



REVIEW ARTICLE

Pseudodictamnus africanus (L.) Salmaki & Siadati (Lamiaceae): Ethnomedicinal uses, phytochemistry and pharmacological properties

Alfred Maroyi

Department of Botany, University of Fort Hare, Private Bag X1314, Alice 5700, South Africa

*Email: amaroyi@ufh.ac.za



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Abstract

Pseudodictamnus africanus (L.) Salmaki & Siadati is a perennial herb which naturally occurs in Namibia and South Africa. Southern Africa is characterized by several indigenous medicinal plants and natural products that are widely used in traditional *materia medica*. However, there is dearth of information on botanical description, medicinal uses, plant parts used, preparation and dosage, active ingredients and pharmacological effects of medicinal plants like *P. africanus* in the public domain. Therefore, this study reviewed the medicinal uses, active bioactives and biological activities of *P. africanus*. A systematic review of electronic databases and pre-electronic sources with information on the botany, medicinal uses, herbal preparations, active bioactives and pharmacological effects of *P. africanus* was conducted. No time limit was set for the research and all literature sources aligned with the scope of the research were included. This study showed that *P. africanus* is used as traditional medicine for liver problems, sores, wounds, heart problems, hysteria, skin ailments, headache, insomnia, fever, typhoid fever and respiratory problems. Pharmacological research identified hispanolone, dehydrohispanolone, saponins, tannins, phenolics, flavonoids, reducing sugars, resveratrol, triterpene steroids and essential oils. The crude extracts of *P. africanus* and essential oils isolated from the species exhibited antibacterial, antifungal, anti-inflammatory, anti-nociceptive, immunological and sedative-hypnotic activities. More research is needed to assert the medicinal and ethnopharmacological properties of the crude extracts of *P. africanus* and phytochemical compounds isolated from the species, and also determine the toxicological effects of the species and its phytochemical compounds.

Keywords

Ballota africana, active bioactives, medicinal uses, Labiatae, Lamiaceae, pharmacological effects, *Pseudodictamnus africanus*

Introduction

Pseudodictamnus africanus (L.) Salmaki & Siadati is an aromatic shrublet belonging to the Lamiaceae or Labiatae or sage or deadnettle or mint family. The majority of species belonging to the Lamiaceae family are aromatic and include widely used culinary and medicinal herbs. Such species include *Ballota nigra* L. indigenous to Europe and Asia, and naturalized in North America is reputed to treat stomach spasms, nausea, as a calming herb, sedative, persistent cough and nervous system disorders, especially minor sleeplessness in both children and adults (1). *Pseudodictamnus africanus*

was originally treated as *Ballota africana* (L.) Benth. (2) but Siadati *et al.* (3, 4) described genus *Ballota* L. as consisting of three herbaceous species confined to Europe, western Asia and the Mediterranean. Species classified under *Pseudodictamnus* Fabr. are herbaceous plants which naturally occur in the African and Mediterranean regions (3, 4). The synonyms of *P. africanus* include *Ballota africana*, *Beringeria africana* (L.) Neck., *Beringeria crispa* (L.) G. Don, *Marrubium africanum* L., *Marrubium crispum* L., *Marrubium laurifolium* Steud., *Marrubium thouinii* Schult. ex Weinm., *Pseudodictamnus emarginatus* (L.) Moench and *Stachys africana* (L.) Kuntze (2, 3). The English common names of *P. africanus* are African horehound, Cape horehound, English cat herb and horehound. *Pseudodictamnus africanus* is an evergreen, perennial, aromatic, soft, greyish shrublet growing up to 1.2 m in height (5, 6). Leaves are opposite, softly hairy, heart-shaped with toothed margins. Flowers are pale pink, purple, mauve or greyish white in colour, occur in spikes, arranged in dense whorls around the stem and alternating with each pair of leaves (7). *Pseudodictamnus africanus* has been recorded in rocky or disturbed places in southern Namibia, through the Eastern Cape, Free State and the Western Cape provinces in South Africa (Fig. 1) at an altitude from 0 to 1525 m above the sea level (8).

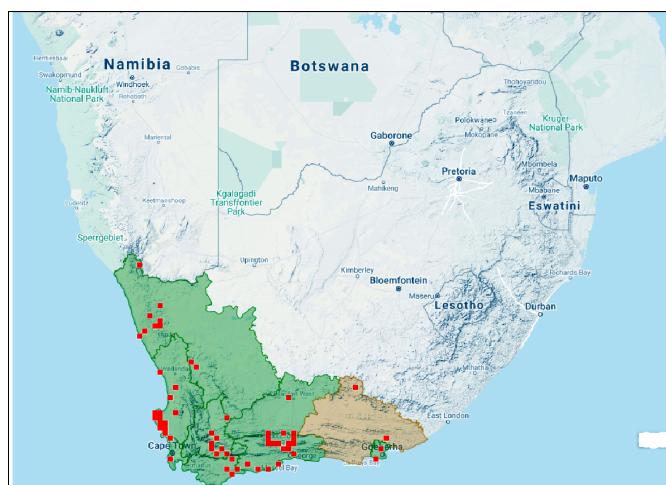


Fig. 1. Distribution of *Pseudodictamnus africanus* in southern Africa (<https://www.inaturalist.org/taxa/524606-Ballota-africana>).

Pseudodictamnus africanus is an important source of traditional medicines in the Eastern Cape, Free State and the Western Cape provinces in South Africa, and the species is listed in three monographs, “medicinal and magical plants of southern Africa: An annotated checklist” (9), “medicinal plants of the world” (1) and “medicinal plants of South Africa” (10). Similarly, arguments are on the leaf infusions or tinctures of *P. africanus* have potential in the development of new medicinal products as they are widely used for various medicinal applications (11). It was showed that in the Eastern Cape, Free State and the Western Cape provinces in South Africa, the leaves of *P. africanus* are often mixed with those of *Stachys thunbergii* Benth. (family Lamiaceae) and *Valeriana capensis* Thunb. (family Caprifoliaceae) as traditional medicines for asthma, bronchitis, hysteria and insomnia (12, 13). *Pseudodictamnus africanus* is mainly collected from the wild but also available in informal herbal medicine markets and sold as bunches of dried

and/or fresh material consisting of stems, leaves and sometimes mixed with flowers, fruits and roots. The leaves of *P. africanus* are also used as snack, vegetable, herbal tea and flavourant in South Africa (14, 15). In South Africa, the conservation status of *P. africanus* is categorized as Least Concern based on the International Union for Conservation of Nature (IUCN) Red List Categories and Criteria version 3.1, indicating that the species is generally widespread and occurring in abundance with a low risk of extinction (16). However, the popularity of *P. africanus* as medicinal plant species requires the need for a holistic conservation approach in its use and future management of the species in southern Africa. Given this background, the current investigation was conducted aimed at documenting the medicinal uses, active bioactives and biological activities of *P. africanus*.

The use of medicinal plants such as *P. africanus* in the management of diverse ailments is entrenched in the culture of indigenous people in southern Africa. From time immemorial, local communities have relied on medicinal plants to treat and manage diseases and ailments, and these plants also provide several health or pharmaceutical products. Some communities rely exclusively on medicinal plants as sources of medicines because they are the most affordable and easily accessible source of treatment in the primary healthcare system of the resource poor communities and those people occupying marginal areas (17-19). It was argued that medicinal plants are an important aspect of the daily lives of many people and an important part of the African cultural heritage (10). Similarly, research revealed that there is an increase in the popularity of natural remedies and botanicals in modern world as is seen in the rapid growth of over-the-counter medicines, dietary supplements and functional foods (20). Therefore, there is need to fully explore the ethnopharmacological properties of plant species widely used as traditional medicines, focusing on their therapeutic potential, phytochemical properties, empirical evidence of their efficacies based on *in vitro*, *in vivo* and appropriate clinical tests and models.

Materials and Methods

A systematic review of electronic databases such as Taylor and Francis, Science Direct, Google Scholar, Scopus, Web of Science, SpringerLink, SciELO, Pubmed and Elsevier. Pre-electronic sources such as national, international journal and other scientific publications, dissertations, theses, books and grey literature with information on the botany, medicinal uses, herbal medicine preparations, active bioactives and pharmacological effects of *Pseudodictamnus africanus* were used. No time limit was set for the research and all literature sources aligned with the scope of the research were included. The key words *Pseudodictamnus africanus* and commonly used synonym *Ballota africana* were used in combination with other key words such as “active bioactives of *Pseudodictamnus africanus* or *Ballota africana*”, “ethnobotany of *Pseudodictamnus africanus* or *Ballota africana*”, “medicinal uses of *Pseudodictamnus africanus* or *Ballota africana*”, “phytochemicals of *Pseudo-*

dictamnus africanus or *Ballota africana*”, “biological activities of *Pseudodictamnus africanus* or *Ballota africana*”, “pharmacological properties of *Pseudodictamnus africanus* or *Ballota africana*” and “traditional uses of *Pseudodictamnus africanus* or *Ballota africana*”.

Results and Discussion

Traditional medicinal uses of *Pseudodictamnus africanus*

The fresh or dried leaves, stems and aerial parts of *P. africanus* are mainly used as traditional medicine for liver problems, sores, wounds, heart problems, hysteria, skin ailments, headache, insomnia, fever, typhoid fever and respiratory infections (Table 1, Fig. 2). Research showed that in South Africa *P. africanus* is often mixed with *Valeriana capensis* as traditional medicine for asthma, bronchitis, heart trouble, hysteria and insomnia (12, 21). Research

showed that in South Africa, the leaves of *P. africanus* are often mixed with those of various *Salvia* species (family Lamiaceae) to treat and manage fevers and measles (10, 12). Similarly, research showed that in South Africa the leaves, roots and stems of *P. africanus* are often mixed with those of *Lasiosiphon deserticola* (Gilg) C.H. Wright (family Thymelaeaceae) and *Lessertia frutescens* (L.) Goldblatt & J.C. Manning (family Fabaceae) as remedy for diabetes and pain (21, 22). Other traditional medicinal uses of the fresh or dried leaves, stems and aerial parts of *P. africanus* supported by at least 5 literature records include colic and traditional medicine for arthritis, gastrointestinal problems, haemorrhoids, high and low blood pressure, mouth infections and thrush, painful feet and legs, rheumatism, snake bite, stress and urinary problems (Table 1).

Phytochemistry of *Pseudodictamnus africanus*

Table 1. Medicinal uses of fresh or dried leaves, stems and aerial parts of *Pseudodictamnus africanus*

Medicinal uses	Plant parts used and administration	References
Arthritis	Leaf infusions or brandy tinctures used as a foot bath	(10, 23-28)
Backache	Leaf infusion taken orally	(29-32)
Blood circulation	Foliage infusion taken orally	(25, 33)
Cancer	Leaf infusion taken orally	(32)
Colic	Leaf infusion taken orally	(12, 22, 23, 27, 34, 35)
Convulsions	Leaf infusion taken orally	(29, 30, 32)
Diabetes mellitus	Leaf infusion taken orally	(31, 36)
Earache	Leaf infusion applied topically	(29)
Fever and typhoid fever	Leaf infusions or brandy tinctures are taken orally	(1, 5, 10, 13, 14, 22-29, 31-33, 35-45)
Galactagogue	Leaf infusion taken orally	(29, 39)
Gastro-intestinal problems (diarrhoea and stomachache)	Leaf infusion taken orally	(24, 25, 29-33, 46)
Gout	Leaf infusion taken orally	(31)
Haemorrhoids	Leaf infusions or brandy tinctures are taken orally	(10, 13, 23, 26, 27, 35, 41)
Headache	Leaf infusions or brandy tinctures are taken orally	(5, 10, 13, 23-33, 35, 39-41, 45, 46)
Heart problems	Leaf infusions or brandy tinctures are taken orally	(10, 23-28, 31, 33, 35, 39-48)
High and low blood pressure	Leaf infusion taken orally	(12, 22, 27, 29, 31, 49-51)
Hysteria	Leaf infusions or brandy tinctures are taken orally	(1, 10, 12, 13, 21, 23-27, 33, 35, 39-41, 48, 52-54)
Inflammation	Leaf infusion applied topically	(31, 55)
Insect repellent	Foliage used as insect repellent	(25)
Insomnia	Leaf infusions or brandy tinctures are taken orally	(10, 12, 13, 21, 23-27, 31, 34, 35, 38, 40-43, 45, 47, 48, 52, 54)
Liver problems	Leaf infusions or brandy tinctures are taken orally	(10, 23-28, 39-41)
Mastitis	Leaf infusion taken orally	(29, 30, 32)
Mouth infections and thrush	Leaf infusion applied topically	(12, 13, 27, 35, 56)
Over-excitement	Leaf infusion taken orally	(23, 35)
Pain	Leaf infusion taken orally	(1, 29, 31, 55, 57)
Painful feet and legs	Leaf infusion applied topically	(29-32, 39)
Postpartum	Leaf infusion taken orally	(31, 39)
Respiratory problems (asthma, bronchitis, chest pains, cough, hoarseness, influenza, lung infections, pneumonia, sore throat and tuberculosis)	Leaf infusions or brandy tinctures are taken orally	(1, 5, 10, 12-14, 23-35, 37-46, 58-61)
Rheumatism (inflamed joints and joint pain)	Leaf infusion applied topically	(13, 29-32)
Skin ailments (boils and measles)	Leaf infusion applied topically	(10, 13, 14, 23-32, 35, 39, 44, 45)
Snake bite	Leaf infusion applied topically	(12, 23, 24, 27, 34, 35)
Sores and wounds	Leaf infusion applied topically	(12, 27, 29-32, 38, 42, 56, 57)

Stress	Leaf infusion taken orally	(13, 27, 38, 42, 45)
Stroke	Leaf infusion taken orally	(31)
Toothache	Leaf infusion applied topically	(29, 30, 32)
Urinary problems (bladder and kidneys)	Leaf infusion taken orally	(13, 27, 31, 32, 35)

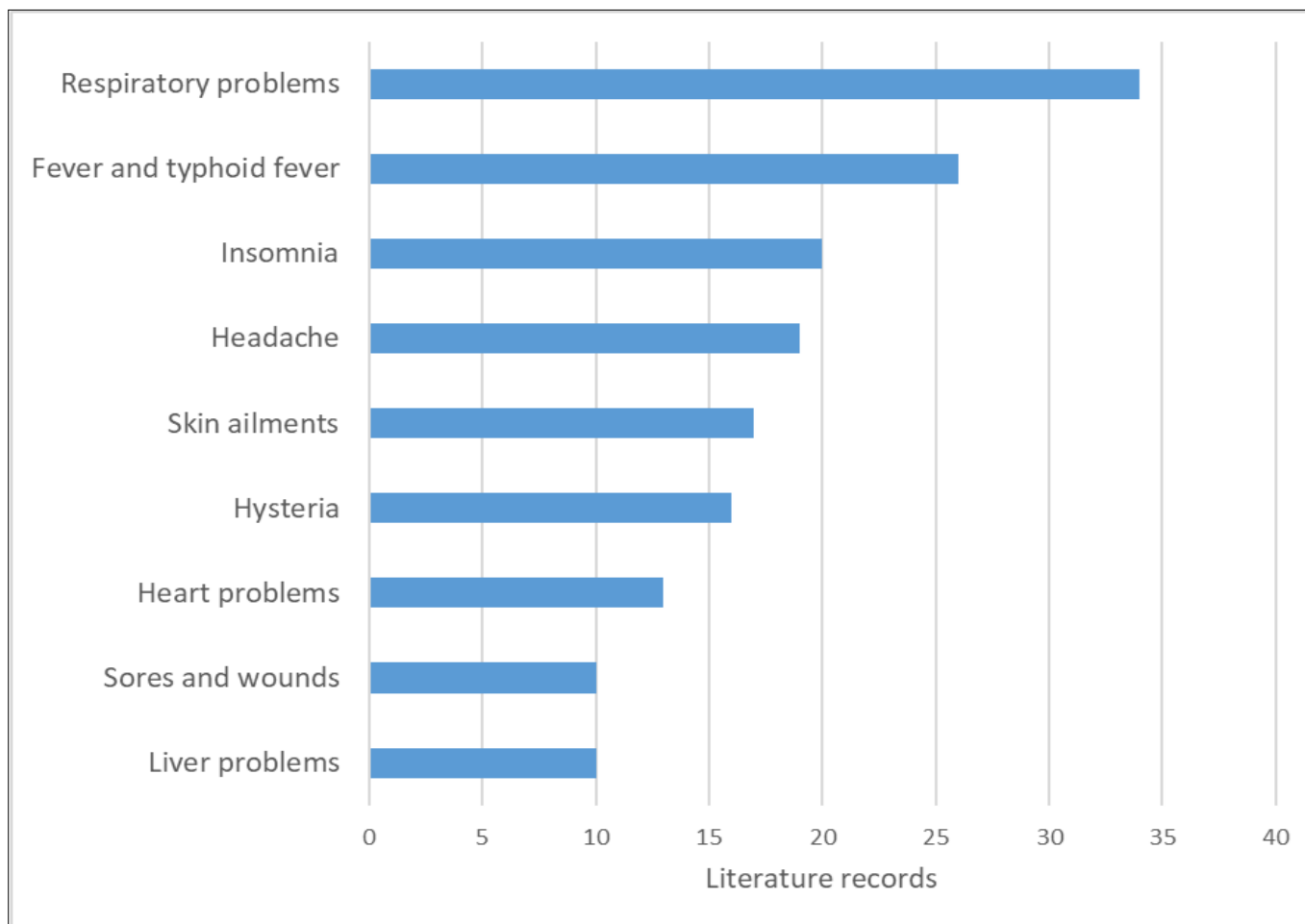


Fig. 2. Medicinal uses of *Pseudodictamnus africanus* based on literature records.

It was identified hispanolone and dehydrohispanolone (Fig. 3) from the aerial parts of *P. africanus* (34) while documentation and isolation of tannins and saponins isolated

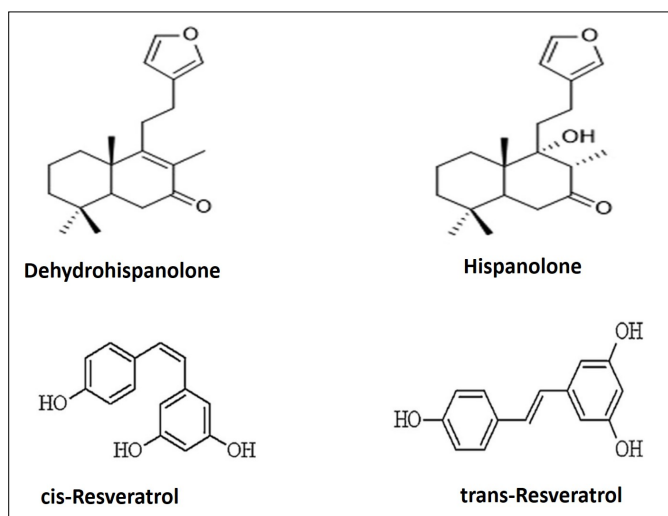


Fig. 3. Chemical structures of phytochemical compounds isolated from the aerial parts and leaves of *Pseudodictamnus africanus*.

from the leaves (38). Similarly, reports are on a phenolic compound resveratrol from the leaves of *P. africanus* (62)

while reports are on flavonoids, reducing sugars, saponins, tannins and triterpene steroids from the leaves (47). Other research carried out showed that *P. africanus* is a source of essential oils and diterpenoids (43). Similar compounds have also been identified from a closely related species, *Ballota nigra* and these phytochemical compounds include diterpenoid lactones of the labdane type such as ballotenol, ballotinone, 7 α -acetoxy-marrubiin and preleosi-birin, flavonoid glycosides, phenylpropanoids and traces of volatile oil (1). The phytochemical compounds identified from different aerial parts and leaves of *P. africanus* are important and these findings could be used to explain the health benefits of the species (Table 1). The identified compounds isolated from the aerial parts and leaves of *P. africanus* clearly highlight the importance of detailed and further investigations on active bioactives of the species in the aerial parts, leaves and stems as these organs remain the most widely utilised plant parts as traditional medicine.

Pharmacological properties of *Pseudodictamnus africanus*

The pharmacological effects (Table 2) of the essential oils isolated from *P. africanus*, stem and leaf extracts of the

Table 2. Summary of pharmacological activities of the extracts and compounds isolated from different parts of *Pseudodictamnus africanus*

Activity tested	Extract/compound	Plant part	Model	Effect	Reference
Antibacterial	Methanol	Leaves	Modified disc diffusion	Showed weak activities against <i>Proteus mirabilis</i> with the inhibition zone of 7.0 mm	28
			Disc diffusion	Showed weak activities against <i>Proteus mirabilis</i> with the minimum inhibitory concentration (MIC) values of 4278.0 µg/ml	28
	Aqueous	Leaves	Microdilution	Showed activities against <i>Staphylococcus aureus</i> with MIC value of 3.1 mg/ml, <i>Klebsiella pneumoniae</i> and <i>Streptococcus pyogenes</i> with MIC value of >12.5 mg/ml	41
			Stems	Microdilution	Showed weak activities against <i>Klebsiella pneumoniae</i> , <i>Staphylococcus aureus</i> and <i>Streptococcus pyogenes</i> with MIC value of >12.5 mg/ml
	Dichloromethane	Leaves	Microdilution	Showed activities against <i>Staphylococcus aureus</i> with MIC value of 0.4 mg/ml, <i>Klebsiella pneumoniae</i> (1.6 mg/ml) and <i>Streptococcus pyogenes</i> (6.3 mg/ml)	41
			Stems	Microdilution	Showed activities against <i>Streptococcus pyogenes</i> with MIC value of 0.4 mg/ml, <i>Klebsiella pneumoniae</i> (1.6 mg/ml) and <i>Staphylococcus aureus</i> (3.1 mg/ml)
	80% ethanol	Leaves	Microdilution	Showed activities against <i>Streptococcus pyogenes</i> with MIC value of 0.4 mg/ml, <i>Klebsiella pneumoniae</i> (3.1 mg/ml) and <i>Staphylococcus aureus</i> (6.3 mg/ml)	41
			Stems	Microdilution	Showed activities against <i>Streptococcus pyogenes</i> with MIC value of 1.6 mg/ml, <i>Klebsiella pneumoniae</i> and <i>Staphylococcus aureus</i> with MIC value of 3.1 mg/ml
	Petroleum ether	Leaves	Microdilution	Showed activities against <i>Klebsiella pneumoniae</i> and <i>Staphylococcus aureus</i> with MIC value of 3.1 mg/ml each, and <i>Streptococcus pyogenes</i> with MIC value of 12.5 mg/ml	41
			Stems	Microdilution	Showed activities against <i>Staphylococcus aureus</i> and <i>Streptococcus pyogenes</i> with MIC value of 1.6 mg/ml each, and <i>Klebsiella pneumoniae</i> with MIC value of 3.1 mg/ml
	Aqueous	Leaves	Disc diffusion	Showed activities against <i>Klebsiella pneumoniae</i> with inhibition zone of 7.0 mm	62
	Methanol	Leaves	Disc diffusion	Showed activities against <i>Klebsiella pneumoniae</i> with inhibition zone of 8.0 mm	62
	Aqueous	Leaves	Microdilution	Showed activities against <i>Klebsiella pneumoniae</i> with MIC value of 379.0 µg/ml	62
	Methanol	Leaves	Microdilution	Showed activities against <i>Klebsiella pneumoniae</i> with MIC value of 438.0 µg/ml	62
Antifungal	Aqueous	Leaves	Microdilution	Showed activities against <i>Candida albicans</i> with MIC value of 3.1 mg/ml and minimum fungicidal concentrations (MFC) value of >12.5 mg/ml	41
			Stems	Microdilution	Showed activities against <i>Candida albicans</i> with MIC value of 6.3 mg/ml and MFC value of >12.5 mg/ml
	Dichloromethane	Leaves	Microdilution	Showed activities against <i>Candida albicans</i> with MIC and MFC value of 1.6 mg/ml and 3.1 mg/ml, respectively	41
			Stems	Microdilution	Showed activities against <i>Candida albicans</i> with MIC and MFC value of 3.1 mg/ml
	80% ethanol	Leaves	Microdilution	Showed activities against <i>Candida albicans</i> with MIC and MFC value of 3.1 mg/ml	41
			Stems	Microdilution	Showed activities against <i>Candida albicans</i> with MIC and MFC value of 3.1 mg/ml and 6.3 mg/ml, respectively
	Petroleum ether	Leaves	Microdilution	Showed activities against <i>Candida albicans</i> with MIC and MFC value of 3.1 mg/ml and 6.3 mg/ml, respectively	41
	Petroleum ether	Stems	Microdilution	Showed activities against <i>Candida albicans</i> with MIC and MFC value of 3.1 mg/ml and 6.3 mg/ml, respectively	41
Anti-inflammatory	Aqueous	Essential oils	5-lipoxygenase inhibitory	Essential oils exhibited activities with half maximal inhibitory concentration (IC ₅₀) value of 30.0 ppm	56,63
Antinociceptive	Methanol	Leaves	Hot plate test	Exhibited dose-dependent activities	47
			Acetic acid writhing test	Exhibited dose-dependent activities	47
Immunological	Ethanol	Leaves	Anti-histamine assay	Exhibited affinity with histamine receptor binding of 90.0%	41
			Stems	Anti-histamine assay	Exhibited affinity with histamine receptor binding of 95.0%
Sedative-hypnotic	Methanol	Leaves	Pentobarbitone induced sleep test	Exhibited dose-dependent activities	47
			Locomotor activity test	Exhibited dose-dependent activities	47

species included the following: antibacterial (28, 41, 62), antifungal (41), anti-inflammatory (56, 63), antinociceptive (47), immunological (41) and sedative-hypnotic (47) activities.

Antibacterial activities

Reports are on the assessment of the antibacterial effects of aqueous and methanol extracts of *P. africanus* leaves were tested using *Proteus vulgaris* (ATCC 33420) and *Proteus mirabilis* (ATCC 43071) against the disc diffusion approach with chloramphenicol (10.0 µg) and ampicillin (2.0 µg) as positive controls (28). The methanolic extract exhibited weak activities against *Proteus mirabilis* (ATCC 43071) with the inhibition zone of 7.0 mm and minimum inhibitory concentration (MIC) values of 4278.0 µg/ml (28). The antibacterial effects of aqueous, petroleum ether, dichloromethane and 80% ethanol extracts of *P. africanus* stems and leaves against *Haemophilus parainfluenzae* (ATCC 7901), *Streptococcus pyogenes* (ATCC 12344), *Staphylococcus aureus* (ATCC 12600) and *Klebsiella pneumoniae* (ATCC 13883) were tested against the disc diffusion and microdilution methods using neomycin (50.0 µg/ml), ampicillin (50.0 µg/ml) and penicillin (50.0 µg/ml) as the positive controls in the investigation (41). The extracts of the species showed activities against *Streptococcus pyogenes* (ATCC 12344), *Staphylococcus aureus* (ATCC 12600) and *Klebsiella pneumoniae* (ATCC 13883) with MIC values within the range of 0.4 mg/ml to >12.5 mg/ml (41). Reports are on the assessment of the antibacterial effects of methanol and water extracts of *P. africanus* leaves tested against *Klebsiella pneumoniae* (ATCC 13883) using the disc diffusion method with ampicillin (2.0 µg) and chloramphenicol (10.0 µg) used as the positive controls (62). The water and methanolic extracts demonstrated the antibacterial effects against *Klebsiella pneumoniae* (ATCC 13883) with inhibition zone of 7.0 mm and 8.0 mm and MIC values of 379.0 µg/ml and 438.0 µg/ml respectively (62).

Antifungal activities

The antifungal effects of aqueous, 80% ethanol, petroleum ethers and dichloromethane extracts of *P. africanus* leaves and stems using *Candida albicans* (ATCC 10231) against the microdilution method using the amphotericin B (50.0 µg/ml) as the positive control were assessed (41). The extracts of the species demonstrated activities against the experimental pathogens with the MIC and minimum fungicidal concentrations (MFC) values within the of 1.6 mg/ml and >12.5 mg/ml (41). The preliminary antibacterial and antifungal activities exhibited by *P. africanus* extracts are strongly linked to several physiological processes and activities which act against microbial growth and multiplication, hence the species is popular as traditional medicine against gastro-intestinal problems, mouth infections and thrush, skin infections, respiratory infections, sores, wounds and toothache. Although the research aimed at establishing the antibacterial and antifungal activities of *P. africanus* is noteworthy, the screened panel of bacterial and fungal microorganisms are inadequate in comparison to the documented microbial-related human and animal health conditions in southern Africa. There is

need to evaluate antibacterial and antifungal activities of *P. africanus* against bacterial and fungal microorganisms that are of relevance to dermatological problems and respiratory infections. There is obviously need to conduct *in vivo* and clinical tests as there are several limitations associated with the *in vitro* models (64).

Anti-inflammatory effects

Reports are on the assessment of the anti-inflammatory effects of methanol and water extracts of *P. africanus* leaves and essential oils isolated from the species by evaluating the 5-lipoxygenase inhibitory effects which were tested using a threefold stepwise dilution approach using Tween®20 and dimethyl sulfoxide (DMSO) as negative controls and nordihydroguaiaretic acid was used as the positive control (56, 63). The essential oils exhibited 5-lipoxygenase inhibitory effects which were supported by half maximal inhibitory concentration (IC₅₀) value of 30.0 ppm (56, 63). These results support the traditional use of the species in various inflammatory ailments and diseases ranging from microbial infection to injury that result in cell injury and death.

Antinociceptive effects

Reports are on the assessment of the antinociceptive effects of methanol extracts of *P. africanus* leaves against the hot plate and the acetic acid writhing tests in mice (47). The extract of the species demonstrated the dose-dependent effects which were similar to the dose-dependent effects demonstrated by a positive control (47). These findings could be used to corroborate traditional uses of *P. africanus* extracts as traditional medicines for mechanical injury and sensory nervous system such as fever, inflammation, rheumatism, toothache, sores and wounds.

Immunological activities

The immunological effects of the ethanolic crudes extracts of *P. africanus* leaves and stems were tested against the anti-histamine assay (41). The *P. africanus* leaves and stems extracts exhibited excellent affinity with histamine receptor binding of 90.0% to 95.0% respectively (41). More research is needed to correlate the traditional use of the species in various inflammatory ailments and diseases with the biological activities of crude extracts or compounds isolated from the species.

Sedative-hypnotic effects

The sedative-hypnotic effects of methanol extract of *P. africanus* leaves were tested against the pentobarbitone induced sleep and locomotor activity tests in mice (47). The extract of the species demonstrated the dose-dependent effects which were similar to the dose-dependent effects demonstrated by a positive control (47).

Toxicity

The oral preparation and administration procedure involving the methanol extracts of *P. africanus* aerial parts demonstrated the median lethal dose (LD₅₀) of the species is probably over 4000.0 mg/kg in mice (47). Therefore, detailed studies focusing on evaluating the toxicological effects, particularly the long-term acute and chronic toxic-

ty effects *in vivo* and animal models are recommended.

Conclusion

This study provided a summary of information on the medicinal uses, active bioactives and the pharmacological effects of *P. africanus*. Considering the high number of studies reporting on ethnomedicinal uses of *P. africanus*, there are still further avenues and opportunities to unravel the phytoconstituents and the biological activities of this species. Such advanced ethnopharmacological research on *P. africanus* will enable local communities in southern Africa to continuously utilize the species for human diseases and ailments.

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Compliance with ethical standards

Conflict of interest: The author declares that there is no conflict of interest associated with this research.

Ethical issues: None.

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