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Review

Ethnopharmacology, Phytochemistry, and Antiparasitic Bioactivity of Two African Species of Euclea (Ebenaceae) in the Phytotherapy of Intestinal Parasitic Infections: A Systematic Review

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Abstract

The genus Euclea (Ebenaceae), represented in this study by *Euclea divinorum* Hiern and *Euclea natalensis* A.DC, is commonly used in traditional medicine in Mozambique and various African countries for the treatment of intestinal parasitic infections, a critical public health issue in developeing countries. This study aimed to review the ethnopharmacology, phytochemistry, and bioactivity of *Euclea divinorum* Hiern and *Euclea natalensis* A.DC in the treatment of intestinal parasitic infections to contribute to the validation of traditional knowledge regarding the medicinal use of these species as phytotherapeutic resources against such infections. A bibliographic review was conducted using articles from indexed scientific journals. The systematic review was performed according to the PRISMA 2020 (Preferred Reporting Itens for Systematic Reviews and Meta-Analyses) guidelines, and the screening process for article selection resulted in a temporal range from 1973 to 2023. The ethnopharmacological use of *Euclea natalensis* and *Euclea divinorum* for the treatment of intestinal parasitic infections has been reported in several Southern African countries. Extracts obtained using different solvents from the roots, tested through the agar disk diffusion method, have demonstrated bioactivity against pathogens responsible for amoebic dysentery, diarrhea, hookworm infections, and schistosomiasis. The phytochemicals, found predominantly in the roots, include naphthoquinones, flavonoids, and pentacyclic terpenoids, with naphthoquinones identified as the key bioactive compounds associated with therapeutic effects.

Keywords: ethnopharmacology; phytochemistry; antiparasitic bioactivity; *Euclea divinorum*; *Euclea natalensis*

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1. Introduction

In Africa, more than 5000 plant species are used in traditional African medicine [1,2], most of which are forest species used in phytotherapy for a wide range of diseases. Mozambique is one of the African countries where the use of plants in traditional medicine is widespread, covering at least 60% of the country's population, particularly in rural

areas [3], where health care services are inadequate. Among the most concerning diseases in these regions are intestinal parasitic infections.

Intestinal parasitic infections represent a major public health issue in Mozambique [4], primarily due to poor sanitation conditions, particularly in suburban areas. These conditions facilitate the proliferation of vectors and the spread of waterborne diseases. Precarious sanitation conditions provide a favorable environment for the transmission cycle of several intestinal parasites, as the absence of an adequate sewage system leads to the contamination of water and food by parasite eggs and cysts, which can result in an intestinal parasitic infection. Additionally, domestic animals such as poultry, pigs, goats, and cattle can also become infected and transmit intestinal parasites to humans through direct contact with eggs in their feces or through the consumption of their meat, as is the case with tapeworms (*Taenia* spp.), which, in addition to humans, also parasitize swine and cattle. Furthermore, some habits linked to socio-economic conditions, especially in rural areas, contribute to the prevalence of intestinal parasitic infections in Mozambique. For example, walking barefoot increases the risk of hookworm infections. Among the plant species recommended by traditional healers for the treatment of intestinal parasitic infections, the genus Euclea stands out, particularly *Euclea divinorum* Hiern and *Euclea natalensis* A.DC, which have notable ethnopharmacological relevance.

The genus Euclea belongs to the family Ebenaceae [5] and is part of the rich floral biodiversity of Africa, particularly in Southern Africa [6], including Mozambique. It is also distributed across the Comoros Islands and the Arabian Peninsula [5]. This genus primarily consists of shrubs and trees, comprising approximately 16 accepted species [7], among which *Euclea divinorum* Hiern and *Euclea natalensis* A.DC are widely used in African traditional medicine for the treatment of various diseases. The name Euclea originates from the Greek word eukleia [8,9], which combines "eu", meaning "good," and "kleus", meaning "fame" or "good reputation" [9].

In Mozambique, *Euclea divinorum* is known as Mulala or Mushangura (Shona). It also has different names in other African countries, such as Munyenya, Mugarazvuro, and Mugurameno (Shona—Zimbabwe), as well as Magic guarri (English—Zimbabwe, South Africa) [10]. This species is commonly found in East and Southern Africa [6,8,11,12], with its distribution extending across Mozambique, Ethiopia, Kenya, South Africa [12,13], Botswana, Namibia, Eswatini, Zimbabwe, Tanzania, and Uganda [13] and forming part of the Miombo forest.

The root bark of *Euclea divinorum* is used in traditional medicine by some African communities for the treatment of diarrhea, convulsions, cancer, skin diseases, and gonorrhea [15]. It is also strongly associated with the phytotherapy of oral cavity infections in various African countries. In Mozambique, as well as in other Southern African nations, it is particularly used to treat intestinal parasitic infections, which are often associated with diarrhea [16]. In Ethiopia, *Euclea divinorum* is traditionally used to treat abdominal pain, scabies, skin inflammation, eczema, gonorrhea, constipation, cancer, hepatitis, urinary problems, chest pain, pneumonia, and edema [17]. In Kenya, the root of *Euclea divinorum* is used to treat chest pain, pneumonia, and internal body swelling [18].

Euclea natalensis A.DC, also known in Mozambique as Mulala or Mushangura (Shona) and in other African countries as hairy guarri (South Africa), is widely distributed across tropical and subtropical Africa [19]. Its native range extends from Somalia to Southern Africa, covering Mozambique, Zimbabwe, Angola, Botswana, the Cape Provinces, Kenya, KwaZulu-Natal, Malawi, the Northern Provinces, Somalia, Eswatini, Tanzania, Zambia, Zaire [20,21], the Democratic Republic of the Congo, and Ethiopia [20]. This species thrives in diverse environmental conditions across a wide range of habitats, including arid and rocky areas, shrub-covered dunes, open grasslands, woodlands, forests, forest margins, riparian fringes, savannas, and swamps, from sea level up to an altitude of 1200

m [22]. In terms of conservation, according to the IUCN Red List and SANBI, *Euclea natalensis* is classified as a species of least concern [23].

Like *Euclea divinorum*, *Euclea natalensis* is widely used for the treatment of dental caries [20,21] and toothache relief, in addition to being used for various other ailments. At least 51 ethnomedicinal uses of *Euclea natalensis* have been documented in the literature across eight tropical African countries. South Africa has the highest number of reported uses, with 30 ethnomedicinal applications based on 11 records in the literature, while Mozambique has 5 documented uses in 5 literature sources. In Africa, the roots and/or bark of *Euclea natalensis* are commonly used as ingredients in a variety of traditional remedies to treat intestinal worms, stomach disorders, toothache, headache, chest problems, pleurisy, urinary tract infections, venereal diseases, schistosomiasis, dysmenorrhea, scrofulous swellings, and leprosy. The plant is also used as a protective amulet [22]. Among the Zulu people in South Africa, *Euclea natalensis* is used to treat bronchitis, pleurisy, chronic asthma, and urinary tract infections [8]. In Zimbabwe, its leaves are traditionally used to treat malaria, while in Mozambique, the plant is also employed in the treatment of diarrhea associated with intestinal parasitic infections [22].

This study reviews the available information on the ethnopharmacology, phytochemistry, and antiparasitic bioactivity of two species of the genus *Euclea* used in ethnomedicine for the treatment of intestinal parasitic infections in Mozambique and other African countries. This review aims to provide scientific foundations that support the medicinal use of these species in the treatment of intestinal parasitic infections and contribute to the identification of promising phytochemicals for the development of antiparasitic phytopharmaceuticals.

Botanical Profile of Euclea natalensis and Euclea divinorum

Euclea divinorum is an evergreen shrub or small tree that can grow up to approximately 6 m in height [6,8]. It has a grayish-green, highly branched canopy, which may branch from the base or sometimes develop a single trunk [8,24]. The young stems are smooth and light gray with rust-colored granules, while the bark is grayish-brown to black, rough, and longitudinally fissured [22]. Its leaves are simple, leathery in texture, lanceolate or elliptical, with wavy margins [8,22,25] (Figure 1). They are opposite or subopposite, alternately arranged, and wider in the middle or just below it, tapering towards both the base and apex [22]. The leaves typically measure 3.5–9 cm in length and 1–2.5 cm in width [8] and are hairless and glossy [22]. The upper surface is light green or grayish-green, sometimes with a yellowish hue [8], while the lower surface is paler [8,11]. The veins appear as fine lines [8], and the petioles are about 6 mm long [22]. The flowers are cup-shaped, characteristically small [8,22], cream-white in color [11,22], and covered in tiny rust-brown dots [8]. They form short, dense, and branched inflorescences in the leaf axils [11] and are fragrant [22]. Typically, male and female flowers occur on separate trees [8,11,22], growing in short, dense clusters up to 15 mm long [24]. The fruits are round berries, slightly fleshy [8,11,22], containing a single seed. They are usually purple or blackish-purple when ripe [8,22], with a diameter of approximately 5–7 mm [22]. The roots are fibrous, thin, and branched, with a smooth texture that may present rough patches.

Euclea natalensis is an evergreen shrub or small tree, typically ranging from 4 to 10 m in height, with a dense, spreading canopy. However, under irrigated conditions and warm temperatures, its average height can range from 12 to 18 m [22]. In arid shrublands, it is often stunted, sometimes reaching less than one meter in height [22]. The trunk is generally straight, with dark gray bark that is finely fissured [22]. The branches are initially covered in fine, rust-colored hairs and become smooth with age [22]. The leaves are tough and leathery, dark green and glossy on the upper surface, while the underside is paler [22] (Figure 1). The lower surface is often covered with thick, velvety red hairs, whereas the upper surface may also occasionally have hairs [22]. The leaves vary in size, shape, and hairiness, ranging from oval to oblong, with either pointed or rounded tips [22]. The veins are prominent, particularly on the upper surface, and the margins are thickened and often wavy [22] (Figure 1). Female and male flowers occur on separate trees. The flowers are small, bell-shaped, and range in color from cream to yellow. They grow in branched, multi-flowered clusters in the axils of the leaves. Male flowers typically contain 16 stamens and a tiny rudimentary ovary with two styles [22]. The fruits are round, fleshy berries, measuring 7–13 mm in diameter. They grow on hairy stalks in dense, conspicuous clusters [22]. When ripe, the fruits display a variety of colors, including yellow, orange, red, and black, forming striking clusters. The outer surface of the roots is dark brown to black, while the pith is light brown to orange, with a fibrous texture.

Figure 1. (**A**) *Euclea divinorum*; (**B**) *Euclea natalensis.* Photograph taken by the authors.

2. Materials and Methods

The present systematic review was performed according to the guidelines of PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [12]. The PRISMA 2020 statement provides updated guidance for reporting different types of systematic reviews [12]. The protocol for this systematic review was registered in the Open Science Framework (OSF), Doi: https://doi.org/10.17605/OSF.IO/SY47P (accessed on 19 December 2025). The molecular structures of the phytochemicals were designed using the Chemdraw platform, version 8.0.

2.1. Search Strategy

Articles were sourced from indexed scientific journals available in electronic databases: PubMed (21), Sciencedirect (11), Researchgate (14) and Scopus (5),The search period took place from October 2024 to April 2025. Data collection was conducted through a bibliographic review of scientific articles focusing on studies related to the ethnopharmacology, phytopharmacology, and bioactivity of *Euclea divinorum* and *Euclea natalensis*.

Keywords were used for identification and filtering. The main keywords employed to retrieve relevant information included: ethnopharmacology, phytochemistry, biological activity, bioactivity, antiparasitic activity, *Euclea divinorum*, *Euclea natalensis*, and *Euclea* genus. Additionally, synonymous terms and African vernacular names of *Euclea divinorum* and *Euclea natalensis* were incorporated. The commonly used vernacular names applied in the search were mulala, mushangula, ushangula, and *magic guarri*, as both species are frequently referred to by the same local names. In the literature search conducted, eight African countries were identified as utilizing *Euclea divinorum* and *Euclea natalensis* in the ethnopharmacology of intestinal parasitic infections (Figure 2).

The search was conducted using the following strings: "Ethnopharmacology" AND "*Euclea divinorum* (Mushangura)"; "Ethnopharmacology" AND "*Euclea natalensis*"; "Phytochemistry AND Bioactivity of *Euclea divinorum*" "Phytochemistry AND Bioactivity (Biological activity) of *Euclea natalensis* (Mulala)"; "Phytochemistry" AND Bioactivity (Biological activity) of *Euclea divinorum* (Mulala)"; "Antiparasitic Bioactivicty" OR "Antimicrobial activity" AND "*Euclea divinorum*"; "Antiparasitic Bioactivicty" OR "Antimicrobial activity" AND "*Euclea natalensis*".

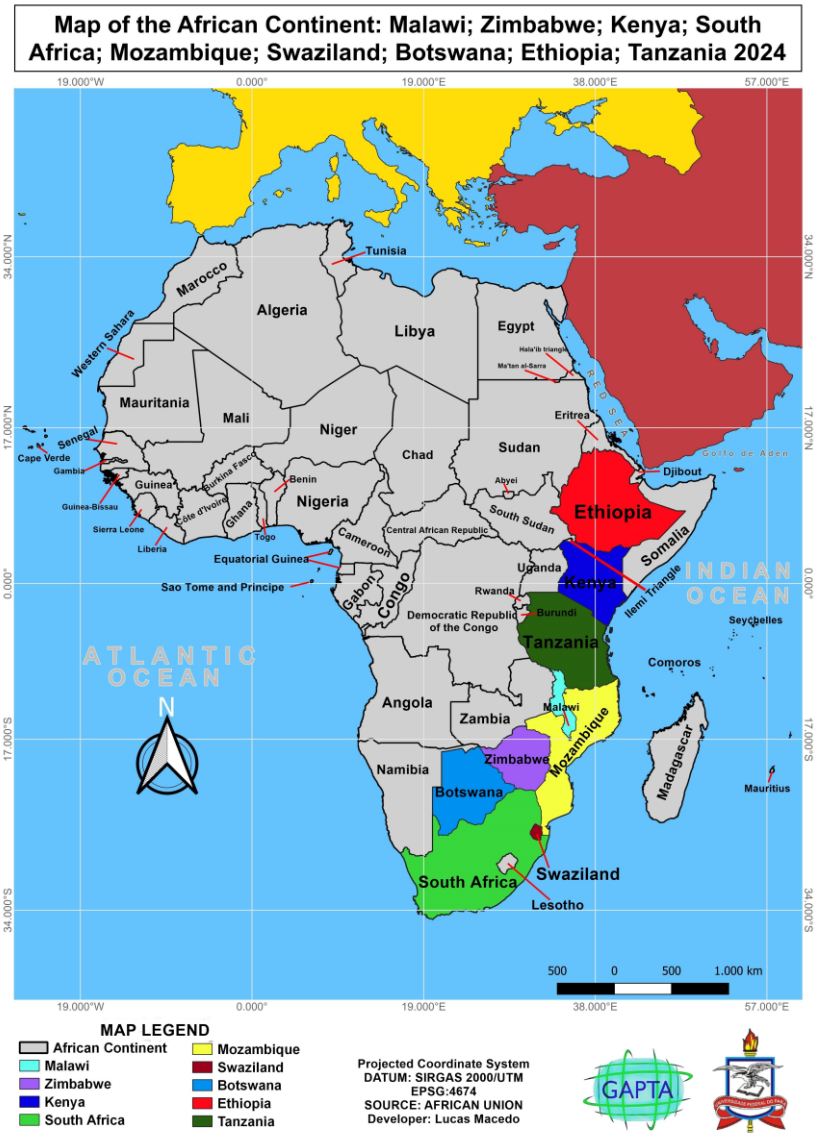


Figure 2. Map of the eight African countries using *Euclea divinorum* and *Euclea natalensis* in the ethnopharmacology of intestinal parasitic infections. Map created by João Márcio Palheta for this study.

Data Collection Process

The principal author (C.M das Dores) conducted the literature search. Articles were primarily searched in English and Portuguese, although all studies selected and identified for review are exclusively in English. Firstly, the literature search was conducted for titles using the search keywords and inclusion criteria. Secondly, the content of the abstracts, objectives, methods, and results sections was analyzed while observing the eligibility criteria.

2.2. Eligibility Criteria

The literature review was guided by inclusion and exclusion criteria. The studies included in this review collectively met the following inclusion criteria:

1. Works and articles focusing on medicinal plant species in Africa, with an emphasis on Southern Africa.
2. Studies addressing the bioactivity, phytochemical identification, and ethnopharmacology of the two species in relation to intestinal parasitic infections.

The selection of works and articles related to medicinal plant species in Southern Africa was made because, despite the geographical and climatic diversity of Southern African countries, they share cultural similarities and ecosystem characteristics. This region is predominantly covered by Miombo woodlands, which extend across Southern Africa and significantly influence the medicinal use of plants in this area.

Incomplete articles and articles whose results did not meet the research objectives were excluded.

2.3. Literature Selection

The filtration of the studies was performed according the PRISMA flowchart (Figure 3). Titles and abstracts of 252 references were evaluated, and 51 eligible full-text references were considered. The screening process for article selection resulted in a temporal range from 1973 to 2023, spanning four decades and yielding 51 articles that met the inclusion criteria (Figure 3).

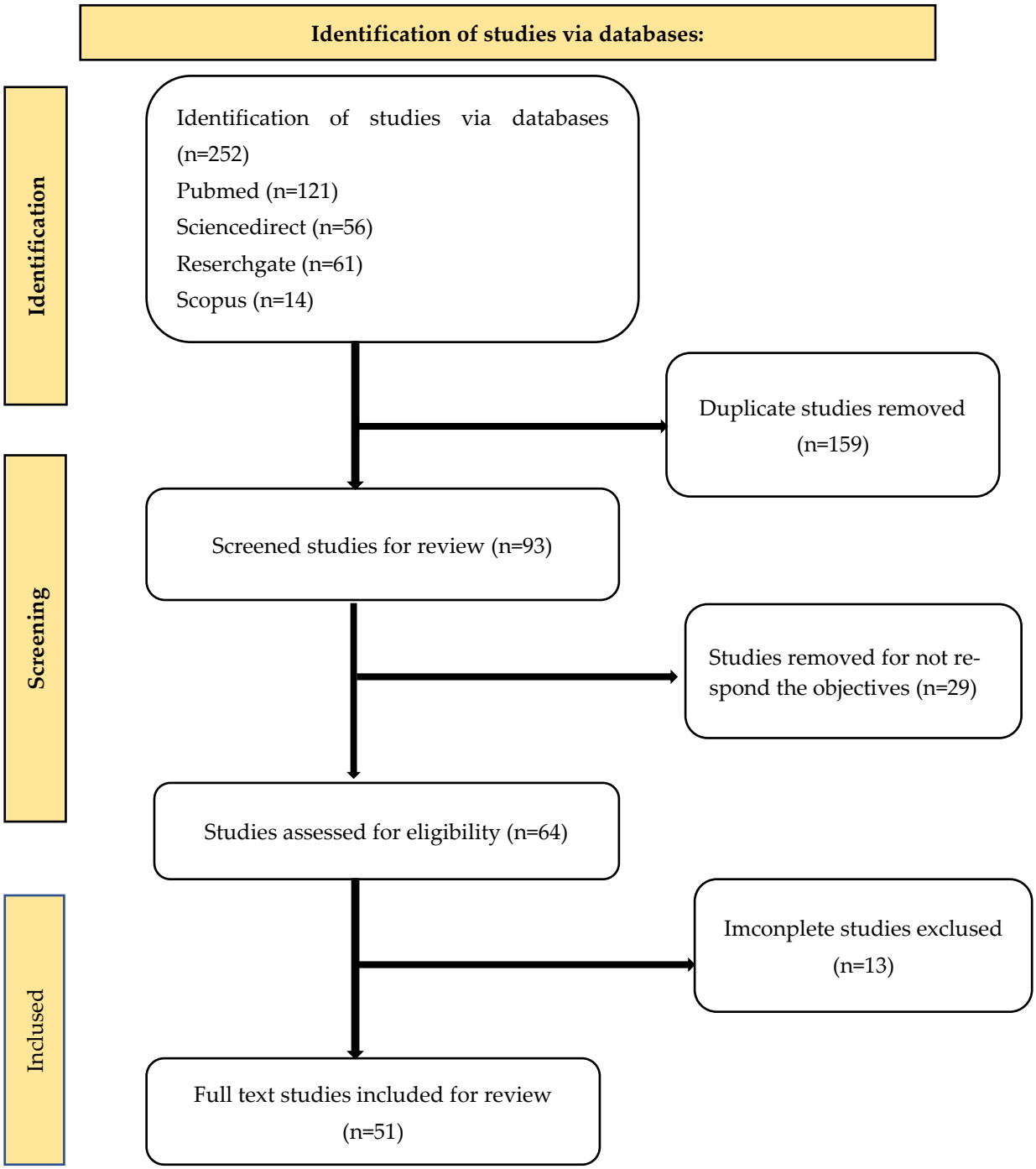


Figure 3. Flowchart for selecting studies included in review.

3. Results and Discussion

Euclea natalensis and *Euclea divinorum* are used for the treatment of intestinal parasitic infections and their symptoms in at least eight Southern African countries. Beyond sharing a similar typical ecosystem—the Miombo woodland—and despite climatic variations,

this region also exhibits cultural similarities, as its ethnolinguistic groups all originate from the Bantu lineage.

3.1. Ethnopharmacological Use of Euclea natalensis and Euclea divinorum in the Treatment of Intestinal Parasitic Infections

Several studies have highlighted the use of both *Euclea divinorum* and *Euclea natalensis* in traditional medicine across Southern Africa, including Mozambique, for the treatment of intestinal parasitic infections. The roots and root bark are the most commonly used plant parts in these treatments (Table 1).

Table 1. Traditional use of *Euclea divinorum* and *Euclea natalensis* for the treatment of intestinal parasitic infections. Data sourced from [16,20,26–30].

Species	Disease/Medical Condition	Plant Part Used	Preparation Method	Country/Ethnic Group	Reference
Euclea natalensis	Hookworm infection	Root	Carbonization	Changana people (Mozambique)	[26]
Euclea natalensis	Helminthiasis, Schistosomiasis	Root	Decoction Carbonization	Mozambique, Kenya, Zimbabwe, Malawi, South Africa, Eswatini (Swaziland), Tanzania, Ethiopia	[20]
Euclea divinorum Euclea natalensis	Schistosomiasis	Root Root bark	Not mentioned	Southern Africa	[27]
Euclea natalensis associated with *Carissa spinarum* L., *Harrisonia abyssinica* Oliv., and *Ximenia caffra* Sond	Amoebic dysentery	Root	Infusion	Tanzania	[20]
Euclea divinorum	Diarrhea Gastrointestinal disorder	Root Root bark	Not mentioned	Not mentioned	[28]
Euclea divinorum	Intestinal worms	Root	Decoction	Kenya Mozambique	[16,29]
Euclea divinorum	Intestinal disturbances and pain	Fruits Flowers	Chewing	Kenya	[29]
Euclea divinorum	Amoebiasis, Tapeworm, Helminthiasis	Leaves Fruits	Not reported	South Africa Ethiopia	[30]

The predominant use of roots relative to other botanical structures in the traditional medicine of these African nations suggests a high concentration of bioactive compounds with antiparasitic potential. This preference may also be attributed to the inherent stability of root tissues, which maintain their phytochemical integrity when dried, thus facilitating long-term preservation.

According to conservation data from the International Union for Conservation of Nature (IUCN) and the South African National Biodiversity Institute (SANBI), *Euclea divinorum* is classified as a species of least concern, both regionally and globally [14]. This indicates that the harvesting of these species for medicinal use has no significant impact.

3.2. Phytochemistry of Euclea natalensis and Euclea divinorum

Several studies have been conducted to isolate and identify the phytochemical constituents of *Euclea divinorum* and *Euclea natalensis*. The root has been the primary focus of phytochemical investigations, as it is the most commonly used plant part in traditional medicine, not only for the treatment of intestinal parasitic infections but also for many other ailments associated with these species.

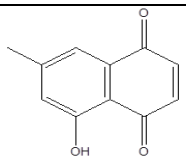
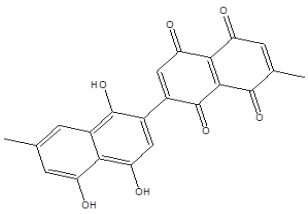
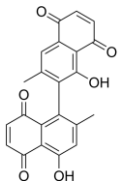
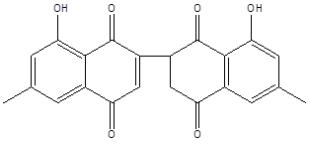
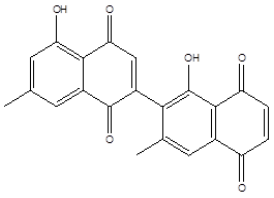
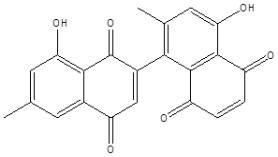
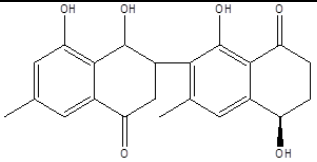
Phytochemical analyses have revealed the presence of alkaloids, terpenoids, flavonoids, tannins, and saponins in the roots of *Euclea divinorum* [8,31–34]. Meanwhile, the roots of *Euclea natalensis* have been found to contain various pentacyclic triterpenes and naphthoquinones [20,35]. Naphthoquinones are the most prominent phytochemicals in both species, as well as in other Euclea species, with the root and root bark serving as their primary sources [5,31].

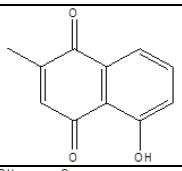
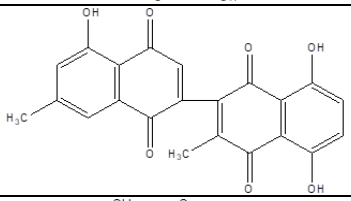
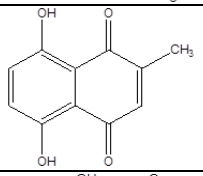
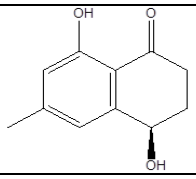
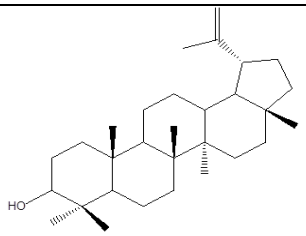
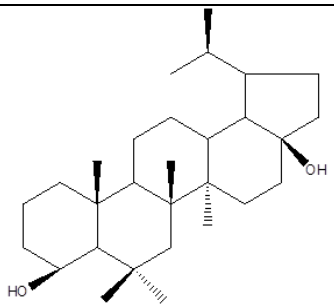
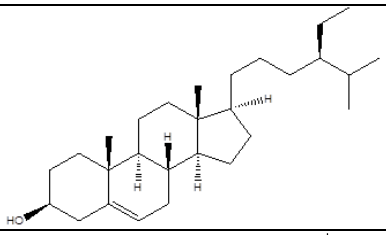
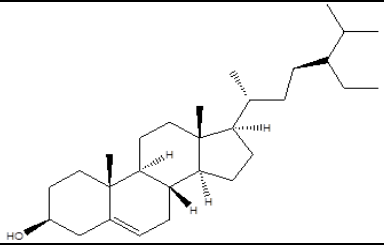
From the root bark of *Euclea natalensis*, several naphthoquinones have been isolated and identified, including octahydroeuclein [19,36]; 4,8-dihydroxy-6-methyl-1-tetralone (plumbagin) [7]; diospirin [34,37,38]; neodiospyrin [37,38]; 8-hydroxydiospyrin, euclanone, galpinone, and methylnaphthazarine [37]; isodiospyrin and mamegaquinone [32,38,39]; 7-methyljuglone, galpinone, natalenone [32,35,37,38,40]; and shinanalone [10,23,41]. Additionally, from the roots of *Euclea natalensis*, naphthoquinones such as 7-methyljuglone, diospirin, methylnaphthazarine, isodiospyrin, and neodiospyrin have also been isolated [10,37,42,43]. The pentacyclic terpenoids identified in the root bark of this species include octahydroeuclein [19]; 20(29)-lupen-3β-isoferulate; betulin [19,36,41]; lupeol [19,32,41]; and β-sitosterol [19,36] (Table 2).

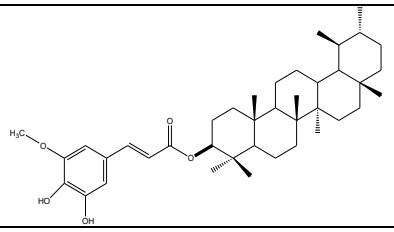
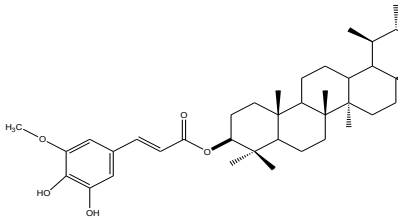
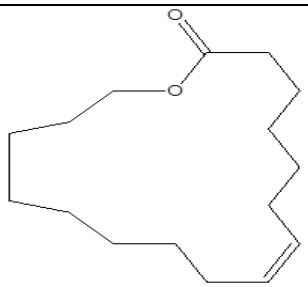
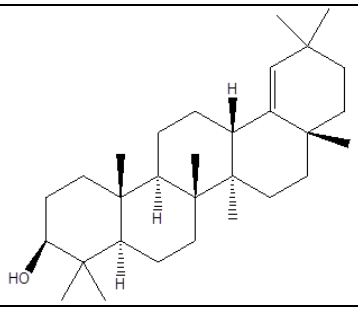
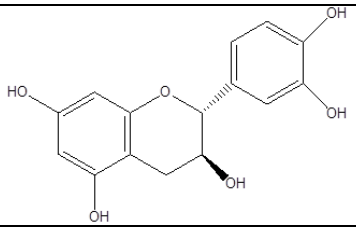
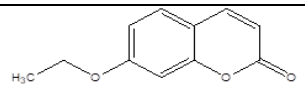
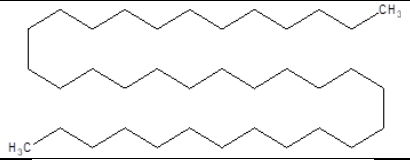
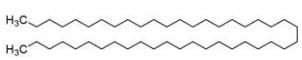
Phytochemical screening of *Euclea divinorum* has revealed the presence of several naphthoquinones in the root bark, including 7-methyljuglone, isodiospyrin, shinanalone [6,44], mamegaquinone [44], and germanicol [45]. Additionally, 7-methyljuglone and diospirin have also been identified in the root [46]. Other naphthoquinones found in the roots include 2-methylnaphthazarine and diosindigo A [44,47], as well as 7-methyljuglone and diospirin [47]. The triterpenoids isolated and identified in the roots include lupeol, betulin, and 3β-(5-hydroxyferuloyl)-lup-20(30)-ene [6,44], along with shinalene [44]. Additionally, the triterpenes γ-sitosterol and oxacycloheptadeco-8-en-2-one have been isolated from the roots [45], as well as the flavonoid catechin [6,44] (Table 2).

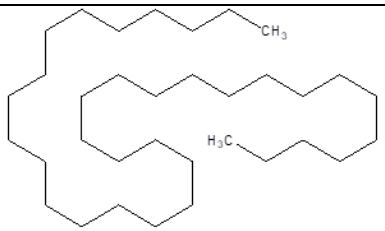
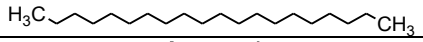
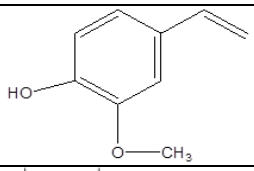
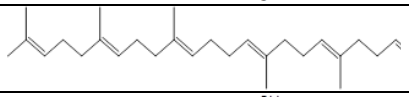
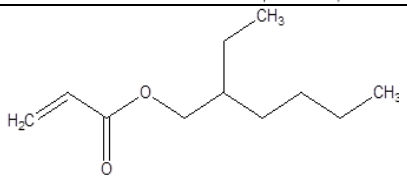
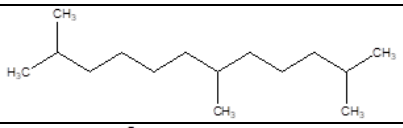
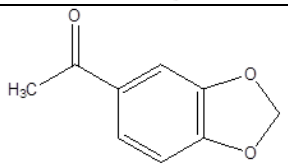
Mbabazi [28] investigated the phytochemical composition of ethanolic, hexanolic, and dichloromethane extracts from different plant parts of *Euclea divinorum*, identifying the presence of various classes of phytochemicals. In the ethanolic extracts, flavonoids, phenols, saponins, tannins, and terpenes were detected. The hexanolic extracts contained alkaloids, cardiac glycosides, quinones, and steroids, with quinones also identified in the dichloromethane extracts [28]. Additionally, in the hexanolic extracts from root bark, the following compounds were identified and quantified: 1,4-naphthoquinone (13.34%), 7-ethoxycoumarin (0.73%), eicosane (3.71%), hexatriacontane (70.91%), tetratetracontane (4.96%), tetratriacontane (4.37%), 4-vinylguaiacol (0.78%), and squalene (0.94%) [28] (Table 2).

Table 2. Phytochemicals identified in *Euclea divinorum* and *Euclea natalensis.* Data are extracted from the studies cited in the table.

No	Chemical Compound	Species	Plant Part	Formula	Structure	References
			Naphthoquinones			
1	7-Methyljuglone	*E. natalensis*	RB	$C_{11}H_8O_3$		[32,35,37,38,40]
		E. natalensis	R			[42,48,49,50, 51,46]
		E. divinorum	R			[44,47,51]
		E. divinorum	RB			[6,44]
2	Euclanone	*E. natalensis*	RB	$C_{22}H_{14}O_7$		[37]
3	Isodiospyrin	*E. natalensis*	RB	$C_{22}H_{14}O_6$		[32,38,39]
		E. divinorum	R			[6,44,47]
		E. natalensis	R			[42,48,49,50]
		E. divinorum	R			[42,46]
4	Mamegaquinone	*E. divinorum*	RB	$C_{22}H_{14}O_6$		[43]
		E. natalensis	RB			[32,37,38]
		E. natalensis	R			[42]
5	Diospyrin	*E. Natalensis*	RB	$C_{22}H_{14}O_6$		[35,37,38]
		E. Natalensis	R			[42,43,48–50]
		E. divinorum	R			[44,47]
6	Neodiospyrin	*E. natalensis*	RB	$C_{22}H_{14}O_6$		[37,44]
		E. natalensis	R			[42,48–50]
7	Octahydroeuclein	*E. natalensis*	RB	$N_{16}H_{24}N_2O_2$		[19,36]

8	Plumbagin	*E. natalensis*	RB	$C_{11}H_8O_3$		[7]
9	8-Hydroxydiospyrin	*E. natalensis*	RB	$C_{22}H_{14}O_7$		[39]
10	Methylnaphthazarin	*E. natalensis* *E. divinorum*	RB R	$C_{11}H_8O_4$		[39,47]
11	Shinanalone	*E.natalensis* *E. divinorum*	RB RB	$C_{11}H_{12}O_3$		[36,42,52]
			Pentacyclic terpenes			
12	Lupeol	*E. natalensis*	RB	$C_{30}H_{50}O$		[19,32,36,40,41]
		E. divinorum *E. divinorum*	R RB			[6,41,44] [41]
13	Betulin	*E. divinorum*	R	$CH_{30}H_{50}O_2$		[6,19,44]
		E. natalensis *E. natalensis*	RB R			[19,36,41] [41]
14	β-Sitosterol	*E. natalensis*	RB	$C_{29}H_{50}O$		[19,31]
15	γ-Sitosterol	*E. divinorum*	R	$C_{50}H_{50}O$		[45]

16	20(29)-Lupen-3β- isoferulate	*E. natalensis*	RB	$C_{36}H_{52}O_4$		[19,36]
17	3β-(5-Hydroxyferuloyl)-lup-20(30)-ene	*E. divinorum*	RB	$C_{40}H_{58}O_4$		[6,44]
18	Oxacyclohepdec-8-en-2-one	*E. natalensis*	R	$C_{16}H_{28}O_2$		[45]
19	Germanicol	*E. divinorum*	RB	$C_{30}H_{50}O$		[45]
			Flavonoid			
20	Catechin	*E. divinorum*	R	$C_{15}H_{14}O_6$		[6,44]
			Other compounds			
21	7-Ethoxycoumarin	*E. divinorum*	RB	$C_{11}H_{10}O_3$		[28]
22	Hexatriacontane	*E. divinorum*	RB	$C_{36}H_{74}$		[28]
23	Tetratetracontane	*E. divinorum*	RB			[28]

24	Tetratriacontane	*E. divinorum*	RB	$C_{34}H_{70}$		[28]
25	Eicosane	*E. divinorum*	RB	$C_{20}H_{42}$		[28]
26	4-Vinylguaiacol	*E. divinorum*	RB	$C_9H_{10}O_2$		[28]
27	Squalene	*E. divinorum*	RB	$C_{30}H_{50}$		[28]
28	2-Ethylhexyl acrylate	*E. divinorum*	RB	$C_{11}H_{20}O_2$		[28]
29	2,6,11-Trimethyldodecane	*E. divinorum*	RB	$C_{15}H_{32}$		[28]
30	3,4-Methylenedioxybenzyl acetone	*E. divinorum*	RB	$C_{10}H_{10}O_4$		[28]

R = root; RB = root bark.

3.3. Antiparasitic Bioactivity for Intestinal Parasitic Infections

Studies on bioactivity often contribute to validating the ethnobotanical uses of medicinal plants in traditional medicine. Confirming the bioactivity of medicinal species enhances the credibility of their therapeutic potential and healing properties. Investigations into the antiparasitic bioactivity of *Euclea divinorum* and *Euclea natalensis* have demonstrated both antimicrobial and anthelmintic activity, supporting their traditional use in the treatment of intestinal parasitic infections (Table 3).

Table 3. Bioactivity of *Euclea divinorum* and *Euclea natalensis* for intestinal parasitic infections. Data sourced from [5,26,27,31,32,51,53,54].

Species	Pharmacological Property	Bioactivity (Antiparasitic)	Observations	References
E. natalensis	Antidiarrheal (dysentery)	Antibacterial activity against *Shigella dysenteriae*	The naphthoquinones 7-methyljuglone and mamegaquinone present in *E. natalensis* are effective against *Shigella dysenteriae*	[5]
E. divinorum	Antimicrobial activity	Ethanolic root extracts showed antimicrobial activity against *E. coli*	Bioactivity observed using the agar diffusion test	[34]
		Ethyl acetate root extracts were effective in inhibiting *E. coli*	Inhibition zone of 17 mm	[31]
E. natalensis	Anthelmintic (schistosomiasis)	Aqueous root extracts showed 100% lethality at 50 mg/mL, 25 mg/mL, 12.5 mg/mL, and 6.25 mg/mL	Minimum lethality was 67% at 3.13 mg/mL	[27]
E. divinorum	Anthelmintic (schistosomiasis)	Aqueous root bark extracts showed 100% lethality at 50 mg/mL, 25 mg/mL, 12.5 mg/mL, and 6.25 mg/mL	Minimum lethality was 67% at 25 mg/mL	[27]
	Antibacterial activity	Methanolic, hexanolic, and acetone root extracts exhibited antimicrobial potency against *E. coli*	The agar disk diffusion test was used to evaluate bioactivity, with acetone extract showing the highest inhibition zone	[43]
E. natalensis	Antibacterial activity	Inhibition of *E. coli* growth was observed with acetonic root extracts at a MIC of 5 mg/mL	The experiment was also performed with aqueous extract, but no inhibition was observed	[26]
		Antimicrobial bioactivity of *E. natalensis* extracts against *Entamoeba histolytica*	Root extracts of *E. natalensis* showed high bioactivity when mixed with root extracts of *Harrisonia abyssinica*, *Carissa edulis*, and *Ximenia caffra*	[53]
E. divinorum	Antimicrobial activity	Aqueous, ethyl acetate, and petroleum root extracts of *E. divinorum* exhibited inhibitory activity against *E. coli*, with MIC values of 25 mg/mL for aqueous extracts and 6.25 mg/mL for petroleum extracts	Bioactivity was linked to the presence of alkaloids and terpenoids in the plant	[45]
		Bioactivity observed in hexane, methanol, and acetone extracts against *E. coli*, with hexane extract showing the	Agar disk diffusion method used	[43]

	highest antimicrobial capacity

3.3.1. Antimicrobial Activity of *Euclea divinorum* and *Euclea natalensis* Against Intestinal Parasites

Kilonzo et al. [45] investigated the in vitro antimicrobial activity of *Euclea divinorum*, traditionally used in Tanzania, through ethyl acetate, petroleum, and aqueous extracts. All three extracts exhibited antimicrobial activity against *Escherichia coli*. The presence of alkaloids and terpenoids in this plant contributes to its antibacterial properties. Taye et al. [5] confirmed that the naphthoquinones 7-methyljuglone and mamegaquinone, present in species of the *Euclea* genus, are effective against *Shigella dysenteriae*, a major causative agent of diarrhea worldwide. Kipkorir et al. [43] evaluated in vitro the antimicrobial activity of methanol, hexane, and acetone extracts from the roots, leaves, and stem bark of *Euclea divinorum* using the agar disk diffusion method. The results demonstrated bioactivity against *E. coli*, with the hexane extract exhibiting the highest antimicrobial potential. To validate its gastrointestinal use in African traditional medicine, Johns et al. [54] tested in vitro methanolic extracts from various medicinal plants used as gastrointestinal remedies, including *Euclea divinorum*. They observed that methanolic extracts from the roots and root bark of *Euclea divinorum* did not cause mortality or inhibit the growth of *Giardia lamblia* trophozoites at concentrations of 500 ppm and 1000 ppm.

Lall & Mayer [7] investigated the in vitro antibacterial activity of water and acetone extracts from *Euclea natalensis* A.DC. roots, observing inhibition of *E. coli* growth with acetone extracts at a minimum inhibitory concentration (MIC) of 0.5 mg/mL. Otieno [53] evaluated in vitro multi-plant extracts from the Lake Victoria region in Tanzania and observed antimicrobial bioactivity of *Euclea natalensis* extracts in combination with *Harrisonia abyssinica*, *Carissa edulis*, and *Ximenia caffra* extracts against *Entamoeba histolytica*.

3.3.2. Anthelmintic Activity of *Euclea natalensis* and *Euclea divinorum* Against Intestinal Parasites

Sparg [27] evaluated the efficacy of aqueous extracts from 21 plant species collected in KwaZulu-Natal, which had been reported in various scientific articles as traditionally used in African medicine for the treatment of schistosomiasis. The study found that aqueous root extracts of *Euclea natalensis* were 100% lethal to schistosomula at concentrations of 50 mg/mL, 25 mg/mL, 12.5 mg/mL, and 6.25 mg/mL. At a lower concentration of 3.13 mg/mL, the extracts exhibited reduced lethality, with a mortality rate of 66.7%. These extracts demonstrated high bioactivity against schistosomula. The same study also reported 100% mortality of schistosomula when exposed to aqueous extracts of *Euclea divinorum*, with a minimum lethal concentration of 25 mg/mL [27]. The confirmation of the efficacy of these two species, particularly *Euclea natalensis*, against schistosomula represents a significant contribution to the recognition and validation of traditional knowledge regarding the use of these species in the treatment of intestinal parasitic infections.

4. Conclusions

Studies indicate that the roots and root bark of *Euclea natalensis* and *Euclea divinorum* are the primary plant parts used in African traditional medicine for the treatment of intestinal parasitic infections. This traditional knowledge is further supported by research on the bioactivity of these species. Ethnopharmacological evidence suggests that these species are used for the treatment of dysentery, hookworm infection, tapeworm infection, schistosomiasis, and diarrhea. The bioactivity studies reviewed in this research confirm that root extracts from these species exhibit bioactivity against *Entamoeba histolytica*,

Schistosoma spp., *Shigella dysenteriae*, and *Escherichia coli*. These findings validate the traditional use of *Euclea* roots in the treatment of intestinal parasitic infections.

Regarding bioactivity against giardiasis, no effect was observed. According to the study conducted by Johns on *Euclea natalensis* and *Euclea divinorum*, neither mortality nor growth inhibition of *Giardia lamblia* trophozoites was recorded, failing to confirm the bioactivity of these plants against giardiasis. However, among the bioactive compounds present in these two *Euclea* species, naphthoquinones and pentacyclic triterpenes are involved in the phytotherapy of intestinal parasitic infections. These compounds are predominantly extracted from the roots, further validating the traditional knowledge of different communities regarding the use of *Euclea divinorum* and *Euclea natalensis* in treating intestinal parasitic infections, particularly diarrhea caused by infectious agents. Therefore, further research is needed to explore the bioactivity of isolated compounds from *Euclea natalensis* and *Euclea divinorum* against intestinal parasites. Additionally, more experimental studies should focus on helminths and other worms associated with intestinal parasitic infections.

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