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Review Article

HELICHRYSUM CYMOSUM (L.) D.DON (*ASTERACEAE*): MEDICINAL USES, CHEMISTRY, AND BIOLOGICAL ACTIVITIES

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ABSTRACT

Helichrysum cymosum is a valuable and well-known medicinal plant in tropical Africa. The current study critically reviewed the medicinal uses, phytochemistry and biological activities of *H. cymosum*. Information on medicinal uses, phytochemistry and biological activities of *H. cymosum,* was collected from multiple internet sources which included Scopus, Google Scholar, Elsevier, Science Direct, Web of Science, PubMed, SciFinder, and BMC. Additional information was gathered from pre-electronic sources such as journal articles, scientific reports, theses, books, and book chapters obtained from the University library. This study showed that *H. cymosum* is traditionally used as a purgative, ritual incense, and magical purposes and as herbal medicine for colds, cough, fever, headache, and wounds. Ethnopharmacological research revealed that *H. cymosum* extracts and compounds isolated from the species have antibacterial, antioxidant, antifungal, antiviral, anti-HIV, anti-inflammatory, antimalarial, and cytotoxicity activities. This research showed that *H. cymosum* is an integral part of indigenous pharmacopeia in tropical Africa, but there is lack of correlation between medicinal uses and existing pharmacological properties of the species. Therefore, future research should focus on evaluating the chemical and pharmacological properties of *H. cymosum* extracts and compounds isolated from the species.

Keywords: *Asteraceae*, Ethnopharmacology, *Helichrysum cymosum*, Herbal medicine, Indigenous pharmacopeia, Tropical Africa.

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INTRODUCTION

Helichrysum cymosum (L.) D.Don is a member of the *Asteraceae* or Compositae family, commonly referred to as aster, daisy, or sunflower family. The family *Asteraceae* is one of the largest families of flowering plants, which is cosmopolitan except for Antarctica region [1-3]. The family consists of over 1600 genera and 23,000 species which have been recorded in grassland, wooded grassland, montane vegetation, and tropical forests [1]. Research by Jeschke *et al.* [4] showed that the family *Asteraceae* has at least 420 known medicinal species and these include *Arnica montana* L. [5-11], *Artemisia annua* L. [12-19], *Calendula officinalis* L. [20-25], *Chamaemelum nobile* (L.) All. [26-30], *Inula helenium* L. [31-36], and *Matricaria recutita* L. [37-43]. Another important source of herbal medicines among *Asteraceae* taxa is the genus *Helichrysum* Mill. [44-60]. According to Lourens *et al.* [61] and Pljevljakušić *et al.* [62], the genus *Helichrysum* is characterized by acylphloroglucinols, humulone derivatives, flavonoids, chalcones, phenolic acids, phthalides, sterols, coumarins, pyrones, diterpenes, sesquiterpenes, and polyacetylenes. The genus *Helichrysum* is characterized by several biological activities such as antimicrobial, anti-inflammatory, antioxidant, cholagogue, choleretic, hepatoprotective, detoxifying, protease-inhibiting, and antiallergic properties [61-63]. *H. cymosum* (L.) D.Don, *Helichrysum aureonitens* Sch. Bip., *Helichrysum nudifolium* (L.) Less., *Helichrysum odoratissimum* (L.) Sweet, *Helicltrysum pedunculatum* Hilliard and B.L. Burtt., and *Helichrysum petiolare* Hilliard and B.L.Burtt. are among the species widely used as herbal medicines in South Africa [64]. The genus name "*Helichrysum*" is derived from the Greek words "*helios*" which means "sun" and "*chrysos*" which means "gold," in reference to the "golden flowers" which are characteristic of the genus [62]. The specific name "*cymosum*" *is a Latin word which means* "with cymes" *in* reference to the flat-topped clusters of flower heads, *as the flowers of the species occur in* clusters in which the flowers open from the center outward [65]. The leaves, stems, and twigs of *H. cymosum* are sold as herbal medicines in the informal herbal medicine markets in the Gauteng and the Western Cape provinces in South Africa [66-68]. Therefore, the current study is aimed at providing a critical appraisal of the existing ethnomedicinal value, phytochemistry and biological activities of *H. cymosum,* as well as exploring the potential of the species as herbal medicine in tropical Africa.

BOTANICAL DESCRIPTION OF *H. CYMOSUM*

In South Africa, *H. cymosum* is known as gold carpet or yellow-tipped strawflower in English, goute tapyt in Afrikaans, and impepho in isiXhosa or Zulu [65]. *H. cymosum* is divided into two subspecies, *H. cymosum* subsp. *cymosum* and *H. cymosum* subsp. *calvum* Hilliard [65,69]. These two subspecies are differentiated on the basis that the head of subsp. *cymosum* has 6–20 flowers, fimbrils are more than twice as long as the ovary, and the pappus is copious [65,70]. While the head of subsp. *calvum* has 4–7 flowers, fimbrils are about as long as the ovary and the pappus is wanting [65,70]. In South Africa, subsp. *calvum* is shorter, ranging in height from 15 to 55 cm and has been recorded at an altitude ranging from 1200 to 3170 m above sea level [69]. The subsp. *cymosum* is taller than subsp. *calvum*, with height ranging from 10 to 180 cm and has been recorded at an altitude ranging from 5 to 2010 m above sea level [69]. However, most ethnobotanical and ethnopharmacological literature does not separate *H. cymosum* into specific subspecies but rather to *H. cymosum sensu lato*, and this is the approach that has been adopted in this study. There are four synonyms associated with *H. cymosum* and these include *Gnaphalium cymosum* L., *G. serratum* L., *G. tricostatum* Sieber ex DC., *Helichrysum infaustum* J.M. Wood and M.S. Evans var. *discolor* Moeser, and *Lepiscline cymosa* Cass [69,70].

H. cymosum is a well-branched spreading, perennial dwarf shrub with thin grayish-white woolly branches densely covered with leaves and becoming pedunculoid upward. The leaves are variable in shape and size, becoming smaller and more distant upward. The leaves are elliptic-oblong or linear-oblong in shape, the apex is acute, sometimes acuminate, mucronate, slightly narrowed, and clasping at the base [65,70]. The leaf margins are flat or subrevolute, upper surface covered in thin silvery gray and paper-like hairs, while the lower surface has white-woolly hairs. The flower heads are disciform,

sometimes discoid, crowded in terminal corymbs, cylindric, glossy, and bright canary-yellow in color [71].

MEDICINAL USES OF *H. CYMOSUM*

The aerial parts, flowers, leaves, roots, twigs, and whole plant parts of *H. cymosum* are used for various traditional and medicinal applications (Table 1). *H. cymosum* is mainly used as a purgative, ritual incense, and magical purposes (chase away evil spirits and rain making) and as herbal medicine for colds, cough, fever, headache, and wounds (Table 1 and Figure 1). Other minor medicinal applications include blocked nose, boost immunity, cardiovascular problems, diarrhea, dizziness, eye problems, flatulence, improve appetite, influenza, insect repellent, insomnia, kidney problems, laxative, menstrual pain, pertussis, pulmonary problems, skin infections, urinary problems, varicose veins, vomiting, and weak bones [72-81].

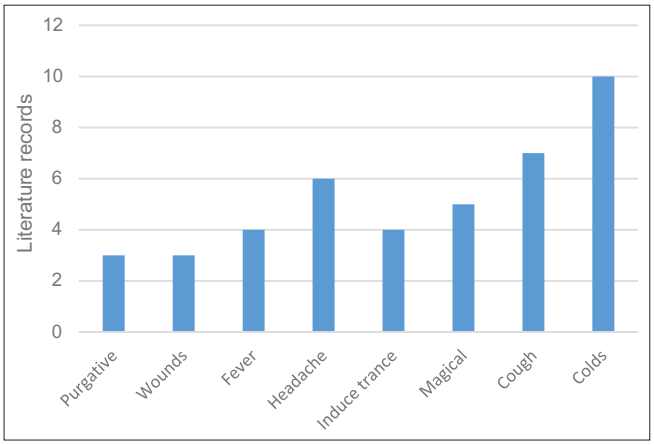

Figure 1: Traditional and medicinal applications of *Helichrysum cymosum*

PHYTOCHEMICAL AND NUTRITIONAL COMPOSITION OF *H. CYMOSUM*

Very little attention has been paid to the macro- and microelements of *H. cymosum*. One report done by Street *et al.* [90] partly studied this subject and reported values of the nutritional composition of leaves, roots, and stems of *H. cymosum* (Table 2). Bohlmann *et al.* [91], Jakupovic *et al.* [92], and van Vuuren *et al.* [89] identified helihumulone, helichromanochalcone, and 5-hydroxy-8-methoxy-7-prenyloxyflavanone from leaves and roots of *H. cymosum*. The composition of essential oils appears to vary with the geographical origin of the specimens as shown in Table 3. The major compounds that have been identified from the species include α-pinene (0.8%–12.4%), Δ-3-carene (6.8%–16.1%), β-caryophyllene (8.5%–17.8%), 1,8-cineole (1.0%–20.4%), trans-caryophyllene (27.0%), and (Z)-β-ocimene (<0.01%–50.4%) [85,89,93-97]. Future research should focus on evaluating the biological activities of the isolated compounds.

BIOLOGICAL ACTIVITIES

The following biological activities have been reported from *H. cymosum* crude extracts and compounds isolated from the species: Antibacterial [72,74,85,89,94], antioxidant [95], antifungal [89,94,95,98], antiviral [72], anti-HIV [99,100], anti-inflammatory [74], antimalarial [89], cytotoxicity [99,100], and toxicity [89] activities.

Antibacterial activities

Sindambiwe *et al.* [72] evaluated antibacterial activities of 80% ethanol whole plant extracts of *H. cymosum* using the liquid dilution method against *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *Bacillus cereus*, *Mycobacterium fortuitum*, *Staphylococcus aureus*, and *Streptococcus pyogenes*. The extract was active against *S. pyogenes* with minimum inhibitory concentration (MIC) value of 5 mg/ml [72]. Stafford

Table 1: Medicinal uses of *Helichrysum cymosum*

Disease	Parts used	Country	References
Blocked nose	Whole plant	South Africa	[81]
Boost immunity	Aerial parts and leaves	South Africa	[77]
Cardiovascular problems	Aerial parts	South Africa	[76]
Colds	Leaves	South Africa	[61,73,78,79,81-86]
Cough	Roots	South Africa	[61,73,78,79,81,85,86]
Diarrhea	Aerial parts and leaves	South Africa	[77]
Dizziness	Aerial parts, flowers, leaves, roots and twigs	South Africa	[80]
Eye problems	Aerial parts	South Africa	[76]
Fever	Leaves	South Africa	[73,82-84]
Flatulence	Whole plant	Cameroon	[75]
Headache	Leaves	South Africa	[61,73,79,82,86,87]
Improve appetite	Aerial parts and leaves	South Africa	[77]
Induce trance	Aerial parts, flowers, leaves, roots and twigs	South Africa	[61,79,80,86]
Influenza	Whole plant	Rwanda	[72]
Insect repellent	Whole plant	South Africa	[81]
Insomnia	Whole plant	South Africa	[81]
Kidney problems	Whole plant	South Africa	[81]
Laxative	Aerial parts	South Africa	[79]
Magical (chase away evil spirits and rain making)	Aerial parts, leaves and whole plant	South Africa and Uganda	[77,83,84,87,88]
Menstrual pain	Whole plant	South Africa	[73,89]
Pertussis	Whole plant	Rwanda	[72]
Pulmonary problems	Aerial parts	South Africa	[76]
Purgative	Aerial parts	South Africa	[61,79,86]
Skin infections	Roots	South Africa	[78]
Urinary problems	Whole plant	South Africa	[81]
Varicose veins	Aerial parts	South Africa	[76]
Vomiting	Aerial parts	South Africa	[79]
Weak bones	Whole plant	Cameroon	[75]
Wounds	Aerial parts and roots	South Africa	[78,85,90]

Table 2: Nutritional composition of leaves, roots, and stems of *Helichrysum cymosum* based on studies done by Street *et al*.[90]

Nutritional composition (mg/kg)	Values
Arsenic	0.8
Boron	21.2
Cadmium	0.4
Cobalt	0.9
Copper	0.8
Iron	1087.8
Lead	2.0
Manganese	759.6
Molybdenum	0.5
Nickel	4.0
Zinc	42.9

et al. [74] evaluated the antibacterial activities of ethanol extracts of whole plant parts of *H. cymosum* against *Bacillus subtilis, S. aureus, E. coli,* and *K. pneumonia* using the micro plate method. The extract exhibited activities with MIC values ranging from 0.8 to 1.6 mg/ml [74]. Van Vuuren *et al.* [89] and Van Vuuren [94] evaluated the antibacterial activities of acetone extracts of aerial parts of *H. cymosum*, essential oil and compound helihumulone isolated from the species against *Enterococcus faecalis, B. cereus, B. subtilis, S. aureus, P. aeruginosa, Yersinia enterocolitica,* and *E. coli* using disc diffusion and microdilution techniques with ciprofloxacin as a positive control. The extract exhibited activities against *E. faecalis, B. cereus, B. subtilis,* and *S. aureus* with zone of inhibition ranging from 3.7 to 8.0 mm which was comparable to 3.0 mm to 11 mm exhibited by the positive control. The extract, essential oil and compound helihumulone exhibited activities with MIC values ranging from 0.02 to 8.0 mg/ml [89,94]. Reddy [85] evaluated antibacterial activities of acetone and methanol extracts of aerial parts of *H. cymosum* as well as essential oils isolated from the species against *E. coli, Yersinia enterocolitica, Klebsiella pneumoniae, S. aureus,* and *B. cereus* using disc diffusion assay with ciprofloxacin (0.01 mg/ml) as a positive control. The acetone and methanol extracts exhibited activities against *S. aureus* and *B. cereus* with zone of inhibition of 7 and 5 mm, respectively, and MIC value of <0.25 mg/ml exhibited against both pathogens. The positive control exhibited zone of inhibition of 6 mm and MIC value of 0.0003 mg/ml [85].

Antioxidant activities

François *et al.* [95] evaluated the antioxidant activities of essential oil isolated from the leaves of *H. cymosum* using 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay with butylated hydroxytoluene as a positive control. The extract exhibited activities with SC_{50} (concentration of sample required to scavenge 50% of DPPH radicals) value of 6.3 g/l which was less than the value of the positive control which exhibited value of 7.0 mg/l [95].

Antifungal activities

Van Vuuren *et al.* [89] and Van Vuuren [94] evaluated the antifungal activities of acetone extract of aerial parts of *H. cymosum*, essential oil and compound helihumulone isolated from the species against *Cryptococcus neoformans* and *Candida albicans* using microdilution technique with amphotericin B as a positive control. The extract, essential oil and compound helihumulone exhibited activities with MIC values ranging from 0.03 to 4.0 mg/ml [89,94]. François *et al.* [95] evaluated the antifungal activities of essential oil isolated from the leaves of *H. cymosum* against *Penicillium oxalicum* using microdilution technique with amphotericin B as a positive control. The extract showed activities with 54.7% inhibition starting from 2.5 to 5 mg/ml [95]. Runyoro *et al.* [98] evaluated the antifungal activities of the essential oils isolated from *H. cymosum* against *C. albicans* using the bioautography agar overlay method with amphotericin B (0.01 µg) as a positive control. The extract showed activities with zone of inhibition ranging from 6 to 8.5 mm while the positive control exhibited zone of inhibition of 14.2 mm [98].

Antiviral activities

Sindambiwe *et al.* [72] evaluated antiviral activities of aqueous and 80% ethanol whole plant part extracts of *H. cymosum* using the method of 50% end point titration technique (50% EPTT) assay against herpes simplex virus Type 1, measles virus strain Edmonston A, Semliki Forest virus A7 (SF A7), and vesicular stomatitis virus T2 (VSV T2). The extract exhibited virucidal activities against VSV T2 and SF A7 [72].

Anti-HIV activities

Heyman [99] evaluated anti-HIV activities of methanol:water and chloroform extracts of aerial parts of *H. cymosum* subsp. *Cymosum* on Vero African green monkey kidney cells using the cytopathic effect (CPE) inhibition assay with acyclovir (0.75 µg/ml) as a positive control. The methanol:water extract showed slight toxicity with CPE of 400.0 µg/ml in comparison to 0.8 µg/ml exhibited by the positive control [99]. Heyman [79] and Heyman *et al.* [100] evaluated anti-HIV activities of dichloromethane and methanol/water extracts of aerial parts of *H. cymosum* subsp. *Cymosum* and *H. cymosum* subsp. *Clavum* using the DeCIPhR method. The extracts exhibited activities with median lethal concentration value ranging from 10.0 to 21.0 µg/mL [79,100].

Anti-inflammatory activities

Stafford *et al.* [74] evaluated the anti-inflammatory activities of aqueous and ethanol extracts of whole plant parts of *H. cymosum* using the cyclooxygenase (COX-1) inhibition assay. The COX-1 inhibition exhibited by aqueous and ethanol extract was 52.0% and 100.0%, respectively [74].

Antimalarial activities

Van Vuuren *et al.* [89] evaluated the antimalarial activities of acetone extract of aerial parts of *H. cymosum*, essential oil and compound helihumulone isolated from the species using the [G-^{3}H] hypoxanthine incorporation assay using *Plasmodium falciparum* as the test organism with chloroquine and quinine as positive controls. The extract, essential oil and compound helihumulone showed activities, exhibiting half maximal inhibitory concentration (IC_{50}) values of 60.8 µg/ml, 1.3 µg/ml and 14.9 µg/ml, respectively. The positive controls exhibited IC_{50} values ranging from 0.09 to 0.1 µg/ml [89].

Cytotoxicity activities

Heyman [99] evaluated cytotoxicity activities of chloroform and methanol:water extracts of aerial parts of *H. cymosum* subsp. *cymosum* on Vero African green monkey kidney cells using the XTT (sodium 3'-[1-(phenyl amino-carbonyl)-3,4-tetrazolium]-bis-[4-methoxy-6-nitro] benzene sulfonic acid hydrate) method with zearalenone as a positive control. The chloroform and methanol:water extracts exhibited IC_{50} values of 36.5 µg/ml and 59.7 µg/ml, respectively, which were higher than 1.3 µg/ml exhibited by the positive control [99]. Heyman [79] and Heyman *et al.* [100] evaluated anti-HIV activities of dichloromethane and methanol/water extracts of aerial parts of *H. cymosum* subsp. *cymosum* and *H. cymosum* subsp. *Clavum* using the DeCIPhR method. The extracts exhibited activities with median lethal dose value of >50.0 µg/mL [79,100].

Toxicity activities

Van Vuuren *et al.* [89] evaluated the toxicity activities of acetone extract of aerial parts of *H. cymosum*, essential oil and compound helihumulone isolated from the species against transformed human kidney epithelial cells using a colorimetric tetrazolium-based 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide cellular viability assay. The extract, essential oil and compound helihumulone showed activities, exhibiting IC_{50} values of 172.0 µg/ml, 17.5 µg/ml, and 57.1 µg/ml, respectively [89].

CONCLUSION

In this review, the medicinal uses, phytochemistry, biological and toxicity activities of different extracts, and compounds of *H. cymosum* have been summarized. The diverse medicinal uses of *H. cymosum* and the preliminary phytochemical and ethnopharmacological

Table 3: Phytochemical composition of *Helichrysum cymosum*

Phytochemical composition (%)	Values	Plant parts	References
cis-Alloocimene	0.4	Aerial parts	[85,89,94]
α-Amorphene	<0.01–3.7	Aerial parts, flowers and leaves	[93,97]
Aromadendrene	1.5–3.6	Aerial parts and leaves	[85,89,94,95]
(+)-Aromadendrene	1.4	Aerial parts	[93]
Alloaromadendrene	<0.01–1.3	Flowers and leaves	[97]
Aromadendrene epoxide	0.08	Aerial parts	[93]
Benzaldehyde	0.1–0.3	Aerial parts	[85,89,94]
Benzylacetone	0.3	Aerial parts	[85,89,94]
Bicyclogermacrene	0.9	Aerial parts	[93]
Borneol	<0.1–1.8	Aerial parts and leaves	[85,89,93-95]
Bornylene	2.7	Leaves	[95]
β-Bourbonene	0.2–0.6	Aerial parts	[85,89,93,94]
trans-Cadina-1 (6),4-diene	0.1	Flowers and leaves	[97]
α-Cadinol	0.1–0.7	Aerial parts, flowers and leaves	[85,89,93-95,97]
epi-α-Cadinol	0.1–0.3	Flowers and leaves	[97]
δ-Cadinol	0.3	Aerial parts	[93]
α-Cadinene	<0.01	Flowers and leaves	[97]
γ-Cadinene	2.0	Aerial parts	[93]
δ-Cadinene	0.3–1.6	Aerial parts, flowers and leaves	[85,93,97]
trans-γ-Cadinene	0.1–0.3	Flowers and leaves	[97]
α-Calacorene	<0.01–0.1	Aerial parts, flowers and leaves	[85,89,94,97]
β-Calacorene	0.4	Aerial parts	[93]
Calamenene	0.6	Aerial parts	[85]
cis-Calamenene	0.6	Aerial parts	[89,94]
Camphene	0.1–7.4	Aerial parts, flowers and leaves	[85,89,93-95,97]
Camphor	<0.01–0.04	Aerial parts, flowers and leaves	[93,97]
Δ-3-Carene	6.8–16.1	Aerial parts and leaves	[93,95]
Carvacrol	1.6	Flowers	[97]
trans-(+)-Carveol	0.09–0.2	Aerial parts	[85,89,93,94]
Caryophylla-4 (14),8 (15)-dien-5-ol	0.1–0.2	Flowers and leaves	[97]
Caryophylladienol I	<0.01	Aerial parts	[85,89,94]
Caryophylladienol II	0.4	Aerial parts	[85,89,94]
Caryophyllenol I	0.2	Aerial parts	[85,89,94]
Caryophyllenol II	0.1	Aerial parts	[85,89,94]
Caryophyllene alcohol(%)	<0.01–1.1	Aerial parts, flowers and leaves	[93,97]
α-Caryophyllene alcohol	1.2	Aerial parts	[93]
β-Caryophyllene alcohol	0.4	Aerial parts	[85,89,93]
Caryophyllene oxide	1.1–7.7	Aerial parts, flowers and leaves	[85,89,93-95,97]
trans-Caryophyllene	27.0	Aerial parts	[93]
β-Caryophyllene(%)	8.5–17.8	Aerial parts, flowers and leaves	[85,89,94-97]
1,8-Cineole	1.0–20.4	Aerial parts, flowers and leaves	[85,89,94,95,97]
Clovenol	0.1	Aerial parts	[85,89,94]
α-Copaene	0.3–1.8	Aerial parts, flowers and leaves	[85,89,93-95,97]
β- Copaene	<0.01–0.1	Flowers and leaves	[97]
1-epi-Cubenol	0.1–0.2	Flowers and leaves	[97]
Cyclosativene	<0.01–0.2	Flowers and leaves	[97]
o-Cymene	0.4–0.7	Flowers and leaves	[97]
p-Cymen-8-ol	0.1–0.2	Aerial parts	[85,89,93,94]
p-Cymene	0.6–7.6	Aerial parts and leaves	[85,89,93-95]
Decanal	1.4	Flowers	[97]
1,10-Di-epi-cubenol	0.1–0.2	Flowers and leaves	[97]
Dodecanal	0.3	Flowers	[97]
β-Elemene	0.8	Leaves	[95]
δ-Elemene	1.9	Leaves	[95]
Epiglobulol	0.3	Aerial parts	[85,89,94]
α-Eudesmol	1.3	Leaves	[95]
β-Eudesmol	2.7	Leaves	[95]
E, e-α-Farnesene	1.6	Aerial parts	[93]
α-Fenchene	0.1–6.3	Aerial parts	[85,89,93,94]
Fenchyl alcohol	0.7	Aerial parts	[85,89,94]
β-Fenchyl alcohol	0.9	Aerial parts	[93]
endo-Fenchol	0.2	Aerial parts	[93]
Furfuryl alcohol	0.2	Aerial parts	[93]
Germacrene B	2.3	Leaves	[95]
Germacrene D	0.6	Leaves	[95]
Globulol	0.6–1.5	Aerial parts and leaves	[85,89,94,95]
α-Guaiene	1.7	Flowers	[97]
δ-Guaiene	1.1	Aerial parts	[85,89,94]
Guaiol	0.1–0.2	Flowers and leaves	[97]
α-Gurjunene	0.1	Aerial parts	[85,89,94]

(Contd...)

Table 3: ***(Continued)***

Phytochemical composition (%)	Values	Plant parts	References
2-Heptanol	0.1	Aerial parts	[85,89,94]
1-Hexanol	<0.01	Aerial parts	[85,89,94]
(Z)-3-Hexen-1-ol	0.1	Aerial parts	[85,89,94]
(3E)-3-Hexen-1-yl acetate	1.6	Flowers	[97]
(Z)-3-Hexen-1-yl 3-methylbutyrate	1.2	Flowers	[97]
Humulene epoxide II	0.2	Aerial parts	[85,89,94]
Humulene oxide	0.9	Leaves	[95]
α-Humulene	1.2–8.7	Aerial parts, flowers and leaves	[85,89,94,95]
Humulene epoxide II	0.9–2.3	Flowers and leaves	[97]
Isoborneol	0.2	Flowers	[97]
Isobornyl acetate	4.3	Flowers	[97]
endo-Isocamphane	0.06	Aerial parts	[93]
Isocaryophyllene oxide	0.1	Aerial parts	[85,89,94]
iso-Italicene	0.1	Flowers	[97]
Limonen-4-ol	0.2	Aerial parts	[85,89,94]
Limonene	0.5–7.2	Aerial parts, flowers and leaves	[85,89,93,95,97]
Linalool	<0.01–1.6	Aerial parts and leaves	[85,89,93-95]
trans-Linalool oxide	0.1	Aerial parts	[93]
Longiborneol (= Juniperol)	0.2	Flowers and leaves	[97]
cis-p-Mentha-1 (7),8-dien-2-ol	<0.01	Aerial parts	[85,89,94]
cis-p-Menth-3-en-1,2-diol	0.1	Aerial parts	[85,89,94]
Methyl hexyl bourgene	7.2	Leaves	[95]
α-Muurolene	0.1–1.5	Aerial parts, flowers and leaves	[85,93,97]
γ-Muurolene	0.3–0.6	Flowers and leaves	[97]
t-Muurolol	1.2	Aerial parts	[89,94]
Myrcene	0.4–1.2	Aerial parts, flowers and leaves	[85,89,93,94,97]
(E)-Myroxide(%)	0.3	Flowers and leaves	[97]
(Z)-Myroxide(%)	<0.01–0.3	Flowers and leaves	[97]
Myrtenol	0.6	Aerial parts	[85,89,94]
Nerol	0.4	Aerial parts	[93]
Neryl acetate	0.7	Aerial parts	[93]
Nonanal(%)	<0.01–4.0	Flowers and leaves	[97]
2-Nonanol	0.1–1.2	Aerial parts	[85,89,94]
2-Nonanone	0.4	Aerial parts	[85,89,94]
Phellandral	0.09	Aerial parts	[93]
α-Phellandrene epoxide	0.2	Aerial parts	[93]
2-Phenylethyl acetate	<0.01	Aerial parts	[85,89,94]
cis-β-Ocimene	0.3	Aerial parts	[93]
trans-β-Ocimene	0.2	Aerial parts	[93]
(E)-β-Ocimene	<0.01–8.0	Aerial parts, flowers and leaves	[85,89,94,95,97]
(Z)-β-Ocimene	<0.01–50.4	Aerial parts, flowers and leaves	[85,89,94,95,97]
allo-Ocimene	6.4	Flowers	[97]
neo-allo-Ocimene	0.6	Flowers	[97]
2-Octanol	0.5	Aerial parts	[85,89,94]
1-Octen-3-ol	0.3–0.8	Aerial parts	[85,89,93,94]
Octyl acetate	1.6	Leaves	[95]
Perilla aldehyde	0.1	Flowers and leaves	[97]
α-Pinene	0.8–12.4	Aerial parts, flowers and leaves	[85,89,93-97]
β-Pinene	0.5–3.7	Aerial parts, flowers and leaves	[85,89,93,95,97]
α-Pinene oxide	0.3–0.5	Flowers and leaves	[97]
Pinocarvone	0.1	Aerial parts	[85,89,94]
trans-Pinocarveol	0.6	Aerial parts	[85,89,94]
Rosifoliol	0.2	Aerial parts	[85,89,94]
Sabinene	0.2–1.0	Aerial parts and flowers	[85,89,94,97]
cis-Sabinene hydrate	0.4	Flowers and leaves	[97]
Safranal	0.04	Aerial parts	[93]
Selina-5,11-diene	0.3	Aerial parts	[85,89,94]
α-Selinene	2.3	Leaves	[95]
γ-Selinene	1.2	Leaves	[95]
β-Selinene	0.7–5.7	Flowers and leaves	[95,97]
Spathulenol	0.9	Leaves	[95]
α-Terpinene	0.2–2.8	Aerial parts, flowers and leaves	[85,89,93-95,97]
γ-Terpinene	0.1–1.4	Aerial parts, flowers and leaves	[85,89,93,94,97]
Terpinen-4-ol	<0.01–0.4	Aerial parts and leaves	[93,95]
1-Terpineol	0.04	Aerial parts	[93]
4-Terpineol	0.5	Flowers and leaves	[97]
α-Terpineol	0.1–2.6	Aerial parts, flowers and leaves	[85,89,94,95,97]
δ-Terpineol	0.1–0.9	Aerial parts, flowers and leaves	[85,89,94,97]
Terpinolene	<0.01–0.4	Aerial parts, flowers and leaves	[85,89,94,95,97]
α-Terpinolene	0.3	Aerial parts	[93]

(Contd...)

Table 3: ***(Continued)***

Phytochemical composition (%)	Values	Plant parts	References
α-Thujene	<0.01	Flowers and leaves	[97]
Valencene	<0.01–1.9	Aerial parts, flowers and leaves	[93,97]
Valerianone	1.4	Leaves	[95]
Viridiflorol	0.7–0.8	Aerial parts	[85,89,93,94]
Vulgarol-β	0.7	Aerial parts	[93]
α-Ylangene	<0.01–0.5	Aerial parts, flowers and leaves	[85,89,93,94,97]

studies carried out so far indicate that the species has potential as herbal medicine. Therefore, there is need to validate the documented ethnomedicinal uses of *H. cymosum* through advanced phytochemical and pharmacological studies. There is a lack of *in vivo* and clinical research on *H. cymosum* and compounds isolated from the species. Further research is required to establish the safety profiles of different *H. cymosum* preparations. Therefore, future studies should address these knowledge gaps through experimental animal studies, randomized clinical trials, and target-organ toxicity studies involving *H. cymosum* crude extracts and compounds isolated from the species.

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AUTHOR'S CONTRIBUTIONS

The author declares that this work was done by the author named in this article.

CONFLICTS OF INTEREST

The author declares that he has no conflict of interest.

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