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Review Article
Nutraceutical and Ethnopharmacological Properties of *Searsia lancea* (L.f.) F.A.Barkley (Family Anacardiaceae): A Narrative Review

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Abstract

Searsia lancea (L.f.) F.A.Barkley is an evergreen tree well-known for its edible fruits and is also widely used in traditional medicine. The current study was aimed at documenting medicinal and traditional uses of *S. lancea* and its phytochemical and pharmacological properties. Research articles on nutraceutical and ethnopharmacological properties of *S. lancea* 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. *Searsia lancea* is used as ethnoveterinary medicine and as traditional medicine for fever, measles, sores, wounds, diabetes, sexually transmitted infections, gastrointestinal problems and skin and respiratory infections. Chemical compounds identified from *S. lancea* include alcohol, alkane, amide, flavonoids, naphthalene, alkaloids, terpenoids, phenols, tannins, steroids, anthraquinones and volatile compounds. *Searsia lancea* crude extracts demonstrated anthelmintic, antibacterial, antimycobacterial, antifungal, anticancer, anticholinesterase (AChE), anti-inflammatory, antioxidant, cytotoxicity and nematicidal activities. This review highlights the need for detailed nutraceutical and ethnopharmacological studies of *S. lancea* focusing on its nutritional, phytochemical, biological and toxicological properties, *in vivo* and clinical studies.

Key words: African sumac, Anacardiaceae, karee, materia medica, *Searsia lancea*

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Searsia lancea (L.f.) F.A.Barkley (Fig. 1) is a member of the Anacardiaceae family commonly known as the cashew, sumac, or wild currant family. The Anacardiaceae family consists of approximately 83 genera and 860 species which are mainly shrubs and trees and also climbers[1]. Members of this family have been recorded in dry habitats and desert conditions to coastal scrub, grassland, woodland and forest in Central Africa, Central America, Madagascar, Indochina, Mediterranean and Malaysia[2]. Some of the economically important species belonging to the Anacardiaceae family wildly grown as food plants include *Anacardium occidentale* L. (cashew), *Mangifera indica* L. (mango), *Pistacia vera* L. (pistachio), *Rhus coriaria* L. (sumac), *Schinus areira* L., *S. terebinthifolia* Raddi (pink peppercorn) and *Sclerocarya birrea* (A.Rich.) Hochst. (marula)[2,3]. In tropical Africa, some Anacardiaceae species such as *Harpephyllum caffrum* Bernh., *Lannea acida* A.Rich., *L. discolor* (Sond.) Engl., *L. edulis* (Sond.) Engl., *L. microcarpa* Engl. and K. Krause, *L. schimperi* (Hochst. ex A.Rich.) Engl. and *L. schweinfurthii* (Engl.) Engl.[4-10] are valuable wild fruit trees and are regarded as important sources of vitamins, minerals, amino acids and trace elements. Similarly, several *Searsia* F.A.Barkley species are considered to be functional food plants and these include *S. burchellii* (Sond. ex Engl.) Moffett, *S. dentata* (Thunb.) F.A.Barkley, *S. gerrardii* (Engl.) Moffett, *S. lancea, S. longipes* (Engl.) Moffett, *S. natalensis* (Bernh. ex C.Krauss) F.A.Barkley, *S. pendulina* (Jacq.) Moffett, *S. pyroides* (Burch.) Moffett, *S. tenuinervis* (Engl.) Moffett and *S. undulata* (Jacq.) T.S.Yi, A.J.Mill. & J.Wen[11-16].

The fruits of *S. lancea* are widely used as a snack, non-alcoholic beverage, alcoholic beverage and sweet preserve throughout the distributional range of the species in Southern Africa[14-19]. Recent research showed that the fruits of *S. lancea* and closely related *S. undulata* 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[14].

Searsia lancea is a multipurpose plant species, with its bark producing a brown dye and traditionally used for tanning leather[11]. *Searsia lancea* is also an important source of timber and used for firewood, fence poles, walking sticks, agricultural implements handles, wagon parts and construction material, used as spars in thatching houses, its smaller younger and longer branches are used for different crafts[11,19]. *Searsia lancea* is termite resistant and its wood is reddish brown in color, hard, heavy, tough, durable, close-grained, works and polishes well and has a pleasant smell when fresh[11,12,19]. *Searsia lancea* is easily grown from seed, cuttings, truncheons or by layering and is fairly fast-growing[19]. In South Africa, *S. lancea* is widely grown as an ornamental and decorative tree in recreational parks, private gardens and along streets in urban centres[17,19]. *Searsia lancea* is also a valuable fodder tree, especially in areas hit by drought as foliage is browsed by livestock and game and birds eat its seeds which make an excellent poultry food[18,19]. Literature studies show that wild ruminant mixed feeders readily consume *S. lancea* leaves in free-ranging environments and also as supplementation feed to meet maintenance requirements for captive-managed wild ruminant mixed feeders[20]. *Searsia lancea* is regarded as an important food and medicinal plant species in Southern Africa and the species is included in the monograph "Medicinal and Magical Plants of Southern Africa: An Annotated Checklist[21] and "People's Plants: A Guide to Useful Plants of Southern Africa[11]. It is therefore, within this context that the current study was undertaken aimed at reviewing the medicinal and food uses, phytochemistry and biological activities of *S. lancea*.

Fig. 1: *Searsia lancea* showing a branch with flowers (Photo: BT Wursten)

MATERIALS AND METHODS

The literature search for the nutraceutical and ethnopharmacological properties of *S. lancea* was conducted from September, 2023 to March, 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 thesis were obtained from the university library. The keywords used in the search included "*Searsia lancea*", the synonyms of the species "*Searsia lancea* (L.f.) F.A.Barkley" and English common names "African sumac", "bastard willow", "Karee", "Karoo tree", "Willow crowberry" and "Willow rhus". An additional search was also conducted using the keywords "Biological activities of *Searsia lancea*", "Pharmacological properties of *Searsia lancea*", "Ethnobotany of *Searsia lancea*", "Medicinal uses of *Searsia lancea*", "Nutraceutical properties of *Searsia lancea*", "Phytochemistry of *Searsia lancea*" and "Traditional uses of *Searsia lancea*".

RESULTS AND DISCUSSION

Taxonomy and morphological description of *Searsia lancea*: The genus *Searsia* consists of shrubs or trees, 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[22,23]. The genus name "*Searsia*" is in honour of Paul Bigelow Sears (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[19]. The specific name "*Lancea*" is a Latin word for a light spear or "Lance", about the shape of the leaflets which are lance-shaped[15]. The synonyms of *S. lancea* include *Rhus denudata* Licht. ex Schult., *R. fragrans* Licht. ex Schult., *R. lancea* L.f. and *R. viminalis* Aiton[12,13,22,24]. The English common names of *S. lancea* include "African sumac", "bastard willow", "karee", "Karoo tree", "willow crowberry" and "willow rhus"[13,15,19]. The common name "karee" is derived from the Hottentot or Khoi name for a honey beer, "karrie" from which the name "karoo" is also derived based[25]. The common name "bastard willow" is about the resemblance of *S. lancea* leaflets to the leaves of the "weeping willow", *Salix babylonica* L. (family Salicaceae) and both species have drooping branchlets.

Searsia lancea is an evergreen tree with a loose rounded crown, with a gnarled, dark brown, rough and often twisted and crooked trunk, which is usually fairly erect but the branchlets drooping and growing to about 12 m in height[12,24]. The bark on young branches is smooth and reddish brown, but rough and irregularly cracked, dark brown to blackish on older branches and stems. The slender reddish branchlets are horizontal or hang downwards. The leaves of *S. lancea* are alternate, petiolate, trifoliolate, linear to lanceolate in shape, the center leaflet is usually a little longer than the laterals. The leaflets are usually fairly stiff, smooth, dark olive-green and shiny above, pale yellow-green below, hairless, leathery, apex and base narrowly tapering, usually pointed and completely untoothed. The midrib is raised on both sides of the leaflets. Flowers are small, yellow-green in colour, occurring in dense axillary panicles with male and female flowers on separate trees. The fruit is roundish and slightly flattened and lopsided, a globose, yellowish-green drupe, with a large seed, a thin layer of flesh and a shiny brown outer skin. *Searsia lancea* has been recorded in Botswana, Lesotho, Namibia, South Africa, Zambia and Zimbabwe. *Searsia lancea* is widespread at medium and higher altitudes along the streambanks, watercourses and drainage lines, also on margins of vleis, termite mounds and in woodland where ground water is not far below the surface. It is drought and frost-resistant and *S. lancea* has been recorded on mountains and koppies and often associated with lime, chalky, calcareous and sandy soils, as well as poorly drained soils, like black cotton soil and deep and rich soils in an altitude ranging from 100 to 2300 m above sea level[24]. *Searsia lancea* is also categorized as a weed in the USA, Mexico, Australia and India and has been recorded along roadsides, woodlands, grasslands, cultivated land and disturbed areas[26]. *Searsia lancea* is dispersed by humans as a seed contaminant, for their edible fruits and as ornamental[26]. *Searsia lancea* is considered an indicator of underground water. *Searsia lancea* is often confused with *S. laevigata* (L.) F.A.Barkley as both species are similar in habit and foliage, with differences in leaf size, colour and fruit shape.

Medicinal uses of *Searsia lancea*: The *Searsia lancea* is used as a source of traditional medicines in Botswana, Lesotho, South Africa and Zimbabwe, that is, 66.7% of the countries where the species is indigenous (Table 1). Traditional medicines prepared from the bark, fruits, leaves, roots, stems and stem bark of *S. lancea* are used to treat and/or manage 44 human and animal diseases and ailments (Table 1). The main diseases and ailments treated by *S. lancea* extracts include its use as ethnoveterinary medicine and its use as

Table 1: Medicinal applications of *Searsia lancea* throughout its distributional range in tropical Africa

Medicinal application	Plant part used	Country	References
Anaemia	Leaf infusion taken orally	Lesotho	Moteetee and van Wyk[28]
Diabetes	Fruit or leaf infusion taken orally	Lesotho and South Africa	Moteetee and van Wyk[28], Kose *et al.*[29] and Hulley and van Wyk[30]
Dizziness	Leaf infusion taken orally	Lesotho	Moteetee and van Wyk[28]
Fever	Leaf or root steam inhaled or decoction taken orally	Botswana and South Africa	Arnold and Gulumian[31] and Jackalas and Mathew[32]
Gastro-intestinal problems (abdominal pains, diarrhoea and stomach ailments)	Bark, fruit and root decoction or infusion taken orally	Botswana, South Africa and Zimbabwe	Hulley and van Wyk[30], Jackalas and Mathew[32], Gelfand *et al.*[33] and Papo *et al.*[34]
Headaches	Leaf steam inhaled or decoction taken orally	South Africa	Arnold and Gulumian[31]
Heart problems	Leaf infusion taken orally	Lesotho	Moteetee and van Wyk[28]
Herpes sores	Fruit or leaf infusion applied topically	Lesotho	Kose *et al.*[29]
Hiccups	Bark or root decoction taken orally	Zimbabwe	Shopo *et al.*[35]
High blood pressure	Leaf infusion taken orally	South Africa	Hulley and van Wyk[30]
Infant jaundice	Roots mixed with those of *Bowiea volubilis* Harv. ex T.Moore & Mast. subsp. *volubilis* and *Kniphofia crassifolia* Barker	South Africa	Gwanya *et al.*[27]
Internal parasites (worms)	Bark infusion taken orally	South Africa	Hulley and van Wyk[30]
Kidney ailments	Leaf infusion taken orally	South Africa	Hulley and van Wyk[30]
Measles	Fruit decoction or root infusion applied topically	South Africa and Zimbabwe	Gelfand *et al.*[33] and Papo *et al.*[34]
Mouth ulcers	Bark infusion applied topically	South Africa	Hulley and van Wyk[30]
Postnatal cleansing	Leaf infusion taken orally	South Africa	Hulley and van Wyk[30]
Prostate problems	Bark infusion taken orally	South Africa	Hulley and van Wyk[30]
Respiratory infections (asthma, chest pains, colds, cough and pneumonia)	Bark, fruit, leaf and root infusion or decoction taken orally	Botswana, Lesotho, South Africa and Zimbabwe	Moteetee and van Wyk[28], Hulley and van Wyk[30], Arnold and Gulumian[31], Jackalas and Mathew[32], Gelfand *et al.*[33] and Seleteng Kose *et al.*[36]
Sexually transmitted infections (gonorrhoea)	Root decoction taken orally	Botswana and South Africa	Jackalas and Mathew[32] and Semenya *et al.*[37,38]
Skin infections (chicken pox, papules, pimples, pustules, rashes, smallpox, tinea capitis, tinea versicolor and varicella)	Leaf, root and stem bark decoction applied topically or taken orally	Botswana, South Africa and Zimbabwe	Arnold and Gulumian[31], Jackalas and Mathew[32], Harvey and Armitage[39], Obi *et al.*[40] and Setshego *et al.*[41]
Sores and wounds	Bark, leaf or root decoction or infusion used as a wash for sores and wounds	South Africa and Zimbabwe	Hulley and van Wyk[30] and Shopo *et al.*[35]
Ulcers	Fruit or leaf infusion taken orally	Lesotho	Kose *et al.*[29]
Urinary ailments	Leaf infusion taken orally	South Africa	Hulley and van Wyk[30]
Ethnoveterinary medicine (abscess, diarrhoea, gallsickness and lump skin disease in cattle)	Bark, leaves, roots and stems	South Africa	Van der Merwe *et al.*[42]; McGaw and Eloff[43]; Luseba and Tshisikhawe[44] and Chakale *et al.*[45]

traditional medicine against fever, measles, sores, wounds, diabetes, sexually transmitted infections, gastro-intestinal problems, skin and respiratory infections (Fig. 2). In South Africa, the roots of *S. lancea* are mixed with those of *Bowiea volubilis* Harv. ex T.Moore & Mast. subsp. *volubilis* (family Asparagaceae) and *Kniphofia crassifolia* Barker (family Asphodelaceae) as remedy for jaundice in infants[27].

Nutritional properties of *Searsia lancea*: The ripe fruits of *S. lancea* are edible and are traditionally used as ferment in mead or honey beer, which is traditionally known as "karri" in South Africa and hence the common name "karee" for the tree[25,46]. The fruits of *S. lancea* 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 source of yeast for brewing[13]. Literature studies conducted in Botswana[47], South Africa[16] and Zimbabwe[48] show that fresh fruits of *S. lancea* are preferred mostly by children. Herbal tea is made from the fruits of *S. lancea*[19]. The fruits of *S. lancea* 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 2).

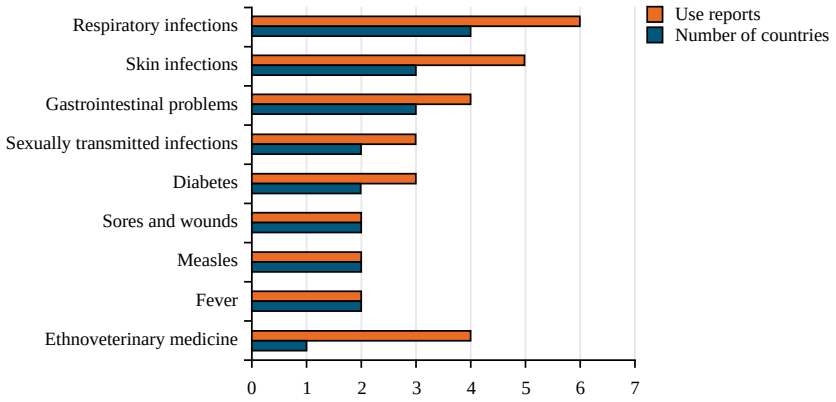

Fig. 2: Main diseases and ailments treated and managed using *Searsia lancea* extracts

Table 2: Nutritional composition of *Searsia lancea* fruits[11]

Nutritional composition	Values
Ash (g/100 g)	1.1
Calcium (mg/100 g)	149.0
Carbohydrates (g/100 g)	8.7
Copper (mg/100 g)	0.1
Crude fibre (g/100 g)	1.7
Energy (KJ/100 g)	187.0
Fat (g/100 g)	0.3
Iron (mg/100 g)	0.1
Magnesium (mg/100 g)	44.4
Moisture (g/100 g)	86.4
Nicotinic acid (mg/100 g)	0.3
Phosphorus (mg/100 g)	42.2
Potassium (mg/100 g)	148.0
Protein (g/100 g)	1.8
Riboflavin (mg/100 g)	0.1
Sodium (mg/100 g)	4.6
Vitamin C (mg/100 g)	108.0
Zinc (mg/100 g)	0.2

Phytochemical and pharmacological properties of *Searsia lancea*: The leaves of *S. lancea* are characterized by alcohol, alkane, amide, fatty alcohol, flavonoids, flavonols, naphthalene and volatile compounds (Table 3). Similarly, Sithole *et al.*[49] identified alkaloids, terpenoids, phenols, flavonoids, tannins, steroids and anthraquinones from *S. lancea* leaves. *Searsia lancea* crude extracts demonstrated pharmacological effects such as anthelmintic, antibacterial, antimycobacterial, antifungal, anticancer, anticholinesterase (AChE), anti-inflammatory, antioxidant, cytotoxicity and nematicidal activities.

Anthelmintic activities: McGaw *et al.*[54] evaluated the anthelmintic activities of hexane and methanol extracts of *S. lancea* leaves and bark against the free-living nematode *Caenorhabditis elegans* var. *bristol*. The extracts exhibited weak to moderate activities by killing 20.0 to 50.0% of nematodes at a concentration of 0.5 mg/mL[54].

Antibacterial activities: Obi *et al.*[40] evaluated the antibacterial activities of aqueous and ethanol extracts of *S. lancea* stem bark against *Streptococcus pyogenes*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella typhi*, *Escherichia coli* and *Shigella sonnei* using the disc diffusion method. The extracts exhibited activities against the tested pathogens with a zone of inhibition ranging from 9.0 to 13.0 mm[40]. Pretorius *et al.*[55] evaluated the antibacterial activities of crude extracts of *S. lancea* leaves at a concentration of 50.0 mg/mL against *Clavibacter michiganensis* pv. *michiganense* and *Pseudomonas solanacearum* using the agar diffusion assay with dimethyl dodecyl ammonium chloride as a positive control. The extract inhibited the growth of the pathogens exhibiting an inhibition zone of 7.0 to 8.0 mm[55]. McGaw *et al.*[54] evaluated the antibacterial activities of methanol, aqueous and hexane extracts of *S. lancea* bark and leaves against *Enterococcus faecalis* and *Staphylococcus aureus* using the microdilution assay with neomycin as a positive control. The extracts exhibited activities with minimum inhibitory concentration (MIC) values ranging from 0.2 to >12.5 mg/mL[54]. Mulaudzi *et al.*[56] assessed the antibacterial properties of dichloromethane, aqueous, 80.0% ethanol and petroleum ether extracts of *S. lancea* leaves against *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus* and *Klebsiella pneumoniae* using the microdilution assay with neomycin as positive control. The extracts exhibited antibacterial activities against the tested pathogens with MIC values which ranged from 0.01 to 12.5 µg/mL[56]. Sharma and Lall[57] evaluated the antibacterial activities of ethanol extract of *S. lancea* leaves against *Propionibacterium acnes* using the microdilution method with tetracycline as a positive control. The extract demonstrated antibacterial properties against the tested pathogen exhibiting a MIC value of 250.0 µg/mL[57]. Vambe *et al.*[58] assessed the antibacterial properties of petroleum ether, dichloromethane, methanol and water

Table 3: Phytochemical composition of *Searsia lancea* leaves

Chemical compound	Formula	References
Alcohol		
1-pentadecanol	$C_{15}H_{32}O$	Vambe *et al.*[50]
Alkane		
1-Iodo-2-methylundecane	$C_{12}H_{25}I$	Makhubu *et al.*[51]
Dotriacontane	$C_{32}H_{66}$	Makhubu *et al.*[51]
Eicosane	$C_{20}H_{42}$	Vambe *et al.*[50]
Amide		
9-Octadecenamide, (Z)-	$C_{18}H_{35}NO$	Makhubu *et al.*[51]
Dodecanamide	$C_{12}H_{25}NO$	Makhubu *et al.*[51]
Fatty alcohol		
1-Nonadecanol	$C_{19}H_{40}O$	Vambe *et al.*[50]
1-Tetracosanol	$C_{24}H_{50}O$	Vambe *et al.*[50]
Flavonoids		
3,5,3,5-tetrahydroxy-7,4 -dimethoxyflavone	$C_{17}H_{14}O_8$	Nair *et al.*[52]
Quercetin-3-O-galactoside	$C_{21}H_{20}O_{12}$	Nair *et al.*[52]
Flavonols		
Kaempferol	$C_{15}H_{10}O_6$	Nair *et al.*[52]
Quercetin	$C_{15}H_{10}O_7$	Nair *et al.*[52]
Myricetin	$C_{15}H_{10}O_8$	Nair *et al.*[52]
Naphthalene		
1,3-Di-iso-propylnaphthalene	$C_{16}H_{20}$	Vambe *et al.*[50]
1,7-Di-iso-propylnaphthalene	$C_{16}H_{20}$	Vambe *et al.*[50]
2,6-Di-iso-propylnaphthalene	$C_{16}H_{20}$	Vambe *et al.*[50]
Volatile compounds		
Benzene	C_6H_6	Koki *et al.*[53]
δ-3-carene	$C_{10}H_{16}$	Koki *et al.*[53]
α-pinene	$C_{10}H_{16}$	Koki *et al.*[53]
Isopropyl toluene	$C_{10}H_{14}$	Koki *et al.*[53]
Trans-caryophyllene	$C_{15}H_{24}$	Koki *et al.*[53]

extracts of *S. lancea* against *Klebsiella pneumoniae*, *Neisseria gonorrhoeae* and *Escherichia coli* using the microdilution method with penicillin, ampicillin, chloramphenicol and cefotaximeas positive controls. The extracts demonstrated antibacterial properties exhibiting MIC values which ranged from 0.3 to >2.5 mg/mL[58]. Vambe *et al.*[50] assessed the antibacterial properties of aqueous methanol and ethyl acetate extracts of *S. lancea* leaves against *Staphylococcus aureus*, *Neisseria gonorrhoeae* and *Enterococcus faecalis* using the microdilution method. The extracts exhibited activities against the tested pathogens showing MIC values ranging from 31.0 to 600.0 µg/mL[50].

Adeyemo *et al.*[59] evaluated the antibacterial activities of acetone extracts of *S. lancea* leaves against *Escherichia coli*, *Bacillus cereus*, *Staphylococcus aureus*, *Salmonella typhimurium*, *Enterococcus faecalis*, *Salmonella enteritidis* and *Pseudomonas aeruginosa* using the twofold serial dilution microplate assay with gentamicin as a positive control. The extracts exhibited antibacterial properties exhibiting MIC values which ranged from 0.03 to 0.1 mg/mL[59]. Papo *et al.*[34] evaluated the antibacterial activities of organic and aqueous extracts of *S. lancea* leaves against gastrointestinal pathogens *Shigella sonnei*, *Bacillus cereus*, *Salmonella typhimurium*, *Enterococcus faecalis*, *Escherichia coli* and *Listeria monocytogenes* using the microdilution method with ciprofloxacin as the positive control. The extracts demonstrated weak antibacterial properties against the tested pathogens exhibiting MIC values that ranged from 0.1 to >8.0 mg/mL[34]. Akinboye *et al.*[60] assessed the antibacterial properties of ethanol and acetone extracts of *S. lancea* leaves against the *Staphylococcus aureus* clinical strains using the serial microdilution assay with gentamicin as a positive control. The extracts demonstrated antibacterial properties exhibiting MIC values that ranged from 0.01 to 0.7 mg/mL[60]. Jackalas and Mathew[32] evaluated the antibacterial activities of aqueous and dichloromethane extracts of *S. lancea* roots against *Escherichia coli* and *Staphylococcus aureus* using the agar dilution method with ciprofloxacin and fluconazole as positive controls. The extracts demonstrated antibacterial properties exhibiting MIC values that ranged from 3.1 to 12.5 mg/mL[32]. Makhubu *et al.*[51] assessed the antibacterial properties of dichloromethane:methanol (1:1), acetone and water extracts of *S. lancea* leaves against *Ralstonia pseudosolanacearum*, *Clavibacter michiganensis* subsp. *michiganensis*, *Xanthomonas perforans*, *Xanthomonas vesicatoria* and *Ralstonia solanacearum* using the serial microplate dilution assay with streptomycin as a positive control. The extracts demonstrated antibacterial properties exhibiting MIC values which ranged from 19.5 to >2500.0 µg/mL[51].

Antimycobacterial activities: Kabongo-Kayoka *et al.*[61] assessed the antimycobacterial properties of acetone extracts of *S. lancea* leaves against *Mycobacterium aurum*, *Mycobacterium smegmatis*, *Mycobacterium tuberculosis*, *Mycobacterium bovis* and *Mycobacterium fortuitum* using the twofold serial microdilution method with streptomycin, ciprofloxacin, rifampicin and isoniazid as positive controls. The extracts showed antimycobacterial properties exhibiting MIC values that ranged from 0.1 to 0.2 mg/mL[61].

Antifungal activities: Mulaudzi *et al.*[56] assessed the antifungal properties of dichloromethane, aqueous, 80.0% ethanol and petroleum ether extracts of *S. lancea* leaves against *Candida albicans* using the microdilution method with amphotericin B as a positive control. The extract demonstrated antifungal properties against the tested pathogen exhibiting MIC and minimal fungicidal concentration (MFC) values which ranged from 1.6 to 6.3 µg/mL[56]. Jackalas and Mathew[32] assessed the antifungal properties of dichloromethane and aqueous extracts of *S. lancea* roots against *Candida glabratus* and *Candida albicans* using the agar dilution assay with fluconazole and ciprofloxacin as positive controls. The extracts exhibited activities with MIC values ranging from 3.1 to 12.5 mg/mL[32]. Makhubu *et al.*[51] evaluated the antifungal activities of water, acetone and dichloromethane:methanol (1:1) extracts of *S. lancea* leaves against *Fusarium oxysporum* using the serial microplate dilution method with amphotericin B as a positive control. The extracts exhibited activities with MIC values ranging from 156.0 to >2500.0 µg/mL[51]. Machaba *et al.*[62] evaluated the antifungal activities of methanol, acetone, water, dichloromethane and hexane extracts of *S. lancea* leaves against *Candida albicans*, *Aspergillus fumigatus* and *Cryptococcus neoformans* using microdilution assay with amphotericin B as the positive control. The extracts exhibited activities against the tested pathogens with MIC values ranging from 0.02 to 2.5 mg/mL[62].

Anticancer activities: Fouche *et al.*[63] evaluated the anticancer activities of dichloromethane extracts of *S. lancea* fruits and stems against a cell line panel consisting of renal TK10, melanoma UACC62 and breast MCF7. The extracts showed activities against the tested cell lines exhibiting total growth inhibition (TGI) values ranging from 13.2 to 19.1 µg/mL[63].

Anticholinesterase (AChE) activities: Mulaudzi *et al.*[56] evaluated the anticholinesterase (AChE) activities of 50.0% aqueous methanolic extract of *S. lancea* leaves using the acetylcholinesterase (AChE) inhibitory bioassay with galanthamine as a positive control. The extract exhibited activities with a Half Maximal Inhibitory Concentration (IC_{50}) value of 0.9 µg/mL[56].

Anti-inflammatory activities: Mulaudzi *et al.*[56] evaluated the anti-inflammatory activities of petroleum ether, 80.0% ethanol and dichloromethane extracts of *S. lancea* leave using the cyclooxygenase (COX-1 and COX-2) inhibitory bioassays with indomethacin as a positive control. The extracts exhibited activities with COX enzyme inhibition ranging from 30.0 to 85.0%[56].

Antioxidant activities: Sithole *et al.*[49] evaluated the antioxidant activities of methanol extracts of *S. lancea* leaves using the 2,2-Diphenyl-1-Picrylhydrazyl (DPPH) free radical scavenging assay with butylated hydroxytoluene and ascorbic acid as positive control. The extract exhibited activities with an IC_{50} value of 14.4 µg/mL[49].

Cytotoxicity activities: Adeyemo *et al.*[59] evaluated the cytotoxicity activities of acetone extracts of *S. lancea* leaves using the 3-(4,5-dimethyl thiazolyl-2)-2.5-diphenyltetrazolium (MTT) assay against Vero monkey kidney cells with doxorubicin chloride as positive control. The extracts exhibited activities with Median Lethal Concentration (LC_{50}) value of 0.2 mg/mL[59]. Akinboye *et al.*[60] evaluated the cytotoxicity activities of acetone and ethanol extracts of *S. lancea* leaves using the MTT assay against Vero monkey kidney cells with doxorubicin chloride as positive control. The acetone and ethanol extracts exhibited activities with LC_{50} values of 0.2 and 0.8 mg/mL, respectively[60].

Nematicidal activities: Sithole *et al.*[49] evaluated the nematicidal activities of crude extracts of *S. lancea* leaves against *Meloidogyne incognita* using the egg-hatching assay. The extracts exhibited activities in a dose-dependent manner as increasing concentrations of the crude extracts suppressed egg mass hatching after 72 hrs[49].

Toxicity activities: McGaw *et al.*[54] evaluated the toxicity activities of methanol and aqueous extracts of *S. lancea* leaves and bark using the brine shrimp lethality mortality assay against the larvae of *Artemia salina* with podophyllotoxin as the positive control. The extracts demonstrated activities with LC_{50} values ranging from 0.6 to 3.9 mg/mL while the positive control exhibited an LC_{50} value of 7.0 µg/mL[54].

CONCLUSION

The present review provides a summary of the food and medicinal uses of *S. lancea* and its phytochemical and pharmacological properties. Such nutraceutical and ethnopharmacological studies are important for plant species widely used as food plants and sources 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.

SIGNIFICANCE STATEMENT

This study contributes to the existing traditional knowledge about *S. lancea* that could be useful in bio-prospecting for new health-promoting and pharmaceutical products. Compilation of the biological properties of *S. lancea* is an important step towards the identification of knowledge gaps required to protect consumers from non-standardized herbal medicine usage of such plant species. Therefore, future studies on *S. lancea* should focus on conducting detailed ethnopharmacological evaluations of the species emphasizing phytochemistry, nutritional, pharmacological properties and toxicological evaluations of the species, *in vivo* and clinical research aimed at corroborating the traditional nutritional and medicinal applications of the species. Such studies are needed as the use of nutraceutical or functional foods and medicinal plants have been increasing over the years throughout the world.

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