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FUNCTIONAL AND MEDICINAL PROPERTIES OF *SEARSIA UNDULATA* (KUNI-BUSH): A NARRATIVE REVIEW

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ABSTRACT

Plant species continue to provide humans with new remedies and also play an important role as sources of vitamins, amino acids, minerals and trace elements that are important for maintaining health and preventing diseases. *Searsia undulata* is an evergreen tree well-known for its edible fruits, and also widely used in traditional medicine. The current study was aimed at documenting the functional and medicinal uses of *S. undulata*, including its phytochemical and pharmacological properties. Research articles on functional and ethnopharmacological properties of *S. undulata* were searched from online databases such as PubMed®, Web of Science, SciELO, Google Scholar, ScienceDirect®, SpringerLink® and Scopus® and also pre-electronic literature obtained from the university library. This study showed that the fruits of *S. undulata* are used as a snack, non-alcoholic and alcoholic beverage, and a sweet preserve throughout the distributional range of the species in Namibia and South Africa. The bark, leaves and roots of *S. undulata* are used in post partem recovery, and also in traditional medicine to treat and/or manage 18 human diseases and ailments, including chest ailments, colds, gastro-intestinal problems, influenza and stomach problems. Ethnopharmacological research conducted so far, showed that *S. undulata* extracts and phytochemical compounds isolated from the species demonstrated antibacterial, antimycobacterial, antifungal, anti-inflammatory, antioxidant and cytotoxicity activities. The importance of *S. undulata* for the survival of local communities in Namibia and South Africa and their livelihoods are demonstrated in recognition of this taxon as a multipurpose species, not only important as food plant and source of herbal medicines, but associated with provision of several ecosystem services and goods. This review highlights the need for detailed nutritional and ethnopharmacological studies of *S. undulata* focusing on its nutritional, phytochemical, biological and toxicological properties, *in vivo* and clinical studies. Such ethnopharmacological research focusing on functional and medicinal properties of *S. undulata* is likely to see an increased recognition given to these uses and values of the species, and their essential role in promoting sustainable development and poverty alleviation.

Key words: Anacardiaceae, functional, *materia medica, Searsia undulata,* southern Africa, traditional medicine

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INTRODUCTION

Searsia undulata (Figure 1) is a member of the Anacardiaceae family commonly known as wild currant, sumac or cashew family. The Anacardiaceae family consists of approximately 860 species distributed in 83 genera, and the majority of these taxa are shrubs and trees with a couple of climbers or lianas [1]. The species belonging to the Anacardiaceae family have been recorded in dry habitats such as desert biomes, coastal scrub, forest, woodland and grassland in Central America, Central Africa, Madagascar, Mediterranean, Indochina and Malaysia [2]. Some of the economically important species belonging to the Anacardiaceae family and widely grown as food plants include *Mandifera indica* (mango), *Anacardium occidentalis* (cashew), *Rhus coriaria* (sumac), *Pistacia vera* (pistachio), *Sclerocarya birrea* (marula), *Schinus areira* and *S. terebinthifolia*, commonly referred to as pink peppercorn [3,4]. In tropical Africa, several species of the Anacardiaceae belonging to the genus *Searsia* are regarded as functional food plants and these include *S. undulata*, *S. burchellii*, *S. gerrardii*, *S. dentata*, *S. lancea, S. longipes*, *S. pendulina*, *S. natalensis*, *S. tenuinervis* and *S. pyroides* [5-8]. *Searsia undulata* is a multipurpose plant species, with its bark producing a dye, traditionally used for tanning leather [8,9]. *Searsia undulata* is an important source of timber, mainly used as firewood as its wood forms charcoal, burning for long periods, and used for cooking, heating and ironing [10,11]. The wood of *S. undulata* is considered to be one of the most important and best quality firewood in Namaqualand in Namibia and South Africa [8,10,11], and its wood often sold in informal markets. *Searsia undulata* is easily grown from seed, cuttings, truncheons or by layering, and is fairly fast-growing. In South Africa, the species is grown as an ornamental, decorative tree in recreational parks, private gardens and along streets in urban centres, and also shortlisted for use in rehabilitation of mining sites [12]. *Searsia undulata* is also a valuable fodder tree, as its foliage is browsed by livestock and game, and birds eat its seeds which make an excellent poultry food [9]. The fruits of *S. undulata* are used as a snack, non-alcoholic beverage, alcoholic beverage and sweet preserve throughout the distributional range of the species in Namibia and South Africa [6,8,13,14]. Similarly, the medicinal properties, administration and dosage of the species, its active ingredients and pharmacological effects of *S. undulata* are outlined in three monographs focusing on medicinal plants in southern Africa, namely, “The medicinal and poisonous plants of southern and eastern Africa” [15], “Medicinal and magical plants of southern Africa: An annotated checklist” [16], “Medicinal plants of South Africa” [17] and “People’s plants: A guide to useful plants of southern Africa” [8]. Nutritional, phytochemical and biological activities of *S. undulata* are included in several databases, and therefore, underscoring the need for inclusion of this species in the diet or *materia medica* of local communities in the future. Moreover, recent

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research showed that the fruits of *S. undulata* and the closely related *S. lancea* have commercial potential in South Africa in the production of a wide diversity of food products and additives such as fresh and dried fruits, processed products and traditional sweets for both local and international markets [6,14]. It is, therefore, within this context that the current study was undertaken aimed at reviewing the functional and medicinal of *S. undulata*.

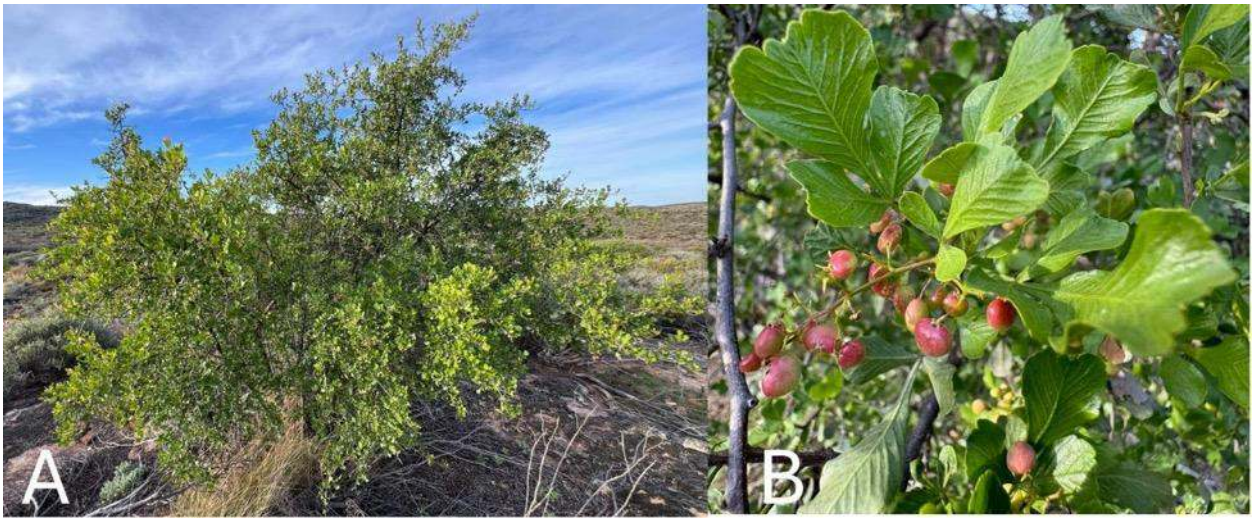

Figure 1: *Searsia undulata*. A: general habit of the species and B: a branch showing leaves and fruits (Photos: K Du Toit)

MATERIALS AND METHODS

The literature search for the functional and medicinal properties of *S. undulata* was conducted from August 2023 to May 2024 using the electronic search for peer-reviewed scientific publications, published books and book chapters. Online search databases used included Web of Science, Scopus®, SpringerLink®, Google Scholar, SciELO, PubMed® and ScienceDirect®. Pre-electronic sources which included books, book chapters, journal articles, dissertations and theses were obtained from the University library. The key words used in the search included "*Searsia undulata*", the synonyms of the species "*Searsia undulata"* and English common names "kuni-bush" and "Namaqua kuni-bush". Additional search was also conducted using the key words "biological activities of *Searsia undulata*", "pharmacological properties of *Searsia undulata*", "ethnobotany of *Searsia undulata*", "food uses of *Searsia undulata*", "medicinal uses of *Searsia undulata*", "nutraceutical properties of *Searsia undulata",* "phytochemistry of *Searsia undulata*" and "traditional uses of *Searsia undulata".* Literature sources excluded from this narrative review are those articles that could be accessed as abstracts only, and also those published or unpublished ethnopharmacological surveys lacking

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information on functional, medicinal uses, phytochemistry, pharmacological or biological activities of *S. undulata.*

RESULTS AND DISCUSSION

Taxonomy and morphological description of *Searsia undulata*

The genus *Searsia* consists of trees or shrubs, which are usually dioecious, rarely with bisexual flowers. This genus has approximately 111 species distributed in the tropics and subtropics in continental Africa, north east India, Bhutan, south west China and north Myanmar [18,19]. The genus name "*Searsia*" is in honour of Paul Bigelow Sears (who lived from 17 December 1891 to 30 April 1990), an American ecologist, botanist and conservationist who pioneered the study of fossil pollen in the USA and also served as head of the Yale School of Botany [20]. The specific name "*undulata*" is a Latin word for "waxy", in reference to undulate margins of the leaflets of this species [21]. The synonyms of *S. undulata* include *Rhus aglaophylla*, *R. celastroides*, *R. excisa*. var. *excisa*, *R. nervosa*, *R. spathulata*, *R. theesans*, *R. undulata*, *R. undulata* var. *celastroides*, *R. undulata* var. *genuina*, *R. undulata* var. *genuina* forma *contracta*, *R. undulata* var. *genuina* forma *excisa*, *R. undulata* var. *genuina* forma *undulata*, *R. undulata* var. *undulata*, *R. undulata* var. *undulata* forma *contracta*, *R. undulata* var. *undulata* forma *excisa*, *Toxicodendron celastroides* and *T. undulatum* [18,22,23]. The English common names of *S. undulata* include "kuni-bush" and "Namaqua kuni-bush" [5,22].

Searsia undulata is an evergreen, dioecious, much-branched and multi-stemmed shrub or small tree growing up to 6 metres in height and sometimes up to 23 cm in diameter [5,23]. The bark is grey to brown, smooth to granular, branches dark brown, spreading branchlets often ribbed and ending in short stiff spur-branchlets and sometimes spine-tipped. The leaves of *S. undulata* are trifoliate, with leaflets that are sessile, aromatic when crushed, obovate to oblanceolate in shape, lateral leaflets slightly smaller, leathery to thinly-textured, narrowing to the base, with the apex pointed, rounded or flat with a pronounced dent in the middle and often with a thorn-like point. The leaflets are yellow-green to dark green in colour, sometimes grow on stout spiny twigs, sometimes on spineless branches, the margins usually untoothed, at times not conspicuously resinous, at others shiny, sticky to the touch, usually much undulate or waxy. The leaf stalk is sometimes slightly winged. The flowers are small, creamy in colour, sweetly-scented, occurring in lax bunches borne in the axils of the leaves or more often terminally. The fruits are small, roundish, somewhat flattened, shiny, thinly fleshy, green and turning red when ripe. *Searsia undulata* has been recorded on limestone formations in scrub on hills and mountain slopes and along dry river beds in the interior [5,22]. This widely spread and variable species has been recorded in arid areas, often in rocky places in

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southern and southwestern Cape in South Africa northwards to southern Namibia at an altitude ranging from 20 m to 1250 m above sea level [18,21,24-27].

Searsia undulata as a functional food

The ripe fruits of *S. undulata* are edible and traditionally used as ferment in mead or honey beer [8]. The fruits of *S. undulata* are rubbed between the palms of the hands or winnowing to remove the tough skins. They are then eaten fresh or soaked overnight in milk to form a kind of curd or traditional sources of yeast for brewing [8]. The fruits of *S. undulata* are mixed with the gum of *Vachellia karroo* (family Fabaceae) to make a sticky sweet with a taste reminiscent of dates [8]. Herbal tea is also made from the fruits of *S. undulata* [9]. The fruits of *S. undulata* are a good source of energy, minerals such as calcium, copper, iron, magnesium, phosphorus, zinc and classic nutrients such as carbohydrates, proteins, fats, fibre and vitamins (Table 1). The fruit pulp of *S. undulata* is nutritious by virtue of having high amounts of carbohydrates, protein, vitamins, phosphorus, magnesium, manganese, fibre, potassium, iron, sodium, copper, zinc and calcium (Table 1). When compared to the recommended dietary allowance (RDA) representing the average daily intake of essential nutrients that are sufficient to meet the nutrient requirements of a health person (Tables 1), *S. undulata* shows good proportions of essential nutrients. Research by Welcome and Van Wyk [13] showed that the fruits of *S. undulata* form the mainstay of the vegetable diet of the Cape Khoekhoe cultural group in an arid region of Namaqualand in Namibia and South Africa.

Searsia undulata as a source of traditional medicines

Searsia undulata is an important component of the traditional pharmacopeia of Namaqualand in southern and southwestern Cape in South Africa (Table 2). Traditional medicines prepared from the bark, leaves and roots of *S. undulata* are used to treat and/or manage 18 human diseases and ailments (Table 2). The main diseases and ailments treated by *S. undulata* extracts include chest ailments, colds, gastro-intestinal problems, influenza, stomach problems and as post partem (Figure 2). Research conducted by Wheat [9] showed that crushed leaves of *S. undulata* are mixed with kidney fat and used against abscesses, boils and ringworm as ointment or plaster. Herbal tea made from the leaves of *S. undulata* mixed with those of *Mentha longifolia*, *Salvia dentata* and *Stachys rugosa* (all members of Lamiaceae family) is taken orally as traditional medicine for colds and influenza [9].

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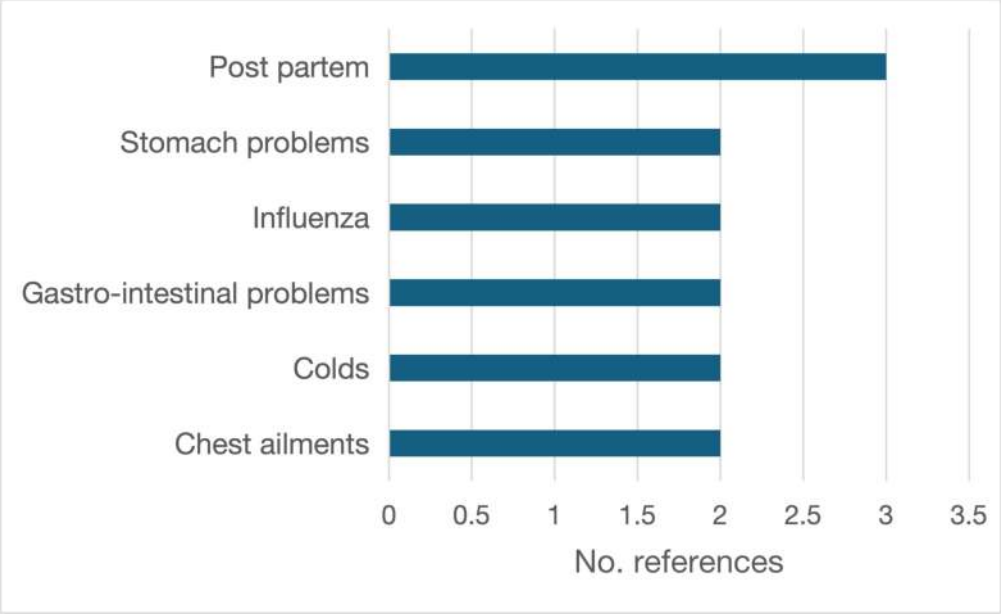

Figure 2: Main diseases and ailments treated and managed using *Searsia undulata* extracts

Phytochemical and pharmacological properties of *Searsia undulata*

Pharmacological research conducted so far, showed that *S. undulata* extracts and phytochemical compounds isolated from the species demonstrated antibacterial, antimycobacterial, antifungal, anti-inflammatory, antioxidant and cytotoxicity activities. Research conducted by Fourie and Snyckers [31] showed that apigenin dimethylether isolated from the roots of *R. undulata* demonstrated anti-inflammatory activities, producing inhibitory effects on carrageenan-induced oedema in rats. Wheat [9] evaluated the antioxidant activities of ethanolic extracts of *S. undulata* leaves and shoots using the 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) free radical scavenging assay. The extracts exhibited moderate antioxidant activities [9]. Similarly, Wheat (2013) also evaluated the antifungal activities of ethanolic extracts of *S. undulata* leaves and shoots against *Candida albicans* using the serial microdilution assay. The extracts exhibited antifungal activities [9].

Wheat [9] evaluated the antibacterial activities of ethanolic extracts of *S. undulata* leaves and shoots against *Escherichia coli* and *Staphylococcus aureus* using the serial microdilution assay. The extracts exhibited antibacterial activities [9]. Kabongo *et al.* [32] and Kabongo-Kayoka *et al.* [33] evaluated the antimycobacterial activities of acetone extracts of *S. undulata* leaves against *Mycobacterium smegmatis* (ATCC 1441), *Mycobacterium bovis* BCG, *Mycobacterium tuberculosis* H37Ra, *Mycobacterium fortuitum* (ATCC 6841) and *Mycobacterium aurum* (NCTC 10437) using the twofold serial microdilution assay with ciprofloxacin, isoniazid, rifampicin and streptomycin as positive controls. The

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extracts demonstrated activities with the minimum inhibition concentration (MIC) values ranging from 0.05 mg/ml to 0.11 mg/ml [32,33]. The compound betulonic acid isolated from the leaves of *S. undulata* exhibited MIC values ranging from 23.4 µg/ml to 250.0 µg/ml against the *Mycobacterium* species [34]. Kabongo-Kayoka *et al*. [32] also evaluated the cytotoxicity activities of acetone extracts of *S. undulata* leaves using a 3-(4,5-dimethylthiazol)-2, 5-diphenyl tetrazolium bromide (MTT) colorimetric assay against C3A liver cells, Vero kidney cells and RAW 264.7 murine macrophage cells. The extract exhibited cytotoxicity activities with median lethal concentration (LC_{50}) values ranging from 0.03 mg/ml to 0.5 mg/ml [32]. The compound betulonic acid isolated from the leaves of *S. undulata* exhibited activities with LC_{50} value of 47.7 µg/ml against Vero kidney cells [34].

Future research and perspective

Searsia undulata provides substantial nutritional, health and ecological benefits to local communities in Namaqualand in Namibia and South Africa. Members of the local community depend on this species as a source of edible fruits and source of traditional medicines. There has been growing interest in the field of functional foods in the last 30 years [35], and the focus is mainly on food plants which contain potentially health-promoting active ingredients which can also provide medicinal or health benefits, such as prevention, treatment and management of diseases or ailments [36]. Although *S. undulata* has the potential to enhance food and health security of local communities in southern Africa, it seems policy makers, researchers, local and global markets are still to fully harness the food and health-promoting characteristics associated with the species. This study showed that *S. undulata* as a functional food is important for food, nutrition security and health.

The Functional Food Center, California, United States of America defines functional food as “natural or processed foods that contain biologically-active compounds, which, in defined, effective, non-toxic amounts, provide a clinically proven and documented health benefit utilizing specific biomarkers, to promote optimal health and reduce the risk of chronic or viral diseases and manage their symptoms" [37,38]. The Functional Food Center has created a classification system categorizing functional foods as A, B or C based on research on their epidemiological and after market studies and the quality of evidence for the functional food product [37,38]. A classification of A shows that aftermarket research, epidemiological studies and certification of the functional food status has been completed, B indicates completion of epidemiological studies and certification while C indicates that the product has only been certified as functional [38]. Current research focusing on functional foods is emphasizing the importance of the international regulatory framework for health-related claims associated with functional foods, particularly the use of these claims in the labelling of functional

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products [39]. Furthermore, Adany *et al.* [40] and Martirosyan *et al.* [38] argue that functional foods should undergo a thorough evaluation process, including publishing such findings in peer reviewed journals to ensure that only safe and effective products will be released to the market. Based on the Functional Food Center's classification system, *S. undulata* can be accorded a C classification category as there are numerous gaps in aftermarket research, epidemiological studies and certification of the functional food status of the species. Amidst heightened consumer demand for plants with functional and medicinal properties such as *S. undulata*, there is mounting pressure from regulatory agencies to assess prioritizing quality, safety and efficacy of pharmaceutical products from such species to safeguard public health. Unfortunately, there is a lack of rigorous safety and efficacy evaluations of the species. Therefore, there is a need for detailed studies aimed at elucidating the micronutrients and phytochemical compounds associated with *S. undulata* that are important for human nutrition and health, and also toxicological evaluations, *in vivo* and clinical studies. Therefore, this review will add valuable literature on an important plant species in Namaqualand that is widely used for local livelihood needs and income generation, particularly by the rural poor and those people living in marginalized areas and deriving their livelihoods from plant biodiversity. Therefore, management and use of *S. undulata* offers enormous potential for contributing to household nutrition and health. Ethnopharmacological research focusing on nutritional and medicinal continuum of *S. undulata* are recommended as results from such research will influence public health knowledge and also inform the health policy.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The present review provides a summary of the food and medicinal uses of *S. undulata*, its phytochemical and pharmacological properties. Such functional and ethnopharmacological studies are important for plant species widely used as food plant and a source of traditional medicines. However, detailed studies focusing on nutritional, phytochemical and pharmacological properties, toxicity and safety, mechanisms of action *in vivo,* and clinical research aimed at corroborating the traditional medical applications of the species are recommended. This study contributes to the existing traditional knowledge about *S. undulata* that could be useful in bio-prospecting for new health-promoting and pharmaceutical products. Compilation of the biological properties of *S. undulata* is an important step towards identification of knowledge gaps required to protect consumers from non-standardized herbal medicine usage of such plant species.

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Table 1: Nutritional composition of *Searsia undulata* fruits after Wehmeyer [28] and compared with the recommended dietary allowance (RDA)

Nutritional composition	Values	Recommended dietary allowance (RDA)
Ash (g/100g)	2.6	-
Calcium (mg/100g)	189.0	1.0 – 2.0
Carbohydrates (g/100g)	55.0	130.0
Copper (mg/100g)	3.7	1.0 – 2.0
Crude fibre (g/100g)	19.4	25.0 – 38.0
Energy kj/100g	1187.0	-
Fat (g/100g)	4.7	300.0
Iron (mg/100g)	3.7	8.0 – 15.0
Magnesium (mg/100g)	56.9	310.0 – 320.0
Manganese (mg/100g)	1.7	1.8 – 2.3
Moisture (g/100g)	13.3	-
Nicotimic acid (mg/100g)	2.6	16.0 – 35.0
Phosphorus (mg/100g)	116.0	1250.0
Potassium (mg/100g)	939.0	4700.0
Protein (g/100g)	5.0	34.0
Riboflavin (mg/100g)	0.02	0.3 – 1.6
Sodium (mg/100g)	43.9	2300.0
Thiamin (mg/100g)	0.1	1.0 – 2.0
Vitamin C (mg/100g)	6.4	46.0
Zinc (mg/100g)	2.9	8.0 – 11.0

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Table 2: Medicinal uses of *Searsia undulata*

Medicinal application	Plant part used	Reference
Mono-therapeutic applications		
Abscesses	Crushed leaves mixed with kidney fat and used as ointment or plaster	[9]
Aches	Not specified	[29]
Backache	Bark, leaf and root infusion taken orally	[30]
Boils	Crushed leaves mixed with kidney fat and used as ointment or plaster	[9]
Chest ailments	Bark, leaf and root infusion taken orally	[5,30]
Colds	Bark, leaf and root infusion taken orally	[30]
Cough	Bark, leaf and root infusion taken orally	[30]
Galactagogue	Not specified	[14]
Gastro-intestinal tract problems	Bark, leaf and root decoction taken orally	[17,31]
Heart diseases	Leaf infusion taken orally	[5]
Influenza	Not specified	[29]
Kidney ailments	Bark, leaf and root infusion taken orally	[30]
Pains	Not specified	[29]
Post partem	Leaf decoction taken orally	[15,17,22]
Ringworm	Crushed leaves mixed with kidney fat and used as ointment or plaster	[9]
Stomach ailments	Not specified	[29]
Stomach cramps	Not specified	[14]
Tonic	Not specified	[14]
Used in combination with other species		
Colds	Tea made from the leaves mixed with those of *Mentha longifolia*, *Salvia dentata* and *Stachys rugosa* (all members of Lamiaceae family) and taken orally	[9]
Influenza	Tea made from the leaves mixed with those of *M. longifolia*, *S. dentata* and *S. rugosa* and taken orally	[9]

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