does not seem to be in immediate danger of extinction in all countries where the species is indigenous. In South Africa, *T. nilotica* is widespread, recorded in a wide range of habitats characterized by a large population size and categorized as of Least Concern on IUCN Red List Categories and Criteria[15].

Turraea nilotica is used as a source of traditional medicines in Tanzania, Mozambique, Zimbabwe, Malawi and Kenya, that is, 35.7% of the countries where the species is indigenous (Table 1). The traditional medicines prepared from the leaves, roots and root bark of *T. nilotica* are used to treat and manage 38 human and livestock diseases and ailments in Tropical Africa. The main ailments and diseases treated by *T. nilotica* crude extracts include its use as traditional medicine against internal worms, dysuria, rectal prolapse, bilharzia, headache, wounds, venereal diseases, diarrhoea, constipation, gonorrhoea and toothache (Fig. 3). The leaves of *T. nilotica* are mixed with those *Catunaregam obovata* (Hochst.) A.E.Gonç. as traditional medicine for asthma[22] while the roots are mixed with those of *Securidaca longepedunculata* Fresen. as a remedy for epilepsy[25]. In Zimbabwe, the roots of *T. nilotica* are mixed with those of *Erythrina abyssinica* Lam., *Grewia monticola* Sond., *Lannea discolor* (Sond.) Engl. and *Pseudolachnostylis maprouneifolia* Pax as traditional medicine for gonorrhoea[25].

Fig. 2: Distribution of *Turraea nilotica* in Tropical Africa

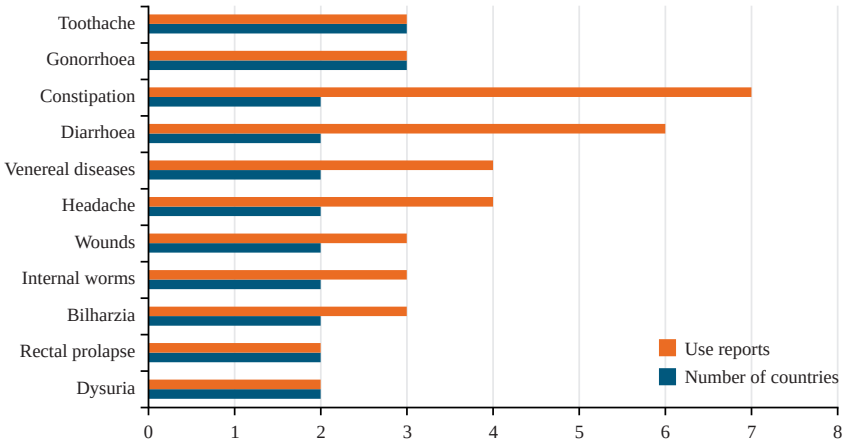

Fig. 3: Main ethnomedicinal applications of *Turraea nilotica* in Tropical Africa

Phytochemistry and pharmacological properties of *Turraea nilotica*: The phytochemical compounds (Table 2), namely cardiac glycosides, limonoids, protolimonoids, saponins and sterols have been isolated from the bark, leaves, roots, root bark and stem bark[37,38]. Some crude extracts and phytochemical compounds isolated from *T. nilotica* exhibited antimicrobial, antiplasmodial, antifeedant and cytotoxicity activities.

Antimicrobial activities: Munodawafa *et al.*[39] evaluated the antimicrobial activities of the methanol extracts of *T. nilotica* roots against fungal pathogens *Candida albicans* and

Table 1: Traditional and ethnomedicinal uses of *Turraea nilotica*

Medicinal uses	Parts used	Country	Reference
Mono-therapeutic applications			
Abdominal pain	Leaf and root infusion and/or decoction taken orally	Zimbabwe	Harvey and Armitage[25], Wild and Gelfand[26], Chinemana *et al.*[27] and Gelfand *et al.*[28]
Abscesses	Root decoction taken orally and applied as a compress	Not specified	Neuwinger[8]
Antidote for snake bite and any poison	Burnt ashes of roots applied to the bite	Zimbabwe	Harvey and Armitage[25] and Gelfand *et al.*[28]
Aphrodisiac	Root powder taken orally	Zimbabwe	Gelfand *et al.*[28]
Bilharzia	Root decoction taken orally	Mozambique and Tanzania	Neuwinger[8], Bruschi *et al.*[23] and Chhabra *et al.*[29]
Cancer	Root bark powder applied topically	Malawi	Masumbu *et al.*[30]
Constipation	Root and root bark infusion taken orally	Tanzania and Zimbabwe	Neuwinger[8], Harvey and Armitage[25], Wild and Gelfand[26], Gelfand *et al.*[28] and Chhabra *et al.*[29]
Depressed fontanelle	Root powder applied topically	Zimbabwe	Gelfand *et al.*[28]
Diarrhea	Leaf and root decoction taken orally	Mozambique and Zimbabwe	Bruschi *et al.*[23], Chinemana *et al.*[27] and Gelfand *et al.*[28]
Dizziness	Leaf infusion taken orally	Zimbabwe	Wild and Gelfand[26] and Gelfand *et al.*[28]
Dysentery	Root decoction taken orally	Mozambique	Bruschi *et al.*[23]
Dyspnea	Root powder taken orally	Zimbabwe	Gelfand *et al.*[28] and Nyagumbo *et al.*[31]
Dysuria	Root bark decoction taken orally	Tanzania and Zimbabwe	Neuwinger[8] and Gelfand *et al.*[28]
Ease childbirth	Root decoction taken orally	Malawi	Morris[22]
Epilepsy	Root powder taken orally	Zimbabwe	Gelfand *et al.*[28]
Gonorrhoea	Root decoction taken orally	Malawi and Tanzania	Morris[22] and Chhabra *et al.*[29]
Hemorrhoids	Root decoction taken orally	Zimbabwe	Shopo *et al.*[32]
Headache	Leaf and root decoction taken orally	Malawi and Zimbabwe	Morris[22], Harvey and Armitage[25] and Gelfand *et al.*[28]
Hernia	Root infusion taken orally	Tanzania	Neuwinger[8] and Chhabra *et al.*[29]
Indigestion	Root decoction taken orally	East Africa	Kokwaro[33]
Infertility	Root decoction taken orally	Tanzania	Chhabra *et al.*[29] and Chhabra *et al.*[34]
Inflammation of the navel cord	Root decoction taken orally	Zimbabwe	Gelfand *et al.*[28]
Intestinal worms	Root decoction taken orally	Malawi and Zimbabwe	Neuwinger[8], Morris[22] and Gelfand *et al.*[28]
Menstrual problems	Root powder taken orally	Zimbabwe	Gelfand *et al.*[28]
Mental problems	Leaf infusion administered orally or smoke from burnt leaves inhaled	Zimbabwe	Harvey and Armitage[25], Wild and Gelfand[26] and Gelfand *et al.*[28]
Pneumonia	Root powder rubbed into scarification or root infusion taken orally	Zimbabwe	Gelfand *et al.*[28] and Nyagumbo *et al.*[31]
Prevent abortion	Root infusion taken orally	Zimbabwe	Gelfand *et al.*[28]
Rectal prolapse	Root bark decoction taken orally	Tanzania and Zimbabwe	Neuwinger[8] and Gelfand *et al.*[28]
Respiratory disorders	Root powder rubbed into scarification or root infusion taken orally	Zimbabwe	Harvey and Armitage[25] and Nyagumbo *et al.*[31]
Rheumatism	Root powder rubbed into scarification	Zimbabwe	Gelfand *et al.*[28]
Sore eyes	Leaf paste applied to eyelids	Zimbabwe	Harvey and Armitage[25] and Gelfand *et al.*[28]
Stomach problems	Root decoction taken orally	Tanzania	Kokwaro[33]
Toothache	Root decoction used as mouthwash	South Africa, Tanzania and Zimbabwe	Mathias[35]
Venereal diseases	Root infusion taken orally	Mozambique and Zimbabwe	Bruschi *et al.*[23] and Gelfand *et al.*[28]
Wounds	Root scrapings applied topically	Kenya and Malawi	Neuwinger[8], Morris[22] and Irungu *et al.*[36]
Ethnoveterinary medicine (anthelmintic for dogs)	Root infusion administered orally	Zimbabwe	Gelfand *et al.*[28]
Multi-therapeutic applications			
Asthma	Leaves mixed with those *Catunaregam obovata* (Hochst.) A.E.Gonç.	Malawi	Morris[22]
Epilepsy	Roots mixed with those of *Securidaca longipedunculata* Fresen.	Zimbabwe	Harvey and Armitage[25]
Gonorrhoea	Roots mixed with those of *Erythrina abyssinica* Lam., *Grewia monticola* Sond., *Lannea discolor* (Sond.) Engl. and *Pseudolachnostylis maprouneifolia* Pax	Zimbabwe	Harvey and Armitage[25]

Aspergillus niger, bacterial pathogens *Escherichia coli*, *Staphylococcus* Group A strain and *Staphylococcus aureus* using the microdilution assay. The extract exhibited weak activities against the tested pathogens exhibiting minimum inhibitory concentration (MIC) values ranging from 0.63 to >10.0 mg/mL[39].

Table 2: Phytochemical composition of *Turraea nilotica*

Chemical composition	Formula	Plant part	Reference
1α,3α-diacety-7α-tigloyvilasinin	$C_{29}H_{50}O_3$	Root bark	Irungu *et al.*[36]
12α-acetoxy-7-deacetylazadirone	$C_{29}H_{52}O_3$	Root bark	Irungu *et al.*[36]
Azadirone	$C_{28}H_{36}O_4$	Roots and root bark	Irungu *et al.*[36] and Bentley *et al.*[38]
Dihydroniloticin	$C_{30}H_{50}O_3$	Bark	Mulholland and Taylor[37]
Hispidol B	$C_{30}H_{52}O_4$	Stem bark	Irungu *et al.*[36]
Mzikonone	$C_{28}H_{38}O_5$	Roots and root bark	Irungu *et al.*[36] and Bentley *et al.*[38]
Niloticin	$C_{30}H_{48}O_3$	Bark and stem bark	Irungu *et al.*[36] and Mulholland and Taylor[37]
Nilotin	$C_{40}H_{52}O_{14}$	Root bark	Bentley *et al.*[38]
Piscidinol	$C_{30}H_{50}O_4$	Bark and stem bark	Irungu *et al.*[36] and Mulholland and Taylor[37]
β-sitosterol	$C_{29}H_{50}O$	Leaves	Irungu *et al.*[36]
Sitosterol-3-O-β-D-glucopyranoside	$C_{35}H_{56}O_6$	Leaves	Irungu *et al.*[36]
Sitosterol-3-O-β-D-glucopyranoside acetate	$C_{35}H_{60}O_6$	Leaves	Irungu *et al.*[36]
Stigmasterol-3-O-β-D-glucopyranoside acetate	$C_{35}H_{58}O_6$	Leaves	Irungu *et al.*[36]
Stigmasterol	$C_{29}H_{48}O$	Leaves	Irungu *et al.*[36]
Toonapubesin F	$C_{30}H_{50}O_5$	Stem bark	Irungu *et al.*[36]

Antiplasmodial activities: Irungu *et al.*[36] evaluated the antiplasmodial activities of the leaf, root and stem bark extracts of *T. nilotica* against the chloroquine-resistant (W2) and chloroquine-sensitive (D6) *Plasmodium falciparum* strains using the (G-^{3}H) hypoxanthine incorporation assay with chloroquine as a positive control. The extracts exhibited activities with the Half Maximal Inhibitory Concentration (IC_{50}) values ranging from 7.3 to 59.0 µg/mL. Similarly, Irungu *et al.*[36] evaluated the antiplasmodial activities of the phytochemical compounds 12α-acetoxy-7-deacetylazadirone, hispidol B, niloticin and pscidinol isolated from *T. nilotica* against the chloroquine-resistant (W2) and chloroquine-sensitive (D6) *Plasmodium falciparum* strains using the (G-^{3}H) hypoxanthine incorporation assay with chloroquine as a positive control. The phytochemical compounds exhibited activities with IC_{50} values ranging from 30.2 to 77.0 µM[36].

Antifeedant activities: The phytochemical compound nilotin isolated from the root bark of *T. nilotica* showed significant antifeedant activities against 4th instar larvae of the Colorado potato beetle, *Leptinotarsa decemlineata* exhibiting half Maximal Effective Dose (ED_{50}) value of 7 µg/mL[38].

Cytotoxicity activities: Irungu *et al.*[36] evaluated the cytotoxicity activities of the leaf, root and stem bark extracts of *T. nilotica* against the mouse Breast Cancer (4T1), African green monkey kidney (vero) and human larynx carcinoma (HEp2) cell lines using the colorimetric 3-(4,5-di-methylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay with melarsoprol and podophyllum resin as positive controls. The extracts exhibited activities with IC_{50} values ranging from 13.7 to 39.1 µg/mL[36]. Similarly, Irungu *et al.*[36] evaluated the cytotoxicity activities of the phytochemical compounds 12α-acetoxy-7-deacetylazadirone, hispidol B, niloticin and pscidinol isolated from *T. nilotica* against the mouse Breast Cancer (4T1), African green monkey kidney (vero) and human larynx carcinoma (HEp2) cell lines using the colorimetric 3-(4,5-di-methylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay with melarsoprol and podophyllum resin as positive controls. The phytochemical compounds exhibited activities with IC_{50} values ranging from 6.9 to 139.6 µM[36].

CONCLUSION

The present review provides a summary of the medicinal uses, chemical and pharmacological properties of *T. nilotica*. Such ethnopharmacological studies are important for plant species widely used as sources of traditional medicines as assessing their phytochemistry, pharmacological properties and toxicological evaluations is important. However, detailed studies focusing on toxicity and safety, mechanisms of action *in vivo* and clinical research aimed at corroborating the traditional medical applications of *T. nilotica* are recommended.

SIGNIFICANCE STATEMENT

This study contributes to the existing knowledge about *T. nilotica* that could be useful in bio-prospecting for new health-promoting products required in the primary healthcare delivery system in Tropical Africa. The use of medicinal plant species such as *T. nilotica*, their extracts or bioactive principles plays an important role in the traditional pharmacopeia. Therefore, a compilation of their taxonomy, medicinal uses, phytochemistry and pharmacological properties is an important step toward ethnopharmacological screening of such species and also further studies focusing on their toxicological properties and clinical and *in vivo* studies. Such advanced studies are required to protect consumers from non-standardized herbal medicine usage.

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