Ethnobotanical uses of *Helinus* species (Rhamnaceae family) in tropical Africa and Asia

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Review

Abstract

Background: *Helinus* species are distributed in tropical Africa and Asia and are widely used as sources of traditional medicines and cosmetics. This review compiles existing information on ethnobotanical uses, chemical, pharmacological properties, and further use potential and applications of *Helinus* species.

Methods: Information on ethnobotanical uses, chemical, pharmacological properties of *Helinus* species was obtained from online databases such as Scopus®, Google Scholar, SpringerLink®, SciELO, ScienceDirect®, PubMed® and Web of Science, and pre-electronic sources such as books, journal articles, dissertations, book chapters, theses and other scientific articles obtained from the University of Fort Hare library.

Results: This comprehensive review summarizes the ethnobotanical uses, phytochemical and pharmacological properties of five *Helinus* species: *H. brevipes*, *H. integrifolius*, *H. lanceolatus*, *H. mystacinus* and *H. spartioides*. Four of these species have ethnomedicinal records, with *H. integrifolius* and *H. mystacinus* having the highest utility reports. Chemical compounds isolated from the species include aconitic acid, saponins, scyllitol, phenols, flavonoids, glycosides, steroids, alkaloids, tannins, terpenoids and benzoic acid. The crude extracts of *H. integrifolius, H. lanceolatus* and *H. mystacinus* exhibited antibacterial, antifungal, antioxidant, glucose stimulatory and cytotoxicity activities.

Conclusions: Results of this study contribute towards the existing knowledge about ethnomedicinal uses of *Helinus* species that could be useful in bio-prospecting for new health-promoting products required in the primary healthcare delivery system. Future research should focus on elucidation of phytochemical, pharmacological, toxicological, *in vivo* and clinical research of *Helinus* species.

Keywords: *Helinus*, pharmacological, phytochemical, Rhamnaceae, traditional knowledge, tropics

Background

In the last decades there has been an increase in research focusing on plant-based products, particularly as sources of food, medicines, fodder, perfumes, repellants, soaps, cosmetics, dyes, tans, utility timbers, firewood, crafts, ropes, thatching materials, mats and brooms. Barrios *et al.* (2018) argued that managing plant resources for provision of ecosystem goods and services requires understanding of the identities of the species, their characteristics, uses and how to manage these species in different socio-ecological contexts. Currently, there is also growing research interest on how plant species influence the four categories of ecosystem services, namely, supporting, provisioning, regulating, and cultural ecosystem services (Millennium Ecosystem Assessment 2005). Ecosystem services is a concept that has gained much attention in diverse scientific and socio-economic circles in recent years, emphasizing the importance of plant species as a basis for livelihoods for many people in developing countries (Rodríguez *et al.* 2006, Varí *et al.* 2020, Nowak-Olejnik & Mocior 2021, Parada & Salas 2024). Despite their importance and everyday use, comprehensive knowledge of the ecology and socio-economic value of plant species is lacking, hindering the ability to monitor, regulate and manage them. Therefore, a clear understanding about the condition of provisioning, regulating, cultural and supporting services provided by plant species is necessary and such information is derived from both the resource use patterns of the people who are most reliant on these services, as well as the utility of the plant species exploited by local communities. Determination of the relative importance of plant species at the household level is required in order to fully understand how ecosystem services derived from plants as this affects livelihoods across different landscapes (Kalaba *et al.* 2013a, b, Lakerveld *et al.* 2015, Mensah *et al.* 2017).

In many studies, *Helinus* E.Mey. ex Endl. species have been recorded as useful sources of non-timber forest products by various indigenous groups in tropical Africa and Asia (Hedberg & Staugård 1989, Hutchings *et al.* 1996, Maundu *et al.* 2001, Tabuti *et al.* 2003, Fowler 2006, Ajaib *et al.* 2012, Ngezahayo *et al.* 2015, Singh & Sharma 2021, Abebaw & Damme 2023, Clement *et al.* 2024). In southern Africa, *H. integrifolius* (Lam.) Kuntze is regarded as an important medicinal plant, and the species is included in the monograph "Medicinal and magical plants of southern Africa: An annotated checklist", a book written by Arnold *et al.* (2002). Similarly, the leaves, roots and stems of *H. integrifolius* are sold as sources of traditional medicines in informal herbal medicine markets in South Africa (Cunningham 1993, Mander 1998, Williams *et al.* 2001, Dold & Cocks 2002, Ndawonde *et al.* 2007) and Tanzania (Mollel *et al.* 2022). Therefore, the current study is aimed at documenting the ethnobotanical records of *Helinus* genus in tropical Africa and Asia. Ethnobotanical assessments aimed at exploring the patterns of indigenous use of *Helinus* species are needed as a means of identifying preferred species in terms of their uses as traditional medicines and also their applications in applied ethnobotanical research.

Materials and Methods

Overall, ethnobotanical information about *Helinus* genus was obtained from floras, taxonomic, botanical and ethnobotanical databases, research articles and pharmacopoeias. In this study, scientific and author names of the documented plant species were carefully scrutinized for latest changes via POWO (2024). To gather information about the ethnobotanical uses of *Helinus* species at a global level, "*Helinus*" was used as a key word to search taxonomic, botanical and ethnobotanical databases. In online databases such as Scopus®, Google Scholar, SpringerLink®, SciELO, ScienceDirect®, PubMed® and Web of Science, "*Helinus*" and "biological activities", "pharmacological properties", "ethnobotany", "medicinal uses", "phytochemistry" and "traditional uses" were used during the search. This search strategy was also applied by using both valid *Helinus* species names and their synonyms. Additional information on the traditional uses, ethnomedicinal applications, chemical and pharmacological properties of *Helinus* species was also obtained by systematic search of various resources that 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

Results and Discussion

Taxonomy and botanical aspects

The genus *Helinus* is a member of the Rhamnaceae, commonly known as the buckthorn or buffalo-thorn family. Rhamnaceae family consists of approximately 55 genera and 950 species (Christenhusz & Byng 2016) which are mainly erect or scandent, often spiny deciduous or evergreen trees or shrubs, climbers and rarely herbs (Leistner 2000, Retief & Meyer 2017). The genus *Helinus* is native to tropical and subtropical regions of Africa and Asia (Leistner 2000). Its members are trees, climbing shrubs and lianas. The species of the genus are unarmed, and the branches have coiled tendrils. The alternative leaves have entire margins with pinnately arranged venation (Schmidt *et al.* 2017). According to the current study, five species (Fig. 1) and two varieties of the genus *Helinus* are recognized (Table 1). Among these, four species have been recorded in tropical Africa, while *H. integrifolius* (Lam.) Kuntze has been recorded in Yemen, and *H. lanceolatus* Brandis has been recorded in Bangladesh, India, Myanmar, Nepal and Pakistan (Kilian *et al.* 2002, 2004). *Helinis brevipes* Radlk. is the only endemic species of the genus, so far only known to occur in Madagascar (Govaerts *et al.* 2021).

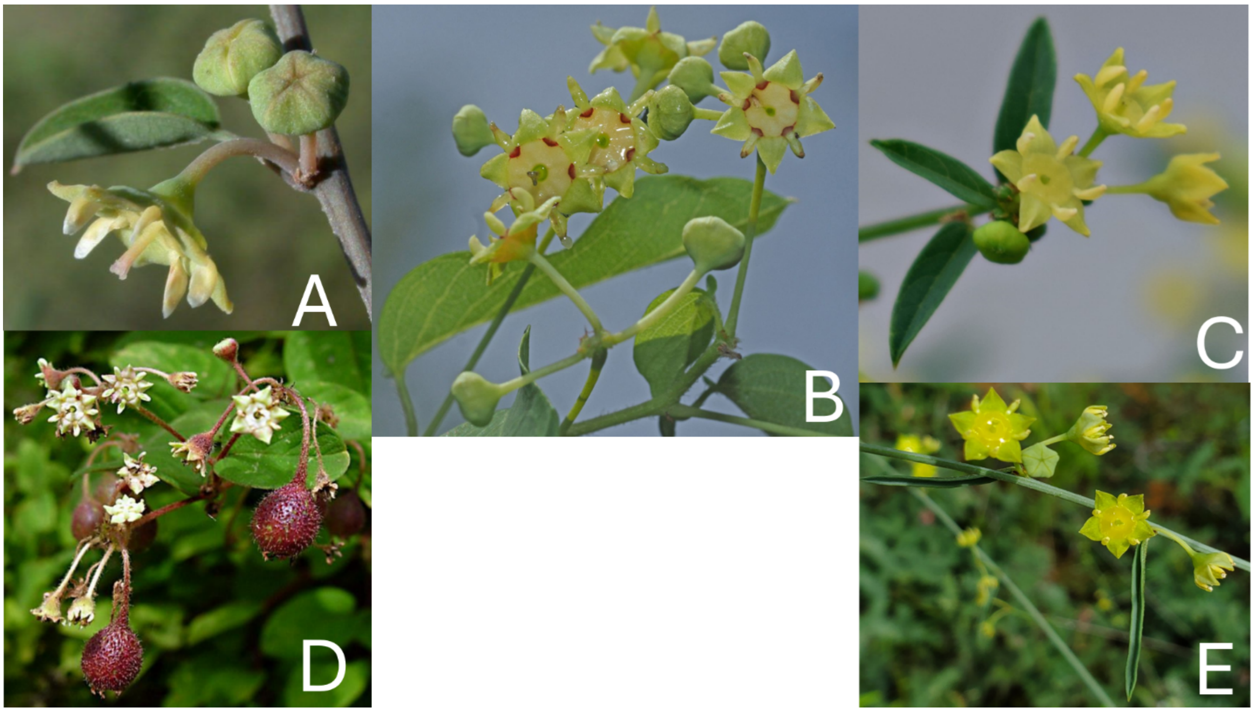

Figure 1. *Helinus* species of tropical Africa and Asia. A = *H. brevipes*, B = *H. integrifolius*, C = *H. lanceolatus*, D = *H. mystacinus* and E = *H. spartioides*. Photos A, B, D and E (www.gbif.org) and C (www.efloraofindia.com)

Table 1. *Helinus* taxa in tropical Africa and Asia

***Helinus* taxa**	**Common name**	**Synonyms**	**Country/region**	**Reference**
H. brevipes Radlk.	-	*Mystacinus brevipes* (Radlk.) Kuntze)	Madagascar	Govaerts *et al.* 2021
H. integrifolius (Lam.) Kuntze	Soap bush, soap creeper, soap plant	*Ceanothus mystacinus* DC., *Gouania integrifolia* Lam., *Helinus arabicus* Jaub., *H. ovatus* E.Mey. ex Sond., *H. ovatus* E.Mey. ex Sond. var. *rotundifolius* Sond., *H. scandens* (Eckl. & Zeyh.) A.Rich., *Mystacinus arabicus* (Jaub. & Spach) Kuntze, *M. ovatus* (E.Mey. ex Harv. & Sond.) Kuntze, *Willemetia scandens* Eckl. & Zeyh.	Angola, Botswana, the Democratic Republic of Congo (DRC), Eswatini, Ethiopia, Kenya, Malawi, Mozambique, Namibia, Somalia, South Africa, Tanzania, Uganda, Yemen, Zambia and Zimbabwe	Drummond 1966, Johnston 1972, Thulin 1999, Retief & Meyer 2017, Schmidt *et al.* 2017, Bredenkamp 2019
H. lanceolatus Brandis var. *lanceolatus*	Lanceleaf helinus, orache, saltbush	*G. lanceolatus* Wall., *M. lanceolatus* (Brandis) Kuntze	Bangladesh, India, Myanmar, Nepal, Pakistan	Qaiser & Nazimuddin 1981
H. lanceolatus Brandis var. *tomentella* Bedd. ex Bhandari & Bhansali	Lanceleaf helinus	*M. lanceolatus* (Brandis) Kuntze	India	Mao & Dash 2020, Govaerts *et al.* 2021
H. mystacinus (Aiton) E.Mey. ex Steud.	Helinus	*Colubrina mystacina* (Aiton) G.Don, *H. mystacinus* (Aiton) E.Mey. ex Steud. forma *pilosiusculus* Radlk., *H. mystacinus* (Aiton) E.Mey. ex	Burundi, DRC, Eritrea, Ethiopia, Kenya, Mozambique, Rwanda, Somalia,	Drummond 1966, Johnston 1972, Thulin 1999, Burrows & Willis 2005

		Steud. forma *tomentosus* Radlk., *H. mystacinus* (Aiton) E.Mey. ex Steud. var. *somalensis* Engl., *M. cirrhifer* Raf, *M. mystacinus* (Aiton) Kuntze, *Rhamnus mystacina* Aiton	Tanzania, Uganda, Zambia, Zimbabwe	
H. spartioides (Engl.) Schinz ex Engl.	Spartium helinus	*Marlothia spartioides* Engl.	Botswana, Namibia, South Africa	Drummond 1966; Germishuizen & Meyer 2003

Helinus species are non-climbing shrublets or slender climbing shrubs with some of the branchlets modified into tendrils (Table 2). To the layman, a knowledge of the distribution of *Helinus* species (Fig. 2) is a valuable aid to identification. Therefore, in terms of identification, there are likely to be difficulties separating *H. integrifolius* from *H. mystacinus* as these two species have been recorded in overlapping geographical regions (Table 1, Fig. 2). But the flower, fruit and habit characters such as height are often used to separate the two species (Table 2). For example, *H. integrifolius* is characterized by "smooth fruits" while *H. mystacinus* is characterized by "rough fruits", see Fig. 1.

Table 2. Main morphological characters of *Helinus* species

Species	**Fruits**	**Flowers**	**Stems and leaves**	**Habitat**	**Reference**
H. brevipes	Obovoid	White-yellow	Shrublet, rarely with coiled tendrils. Leaves narrowly ovate, apex acute, base rounded to cuneate, sparingly puberulous	Seasonally dry areas with limestone soils, 100 m altitude	Govaerts *et al.* 2021
H. integrifolius	Obovate-globose, areolate at apex	Yellowish-green, in few-flowered umbels	Climbing or sprawling shrub, up to 6 m high, some branchlets reduced to unbranched, coiled tendrils. Leaves alternate, ovate to cordate with obtuse apex	Streams, riverbanks, valleys, undergrowth in forests, savanna, thicket, woodland and grassland, 45-1980 m altitude	Drummond 1966, Thulin 1999, Retief & Meyer 2017, Bredenkamp, 2019
H. lanceolatus	Obovoid	Yellowish, small numerous axillary flowers	Climbing shrub by means of unbranched tendrils. Leaves ovate to lanceolate	Forest, 400-900 m altitude	Qaiser & Nazimuddin 1981
H. mystacinus	Obovoid, pendulous	Whitish, small, pubescent flowers in axillary clusters	Climber to 10 m or more, branchlets hairy, with hairy coiled tendrils. Leaves ovate to almost circular with rounded apex, upper surface hairless and lower surface hairy	Forest margins and wooded grassland, 100-2300 m altitude	Drummond 1966, Johnston 1972, Thulin 1999, Burrows & Willis 2005
H. spartioides	Obovoid	Purplish-brown flowers, in clusters of 1-3 flowers	Shrublet, 0.3-1.5 m high, rarely with coiled tendrils, sparingly puberulous or glabrous. Leaves narrowly ovate, apex acute, base rounded to cuneate, sparingly puberulous	Grassland, arid areas with scattered bushes, sandy flats, rocky outcrops, 410-1370 m altitude	Drummond, 1966; Germishuizen & Meyer 2003

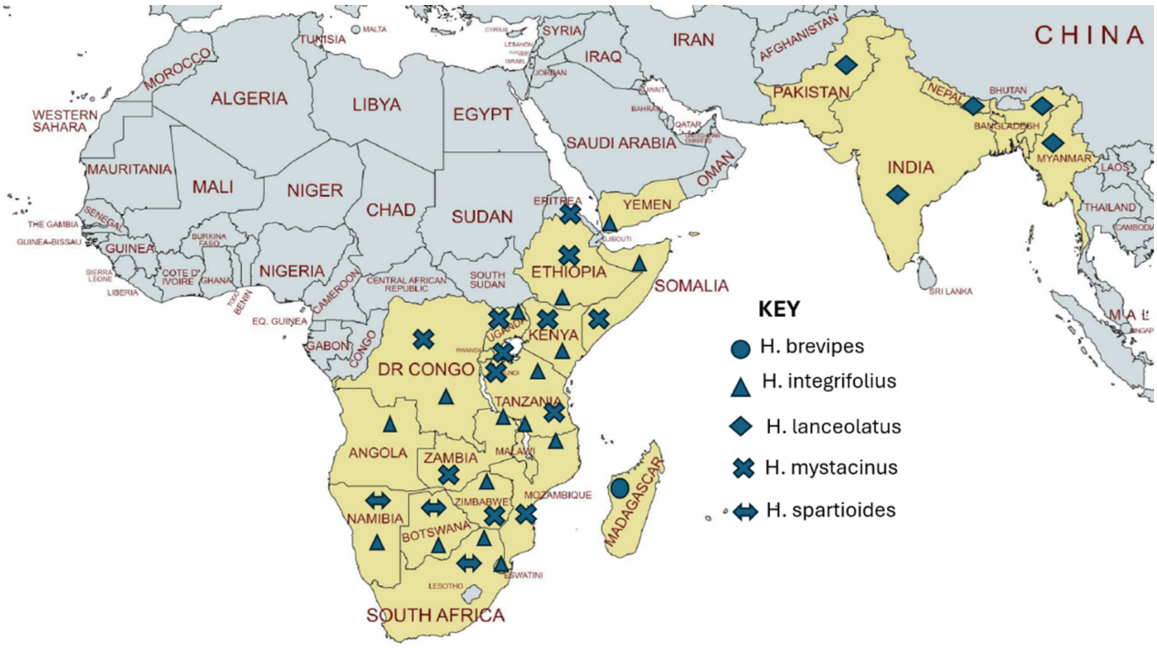

Figure 2. Recorded geographical distribution of *Helinus* species in tropical Africa and Asia (map drawn using mapchart.net)

Ethnobotanical uses of *Helinus* species

Ethnomedicinal and functional uses of *Helinus* species are reported in Tables 3 and 4, respectively. *Helinus integrifolius* demonstrated the highest utility reports followed by *H. mystacinus* (Fig. 3, Tables 3 and 4). In South Africa, *H. integrifolius* is commonly known as **ubulawu**, meaning to interpret dreams as the species is believed to facilitate communication with ancestors. A traditional herbal concoction known as **ubulawu**, is prepared from the stems of *H. integrifolius* mixed with the roots of *Silene undulata* Aiton subsp. *undulata* (family Caryophyllaceae) and, is used to cleanse the body and the mind (Sobiecki 2014, Mothibe & Sibanda 2019). Cold water infusions prepared from the roots of *H. integrifolius* mixed with those of *Psoralea pinnata* L. (Fabaceae family) are pounded and stirred until the liquid froths and taken as emetics by the traditional healers afflicted with mental disturbances associated with their calling as traditional healers (Bryant 1966, Hutchings 1989, Hutchings *et al.* 1996, Schmidt et al. 2017). *Helinus integrifolius* is also mixed with *Dianthus moviensis* F.N.Williams (family Caryophyllaceae) and *Hippobromus pauciflorus* (L.f.) Radlk. (Sapindaceae family) and used for facilitating communication with the ancestors (Sobiecki 2008). Similarly, the leaf, root and stem infusion of *H. integrifolius* is taken orally in the initiation of diviners to "strengthen his memory and give the initiate keen powers of observation" (Sobiecki 2008). The roots of *H. integrifolius* are mixed with those of *Vangueria infausta* Burch. subsp. *infausta* (family Rubiaceae) as traditional medicine for infertility (Chauke *et al.* 2015, Maroyi 2018). Similarly, the roots of *H. integrifolius* are mixed with those of *Senna italica* Mill. (Fabaceae family), *Ximenia caffra* Sond. (Olacaceae family), leaves of *Aloe* species (Asphodelaceae), leaves and stems of *Tinospora fragosa* (I.Verd.) I.Verd. & Troupin (Menispermaceae family) as traditional medicine for sexually transmitted infections (Chauke *et al.* 2015).

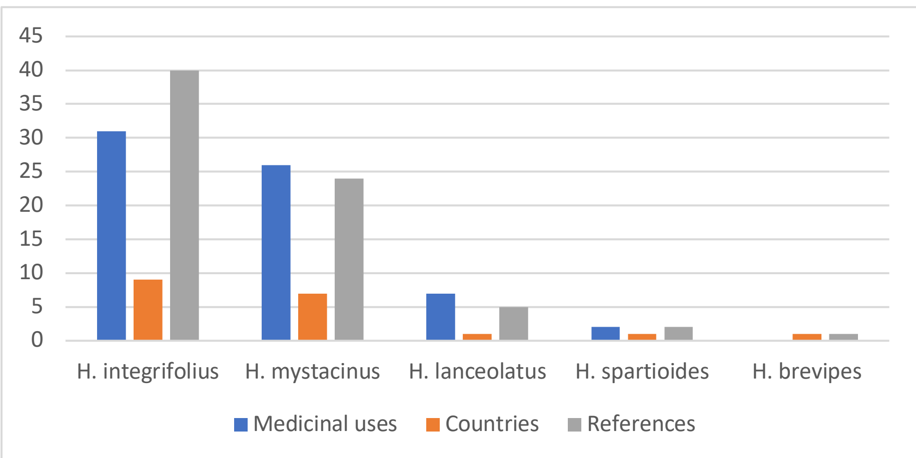

Figure 3. Number of medicinal uses, countries where the species are used and references for each *Helinus* species

Table 3. Medicinal applications of *Helinus* species

Species	Vernacular name	Disease/ailment	Part used	Country	Reference
H. brevipes	No ethnomedicinal record				
H. integrifolius	**Lmekori**	Arthritis	Root bark	Kenya	Nanyingi et al. 2008
	Isilawu	Backache	Roots	South Africa	Chigor 2014
	Seepbos, ubhubhubhu, ubububu	Backache	Roots	South Africa	Hutchings *et al.* 1996, Schmidt *et al.* 2017
	Seepbos, ubhubhubhu, ubububu	Bile	Roots	South Africa	Pujol 1990, Hutchings *et al.* 1996
	Seepbos, ubhubhubhu, ubububu, ugubhugubhu, uxubhugwegwe, uxuphukwekwe	Blood tonics	Roots	South Africa	Pujol 1990, Hutchings *et al.* 1996, Mbanjwa 2020
	Enkurishashi	Breast pain	Leaves and roots	Tanzania	Mollel *et al.* 2022
	Mupupuma	Cleansing	Leaves	South Africa	Cumes *et al.* 2009
	Ubulawu	Cleanse body and mind	Stems mixed with roots of *Silene undulata* Aiton subsp. *undulata*	South Africa	Sobiecki 2014, Mothibe & Sibanda 2019
	-	Convulsions	Roots	Tanzania	Fowler 2006
	Moritana, morotolodi, penda-moshaya	Cough	Leaves and roots	South Africa	Mataha 2021
	Ubhubhubhu, ubububu, ugubhugubhu, uxubhugwegwe, uxuphukwekwe	Dandruff	Not specified	South Africa	Mbanjwa 2020
	-	Diabetes	Leaves	South Africa	Chauke 2014
	-	Digestive problems	Not specified	Mozambique	Conde *et al.* 2014, Sitoe & Van Wyk 2024
	Leheto, seepbos, ubhubhubhu, ubububu	Gonorrhoea	Roots	Botswana	Hedberg & Staugård 1989, Hutchings *et al.* 1996
	Mampehlele, mupupuma, seepplant, seepbos, ubhubhubhu	Gonorrhoea	Leaves	South Africa	Watt & Breyer-Brandwijk 1962, Cumes *et al.* 2009, Schmidt *et al.* 2017, Van Wyk & Gericke 2018
	Ubhubhubhu, ubububu, ugubhugubhu,	Good luck and love charm emetics	Not specified	South Africa	Gerstner 1938, Hutchings 1989, Hutchings *et al.* 1996, Cocks & Dold 2006, Nzue

	uxubhugwegwe, uxuphukwekwe				2009, Zukulu *et al.* 2012, Mbanjwa 2020
	Isilawu, murore	Hair loss	Leaves	South Africa, Zambia	Afolayan *et al.* 2014, Chinsembu *et al.* 2015
	Isilawu, mampehlele, seepplant, seepbos, ubhubhubhu	Hysteria	Roots and stems	South Africa	Sobiecki 2002, 2008, Cocks & Dold 2006, Ndawonde *et al.* 2007, Nzue 2009, Chigor 2014, Van Wyk & Gericke 2018, Mbanjwa 2020, Mohlakoana & Moteetee 2021
	Seepbos, ubhubhubhu, ubububu	Hysteria	Roots mixed with those of Psoralea pinnata L.	South Africa	Bryant 1966, Hutchings 1989, Hutchings *et al.* 1996, Schmidt *et al.* 2017
	Mampehlele, mupupuma, seepplant, seepbos, ubhubhubhu	Itching caused by sandworms	Leaves	South Africa	Watt & Breyer-Brandwijk 1962, Cumes *et al.* 2009, Schmidt *et al.* 2017, Van Wyk & Gericke 2018, Mohlakoana & Moteetee 2021
	Moritana, morotolodi, penda-moshaya	Infertility	Leaves and roots	South Africa	Mataha 2021
	-	Infertility	Roots mixed with those of *Vangueria infausta* Burch. subsp. *infausta*	South Africa	Chauke *et al.* 2015, Maroyi 2018
	Murora	Leg pains	Fruits and whole plant	Namibia	Cheikhyoussef *et al.* 2011a, b, Mohlakoana & Moteetee 2021
	-	Malaria	Roots	Tanzania	Fowler 2006
	Isilawu, seepbos, ubhubhubhu	Nervous system	Roots	South Africa	Nzue 2009
	Lmekori	Paralysis	Root bark	Kenya	Nanyingi *et al.* 2008
	Isilawu, seepbos, ubhubhubhu	Pimples	Roots	South Africa	Nzue 2009
	Mampehlele, seepplant, seepbos, ubhubhubhu	Prophylactic medicine	Not specified	South Africa	Van Wyk & Gericke 2018
	-	Sexually transmitted infections	Roots mixed with those of *Senna italica* Mill. and *Ximenia caffra* Sond., leaves of *Aloe* spp., leaves and stems of *Tinospora fragosa*	South Africa	Chauke *et al.* 2015;

			(I.Verd.) I.Verd. & Troupin		
	Murore	Skin infections	Leaves	Zambia	Chinsembu *et al.* 2015
	Murora	Stroke	Leaves and roots	Namibia	Cheikhyoussef *et al.* 2011a, b, Mohlakoana & Moteetee 2021
	Ongambiyondjou	Syphilis	Roots	Namibia	Hamunyela *et al.* 2020
	Ubhubhubhu, ubububu, ugubhugubhu, uxubhugwegwe, uxuphukwekwe	Tonic	Roots	South Africa	Ndawonde *et al.* 2007, Mhlongo & Van Wyk 2019, Mbanjwa 2020
	Moritana, morotolodi, penda-moshaya, ubhubhubhu	Ward-off evil spirits	Leaves and roots	Eswatini, South Africa	Loffler & Loffler 2005, Ndawonde *et al.* 2007, Mataha 2021
	-	Ward-off bad luck	Roots	Zimbabwe	Gelfand *et al.* 1985
		Ethnoveterinary medicine			
	Mampehlele, seepplant, seepbos, ubhubhubhu	Black quarter/black-leg in cattle)	Not specified	South Africa	Smith 1966, Van Wyk & Gericke 2018
H. lanceolatus	**Chamba**	Expectorant	Not specified	India	Singh & Sharma 2021
	Chamba, chamba Ki bel, haldur	Scabies	Fruits, leaves and whole plant	Jammu and Kashmir, India	Ajaib 2012, Ajaib *et al.* 2012, Mohmood 2019, Singh & Sharma 2021
	Chamba, chamba Ki bel, haldur	Skin disease	Fruits, leaves and whole plant	Jammu and Kashmir, India	Ajaib 2012, Ajaib *et al.* 2012, Mohmood 2019, Singh & Sharma 2021
		Ethnoveterinary medicine			
	Haldur	Bloating	Whole plant	India	Kumari & Rawat 2023
	Haldur	Dysentery	Whole plant	India	Kumari & Rawat 2023
	Haldur	Galactagogue	Whole plant	India	Kumari & Rawat 2023
	Haldur	Loss of appetite	Whole plant	India	Kumari & Rawat 2023
H. mystacinus	**-**	Abdominal pains	Not specified	Ethiopia	Ollesen 1989
	Olesupeni	Aphrodisiac	Roots	Tanzania	Clement *et al.* 2024
	Olesupeni	Back pain	Roots	Tanzania	Clement *et al.* 2024
	Esat abered, esat abrid	Burns	Leaves	Ethiopia	Teklehaymanot & Giday 2007, Chekole *et al.* 2015
	Muiza bagya	Coma	Leaves	Uganda	Tabuti *et al.* 2003
	Olesupeni	Diuretic	Roots	Tanzania	Clement *et al.* 2024
	Bimbafuro	Galactagogue	Whole plant	DRC	Chifundera 2001
	-	Galactagogue	Not specified	Uganda	Hamill 2001
	-	Galactagogue	Leaves	Burundi, DRC, Rwanda	Dallemagne *et al.* 1959

	Olesupeni	Gonorrhoea	Roots	Kenya	Maundu *et al.* 2001
	Olesupeni	Gonorrhoea	Roots	Tanzania	Clement *et al.* 2024
	-	Headache	Roots	Kenya	Ongito 2011
	Olesupeni	Kidney problems	Roots	Tanzania	Clement *et al.* 2024
	Umubimbamfuro	Liver diseases	Leaves	Rwanda	Mukazayire *et al.* 2011
	-	Malaria	Not specified	Ethiopia	Ollesen 1989
	Umubimbafuro	Measles	Roots	Burundi	Ngezahayo *et al.* 2015
	Esataberd	Pain	Roots	Ethiopia	Ayalw & Merawi 2021
	Umubimbafuro	Purulent rashes	Roots	Burundi	Ngezahayo *et al.* 2015
	Bingwoo	Respiratory disorders	Bark	Kenya	Kigen *et al.* 2017
	Hidda xarii	Rheumatism	Roots	Ethiopia	Abebaw & Damme 2023
	Olesupeni	Rheumatism	Roots	Tanzania	Clement *et al.* 2024
	Loitegomi	Snakebite	Roots	Kenya	Ichikawa 1987
	-	Snakebite	Not specified	DRC	Molander *et al.* 2014
	-	Stomachache	Roots	Kenya	Ongito 2011
		Ethnoveterinary medicine			
	Gofe gofa	Blackleg	Roots	Ethiopia	Moliso *et al.* 2016
	Omochesa	Blackleg	Leaves	Ethiopia	Yigezu *et al.* 2014
	Fechaa	Blackleg	Roots	Ethiopia	Mossie & Urge 2022
	Gofe gofa, yegib mirkuz	Blackleg	Roots	Ethiopia	Wendimu *et al.* 2024
	Fechaa	Bloat	Roots	Ethiopia	Mossie & Urge 2022
	Fechaa	Colibacilosis	Roots	Ethiopia	Mossie & Urge 2022
	Fechaa	Colic	Roots	Ethiopia	Mossie & Urge 2022
	-	East coast fever	Not specified	Uganda	Ndizihiwe *et al.* 2019
	Hidda hoomoo	Ecoparasites	Leaves	Ethiopia	Megersa *et al.* 2013
	Shnbirit	Eye problems	Leaves	Ethiopia	Getaneh & Girma 2014
H. spartioides	**Omutiwoheva**	Leg pains	Whole plant	Namibia	Cheikhyoussef *et al.* 2011a, b
	Omutiwoheva	Stroke	Leaves and roots	Namibia	Cheikhyoussef *et al.* 2011a, b

Table 4: Functional uses of *Helinus* species

Species	**Functional use**	**Part used**	**Country**	**Reference**
H. integrifolius	Edible fruits	Fruits	South Africa	Fox & Norwood Young 1982, Rose & Jacot Guillarmod 1974, Welcome & Van Wyk 2019
H. integrifolius	Soap substitute	Leaves and stems	South Africa	Mabogo 1990, Van Wyk & Gericke 2018, Magwede *et al.* 2019, Ndhlovu *et al.* 2019, Mbanjwa 2020, Setshego *et al.* 2020, Mohlakoana & Moteetee 2021
H. integrifolius	Vegetable	Leaves and whole plant parts	South Africa	Fox & Norwood Young 1982, Rose & Jacot Guillarmod 1974, Welcome & Van Wyk 2019
H. lanceolatus	Fodder	Leaves	Western Himalaya in India	Pandey *et al.* 2017, 2021
H. mystacinus	Baskets and other crafts	Bark and stems	Kenya	Ichikawa 1987
H. mystacinus	Soap substitute	Leaves	Tanzania	Clement *et al.* 2024

Out of the functional uses, *H. integrifolius* is used as a food plant in South Africa, mainly for its edible fruits, leaves and stems (Fox & Norwood Young 1982, Rose & Jacot Guillarmod 1974, Welcome & Van Wyk 2019). In South Africa (Mabogo 1990, Van Wyk & Gericke 2018, Magwede *et al.* 2019, Ndhlovu *et al.* 2019, Mbanjwa 2020, Setshego *et al.* 2020, Mohlakoana & Moteetee 2021) and Tanzania (Clement *et al.* 2024), the leaves and stems of *H. integrifolius* and *H. mystacinus* are used as soap substitute. In the Western Himalaya in India, *H. lanceolatus* is used as fodder (Pandey *et al.* 2017, 2021), while in Kenya, the bark and stems of *H. mystacinus* are used to make baskets and other crafts (Ichikawa 1987).

The plant parts of *Helinus* species used to prepare traditional medicines are bark, fruits, leaves, roots, root bark, stems and whole plant parts (Fig. 4). The roots are the most frequently used plant parts (63.0%), followed by leaves (30.0%) and whole plant parts (13.5%) (Figure 4). However, harvesting of whole plants and roots of *Helinus* species for medicinal purposes is not sustainable as collection of whole plants or roots threaten the survival of the same species used as sources of traditional medicines. Some *Helinus* species are threatened with extinction, and these include *H. lanceolatus* which is categorized as Endangered (EN) in the Himalayan Region Poonch Valley Azad Kashmir region of Pakistan (Khan *et al.* 2014). *Helinus integrifolius* which is widely collected from the wild as traditional medicine and also marketed in informal herbal medicine markets in South Africa does not seem to be in immediate danger of extinction in the country (Raimondo *et al.* 2009). *Helinus integrifolius* is widespread in South Africa, recorded in a wide range of habitats and characterized by a large population size, and categorized as of Least Concern on IUCN Red List Categories and Criteria (Raimondo *et al.* 2009).

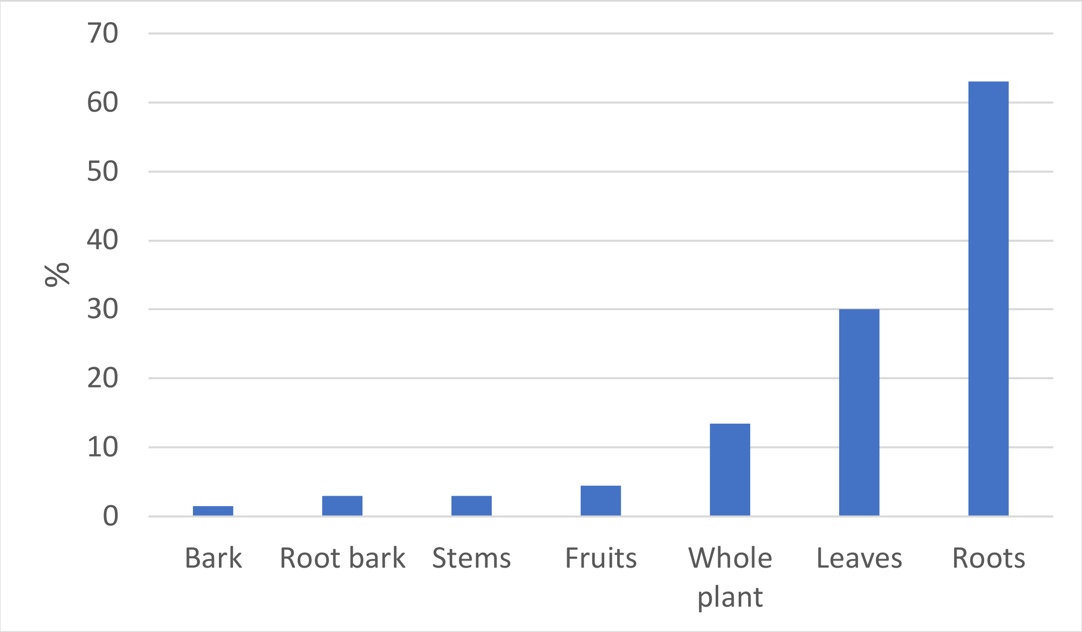

Figure 4. Percentage of different plant parts of *Helinus* species reported to be used as traditional medicines

Reported phytochemistry and biological activities of *Helinus* species

Very little phytochemical research has been conducted on *Helinus* species. For example, Goodson (1920) isolated aconitic acid, quercetin, saponin and scyllitol from the leaves of *H. integrifolius.* Recently, Olaokun and Ntini (2023) isolated phenols, flavonoids, glycosides and steroids from *H. integrifolius* leaves. Similarly, Kerayu (2015) isolated β-sitosterol and betulinic acid from *H. mystacinus* stem bark, while Getahun *et al.* (2012) isolated alkaloids, tannins, saponins, terpenoids, glycosides, betulinic acid and benzoic acid from the same species. The crude extracts of the bark, leaves, roots and stem bark of *H. integrifolius, H. lanceolatus* and *H. mystacinus* exhibited the following antibacterial, antifungal, antioxidant, glucose stimulatory and cytotoxicity activities.

Antibacterial activities

Gundidza (1987) evaluated the antibacterial activities of aqueous extracts of *H. integrifolius* bark and leaves against *Staphylococcus aureus* using the hole plate diffusion and test-tube dilution assays. The extract exhibited activities against the tested pathogen (Gundidza 1987). Shai *et al.* (2013) evaluated the antibacterial activities of acetone extracts of *H. integrifolius* roots against *Lactobacillus acidophilus, Escherichia coli*, *Micrococcus luteus, Klebsiela pneumonia*, *Streptococcus pyogenes, Klebsiela oxytoca*, *Bacillus cereus, Pseudomonas aeruginosa*, *Bacillus stearothermophilus, Pseudomonas* *fluorescens*, *Enterococcus faecalis, Salmonella typhi*, *Staphylococcus epidermidis, Serratia marcescens*, *Staphylococcus aureus, Proteus vulgaris, Enterobacter aerogenes*, *Citrobacter fruendii, Proteus vulgaris* and *Proteus mirabilis* using the serial microplate dilution method with *gentamicin* as positive control. The extracts exhibited activities with the minimal inhibitory concentrations (MIC) values ranging from 0.02 mg/ml to 2.5 mg/ml (Shai *et al.* 2013). Ajaib *et al.* (2015) evaluated the antibacterial activities of aqueous, petroleum ether, methanol and chloroform extracts of *H. lanceolatus* bark and leaves against *Escherichia coli, Streptococcus faecalis, Pseudomonas aeruginosa* and *Staphylococcus aureus* using microdilution assay with amikacin, sulfamethoxazole and ampicillin as positive controls. The extracts exhibited activities against the tested pathogens with MIC values ranging from 0.01 µg/ml to 0.2 µg/ml (Ajaib *et al.* 2015). Kerayu (2015) evaluated the antibacterial activities of chloroform, petroleum ether, methanol and acetone extracts of *H. mystacinus* stem bark against *Salmonella thyphimurium, Staphylococcus aureus, Pseudomonas aeruginosa* and *Escherichia coli* using the agar disc diffusion assay with ciprofloxacin as positive control. The extracts exhibited activities with zone of inhibition ranging from 12.0 mm to 29.0 mm (Kerayu, 2015).

Antifungal activities

Gundidza (1987) evaluated the antifungal activities of aqueous extracts of *H. integrifolius* bark and leaves against *Candida albicans* using the hole plate diffusion and test-tube dilution assays. The extract exhibited activities against the tested pathogen (Gundidza 1987). Ajaib *et al.* (2015) evaluated the antifungal activities of aqueous, petroleum ether, methanol and chloroform extracts of *H. lanceolatus* bark and leaves against *Aspergillus niger* and *Aspergillus oryzae* using agar dilution method with nystatin, kanamycine and tezole as positive controls. The extracts exhibited activities against the tested pathogens with the zone of inhibition ranging from 10.0 mm to 17.0 mm (Ajaib *et al.* 2015).

Antioxidant activities

Ajaib *et al.* (2015) evaluated the antioxidant activities of aqueous, petroleum ether, methanol and chloroform extracts of *H. lanceolatus* bark and leaves using 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging and ferric reducing antioxidant potential (FRAP) assays with butylated hydroxytoluene (BHT) as a positive control. The extracts exhibited activities against both DPPH and FRAP with half maximal inhibitory concentration (IC_{50}) values ranging from 15.3 µg/ml to 92.5 µg/ml (Ajaib *et al.* 2015).

Glucose stimulatory activities

Olaokun & Ntini (2023) evaluated the glucose stimulatory activities of acetone and ethyl acetate extracts *H. integrifolius* leaves on C2C12 muscle and H-4-II-E liver cells using the glucose utilization assay with insulin and metformin as positive controls. The extracts exhibited concentration dependent C2C12 muscle and H-4-II-E cells glucose utilization activities (Olaokun & Ntini 2023).

Cytotoxicity activities

Olaokun & Ntini (2023) evaluated the cytotoxicity activities of acetone and ethyl acetate extracts *H. integrifolius* leaves on the raw 264.7 cells using the using real-time xCelligence assay with actinomycin D as the positive control. The extracts demonstrated concentration dependent activities by decreasing the viability of the raw 264.7 cells with concentrations of 0.05 mg/ml (Olaokun & Ntini 2023).

Conclusion

The current study provides a summary of the botanical, ethnomedicinal uses, phytochemical and biological properties of *Helinus* species. Such comprehensive evaluations are necessary considering that some *Helinus* species are widely used as sources of traditional medicines throughout their distributional range in the tropics. 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 medical and food applications of the species. This study contributes to the existing knowledge about *Helinus* species that could be useful in bioprospecting for new health-promoting products required in the primary healthcare delivery system in the tropics. Moreover, the use of medicinal plants in primary healthcare has been increasing in developing countries. This calls for strict regulations of such products to protect consumers from non-standardized herbal medicine usage.

Declarations

List of abbreviations: BHT - butylated hydroxytoluene; DPPH - 1,1-diphenyl-2-picrylhydrazyl; EN - Endangered; (EN); FRAP - ferric reducing antioxidant potential; IC_{50} - half maximal inhibitory concentration; MIC - minimal inhibitory concentration

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Literature cited

Abebaw AF, Damme PV. 2023. Diversity and role of woody Non-Timber Forest Products in Doba District, Eastern Ethiopia. Nusantara Bioscience 15:38-47.

Afolayan AJ, Grierson DS, Mbeng WO. 2014. Ethnobotanical survey of medicinal plants used in the management of skin disorders among the Xhosa communities of the Amathole District, Eastern Cape, South Africa. Journal of Ethnopharmacology 153:220-232. doi: 10.1016/j.jep.2014.02.023

Ajaib M. 2012. Exploration of floral diversity of District Kotli (Azad Jammu & Kashmir) and evaluation of ethnopharmacological effects of some medicinal plants of the area. PhD Thesis. GC University, Lahore, Pakistan

Ajaib M, Khan KM, Perveen S, Shah S. 2015. Antioxidant and antimicrobial activities of *Helinus lanceolatus*. Journal of the Chemical Society of Pakistan 37:139-143.

Ajaib M, Khan ZUD, Siddiqui MF. 2012. Ethnobotanical study of useful climbers/twiners of District Kotli, Azad Jammu & Kashmir. International Journal of Biology and Biotechnology 9(4):421-427.

Arnold TH, Prentice CA, Hawker LC, Snyman EE, Tomalin M, Crouch NR, Pottas-Bircher C. 2002. Medicinal and magical plants of southern Africa: An annotated checklist. National Botanical Institute, Strelitzia 13, Pretoria, South Africa.

Ayalw T, Merawi E. 2021. Assessment of traditional knowledge associated with medicinal plants in North Achfer District, Amhara region, North Ethiopia. Journal of Diseases and Medicinal Plants 7(2):35-43. doi: 10.11648/j.jdmp.20210702.12

Barrios E, Valencia V, Jonsson M, Brauman A, Hairiah K, Mortimer PE, Okubo S. 2018. Contribution of trees to the conservation of biodiversity and ecosystem services in agricultural landscapes. International Journal of Biodiversity Science Ecosystem Services and Management 14:1-16. doi: 10.1080/21513732.2017.1399167

Bredenkamp CL. 2019. A flora of the Eastern Cape province. Strelitzia 41. Volume 2. South African National Biodiversity Institute, Pretoria, South Africa.

Bryant AT. 1966. Zulu medicine and medicine-men. Struik, Cape Town, South Africa.

Burrows JE, Willis CK. 2005. Plants of the Nyika Plateau: An account of the vegetation of the Nyika National Parks of Malawi and Zambia. Southern African Botanical Diversity Network Report No. 31. SABONET, Pretoria, South Africa.

Chauke MA. 2014. Study of medicinal plant materials used by traditional healers in the Phalaborwa area to treat and manage type 2 diabetes mellitus. MTech Dissertation. Tshwane University of Technology, South Africa.

Chauke MA, Shai LJ, Mogale MA, Tshisikhawe MP, Mokgotho MP. 2015. Medicinal plant use of villagers in the Mopani district, Limpopo province, South Africa. African Journal of Traditional Complementary and Alternative Medicine 12:9-26. doi: 10.4314/ajtcam.v12i3.29

Cheikhyoussef A, Mapaure I, Shapi M. 2011a. The use of some indigenous plants for medicinal and other purposes by local communities in Namibia with emphasis on Oshikoto region: A review. Research Journal of Medicinal Plant 5:406-419. doi: 10.3923/rjmp.2011.406.419

Cheikhyoussef A, Shapi M, Matengu K, Ashekele HM. 2011b. Ethnobotanical study of indigenous knowledge on medicinal plant use by traditional healers in Oshikoto region, Namibia. Journal of Ethnobiology and Ethnomedicine 7:10. doi: 10.1186/1746-4269-7-10

Chekole G, Asfaw Z, Kelbessa E. 2015. Ethnobotanical study of medicinal plants in the environs of Tara-gedam and Amba remnant forests of Libo Kemkem District, northwest Ethiopia. Journal of Ethnobiology and Ethnomedicine 11:4. doi: 10.1186/1746-4269-11-4

Chifundera K. 2001. Contribution to the inventory of medicinal plants from the Bushi area, South Kivu province, Democratic Republic of Congo. Fitoterapia 72:351-368. doi: 10.1016/s0367-326x(00)00294-x

Chigor CB. 2014. Development of conservation methods for *Gunnera perpensa* L.: An overexploited medicinal plant in the Eastern Cape, South Africa. PhD Thesis. University of Fort Hare, Alice, South Africa

Chinsembu KC, Hijarunguru A, Mbangu A. 2015. Ethnomedicinal plants used by traditional healers in the management of HIV/AIDS opportunistic diseases in Rundu, Kavango East Region, Namibia. South African Journal of Botany 100:33-42. doi: 10.1016/j.sajb.2015.05.009

Christenhusz MJM, Byng JW. 2016. The number of known plants species in the world and its annual increase. Phytotaxa261:201-217. doi: 10.11646/phytotaxa.261.3.1

Clement RP, Runyogote J, Raymond J, Chacha MN. 2024. Ethnobotanical survey of plants used in the Maasai food system and traditional medicine against gout and associated conditions in Monduli-Tanzania. Journal of Herbs Spices and Medicinal Plants. doi: 10.1080/10496475.2024.2369874

Cocks ML, Dold A. 2006. Cultural significance of biodiversity: The role of medicinal plants in urban African cultural practices in the Eastern Cape, South Africa. Journal of Ethnobiology 26(1):60-81. doi: 10.2993/0278-0771(2006)26[60:CSOBTR]2.0.CO;2

Conde P, Figueiro R, Saraiva S, Catarino L, Romeiros M, Duarte MC. 2014. The botanic mission to Mozambique (1942-1948): Contributions to knowledge of the medicinal flora of Mozambique: The medicinal flora of Mozambique. História, Ciências Saúde Manguinhos Rio de Janeiro 21(2):1-49. doi: 10.1590/s0104-59702014000200007

Cumes D, Loon R, Bester D. 2009. Healing trees and plants of the Lowveld. Struik Nature. Cape Town, South Africa

Cunningham AB. 1993. African medicinal plants: setting priorities at the interface between conservation and primary health care. People and Plants working paper 1. UNESCO, Paris, France.

Dallemagne MJ, Renversez G, Robyns E, Troupin G. 1959. Stimulation of milk secretion by *Helinus mystacinus* (Ait.) E. Mey and *Periploca linearifolia* Dill. and Rich. International Archives of Pharmacodynamics 122:48-56.

Dold AP, Cocks ML. 2002. The trade in medicinal plants in the Eastern Cape province, South Africa. South African Journal of Science 98:589-597.

Drummond RB. 1966. Rhamnaceae. In: Exell AW, Fernandes A, Wild H. (eds). Flora Zambesiaca volume 2 part 2. Flora Zambesiaca Managing Committee, London, UK, Pp. 419-439.

Fox FW, Norwood Young ME. 1982. Food from the veld. Delta Books, Johannesburg, South Africa.

Fowler DG. 2006. Traditional fever remedies: A list of Zambian plants. Royal Botanic Gardens, Kew, Richmond, UK.

Gelfand M, Mavi S, Drummond RB, Ndemera B. 1985. The traditional medical practitioner in Zimbabwe: His principles of practice and pharmacopeia. Mambo Press, Gweru, Zimbabwe.

Germishuizen G, Meyer NL. 2003. Plants of southern Africa: An annotated checklist. National Biodiversity Institute, Strelitzia 14, Pretoria, South Africa.

Gerstner J. 1938. A preliminary checklist of Zulu names of plants with short notes. Bantu Studies 12:215-236. doi: 10.1080/02561751.1941.9676141

Getahun T, Reneela P, Aman D. 2012. Isolation and characterization of natural products from *Helinus mystacinus* (Rhamnaceae). Journal of Chemical and Pharmaceutical Research 4:1756-1762.

Getaneh S, Girma Z. 2014. An ethnobotanical study of medicinal plants in Debre Libanos Wereda, Central Ethiopia. African Journal of Plant Science 8(7):366-379. doi: 10.5897/AJPS2013.1041

Goodson JA. 1920. Constituents of the leaves of *Helinus ovatus*. Journal of Chemical Society Transactions 117:140-144.

Govaerts R, Nic Lughadha E, Black N, Turner R, Paton A. 2021. The world checklist of vascular plants: A continuously updated resource for exploring global plant diversity. Sciintific Data 8:1-10. doi: 10.1038/s41597-021-00997-6

Gundidza M. 1987. Antimicrobial activities of *Helinus integrifolius*. *Fitotempia* 58(3):180-183.

Hamill FA. 2001. Studies of the medical ethnobotany of the Buganda Kingdom. PhD Thesis. University of Illinois, Chicago, USA.

Hamunyela MN, Nekongo-Nielsen H, Kanyimba A. 2020. Indigenous knowledge on health care among the Ovahimba community of Oukongo village in Kunene region of Namibia. Journal for Studies in Humanities and Social Sciences 8(2):107-140. doi: 10.32642/.v8i2.1451

Hedberg IF, Staugård F. 1989. Traditional medicinal plants: Traditional medicine in Botswana. Ipelegeng Publishers, Gaborone, Botswana.

Hutchings A. 1989. A survey and analysis of traditional medicinal plants as used by the Zulu, Xhosa and Sotho. Bothalia 19(1):111-123. doi: 10.4102/abc.v19i1.947

Hutchings A, Scott AH, Lewis G, Cunningham B. 1996. Zulu medicinal plants: An inventory. University of Natal Press, Pietermaritzburg, South Africa.

Ichikawa M. 1987. A preliminary report on the ethnobotany of the Suiei Dorobo in Northern Kenya. African Study Monograph 7:1-52.

Johnston MC. 1972. Rhamnaceae: Flora of tropical East Africa. Crown Agents for Overseas Governments and Administration, London, UK.

Kalaba F, Quinn C, Dougill A. 2013a. Contribution of forest provisioning ecosystem services to rural livelihoods in the Miombo woodlands of Zambia. Population and Environment 35:159-182. doi: 10.1007/s11111-013-0189-5

Kalaba FK, Quinn CH, Dougill AJ. 2013b. The role of forest provisioning ecosystem services in coping with household stresses and shocks in Miombo woodlands, Zambia. Ecosystem Services 5:143-148. doi: 10.1016/j.ecoser.2013.07.008

Kerayu BA. 2015. Phytochemical investigation and *in vitro* antibacterial evaluation on stem extracts of *Helinus mystacinus*. International Research Journal of Natural and Applied Sciences 2(10): 27-57.

Khan MA, Khan MA, Hussain M, Mujtaba G. 2014. Plant diversity and conservation status of Himalayan region Poonch Valley Azad Kashmir (Pakistan). Pakistan Journal of Pharmaceutical Sciences 27(5):1215-1239.

Kigen G, Kipkore W, Wanjohi B, Haruki B, Kemboi J. 2017. Medicinal plants used by traditional healers in Sangurur, Elgeyo Marakwet County, Kenya. Pharmacognosy Research 9:333-347. doi: 10.4103/pr.pr_42_17

Kilian N, Hein P, Hubaishan MA. 2004. Further notes on the flora of the southern coastal mountains of Yemen. Willdenowia 34(1):159-182. doi: 10.3372/wi.34.34114

Kilian N, Hein P, Hubaishan MA. 2002. New and noteworthy records for the flora of Yemen, chiefly of Hadhramout and Al-Mahra. Willdenowia 32(2):239-269. doi: 10.3372/wi.32.32207

Kumari P, Rawat DS. 2023. Ethnoveterinary practices of Arki and Kandaghat Tehsils of District Solan, Himachal Pradesh (India). International Journal of Science and Research 12(6):561-565. doi: 10.21275/SR23603112609

Lakerveld RP, Lele S, Crane TA, Fortuin KPJ, Springate-Baginski O. 2015. The social distribution of provisioning forest ecosystem services: Evidence and insights from Odisha, India. Ecosystem Services 14:56-66. doi: 10.1016/j.ecoser.2015.04.001

Leistner OA. 2000. Seed plants of southern Africa: Families and genera. Strelitzia 10. National Botanical Institute, Pretoria, South Africa.

Loffler L, Loffler P. 2005. Swaziland tree atlas: Including selected shrubs and climbers. Southern African Botanical Diversity Network Report No. 38. SABONET, Pretoria, South Africa.

Mabogo DEN. 1990. The ethnobotany of the VhaVenda. MSc Dissertation. University of Pretoria, Pretoria, South Africa.

Magwede K, Van Wyk B-E, Van Wyk AE. 2019. An inventory of Vhavenḓa useful plants. South African Journal of Botany 122:57-89. doi: 10.1016/j.sajb.2017.12.013

Mander M. 1998. Marketing of medicinal plants in South Africa: A case study in Kwazulu-Natal. Food and Health Organization of the United Nations, Rome, Italy.

Mao AA, Dash SS. 2020. Flowering plants of India: An annotated checklist (dicotyledons) 1. Botanical Survey of India, New Delhi, India

Maroyi A. 2018. Nutraceutical and ethnopharmacological properties of *Vangueria infausta* subsp. *infausta*. Molecules 23(5):1089. doi: 10.3390/molecules23051089

Mataha L. 2021. Medicinal ethnobotany of the Modjadji area of the Limpopo Province, South Africa. MSc Dissertation. University of Johannesburg, Johannesburg, South Africa.

Maundu P, Berger D, Saitabau C, Nasieku J, Kipelian M, Mathenge S, Morimoto Y, Höft R, 2001. Ethnobotany of the Loita Maasai: Towards community management of the forest of the lost child: Experiences from the Loita Ethnobotany Project. UNESCO People and Plants Working Paper 8, Paris, France.

Mbanjwa SG. 2020. A quantitative ethnobotanical survey of the Ixopo area of KwaZulu-Natal, South Africa. MSc Dissertation. University of Johannesburg, Johannesburg, South Africa.

Millennium Ecosystem Assessment (MEA). 2005. Ecosystems and human well-being: synthesis. Island Press, Washington DC, USA.

Megersa M, Asfaw Z, Kelbessa E, Beyene A, Woldeab B. 2013. An ethnobotanical study of medicinal plants in Wayu Tuka District, East Welega Zone of Oromia Regional State, West Ethiopia. Journal of Ethnobiology and Ethnomedicine 9:68. doi: 10.1186/1746-4269-9-68.

Mensah S, Veldtman R, Assogbadjo AE, Ham C, Kakaï RG, Seifert T. 2017. Ecosystem service importance and use vary with socio-environmental factors: A study from household-surveys in local communities of South Africa. Ecosystem Services 23:1-8. doi: 10.1016/j.ecoser.2016.10.018

Mhlongo LS, Van Wyk B-E. 2019. Zulu medicinal ethnobotany: New records from the Amandawe area of KwaZulu-Natal, South Africa. South African Journal of Botany 122:266-290. doi: 10.1016/j.sajb.2019.02.012

Mohlakoana M, Moteetee A. 2021. Southern African soap plants and screening of selected phytochemicals and quantitative analysis of saponin content. Resources 10:96. doi: 10.3390/resources10100096

Mohmood T. 2019. Ethnobotanical study of useful climbers creepers and twiners of Baba Ghulam Shah Badshah University campus and adjoining areas of District Rajouri (J&K). Medicinal and Aromatic Plants (Los Angeles) 8:340. doi: 10.35248/2167-0412.19.8.340

Molander M, Nielsen L, Søgaard S, Staerk D, Rønsted N, Diallo D, Chifundera KZ, Van Staden J, Jäger AK. 2014. Hyaluronidase, phospholipase A_2 and protease inhibitory activity of plants used in traditional treatment of snakebite-induced tissue necrosis in Mali, DR Congo and South Africa. Journal of Ethnopharmacology 157:171-180. doi: 10.1016/j.jep.2014.09.027

Moliso MM, Tessema F, Yilma M, Getachew T, Asrat M. 2016. Documentation of ethno veterinary practices in selected sites of Wolaita and Dawuro Zones, Ethiopia. Global Journal of Science Frontier Research Agriculture and Veterinary 16(5):27-33

Mollel NP, Otieno JN, Sitoni DK. 2022. Medicinal plants traded in Arusha city, Tanzania. Journal of Medicinal Plants Studies 10(1):175-182.

Mossie T, Urge B. 2022. An ethnoveterinary survey of medicinal plants used by local informants in selected districts of Jimma Zone, Ethiopia. International Journal of Agriculture and Nutrition 4(2):21-33. doi: 10.33545/26646064.2022.v4.i2a.76

Mothibe ME, Sibanda M. 2019. African traditional medicine: South African perspective. In: Cengiz M. (ed). Traditional and complementary medicine. IntechOpen, London, UK. doi: 10.5772/intechopen.83790

Mukazayire M-J, Minani V, Ruffo CK, Bizuru E, Stevigny C, Duez P. 2011. Traditional phytotherapy remedies used in Southern Rwanda for the treatment of liver diseases. Journal of Ethnopharmacology 138(2):415-431. doi: 10.1016/j.jep.2011.09.025

Nanyingi MO, Mbaria JM, Lanyasunya AL, Wagate CG, Koros KB, Kaburia HF, Munenge RW, Ogara WO. 2008. Ethnopharmacological survey of Samburu district, Kenya. Journal of Ethnobiology and Ethnomedicine 4:14. doi: 10.1186/1746-4269-4-14

Ndawonde BG, Zobolo AM, Dlamini ET, Siebert SJ. 2007. A survey of plants sold by traders at Zululand muthi markets, with a view to selecting popular plant species for propagation in communal gardens. African Journal of Range and Forage Science 24(2):103-107. doi: 10.2989/A JRFS.2007.24.2.7.161

Ndizihiwe D, Ahishakiye E, Nkuuhe D, Sunday B, Tumwesigye W. 2019. Utilization of medicinal plants in treating livestock diseases around Queen Elizabeth national park, western Uganda. International Journal of Herbal Medicine 7(2):4-7.

Ndhlovu P, Mooki O, Mbeng WO, Aremu A. 2019. Plant species used for cosmetic and cosmeceutical purposes by the Vhavenda women in Vhembe District municipality, Limpopo, South Africa. South African Journal of Botany 122:422-431. doi: 10.1016/j.sajb.2019.03.036

Ngezahayo J, Havyarimana F, Hari L, Stévigny C, Duez P. 2015. Medicinal plants used by Burundian traditional healers for the treatment of microbial diseases. Journal of Ethnopharmacology 173:338-351. doi: 10.1016/j.jep.2015.07.028

Nowak-Olejnik A, Mocior E. 2021. Provisioning ecosystem services of wild plants collected from seminatural habitats: A basis for sustainable livelihood and multifunctional landscape conservation. Mountain Research and Development 42(1):11-19. doi: 10.1659/MRD-JOURNAL-D-21-00036.1

Nzue APMM. 2009. Use and conservation status of medicinal plants in the Cape Peninsula, Western Cape Province of South Africa. MSc Dissertation. Stellenbosch University, Cape Town, South Africa.

Olaokun OO, Ntini VP. 2023. Phytochemical analyses, glucose stimulatory effects and cytotoxicity of *Cassia abbreviata* and *Helinus integrifolius* leaf extracts in *in vitro* cell cultures. Asian Journal of Chemistry 35(3):687-691. doi: 10.14233/ajchem.2023.27564

Ollesen K. 1989. Rhamnaceae. In: Hedberg I, Edward S. (eds). Flora of Ethiopia volume 3, Pittoseraceae to Araliceae. Uppsala University, Uppsala, Sweden, Pp. 385-387.

Ongito RA. 2011. Rhamnaceae family as a source of herbal and conventional medicines. MSc Dissertation. University of Nairobi, Nairobi, Kenya.

Pandey NC, Tewari LM, Joshi GC. 2021. Diversity, distribution and utilization pattern of shrubs of Betalghat region (Kumaun Himalaya). Asian Journal of Plant and Soil Sciences 6(1):159-174. doi: 10.56557/ajopss/2021/v6i134

Pandey NC, Joshi GC, Tewari LM, Pangtey YPS. 2017. Diversity of fodder plants of Betalghat Block, Nainital District, Western Himalaya. International Journal of Environment 6(4):1-27. doi: 10.3126/ije.v6i4.18907

Parada SP, Salas CB. 2024. Multifunctional plants: Ecosystem services and undervalued knowledge of biocultural diversity in rural communities: Local initiatives for agroecological transition in Chile. Land 13:39. doi: 10.3390/land13010039

POWO. 2024. Plants of the world online. Facilitated by the Royal Botanic Gardens, Kew. 2023. Available online: https://powo.science.kew.org, accessed on 23 June 2024

Pujol J. 1990. Natur Africa: the herbalist handbook. Jean Pujol Natural Healers Foundation, Durban, South Africa

Qaiser M, Nazimuddin S. 1981. Rhamnaceae. In: Nasir E, Ali SI. (eds). Flora of Pakistan. Department of Botany, University of Karachi, Karachi, Pakistan, Pp. 1-24

Raimondo D, Von Staden L, Foden W, Victor JE, Helme NA, Turner RC, Kamundi DA, Manyama PA. 2009. Red List of South African plants. Strelitzia 25, South African National Biodiversity Institute, Pretoria, South Africa.

Retief E, Meyer NL. 2017. Plants of the Free State: Inventory and identification guide. Strelitzia 38. South African National Biodiversity Institute, Pretoria, South Africa

Rodríguez LC, Pascual U, Niemeyer HM. 2006. Local identification and valuation of ecosystem goods and services from *Opuntia* scrublands of Ayacucho, Peru. Ecological Economics 57:30-44. doi: 10.1016/j.ecolecon.2005.03.022

Rose EF, Jacot Guillarmod A. 1974. Plants gathered as foodstuffs by the Transkeian peoples. South African Medical Journal 48:1688-1690.

Schmidt E, Lotter M, McCleland W. 2017. Trees and shrubs of Mpumalanga and Kruger National Park. Jacana Media, Johannesburg, South Africa.

Setshego MV, Aremu AO, Mooki O, Otang-Mbeng W. 2020. Natural resources used as folk cosmeceuticals among rural communities in Vhembe district municipality, Limpopo province, South Africa. BMC Complementary Medicine and Therapies 20:81. doi: 10.1186/s12906-020-2869-x

Shai LJ, Chauke MA, Magano SR, Mogale AM, Eloff JN. 2013. Antibacterial activity of sixteen plant species from Phalaborwa, Limpopo province, South Africa. Journal of Medicinal Plants Research 7(26):1899-1906. doi: 10.5897/JMPR2013.2598

Singh P, Sharma S. 2021. Ethnobotanical studies on climbers of Chotanagpur Plateau region. International Journal of Scientific and Engineering Research 12(1):681-687.

Sitoe E, Van Wyk B-E. 2024. An inventory and analysis of the medicinal plants of Mozambique. Journal of Ethnopharmacology 319:117137. doi: 10.1016/j.jep.2023.117137

Smith CA. 1966. Common names of South African plants. Memoirs of the Botanical Survey of South Africa 35. Department of Agricultural Technical Services, Pretoria, South Africa.

Sobiecki JF. 2014. The intersection of culture and science in South African traditional medicine. Indo-Pacific Journal of Phenomenology 14(1):1-10. doi: 10.2989/IPJP.2014.14.1.6.1238

Sobiecki JF. 2008. A review of plants used in divination in southern Africa and their psychoactive effects. South African Humanities 20:333-351.

Sobiecki JF. 2002. A preliminary inventory of plants used for psychoactive purposes in southern African healing traditions. Transactions of the Royal Society of South Africa 57:1-24. doi: 10.1080/00359190209520523

Tabuti JRS, Lye KA, Dhillion SS. 2003. Traditional herbal drugs of Bulamogi, Uganda: Plants, use and administration. Journal of Ethnopharmacology 88:19-44. doi: 10.1016/S0378-8741(03)00161-2

Teklehaymanot T, Giday M. 2007. Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, Northwestern Ethiopia. Journal of Ethnobiology and Ethnomedicine 3:12. doi: 10.1186/1746-4269-3-12

Thulin M. 1999. Flora of Somalia volume 2. The Royal Botanic Gardens, Kew, Richmond, UK.

Van Wyk B-E, Gericke N. 2018. People's plants: A guide to useful plants of southern Africa. Briza Publications, Pretoria, South Africa.

Varí A, Arany I, Kaloczkaí A, Kelemen K, Papp J, Czucz B. 2020. Berries, greens, and medicinal herbs: Mapping and assessing wild plants as an ecosystem service in Transylvania (Romania). Journal of Ethnobiology and Ethnomedicine 16:13. doi: 10.1186/s13002-020-0360-x

Watt JM, Breyer-Brandwijk MG. 1962. The medicinal and poisonous plants of southern and eastern Africa. E. & S. Livingstone LTD, Edinburgh, UK.

Welcome AK, Van Wyk B-E. 2019. An inventory and analysis of the food plants of southern Africa. South African Journal of Botany 122:136-179. doi: 10.1016/j.sajb.2018.11.003

Wendimu A, Bojago E, Abrham Y. 2024. Medicinal ethnoveterinary plants used for treating livestock ailments in the omo-gibe and rift valley basins of Ethiopia. BMC Veterinary Research 20:166. doi: 10.1186/s12917-024-04019-6

Williams VL, Balkwill K, Witkowski ETF. 2001. A lexicon of plants traded in the Witwatersrand *umuthi* shops, South Africa. Bothalia 31:71-98. doi: 10.4102/abc.v31i1.508

Yigezu Y, Haile DB, Ayen WY. 2014. Ethnoveterinary medicines in four districts of Jimma zone, Ethiopia: cross sectional survey for plant species and mode of use. BMC Veterinary Research 10:76. doi: 10.1186/1746-6148-10-76

Zukulu S, Dold T, Abbott T, Raimondo D. 2012. Medicinal and charm plants of Pondoland. South African National Biodiversity Institute (SANBI), Pretoria, South Africa