**SCABIOSA COLUMBARIA: A REVIEW OF ITS MEDICINAL USES, PHYTOCHEMISTRY, AND BIOLOGICAL ACTIVITIES**

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**ABSTRACT**

*Scabiosa columbaria* is a perennial herb widely used as herbal medicine throughout its distributional range in tropical Africa, Asia, and Europe. This study is aimed at providing a critical review of the biological activities, phytochemistry, and medicinal uses of *Scabiosa columbaria*. Documented information on biological activities, medicinal uses, and phytochemistry of *S. columbaria* was collected from several online sources which included BMC, Scopus, SciFinder, Google Scholar, ScienceDirect, Elsevier, PubMed, and Web of Science. Additional information on the biological activities, phytochemistry, and medicinal uses of *S. columbaria* was gathered from pre-electronic sources such as books, journals, articles, theses, and scientific publications sourced from the university library. This study showed that the aerial parts, leaves, roots, stems, and the whole plant parts of *S. columbaria* are used as colic, love charm and for magical purposes, and as herbal medicine for eye problems, heartburn, respiratory problems, wounds, female infertility, venereal diseases, skin infections, and menstrual problems. Phytochemical compounds identified from the aerial parts and roots of *S. columbaria* are glycoside scabiosin, loganic, sveroside, palmitic acid, phthalic acid, diisooctyl phthalate, bis-(ethylhexyl) phthalate, and dibutyl phthalate. Pharmacological research revealed that *S. columbaria* extracts and compounds have antibacterial, antifungal, and antiprotozoan activities. Future research should focus on evaluating the phytochemical, pharmacological, and toxicological properties of *S. columbaria* crude extracts as well as compounds isolated from the species.

**Keywords:** *Caprifoliaceae*, *Dipsacaceae*, Ethnopharmacology, Herbal medicine, Indigenous pharmacopeia, *Scabiosa columbaria*.

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**INTRODUCTION**

*Scabiosa columbaria* L. is a member of the *Dipsacaceae* or teasel family. Although the species is often included in the family *Caprifoliaceae* in some classification systems [1-3], the phylogenetic analyses of both the chloroplast and nuclear genomes as well as their combination show that *Dipsacaceae* is a monophyletic group [4-11]. The *Dipsacaceae* family contains about 300 species of annual and perennial herbs or shrubs that have been recorded mainly in the Mediterranean Basin, with about 20% distributed in Asia, Eastern and Southern Africa [7,1,12]. The genus *Scabiosa* L. has been recorded in Europe, primarily in the Mediterranean Basin (five species and two species complexes that include about 14 taxa), Asia (12 species), and Eastern and Southern Africa (eight species) [13]. The species of *Scabiosa* are mainly annuals; others are perennials, with some of the species characterized by woody rootstocks [14]. Several species of the genus *Scabiosa* are widely used in the food, cosmetic, and pharmaceutical industries [15]. The biological activities of *Scabiosa* species include antibacterial, analgesic, anti-diabetic, hepatoprotective, anti-inflammatory, antifungal, antioxidant, antiviral, and anti-parasitic and these pharmacological activities are closely related to its high content of phenolic compounds, and these activities corroborate the beneficial properties of these medicinal plants [16].

Research by Van Wyk [17] showed that the leaves and roots of *S. columbaria* L. have commercial potential as colic and herbal medicine for heartburn in South Africa. Moreover, the roots and whole plants of *S. columbaria* are sold as herbal medicines in informal herbal medicine markets in 66.7% of the provinces in South Africa, that is, in the Eastern Cape [18], Gauteng [19-22], KwaZulu-Natal [23], Limpopo [24], Mpumalanga [22], and Northern Cape [25] Provinces. Williams [19] categorized *S. columbaria* as a fast-selling and popular herbal medicine, with its roots purchased at least once a day in the Witwatersrand herbal medicine informal market in the Gauteng Province in South Africa. Research by Williams et al. [26] showed that 58% of informal herbal medicine shops in the Gauteng Province were selling the whole plants of *S. columbaria* in 1995 at prices ranging from R77.5 to R98.6/kg (US$21.3–US$27.2). *S. columbaria* has been incorporated into the traditional material medicin in South Africa and is included in the book “medicinal plants of South Africa,” a photographic guide to the most commonly used plant medicines in the country, with a potential contribution to primary health care of local communities in South Africa. Therefore, this is the rationale behind the current study, aimed at providing a critical review of the ethnomedicinal uses, phytochemistry, and biological activities of *S. columbaria* as well as exploring the potential of the species as herbal medicine.

**BOTANICAL DESCRIPTION OF S. COLUMBARIA**

*S. columbaria* is native to Southern, East and North Africa, temperate Asia and Europe [27-46]. In Europe, *S. columbaria* has been recorded exclusively in semi-dry or dry grasslands, a vegetation type which has been drastically reduced in the Swiss lowlands, and to a lesser extent in the Pre-alps and the Swiss Jura mountains, due to land-use changes and transformation processes in the last decades [47]. In Italy, *S. columbaria* has been recorded in grasslands, arid pastures, nutrient poor habitats, grazed, and mown calcareous grasslands [48]. *S. columbaria* is considered endangered in the Netherlands [49,50], the Pre-alps and the Swiss Jura mountains in Northern Switzerland [51]. In Africa, *S. columbaria* has been recorded in open woodland, grassland, Bushveld, sandy flats, rocky slopes, mountain slopes, and valleys at an altitude ranging from 5 m to 3475 m above sea level [28,33,34]. The genus name “Scabiosa” is derived from the word scabies meaning “to scratch” because, in medieval times, the species was used as an herbal medicine for scabies, skin sores, and other skin infections [52]. The specific epithet, “columbaria” is a Latinized word meaning “dove-like or dove-colored” in reference to some flower forms of the genus name “Scabiosa” [46,52]. Two infra species of *S. columbaria* are recognized,
namely *S. columbaria* subsp. *banatica* (Waldst. and Kit.) Diklic, and *S. columbaria* subsp. *Caespitosa* Jamzad. The common English names of *S. columbaria* include butterfly blue and wild scabious [53].

*S. columbaria* is a perennial evergreen herb up to 1 m in height with annual branches developing from persistent fleshy roots [52,53]. The leaves are ob lanceolate in shape, thin-textured, slightly hairy, and variable in shape with characteristically lobed margins forming a rosette on the ground. The basal leaves have serrated margins, while those higher on the stems have deeply lobed margins. The long, slender, erect, and seldom branched stems have a terminal head of small flowers which are surrounded by bristly bracts. The flowers are compact, pink, and sometimes white or lilac in color [52].

**MEDICINAL USES OF S. COLUMBARIA**

The aerial parts, leaves, roots, stems, and the whole plant parts of *S. columbaria* are used as herbal medicines against 20 human diseases in Southern Africa and Europe (Table 1). *S. columbaria* is mainly used as colic, love charm, and for magical purposes, and as an herbal medicine for eye problems, heartburn, respiratory problems, wounds, female infertility, venereal diseases, skin infections, and menstrual problems (Fig. 1). In Lesotho, the roots of *S. columbaria* are mixed with those of *Diconoma anomala* Sond. or leaves of *Asclepias humilis* (E. Mey.) Schltr. and rhizome of *Gunniera perpensa* L. or those of *Searsia divaricata* (Eckl. & Zeyh.) Moffett and *Cussonia paniculata* Thumb. as herbal medicine for menstrual problems [54-59]. The roots of *S. columbaria* are mixed with those of *S. divaricata* and *C. paniculata* and used as colic [54]. The roots of *S. columbaria* are mixed with those of Aster bakerianus Burtt Davy ex C.A.Sm. as herbal medicine for skin rash [60,61] and roots of *S. columbaria* are mixed with those of *D. anomala*, *Helichrysum caespititium* (DC.) Sond. ex Harv. and *Zantedeschia albomaculata* (Hook.) Baill. as herbal medicine for venereal diseases [59,62,63]. Apart from its usage as herbal medicine, *S. columbaria* is also used as a leafy vegetable in Italy [64].

**PHYTOCHEMISTRY OF S. COLUMBARIA**

The compound glycoside scabiosin has been isolated from the roots of *S. columbaria* [66] while Horn et al. [73] identified two iridoid glycosides, namely, loganin and sweroside from the roots of *S. columbaria*. Vinitska [93] isolated palmitic acid, phthalic acid, diisooctyl phthalate, bis-(ethylhexyl) phthalate, and dibutyl phthalate from the aerial parts of *S. columbaria*. Horn et al. [73] evaluated the antibacterial activities of the compounds loganin and sweroside isolated from the roots of *S. columbaria* against *Bacillus cereus*, *Bacillus pumilus*, *Bacillus subtilis*, *Cussonia paniculata*, *D. anomala*, *Helichrysum caespititium*, *Kaliya caespititium*, *Leucadendron caesiatum*, *Plectranthus caesiatum*, *Scabiosa columbaria* and *Zantedeschia albomaculata* (Hook.) Baill. as herbal medicine for venereal diseases [59,62,63]. Apart from its usage as herbal medicine, *S. columbaria* is also used as a leafy vegetable in Italy [64].

### Table 1: Medicinal uses of Scabiosa columbaria

| Medicinal use                               | Parts of the plant used                                                                 | Country                      | References |
|---------------------------------------------|------------------------------------------------------------------------------------------|------------------------------|------------|
| Abdominal pains                             | Roots and stems                                                                          | Lesotho                      | [65]       |
| Augmentation of labor                       | Roots                                                                                    | Lesotho                      | [54,60]    |
| Broncho-sedative, fluidizing, purifying, and | Roots                                                                                    | Italy                        | [48]       |
| dialagogue                                  |                                                                                         |                              |            |
| Chills                                       | Roots                                                                                    | Italy                        | [48]       |
| Colic                                       | Leaves and roots                                                                         | South Africa and Swaziland   | [52,53,66-69]|            |
| Menstrual problems                          | Roots mixed with *Searsia divaricata* (Eckl. and Zeyh.) *Moffett* and *Cussonia paniculata* Thumb | Lesotho                      | [54]       |
| Constipation                                | Whole plant                                                                              | Turkey                       | [70]       |
| Diuretic                                    | Whole plant                                                                              | Turkey                       | [70]       |
| Eye problems                                | Leaves and roots                                                                         | South Africa and Swaziland   | [67,67,71] |
| Female infertility                          | Roots                                                                                    | Lesotho and South Africa     | [52,57,60,66,67,72-75]|          |
| Heartburn                                   | Leaves and roots                                                                         | South Africa and Swaziland   | [52,53,68,69]|            |
| High blood pressure                         | Roots                                                                                    | Lesotho                      | [76,77]    |
| Love charm and magical purposes             |                                                                                         | South Africa and Swaziland   | [68,71,78,79]|            |
| Menstrual problems                          | Leaves, roots, and stems                                                                 | Lesotho, South Africa, and   | [52,65,67,68,72,74,76,77,80]|          |
| Menstrual problems                          | Roots mixed with *Diconoma anomala* Sond. and leaves of *Asclepias humilis* (E. Mey.) Schltr. and rhizome of *Gunniera perpensa* L. | Lesotho                      | [54,55,59]|            |
| Menstrual problems                          | Roots mixed with leaves of *Asclepias humilis* (E. Mey.) Schltr. and rhizome of *Gunniera perpensa* L. | Lesotho                      | [56-58]    |
| Menstrual problems                          |                                                                                         | Lesotho                      | [54]       |
| Menstrual problems                          | Leaves and roots                                                                         | Lesotho                      | [57,60,76,77]|            |
| Menstrual problems                          | Aerial parts, leaves, and roots                                                          | Iberian Peninsula and        | [76,77,82-84]|          |
| Respiratory problems, diphtheria, and flu    | Leaves, roots, and stems                                                                 | Lesotho                      | [48,79,85] |
| Skin infections (acariosis, dermatitis, eczema, follicular acne, fungus-borne skin disease, measles, and rash) | Roots mixed with *Aster bakerianus* Burtt Davy ex C.A.Sm. | Lesotho                      | [60,61]    |
| Skin rash                                   | Leaves and roots                                                                         | Lesotho                      | [76,86]    |
| Uterine disorders                           | Roots mixed with *D. anomala*, *Helichrysum caespititium* (DC) Sond. ex Harv. and *Zantedeschia albomaculata* (Hook.) Baill. | Lesotho                      | [59,62,63] |
| Veneral sores                                | Roots                                                                                    | Lesotho and South Africa     | [53,54,60,66,67,72,77,81,87,88]|          |
| Wounds                                      | Leaves, roots, and whole plant                                                           | South Africa and Turkey      | [53,70,89-92]|          |
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Micrococcus kristinae, Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Enterobacter cloacae, and Serratia marcescens at concentrations of 0.001 mg/ml–1.0 mg/ml. The compound sweroside showed moderate activities at a concentration of 1.0 mg/ml against all tested pathogens with the exception of S. marcescens [73].

BIOLGICAL ACTIVITIES OF S. COLUMBARIA EXTRACTS

From literature, only antibacterial [77,88], antifungal [88], and antiprotozoan [89] activities were identified.

Antibacterial activities
Van Vuuren and Naidoo [88] evaluated antibacterial activities of aqueous and a mixture of methanol and dichloromethane (1:1) leaf and root extracts of S. columbaria against bacterial pathogens associated with urogenital or sexually transmitted infections which included Gardnerella vaginalis, Neisseria gonorrhoeae, Oligella ureolytica, and Ureaplasma urealyticum using the microdilution technique with ciprofloxacin (0.01 mg/ml) as a positive control. The extracts exhibited activities with minimal inhibitory concentration (MIC) values ranging from 2.0 mg/ml to >16.0 mg/ml which were higher than 0.1 mg/ml exhibited by the control [88]. Seleteng-Kose [77] evaluated the antibacterial activities of aqueous and organic root extracts of S. columbaria against Citrobacter freundii, Enterobacter hormaenidis, K. pneumoniae, Moraxella catarrhalis, Mycobacterium fortuitum, Mycobacterium smegmatis, and S. aureus using microdilution technique using ciprofloxacin (0.01 mg/ml) as a positive control. The extracts showed activities against all tested microorganisms with the exception of Mycobacterium fortuitum and Mycobacterium smegmatis, exhibiting MIC values ranging from 1.3 mg/ml to >8.0 mg/ml [77].

Antifungal activities
Van Vuuren and Naidoo [88] evaluated antifungal activities of aqueous and a mixture of methanol and dichloromethane (1:1) leaf and root extracts of S. columbaria against fungal pathogen associated with urogenital or sexually transmitted infections, Candida albicans using the microdilution technique with amphotericin B (0.1 mg/ml) as a positive control. The extracts showed activities against all tested microorganisms with the exception of Mycobacterium fortuitum and Mycobacterium smegmatis, exhibiting MIC values ranging from 1.3 mg/ml to >8.0 mg/ml [77].

Antiprotozoan activities
Van Vuuren and Naidoo [88] evaluated antiprotozoal activities of aqueous and a mixture of methanol and dichloromethane (1:1) leaf and root extracts of S. columbaria against protozoan pathogen associated with urogenital or sexually transmitted infections, Trichomonas vaginalis using the microdilution technique with ciprofloxacin (0.01 mg/ml) as a positive control. The extracts exhibited activities with MIC values ranging from 3.0 mg/ml to >16.0 mg/ml which were higher than 0.1 mg/ml exhibited by the control [88].

CONCLUSION

The diverse medicinal uses of S. columbaria documented throughout the distributional range of the species and the scientific evidence of its phytochemistry and biological activities indicates its potential as herbal medicine. The preliminary pharmacological activities carried out so far are directly or indirectly involved in the protection against the growth of undesirable microbes. There is a need for further research on the phytochemistry, pharmacological, and toxicological activities of the crude extracts and compounds isolated from the species. Future research should also focus on the clinical significance of the pharmacological properties, cytotoxicity, and toxicity using in vivo models. The biological potency of such phytochemicals and crude extracts need to be evaluated aimed at exploring the potential of the species as herbal medicine.

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AUTHORS’ CONTRIBUTIONS

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

CONFLICTS OF INTEREST

The author declares that they have no conflicts of interest.

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