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Helichrysum kraussii Sch.Bip.: Review on its medicinal uses, phytochemistry and pharmacological properties

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Abstract

Helichrysum kraussii Sch.Bip. is a woody shrub that naturally occurs in grasslands and woodlands in South-Central Africa. The various parts of *H. kraussii* serve as components used in traditional medicines within the South Central Africa region. This review provides an overview of the existing literature on the medicinal uses, phytochemical composition, and pharmacological properties of *H. kraussii.* The study reveals that various parts of the plant, including branches, flowers, leaves, roots, seeds, twigs, and whole plant parts, are used in ritual practices and traditional medicine to treat a range of human ailments. These include venereal diseases, nasal congestion, chest pain, skin infections, tuberculosis, respiratory infections, and cough. Phytochemical analysis of *H. kraussii* demonstrates the presence of acylated flavonol glucoside, diterpenes, flavonoids, phloroglucinol, and terpenoids. The pharmacological assessments indicate that crude extracts and isolated phytochemical compounds from this species possess antioxidant, antibacterial, antifungal, antiviral, cytotoxic, and anti-inflammatory activities. This mini review underscores the traditional uses, phytochemical composition, and pharmacological properties of *H. kraussii*. Based on the findings, it is recommended to conduct comprehensive ethno pharmacological evaluations of *H. kraussii*, focusing on phytochemistry, pharmacological properties, toxicological assessments, as well as in vivo and clinical research.

Keywords

Asteraceae, Compositae, *Helichrysum kraussii, materia medica*, traditional medicine

Introduction

Helichrysum kraussii Sch.Bip. (Fig. 1) is a well-known plant species in South Central Africa, widely used for its traditional medicinal properties (1-3). It is a perennial shrub belonging to the Asteraceae family. The genus name Helichrysum Mill. originates from the Greek words "helios" meaning "sun" and "chryson" meaning "gold," referring to the characteristic "golden flowers" of this genus (3). The species name "kraussii" is a tribute to Christian Ferdinand Friedrich Krauss, a German traveler, scientist, and plant collector who explored the Cape and Natal regions in South Africa during the 19th century (3). *H. kraussii* is also known by several synonyms, including *H. steetzii* O.Hoffm., *Achyrocline batocana* Oliv. & Hiern., *A. steetzii* (Vatke) O.Hoffm., and *Gnaphalium kraussii* (Sch.Bip.) Sch.Bip. (4, 5). This plant species is naturally found in grasslands and woodlands in South Central Africa (Fig. 2). While considered invasive in most rangelands in Zimbabwe, *H. kraussii* is listed as a weed in South Africa, primarily spread by humans due to its ornamental value (6-8). The local population in South Central Africa has acquired indigenous knowledge and skills to utilize the medicinal properties of *H. kraussii*. Medicinal plants, their extracts, and active components derived from them play a crucial role in traditional therapy (9). Therefore, it is essential to understand the phytochemical composition of *H. kraussii*, as these active compounds directly or indirectly contribute to disease prevention, treatment, and overall health maintenance. Hence, this review aims to gather and summarize information on the medicinal uses, phytochemistry, and pharmacological properties of *H. kraussii*.

Figure 1. *Helichrysum kraussii* showing the habit of the species (Photo: BT Wursten)

Figure 2. Distribution of *Helichrysum kraussii* in south central Africa(https://www.gbif.org/occurrence/map?taxon_key=3131274)

A literature search was conducted to explore the medicinal uses, phytochemistry, and pharmacological properties of *Helichrysum kraussii* across its distributional range in south -central Africa. Various online databases, including Scopus, JSTOR, Google Scholar, PubMed, and Science Direct, were utilized (refer to Table 1). Additionally, traditional sources like books, journal articles, dissertations, book chapters, theses, and scientific articles from the University library were consulted. To facilitate the search, keywords such as "*Helichrysum kraussii*," "biological activities of *Helichrysum kraussii*," "pharmacological properties of *Helichrysum kraussii*," "ethnobotany of *Helichrysum kraussii*," "medicinal uses of *Helichrysum kraussii*," "phytochemistry of *Helichrysum kraussii*," and "traditional uses of *Helichrysum kraussii*" were employed. The chemical structures of phytochemical compounds isolated from *H. kraussii* were depicted using the ChemSketch program. Only literature sources that evaluated the medicinal uses, phytochemistry, pharmacological, or biological activities of *H. kraussii* were included in this review. Excluded from this review were articles that were only partially accessed, such as abstracts, as well as published or unpublished ethnopharmacological surveys lacking information on the medicinal uses, phytochemistry, pharmacological, or biological activities of *H. kraussii*.

Table 1. Website links for all databases used in this study

Name of database	Website link
Google Scholar	http://scholar.google.com
JSTOR	https://www.jstor.org
PubMed	http://www.ncbi.nlm.nih.gov/PubMed
Science Direct	http://www.science direct.com
Scopus	http://scopus.com

Habitat and morphology

Helichrysum kraussii, a woody shrub, reaches a maximum height of 1.5 meters (4, 10). Its sturdy stems branch repeatedly (Fig. 1), displaying a brownish color. The stems are finely woolly, becoming less hairy with age, and are adorned with leaves. The leaves of *H. kraussii* are linear and positioned along the smaller branches. They spread out, resembling narrow needles, and have a smooth underside while being woolly and white on the upper surface. The leaves are sessile, with slightly rolled-under margins, a sharply pointed apex, and occasional fluffy galls on the branchlets. The cylindrical capitula, arranged in a corymbose manner, occur at the tips of the branches. The flowers of *H. kraussii* form dense terminal heads and exhibit pale yellow to straw-colored hues. This species is documented in Angola, Botswana, Eswatini, Malawi, Mozambique, South Africa, Zambia, and Zimbabwe (5, 10) within altitudes ranging from 5 to 1850 meters above sea level (5, 10). It is found in submontane grasslands, escarpment woodlands, rocky ridges on the highveld, as well as on poor soils and overgrazed land.

Ethnobotanical and ethno pharmacological uses

Helichrysum kraussii is mentioned in the monograph "Medicinal and magical plants of southern Africa: An annotated checklist" (11). It is also sold in informal herbal medicine markets in South Africa's Limpopo province (12-14) and is highly valued as a traditional medicine source. KwaZulu-Natal diviners in South Africa burn *H. kraussii* as incense (15, 16), and religious beliefs have ensured its careful harvesting to preserve the species. Additionally, the woolly stems of *H. kraussii* are used for making twig brooms in South Africa (17). Brooms are widely traded and commonly purchased by rural households instead of being made at home (17).

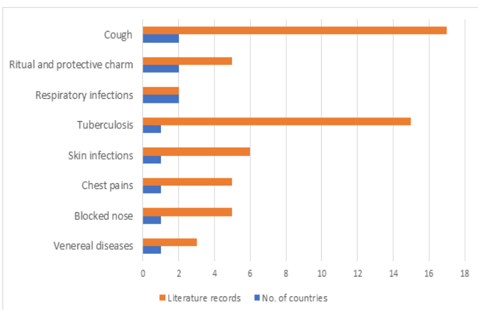
H. kraussii is used for traditional medicines in Eswatini, Malawi, Mozambique, South Africa, and Zimbabwe, accounting for 62.5% of the countries where the species is native (Table 2). The plant parts, including branches, flowers, leaves, roots, seeds, twigs, and whole plants, are used to treat and manage 14 human diseases and ailments in southern Africa. Crude extracts of *H. kraussii* are primarily used to treat venereal diseases, as indicated by a single country record and three literature sources. Other common uses include treating blocked nose and chest pains (one country record and five literature records), skin infections (one country record and six literature records), tuberculosis (one country record and 15 literature records), respiratory infections (two country records and two literature records), and as ritual and protective charms (two country records and five literature records). It is also used to alleviate coughs (two country records and 17 literature records) (Fig. 3).

H. kraussii has additional medicinal applications, such as being used as an intoxicant and pesticide, and for treating fever, headache, and temporary blindness (18-20). In combination with the leaves of *Warburgia salutaris* (G. Bertol.) Chiov., the leaves of *H. kraussii* are used as traditional medicine for asthma when taken orally as a decoction (21). When combined with the branches of *Lippia javanica* (Burm.f.) Spreng. and the leaves of *Trichilia emetica* Vahl, the branches of *H. kraussii* are used as a decoction to alleviate blocked nose, chest pains, and cough (22-26). In Zimbabwe, the roots or whole plant parts of *H. kraussii* are burned, mixed with salt, and taken orally as traditional medicine for coughs (1, 27). While the practice of combining *H. kraussii* with other medicinal plants is common in south-central Africa, research on Chinese herbal medicines has shown that multi-herbal and/or drug-herbal combinations do not necessarily lead to synergistic effects (28).

Table 2. Medicinal uses of *Helichrysum kraussii*

Region	Plant part	Mode of preparation	Pharmacological action or traditional uses	Reference
South Africa	Leaves	Leaves mixed with those of *Warburgia salutaris* (G. Bertol.) Chiov. and decoction taken orally	Asthma	(21)
South Africa	Leaves	Leaf smoke inhaled	Blocked nose	(24, 29, 30)
South Africa	Branches	Branches mixed with *Lippia javanica* (Burm.f.) Spreng. and *Trichilia emetica* Vahl leaves and decoction taken orally	Blocked nose	(23, 26)
South Africa	Branches	Branches mixed with *Lippia javanica* and *Trichilia emetica* leaves and decoction taken orally	Chest pains	(23, 26)
South Africa	Leaves	Leaf decoction taken orally	Chest pains	(24, 29, 30)
South Africa	Branches	Branches mixed with *Lippia javanica* and *Trichilia emetica* leaves and decoction taken orally	Cough	(22-26)
Zimbabwe	Roots and whole plant	Roots or whole plant burnt and salt added to the ashes and the mixture taken orally	Cough	(1, 27)
South Africa	Flowers, leaves and seeds	Flower, leaf and seed infusion taken orally	Cough	(22-24, 29-37)
Mozambique	Leaves	Leaf infusion taken orally	Fever	(20)
South Africa	Whole plant	Whole plant decoction taken orally	Headache	(19)
Mozambique	Leaves	Leaves burnt and smoke inhaled	Intoxicant	(20)
Eswatini	Leaves and twigs	Leaves and twigs used	Pesticide	(18)
South Africa and Zimbabwe	Leaves	Leaf infusion taken orally	Respiratory infections	(27, 38)
South Africa	Leaves and twigs	Leaves and twigs used	Ritual and protective charm	(11, 16, 33)
South Africa	Leaves	Leaf decoction applied topically	Skin infections	(22, 24, 33, 36, 37, 39)
Mozambique	Leaves	Leaf decoction applied topically	Temporary blindness	(20)
Malawi	Leaves and roots	Body washed with infusion of leaves and roots	To drive away bad spirits	(1, 22, 33)
South Africa	Flowers, leaves, seeds and whole plant	Flower, leaf, seed and whole plant decoction taken orally	Tuberculosis	(22, 24, 29, 31-33, 35, 36, 40-46)
South Africa	Roots	Root decoction taken orally	Venereal diseases	(36, 47, 48)

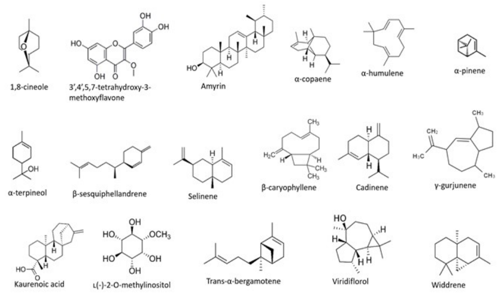
Figure 3. Main diseases and ailments treated and managed by *Helichrysum kraussii* in south tropical Africa



Phytochemical constituents of *Helichrysum kraussii*

Chemical compounds from the aerial parts, flowers, and leaves of *H. kraussii* have been identified by various researchers (Fig. 4; Table 3). These compounds include flavonoids, kaurenoic acid, prenyl-butyrylphloroglucinol, and terpenoids (31, 35, 40, 49-51). Terpenoids and essential oils have pharmacological effects on both transmissible and non-transmissible diseases. Their antimicrobial, anti-inflammatory, anticancer, antispasmodic, and antidiabetic properties are well-documented (52, 53). Similarly, flavonoid compounds have potential medicinal applications due to their anticancer, antibacterial, antioxidant, skin protective, anti-inflammatory, cardio-protective, antiviral, and neuroprotective effects (54, 55).

Figure 4. Chemical structures of acylated flavonol glucosides, diterpene, flavonoids and terpenoids isolated from *Helichrysum kraussii*



Biological activities of *Helichrysum kraussii*

Antibacterial activity

Table 4 presents the antibacterial properties of various extracts and compounds derived from *H. kraussii*. Kaurenoic acid, α-amyrin, β-amyrin, and essential oils obtained from *H. kraussii* demonstrated antibacterial effects (31, 40, 51, 56). The acetone extracts derived from the aerial parts of *H. kraussii* displayed antibacterial activity (32). Antibacterial activities were observed in the chloroform: methanol extracts of *H. kraussii* leaves and stems (34). The ethanol extracts of *H. kraussii* flowers, leaves, and stems exhibited antibacterial properties (39). Moreover, water extracts from the leaves and stems of *H. kraussii* also showed antibacterial activity (56).

Antifungal activities

Table 5 presents the antifungal activities of various extracts and essential oils obtained from *H. kraussii.* The essential oils derived from the leaves and stems of *H. kraussii* demonstrated antifungal effects (56). Antifungal activities were also observed in the acetone extracts of the aerial parts of *H. kraussii* (32), as well as in the dichloromethane:methanol and aqueous extracts from the leaves and stems of the plant species (56).

Table 3. Phytochemical composition of *Helichrysum kraussii*

Type of compound	Name of the compound	Plant part from where extracted/ identified/ documented	Process of detection/ isolation/extraction	Reference
Flavonoid	3',4',5,7-tetrahydroxy-3-methoxyflavone	Flowers	GC-MS	35, 49, 50
Flavonoid	5,6-dihydroxy-3,7,8-trimethoxyflavone	Flowers	GC-MS	35
Flavonoid	5,7-dihydroxy-3-methoxyflavone	Flowers	GC-MS	35
Diterpene	Kaurenoic acid	Aerial parts	GC-MS	31
Phloroglucinol	Prenyl-butyrylphloroglucinol	Aerial parts	H-and C-NMR and El-MS	31
Acylated flavonol glucoside	3,5-dihydroxy-6,7,8-trimethoxyflavone	Flowers	H-and C-NMR and El-MS	49, 50
Acylated flavonol glucoside	Helichrysoside	Flowers	H-and C-NMR and El-MS	49, 50
Acylated flavonol glucoside	L(-)-2-O-methylinositol	Flowers	H-and C-NMR and El-MS	49, 50
Acylated flavonol glucoside	Quercetin-3β-⊠-(Þ-coumaroyl)glucoside	Flowers	H-and C-NMR and El-MS	49
Monoterpene	1,8-Cineole	Aerial parts	GC and GC-MS	51
Monoterpene	α-Pinene	Aerial parts	GC and GC-MS	51
Monoterpene	α-Terpineol	Aerial parts	GC and GC-MS	51
Triterpene	α- and β-Amyrin	Leaves	H-and C-NMR and GC-MS	40
Bicyclic sesquiterpene	Trans-α-Bergamotene	Aerial parts	GC and GC-MS	51
Bicyclic sesquiterpene	δ- and ⊠-Cadinene	Aerial parts	GC and GC-MS	51
Bicyclic sesquiterpene	β-Caryophyllene	Aerial parts	GC and GC-MS	51
Bicyclic sesquiterpene	β-Caryophyllene oxide	Aerial parts	GC and GC-MS	51
Bicyclic sesquiterpene	α- and β-Selinene	Aerial parts	GC and GC-MS	51
Monocyclic sesquiterpene	α-Humulene	Aerial parts	GC and GC-MS	51
Tricyclic sesquiterpene	α-Copaene	Aerial parts	GC and GC-MS	51
Tricyclic sesquiterpene	⊠-Gurjunene	Aerial parts	GC and GC-MS	51
Tricyclic sesquiterpene	β-Sesquiphellandrene	Aerial parts	GC and GC-MS	51
Tricyclic sesquiterpene	Viridiflorol	Aerial parts	GC and GC-MS	51
Tricyclic sesquiterpene	Widdrene	Aerial parts	GC and GC-MS	51

Table 4. Summary of antibacterial activities of the extracts and compounds isolated from different parts of *Helichrysum kraussii*

Extract/ compound	Plant part	Model	Effect	Reference
Kaurenoic acid	Aerial parts	Agar diffusion	Showed activities against *Escherichia coli* with minimum inhibitory concentration (MIC) value of 1.0 µg/ml) and MIC value of 10.0 µg/ml) against *Bacillus cereus, Bacillus subtilis, Staphylococcus aureus* and *Serratia marcescens*	31
Acetone	Aerial parts	Agar diffusion	Showed activities against *Bacillus subtilis, Bacillus cereus, Pseudomonas aeruginosa, Bacillus pumilus, Micrococcus kristinae* and *Staphylococus aureus* with MIC value of 1.0 mg/ml	32
Essential oils	Aerial parts	Dilution technique	Showed activities against *Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Enterobacter cloacae, Pseudomonas aeruginosa* and *Staphylococcus epidermidis* with MIC values ranging from 0.073 mg/ml to >20.000 mg/ml	51
Terpenoids	Leaves	TLC bioautography	Terpenoids α-amyrin and β-amyrin exhibited activities against *Bacillus cereus*	40
Chloroform : methanol	Leaves and stems	Microdilution technique	Showed activities against *Staphylococcus aureus, Staphylococcus epidermidis, Klebsiella pneumoniae* and Bacillus cereus with MIC values ranging from 0.004 mg/ml to 4.0 mg/ml	34
Dichlorometha ne : methanol	Leaves and stems	Micro-dilution	Exhibited activities against *Staphylococcus aureus, Klebsiella pneumoniae*, *Mycobacterium smegmatis* and *Moraxella catarrhalis* with MIC values ranging from 1.3 mg/mL to 4.0 mg/mL	56
Aqueous	Leaves and stems	Micro-dilution	Exhibited activities against *Staphylococcus aureus, Klebsiella pneumoniae*, *Mycobacterium smegmatis* and *Moraxella catarrhalis* with MIC values ranging from 2.67 mg/mL to 13.33 mg/mL	56
Essential oils	Leaves and stems	Micro-dilution	Exhibited activities against *Staphylococcus aureus, Klebsiella pneumoniae* and *Moraxella catarrhalis* with MIC values ranging from 3.0 mg/mL to >16.0 mg/mL	56
Ethanol	Flowers, leaves and stems	Micro-dilution	Exhibited activities against *Propionibacterium acnes* with MIC value of 125.0 µg/ml	39

Table 5. Summary of antifungal activities of the extracts and essential oils isolated from different parts of *Helichrysum kraussii*

Extract/ compound	Plant part	Model	Effect	Reference
Acetone	Aerial parts	Agar diffusion	Showed activities against *Cladosporium cladosporioides, Aspergillus niger, Cladosporiums sphaerospermum, Phytophthora capsici, Aspergillus flavus* and *Cladosporium cucumerinum* with MIC values ranging from 0.01 mg/ml to 1.0 mg/ml	32
Dichloro-methane : methanol	Leaves and stems	Micro-dilution	Exhibited activities against *Cryptococcus neoformans* with MIC value of 0.83 mg/ml	56
Aqeous	Leaves and stems	Micro-dilution	Exhibited activities against *Cryptococcus neoformans* with MIC value of 16.0 mg/ml	56
Essential oils	Leaves and stems	Micro-dilution	Exhibited activities against *Cryptococcus neoformans* with MIC value of 1.0 mg/ml	56

Antiviral activities

The antiviral activities of *H. kraussii* flowers, leaves, and stems against the herpes simplex virus type-1 (HSV-1) using the cytopathic effect (CPE) inhibition assay with acyclovir as the positive control have been assessed (48). The extract exhibited potential anti-viral activities at 50.00 µg/ml with 100% viral inhibition when tested at the highest viral dose (100TCID50), which was comparable to the antiviral activities exhibited by the positive control, which showed 100% inhibition at 1.00 µg/ml (48). In another study, the antiviral activities of acetone, dichloromethane, hexane, and methanol: water extracts of *H. kraussii* leaves using a colorimetric cell-based (HeLa-SXR5) assay have been evaluated (37). The acetone, dichloromethane, and hexane extracts exhibited potential anti-viral activities at 2.5 µg/ml with 97.0% HIV inhibition in the cell-based assay (37).

Anti-inflammatory activities

The anti-inflammatory activities of the flavonoid 5,6-dihydroxy-3,7,8-trimethoxyflavone isolated from the flowers of *H. kraussii* were assessed using a cyclooxygenase-1 and -2 (COX-1 and COX-2) catalyzed reaction of the arachidonic acid-prostaglandin pathway with indomethacin as the positive control (35). The flavonoid compound exhibited prostaglandin synthesis inhibition of 54.4% and 84.7% against COX-1 and COX-2, respectively (35). Similarly, the anti-inflammatory activities of ethanol extracts of *H. kraussii* flowers, leaves, and stems were assessed using the COX-2 assay with ibuprofen as a positive control (48). The extract exhibited weak activities with COX-2 inhibition at 10.0 µg/ml, showing an inhibition of 57.2% compared to the 90.2% exhibited by the positive control (48).

Antioxidant activities

The flowers of *H. kraussii* were analyzed to determine the antioxidant activities of three flavonoids: 3',4',5,7-tetrahydroxy-3-methoxyflavone, 5,6-dihydroxy-3,7,8-trimethoxyflavone, and 5,7-dihydroxy-3-methoxyflavone. The assessment was conducted using the α,α-diphenyl-β-picrylhydrazyl (DPPH) free radical scavenging assay (35). The results indicated that these flavonoids demonstrated weak antioxidant activities, ranging from 40.7% to 44.4% (35). In another experiment, the antioxidant activities of ethanol and methanol extracts obtained from the flowers, leaves, and stems of *H. kraussii* were evaluated. The DPPH free radical scavenging assay was employed, with vitamin C serving as the positive control (39). Both extracts exhibited antioxidant activities, with half maximal inhibitory concentrations (IC50) values ranging from 4.0 µg/ml to 4.2 µg/ml (39). Moreover, the ethanol extracts of *H. kraussii* flowers, leaves, and stems were further examined to determine their antioxidant activities using the DPPH radical scavenging and nitric oxide (NO) radical scavenging assays. Ascorbic acid was used as a positive control (48). The ethanol extract showed significant DPPH scavenging activity, with an IC50 value of 4.66 µg/ml (36, 48).

Cytotoxicity activities

Table 6 presents the cytotoxicity activities of various extracts derived from *H. kraussii*. Cytotoxic effects were observed in the chloroform: methanol extract obtained from both the leaves and stems of *H. kraussii* (34). The flowers, leaves, and stems of *H. kraussii* yielded ethanol extracts that displayed cytotoxic activities (39, 48).

The present review aims to provide comprehensive information on the medicinal uses, phytochemistry, biological activities, and botany of *H. kraussii*, encompassing literature published from 1962 to 2023 (34). *H. kraussii* is a member of the Helichrysum genus, which is widely utilized as a source of traditional medicines in southern Africa. Other species within this genus, such as *H. caespititium* (DC.) Harv., *H. cymosum* (L.) D.Don ex G.Don, *H. longifolium* DC., *H. nudifolium* (L.) Less., *H. odoratissimum* (L.) Sweet, *H. pedunculatum* Hilliard & B.L. Burtt, and *H. petiolare* Hilliard & B.L. Burtt, have also been documented for their medicinal properties (57-63). Some of these Helichrysum species, including *H. nudifolium* and *H. odoratissimum*, have commercial potential as ritual incense, sedatives, and herbal remedies in southern Africa, particularly for colds and chest pains. Additionally, their essential oils exhibit commercial potential for inhalation and aromatherapy purposes (64-66). These reports align with the findings of our review, which highlight the diverse medicinal uses of *H. kraussii*, varying across different countries.

The treatment of respiratory infections, such as asthma, blocked nose, chest pains, cough, and tuberculosis (TB), using herbal concoctions prepared from *H. kraussii*, is common in south central Africa. These reports of *H. kraussii*'s use for similar ailments and diseases in different countries call for detailed ethnopharmacological research focusing on its effectiveness and safety (38, 67). Pharmacological studies on *H. kraussii* extracts and isolated phytochemical compounds have demonstrated various activities, including antioxidant, antibacterial, antifungal, antiviral, cytotoxicity, and anti-inflammatory effects. However, there is a lack of information on both in vitro and in vivo studies specifically examining its anti-TB activities or tests against a panel of various Mycobacteria species. Respiratory infections are a significant public health concern in south central Africa, and traditional medicines have shown great potential in their treatment and management (43, 44, 68, 69). Therefore, it is important to understand the ethno pharmacological properties of *H. kraussii* extracts and phytochemical compounds isolated from the species, as these active ingredients may act directly or indirectly to prevent or treat diseases and maintain health. Evaluating the phytochemical properties of medicinal plants is essential not only to identify the main phytochemical compounds but also to gain a scientific understanding of the medicinal properties of the plant species (70). Medicinal plants like *H. kraussii* have been used for centuries in the treatment and management of various diseases, and their improved phytochemical profiling and ethno pharmacological research contribute to the development of current therapeutic systems. The pharmacological properties of traditional medicines depend on their primary and secondary phytochemical constituents (71).

Phytochemical compounds identified from various parts of *H. kraussii* include acylated flavonol glucosides, diterpenes, essential oils, flavonoids, phloroglucinol, and terpenoids (31, 35, 40, 49-51). Some of these secondary phytochemical constituents may be responsible for the documented biological activities of *H. kraussii*. Therefore, it is necessary to investigate the resulting pharmacological and toxicological properties of these phytochemical constituents in controlled clinical trials to determine their therapeutic potential and their association with specific diseases or indications related to the species. Although several phytochemical compounds have been isolated, purified, and characterized from *H. kraussii*, many of them still require detailed studies. So far, limited ethno pharmacological research has been conducted on the pharmacokinetics studies related to the mechanism of action of individual isolated phytochemical compounds under in vivo conditions. Ethno pharmacological research should also focus on toxicity, preclinical and clinical trials aimed at assessing the safety, effectiveness, and side effects of the phytochemical compounds in *H. kraussii* formulations used as traditional medicines.

Table 6. Summary of cytotoxicity activities of the extracts isolated from different parts of *Helichrysum kraussii*

Extract/ compound	Plant part	Model	Effect	Reference
Chloroform : methanol	Leaves and stems	Sulforhodamine B assay	Exhibited activities against transformed human kidney epithelial (Graham) cells with inhibition ranging from 9.0% to 45.2%	34
Ethanol	Flowers, leaves and stems	2,3-bis[2-methoxy-4-nitro-5-sulfophenyl]-2H-tetrazolium-5-carboxanilide reduction (XTT) assay	Showed activities half maximal inhibitory concentrations (IC_{50}) value of 51.7 µg/ml	39
Ethanol	Flowers, leaves and stems	XTT assay	Exhibited activities against human melanoma (A375), epidermoid carcinoma (A431), cervical epithelial carcinoma (HeLa) and human embryonic kidney cells (HEK-293) with IC_{50} values ranging from 34.9 µg/ml to 151.0 µg/ml	48

Conclusion

This mini-review summarizes the medicinal use, chemical composition, and pharmacological properties of *H. kraussii*. Such studies are crucial for plants commonly employed in traditional medicine, as they allow for the assessment of their phytochemistry, pharmacology, and toxicology. Notably, various phytochemical compounds have been isolated from *H. kraussii*, including acylated flavonol glucosides, diterpenes, essential oils, flavonoids, phloroglucinol, and terpenoids. These compounds have exhibited antibacterial, anti-inflammatory, and antioxidant activities. However, it is important to note that these studies are preliminary, and further ethno pharmacological research is needed. This research should focus on comprehensive evaluations, safety assessments, in vivo mechanisms of action, and clinical investigations to validate the traditional medicinal applications of *H. kraussii*. Due to the variations in phytochemical constituents depending on the origin and plant parts, it is crucial to establish a standardized phytochemical profiling protocol to isolate and obtain pure compounds from *H. kraussii*. Additionally, considering the diverse mechanisms of action exhibited by the phytochemical compounds mentioned in this review, future studies should prioritize the assessment of toxicity and safety using animal models.

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Authors' contributions

SN and OS conceptualized and designed the study, and also drafted the manuscript. SN and CK conducted the research. UC performed statistical analysis, and also prepared the figures and tables. EG, CC and OE participated in the design, coordination of the research, and also helped draft the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The author declares no conflict of interest

Ethical issues: None .

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