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Lobostemon fruticosus: A review of its botany, medicinal uses, phytochemistry and biological activities

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Abstract

Lobostemon fruticosus is a shrub widely used as traditional medicine in South Africa. This study is aimed at providing a critical review of the botany, medicinal uses, phytochemistry and biological activities of *L. fruticosus*. Several electronic search engines and specialized reference tools such as Google, Google Scholar, Scopus, Web of Science, scientific literature, publishing sites and electronic databases (Pubmed, Springer, Wiley and Science Direct) were used for data retrieval. This study showed that the leaves and twigs of *L. fruticosus* are mainly used as blood purifier and traditional medicine for burns, ulcers, eczema or erysipelas, gynaecological problems, stomachache, sores, syphilis, skin ailments, ringworm and wounds. Phytochemical compounds identified from the leaves and twigs of *L. fruticosus* include alkaloids, anthocyanins, coumarins, dipeptides, fatty acids, flavonoids, lignins, phenols and toluenes. Pharmacological research revealed that leaf extracts of *L. fruticosus* exhibited antibacterial, antiviral, anti-proliferative and cytotoxic activities. Future research should focus on evaluating the phytochemical, pharmacological and toxicological properties and clinical relevance of crude extracts of *L. fruticosus* as well as compounds isolated from the species.

Keywords: Boraginaceae, ethnopharmacology, herbal medicine, indigenous pharmacopeia, *Lobostemon fruticosus*

INTRODUCTION

Lobostemon fruticosus (L.) H. Buek is a perennial woody shrub belonging to the "forget-me-not" family or borage or Boraginaceae. Boraginaceae family consists of about 120 genera and 2600 tree, shrub and herbaceous species found throughout the world.[1-4] The *Lobostemon* Lehm. genus consists of about 28 species, which are endemic to the Cape Floristic Kingdom of South Africa, and is found mostly in the south-western parts of the Western Cape Province, extending northwards into Namaqualand and eastwards to the Albany District.[5-12] Unfortunately about a third (35.7%) of these species are threatened with extinction mainly because they are endemic and naturally rare or experiencing significant human induced threats such as habitat loss and fragmentation, overexploitation, threats associated by pollution, urbanisation and spread of invasive alien plants. The IUCN Red List Categories and Criteria of threatened species (http://www.iucnredlist.org) was used in the assessments of threatened *Lobostemon* species in South Africa.[7,13-15] According to Victor and Keith[16] and Von Staden et al.,[17] a species categorized as Least Concern (LC) under the IUCN Red List Categories and Criteria can additionally be flagged as of conservation concern either as rare, critically rare or declining, for example *L. muirii* Levyns.[7,13-15] *Lobostemon belliformis* M.H. Buys is Critically Endangered and highly restricted species, known from one small sandstone outcrop on the Riversdale Plain in the Western Cape province and therefore, threatened by invasive alien species, harvesting, habitat degradation and loss.[14,15] *Lobostemon collinus* Schltr. ex C.H. Wright, *L. daltonii* M.H. Buys and *L. hottentoticus* Levyns are Endangered mainly because of their small extent of occurrences, severely fragmented subpopulations, declining population sizes due to urbanisation, agricultural expansion, alien plant invasion, habitat degradation and loss.[13-15] *Lobostemon lucidus* (Lehm.) H. Buek, *L. regulariflorus* (Ker Gawl.) M.H. Buys, *L. sanguineus* Schltr. and *L. capitatus* (L.) H. Buek are Vulnerable mainly because of small extent of occurrences, severely fragmented subpopulations, declining population sizes due to agriculture, urban development, invasive alien plants, pollution, habitat degradation and loss.[13-15] *Lobostemon gracilis* Levyns is Near Threatened as the species is known from seven locations and potentially threatened by vineyard expansion[13-15] and *L. muirii* is naturally rare and a range-restricted endemic with extent of occurrence of less than 500 km².[13-15]

Lobostemon fruticosus is widely used as traditional medicine and ornamental plant.[4,18-21] Therefore, *L. fruticosus* has been introduced in other provinces of South Africa as an ornamental plant. For example, *L. fruticosus* is cultivated in urban and peri-urban domestic gardens in the Limpopo province as an ornamental plant.[22,23] The leaves and stems of *L. fruticosus* are sold as traditional medicines in the informal herbal medicines markets of the Eastern Cape and Western Cape provinces of South Africa[24] and commonly gathered from the wild when required as traditional medicine. Lodama et al.[25] argued that the populations of *L. fruticosus* have become fewer and more scattered in the wild, which may be attributed to its intensive harvesting for traditional medicine use, coupled with its low potential for natural regeneration. Natural regeneration was found to be low in nature due to over-exploitation of the leaves that affected also the root system before flowering and poor seed germination.[25] Given its importance as both ornamental and medicinal plant species, the natural populations of *L. fruticosus* are being destroyed and the species is overharvested and hence the need for propagation and conservation of the plant species. Vegetative propagation of *L. fruticosus* using stem cuttings[26,27] could be used to produce plants in a shorter time compared to seed while at the same time maintaining some of the desired characteristics of the species. Moreover, *L. fruticosus* is one of the valuable medicinal plant species in South Africa, and the species is included in the book "medicinal plants of South Africa," a

photographic guide to the most commonly used herbal medicines in the country, including its botany, major medicinal applications and active phytochemical compounds.[28] Research by Van Wyk[29] showed that the leaves of *L. fruticosus* have commercial potential as an important traditional multi-purpose plaster and as traditional medicine for ringworm and wounds in South Africa. It is therefore, within this context that this review was undertaken aimed at reviewing the botany, medicinal uses, phytochemical and biological activities of *L. fruticosus* so as to provide baseline data required in evaluating the therapeutic potential of the species.

Botanical profile of *Lobostemon fruticosus*

Lobostemon fruticosus is a small, evergreen woody shrub which can grow up to one metre in height with densely hairy branches.[29,30] *Lobostemon fruticosus* has numerous and long branches shooting from the base with the older lower part of the stems getting woody while the younger tips are much softer with an attractive red colouring. The leaves are sessile, oblanceolate to obovate in shape, silver-green in colour and covered with a mixture of coarse and soft hairs. The flowers are in branched clusters, trumpet-shaped, hairy outside, characterized by different shades of blue and pink (or rarely white) and varying in colour even in the same plant. The seeds of *L. fruticosus* are four little nutlets with longitudinal ridges and spiny tips.[20] The genus name *Lobostemon* is derived from the Latin word "*lobos*", meaning lobe, and the Greek word "*stemon*", meaning stamen. The specific name "*fruticosus*" is a Latin word which means "shrubby".[31] The English common names of *L. fruticosus* are "pyjama" and "pyjama bush". The synonyms associated with the name *L. fruticosus* include *Echium africanum* Pers., *E. bergianum* E. Mey. ex A. DC., *E. frondosum* Salisb., *E. fruticosum* L., *E. fruticosum* L. var. *fruticosum*, *E. fruticosum* L. var. *major* Lehm., *E. fruticosum* L. var. *minor* Curtis, *E. lasiophyllum* Link, *E. obovatum* (A. DC.) I.M. Johnst., *E. scabrum* Thunb., *E. spathulatum* Drège ex A. DC., *L. fruticosus* (L.) H. Buek var. *bergianus* A. DC., *L. fruticosus* (L.) H. Buek var. *fruticosus*, *L. lasiophyllus* A. DC., *L. obovatus* A. DC. and *L. scaber* (Thunb.) A. DC.[8,10] *Lobostemon fruticosus* has been recorded on sandstone slopes or sandy or shale flats and rocky mountain slopes in the Western Cape province in South Africa at an altitude ranging from 30 m to 1372 m above sea level.[8,10,11,12]

Medicinal uses of *Lobostemon fruticosus*

The leaves and twigs of *L. fruticosus* are mainly used as blood purifier and traditional medicine for burns, ulcers, eczema or erysipelas, gynaecological problems, stomachache, sores, syphilis, skin ailments, ringworm and wounds (Table 1; Figure 1). The leaves of *L. fruticosus* are mixed with roots of *Hermannia salviifolia* L.f. and *Otholobium decumbens* (Aiton) C.H. Stirt. as traditional medicine for eczema or erysipelas.[20,32,33] The leaves of *L. fruticosus* are mixed with those of *Galenia africana* L. and *Melianthus comosus* Vahl as traditional medicine for sympilis[20] while leaves of *L. fruticosus* are mixed with those of *Cyanella lutea* L. f., *Galenia africana*, *Helichrysum litorale* Bolus, *Melianthus comosus* and *Melianthus major* L. as tradicinal medicine for wounds.[20,34-36]

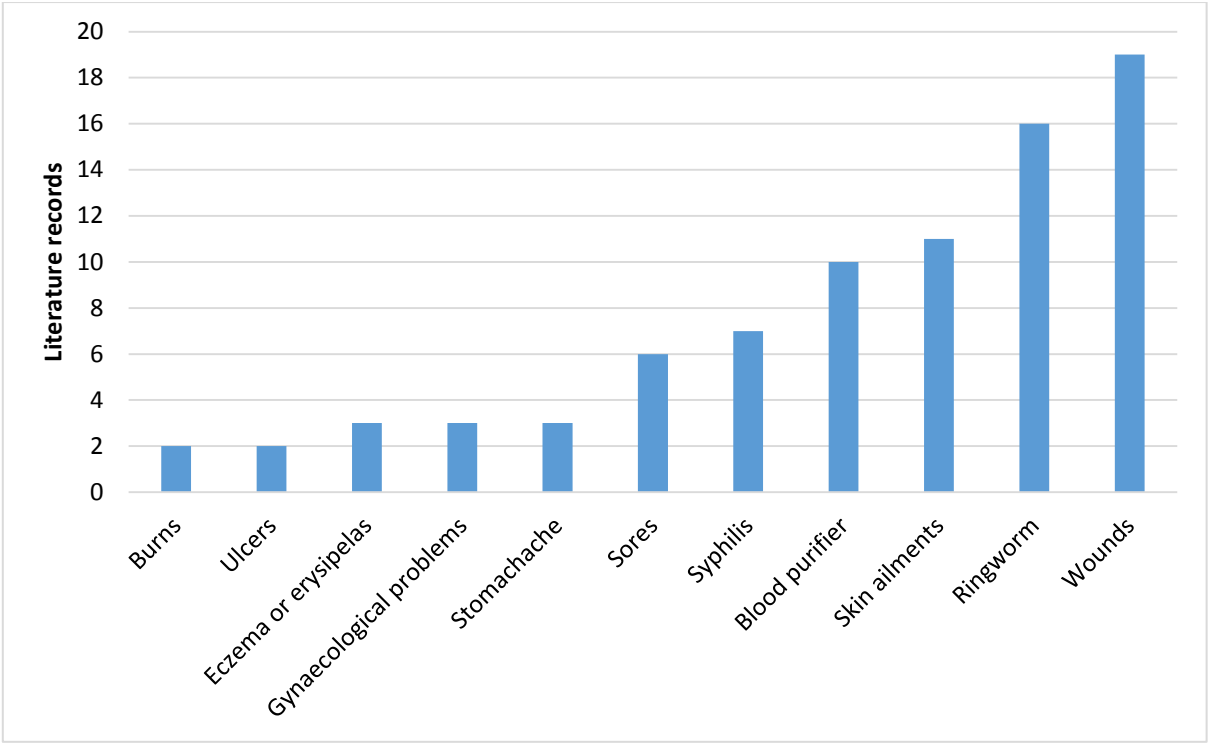

Figure 1. Medicinal applications of *Lobostemon fruticosus* derived from literature records

Table 1: Medicinal uses of *Lobostemon fruticosus*

Medicinal use	Part used	Reference
Antiseptic	Leaves	Nzue[37]
Blood purifier	Twigs	Lodama et al.[25]; Lodama et al.[26]; Swarts et al.[27]; Van Wyk et al.[28]; Nzue[37]; Philander[38]; Lunat[39]; Philander[40]; Lodama et al.[41]; Lodama et al.[42]
Body cleansing	Leaves	Nzue[37]
Burns	Leaves	Nortje and Van Wyk[43]; Van Wyk and Gericke[44]
Chest problems	Leaves	Louw[45]
Colds	Leaves	Louw[45]
Eczema or erysipelas	Leaves mixed with roots of *Hermannia salviifolia* L.f. and *Otholobium decumbens* (Aiton) C.H. Stirt.	Van der Walt[20]; Essop et al.[32]; Blose[33]
Flatulence	Leaves	Nortje and Van Wyk[43]
Flu	Leaves	Louw[45]
Gynaecological problems	Leaves	Swarts et al.[27]; Levyns[30]; Nzue[37]
Pain	Leaves	Nzue[37]
Ringworm	Twigs	Van der Walt[20]; Lodama et al.[25]; Lodama et al.[26]; Swarts et al.[27]; Van Wyk et al.[28]; Van Wyk[29]; Blose[33]; Philander[38]; Lunat[39]; Philander[40]; Lodama et al.[41]; Lodama et al.[42]; Van Wyk and Gericke[44]; Roberts[46]; Ndlovu[47]; Hulley and Van Wyk[48]
Skin ailments	Twigs	Lodama et al.[25]; Lodama et al.[26]; Swarts et al.[27]; Van Wyk et al.[28]; Blose[33]; Nzue[37]; Philander[38]; Lunat[39]; Philander[40]; Lodama et al.[41]; Lodama et al.[42]
Sores	Leaves	Van Wyk[29]; Blose[33]; Philander[38]; Nortje and Van Wyk[43]; Van Wyk and Gericke[44]; Hulley and Van Wyk[48]
Stomachache	Twigs	Philander[38]; Philander[40]; Nortje and Van Wyk[43]
Syphilis	Twigs	Lodama et al.[25]; Lodama et al.[26]; Swarts et al.[27]; Blose[33]; Lodama et al.[41]; Lodama et al.[42]; Ndlovu[47]
Sympilis	Leaves mixed with *Galenia africana* L. and *Melianthus comosus* Vahl	Van der Walt[20]
Swellings	Leaves	Nzue[37]
Ulcers	Leaves	Lunat[39]; Van Wyk and Gericke[44]
Worms	Leaves	Nzue[37]
Wounds	Leaves and twigs	Lodama et al.[25]; Lodama et al.[26]; Swarts et al.[27]; Van Wyk et al.[28]; Van Wyk[29]; Blose[33]; Watt and Breyer-Brandwijk[34]; Mabona[35]; Mabona and Van Vuuren[36]; Lunat[39]; Lodama et al.[41]; Lodama et al.[42]; Nortje and Van Wyk[43]; Van Wyk and Gericke[44]; Roberts[46]; Ndlovu[47]; George et al.[49]; Twilley and Lall[50]; Pattanayak[51]
Wounds	Leaves mixed with *Cyanella lutea* L. f., *Galenia africana Helichrysum litorale* Bolus, *Melianthus comosus* and *Melianthus major* L.	Van der Walt[20]; Watt and Breyer-Brandwijk[34]; Mabona[35]; Mabona and Van Vuuren[36]

Phytochemistry and biological activities of *Lobostemon fruticosus*

Bose[33] and Ndlovu[47] and identified alkaloids, anthocyanins, coumarins, dipeptides, fatty acids, flavonoids, lignins and toluenes from the leaves of *L. fruticosus* (Table 2). Lodama et al.[41] identified GABA, maleic acid, xylose, glucose, fructose, sucrose, alanine, pyrrolizidine alkaloids and chorine from the leaves of *L. fruticosus*. Similarly, Lodama et al.[42] identified flavonoids and phenolic compounds from the leaves of *L. fruticosus*. The following biological activities have been reported from the leaf extracts of *L. fruticosus*: antibacterial,[42] antiviral,[42] anti-proliferative[33] and cytotoxic[47,52] activities.

Table 2: Phytochemical composition of *Lobostemon fruticosus*

Phytochemical	Value	Plant part	Reference
Alkaloid			
Sarpagine	-	Leaves	Bose[33]; Ndlovu[47]
Tropine	-	Leaves	Ndlovu[47]
Anthocyanins			
Delphinidin-3,5-diglucoside (%)	15.0	Flowers	Van Wyk et al.[53]
Delphinidin-3-glucoside (%)	2.0	Flowers	Van Wyk et al.[53]
Delphinidin-3-rutinoside (%)	<0.05	Flowers	Van Wyk et al.[53]
Cyanidin-3,5-diglucoside (%)	29.0	Flowers	Van Wyk et al.[53]
Cyanidin-3-glucoside (%)	47.0	Flowers	Van Wyk et al.[53]
Cyanidin-3-rutinoside (%)	7.0	Flowers	Van Wyk et al.[53]
Coumarin			
4-Hydroxycoumarin	-	Leaves	Bose[33]; Ndlovu[47]
Nodakenin	-	Leaves	Ndlovu[47]
Dipeptide			
Hypoglycin B	-	Leaves	Ndlovu[47]
Fatty acid			
Ricinoleate	-	Leaves	Ndlovu[47]
Flavonoid			
7-O-β-D-glucosylapigenin	-	Leaves	Ndlovu[47]
7-O-methylvitexin 2"-O-β-rhamnoside	-	Leaves	Ndlovu[47]
Fisetin	-	Leaves	Bose[33]; Ndlovu[47]
Flavocommelin	-	Leaves	Bose[33]; Ndlovu[47]
Lignin			
Justicidin B	-	Leaves	Bose[33]; Ndlovu[47]
Toluene			
2-Hydroxylamino-4,6-dinitrotluene	-	Leaves	Bose[33]; Ndlovu[47]

Antibacterial activities

Lodama et al.[42] evaluated antibacterial activities of methanolic leaf extracts of *L. fruticosus* against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas aerguinosa* and *Salmonella typhi* using micro dilution assay. The extract exhibited activities with the minimum inhibitory concentration (MIC) values ranging from 3.1 mg/ml to 12.5 mg/ml.[42]

Antiviral activities

Lodama et al.[42] evaluated antiviral activities of methanolic leaf extracts of *L. fruticosus* by assessing the ability of the extract to inhibit HIV-1 reverse transcriptase (RT) enzyme. The highest inhibitory activity of 75.6% against HIV-1 RT was observed.[42] An aqueous leaf extract of the closely related species *L. trigonus* H. Buek inhibited the human immunodeficiency virus (HIV) with half maximal inhibitory concentration (IC_{50}) value of 49.0 µg/ml in the reverse transcriptase (RT) assay.[54]

Anti-proliferative activities

Blose[33] evaluated the anti-proliferative activities of methanol and butanol leaf extracts of *L. fruticosus* on pancreatic cancer cell line (AsPC-1) using 3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide (MTT) assay, xCELLigence and cell cycle analysis with MRC-5 cell line as a positive control cell line. The methanol and butanol extracts induced cell death at IC_{50} value of 60 µg/ml and 50µg/ml, respectively at 48 hour treatments on AsPC-1 cell line.[33]

Cytotoxic activities

Motadi and Ndlovu[52] evaluated the cytotoxic activities of methanol and butanol leaf extracts of *L. fruticosus* against A549 cell lines. The extract exhibited cytotoxic activities on A549 cells.[52] Similarly, Ndlovu[47] evaluated the cytotoxic activities of methanol and butanol leaf extracts of *L. fruticosus* against A549 cell lines using the MTT assay. The extract exhibited activities with IC_{50} values of the methanol and butanol extracts of 40 µg/ml and 50 µg/ml, respectively.[47]

CONCLUSION

Further research should focus on the phytochemical and pharmacological properties of the crude extracts and compounds isolated from the species, as well as their mechanisms of action aimed at illustrating the correlation between ethnomedicinal uses and the ethnopharmacological properties of various extracts of *L. fruticosus*. Thus, more systematic research is required on *L. fruticosus* compounds, their effects need to be further proved through additional animal experiments. Future research should combine the pharmacological effects, mechanisms of action, and clinical applications in assessing the efficacy of *L. fruticosus* compounds and/or their extracts. Continued research on *L. fruticosus* compounds, development and discovery of pharmaceutical products and drugs from this species in the future will require more detailed studies in both the preclinical and clinical trials. Future research should also focus on assessing toxicological aspects of the leaves, roots and stems of *L. fruticosus* as at present there is not enough

systematic data about the pharmacokinetics and toxicity of this species, especially target-organ toxicity.

Conflict of interest

The author declares that he has no conflict of interest.

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