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BIOLOGICAL AND MEDICINAL PROPERTIES OF *POUZOLZIA MIXTA* SOLMS (*URTICACEAE*): A NARRATIVE REVIEW

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ABSTRACT

Local communities use plant resources from the surrounding environment for firewood, food and medicines, and for their livelihood maintenance, security and income generation. The different parts of *Pouzolzia mixta* Solms are characterized by nutritional, cultural and pharmaceutical properties. *Pouzolzia mixta* is a small tree or shrub which grows naturally in tropical woodlands and thickets of Africa and Asia. The current study is aimed at providing information on the biological and medicinal properties of *P. mixta.* Information on the biological and medicinal properties of *P. mixta* was obtained from online databases such as Scopus, JSTOR, Scimago, Google Scholar, PubMed and Science Direct, and pre-electronic sources such as books, journal articles, dissertations, book chapters, thesis and other scientific articles obtained from the University of Fort Hare library. This study showed that the leaves of *P. mixta* are used as culinary herb and leafy vegetable in tropical Africa and Asia. In south central Africa, the bark, leaves, roots and stems of *P. mixta* are used as ritual and protective charm, and traditional medicine to treat and manage 48 human and 13 animal diseases and ailments. The phytochemical evaluations of the species showed that the leaves and roots of the species are characterized by alkaloids, flavonoids, glycosides, phenolics, steroids and tannins. The pharmacological assessments showed that the crude extracts of *P. mixta* leaves, roots and stems are characterized by antibacterial, antifungal, antiviral, anti-diabetic, anti-fertility and antioxidant activities. This review highlighted the food, pharmaceutical and health benefits of *P. mixta* in different countries in east and southern Africa, and Asia. Based on the results of this review, detailed ethnopharmacological evaluations of *P. mixta* focusing on phytochemistry, pharmacological properties and toxicological evaluations, in vivo and clinical research are recommended. The data from the current study should contribute to improved management and conservation of *P. mixta* in tropical Africa and Asia, considering concerns about anthropogenic pressure on plant biodiversity.

Key words: Biological activities, indigenous knowledge, pharmacological properties, *Pouzolzia mixta*, traditional medicine, Urticaceae

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INTRODUCTION

Many people throughout the world use a variety of plants in their daily lives as food, shelter, fuel, craftwork, medicine and several other necessities of life [1]. There is renewed interest in traditional uses of plants, particularly medicinal plants and species used as functional foods. Research showed that about 80% of the African population use traditional medicines as a component of their primary healthcare in comparison with about 60% of the global population [2]. Medicinal plants are now an important part of human history, culture and tradition in tropical Africa [3-6]. Similarly, the use of herbal medicine products from the European and Asian countries has been increasing globally [7]. Traditional medicines including plants, other organisms and mineral elements is often used interchangeably with terms such as complementary or alternative or non-conventional medicines to refer to "the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement, or treatment of physical and mental illness" [8]. Research shows that complementary or alternative or non-conventional medicines use is increasing throughout the world with use ranging between 10% and 86% in the United States and Europe [9-13]. In sub-Saharan Africa, complementary or alternative or non-conventional medicines are used concurrently with conventional medicines, therefore, this is complementary therapy rather than an alternative to conventional medicines [14]. It is also well documented that in local communities where access to conventional healthcare is difficult, such people use traditional medicines as an alternative to conventional or western medicines [15,16].

Research by Hedberg and Staugård [2] revealed that the use of medicinal plants, plant extracts or their active principles play an important role in therapy within the traditional healthcare systems globally. Similarly, Van Wyk and Gericke [1] argued that the use of traditional medicines for the treatment and management of various human health challenges continues to expand rapidly in both developing and developed countries, with herbal concoctions being sold not only in pharmacies but also in informal herbal medicine markets. Therefore, herbal medicine products translate to a high trade value of pharmaceutical products although lack of standardized quality control procedures is regarded as a major hurdle in the commercialization of these phytomedicines [7,17,18]. One of the widely used plant species in southern Africa as a source of traditional medicines is *Pouzolzia mixta* Solms (Figure 1). *Pouzolzia mixta* is included in a monograph entitled "Medicinal and magical plants of southern Africa: An annotated checklist" [19]. The species is also among the species in the monograph "Plant resources of tropical Africa" as

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medicinal, fibre, vegetable, fodder and ornamental plant species [20]. It is, therefore, within this context that the current study was undertaken aimed at documenting the biological and medicinal properties of *P. mixta*.

Figure 1: *Pouzolzia mixta* A: branch showing discoloured leaves and flowers, and B: branch showing fruits (photos: BT Wursten)

MATERIALS AND METHODS

Literature search on medicinal uses, phytochemistry and pharmacological properties of *Pouzolzia mixta* was conducted using online databases such as Scopus, JSTOR, Scimago, Google Scholar, PubMed and Science Direct (Table 1). In addition to this, pre-electronic sources such as books, journal articles, dissertations, book chapters, these and other scientific articles obtained from the University of Fort Hare library were used. Keywords used in the search included "*Pouzolzia mixta*", "biological activities of *Pouzolzia mixta*", "pharmacological properties of *Pouzolzia mixta*", "ethnobotany of *Pouzolzia mixta*", "medicinal uses of *Pouzolzia mixta*", "phytochemistry of *Pouzolzia mixta*" and "traditional uses of *Pouzolzia mixta*". Literature sources included in this review are those that assessed the biological and medicinal properties of *P. mixta* (Figure 2). Literature sources excluded from this review are those articles that are partially accessed, that is, accessed as abstracts only, and also published or unpublished ethnopharmacological surveys lacking information on medicinal uses or biological activities of *P. mixta*.

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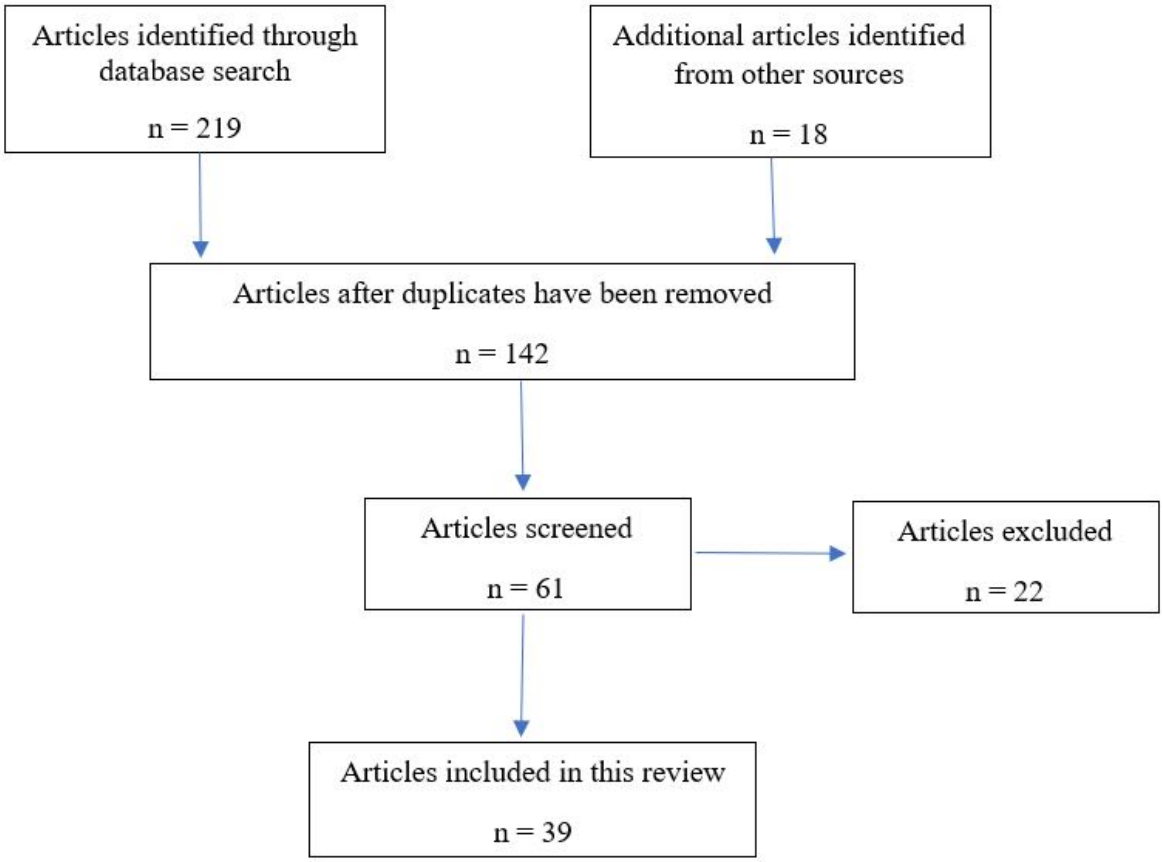

Figure 2: Flow diagram showing identification and screening of articles used in this review

RESULTS AND DISCUSSION

Habit and morphology

Pouzolzia mixta is a shrub belonging to the Urticaceae or nettle family. The majority of species belonging to the Urticaceae family are annual or rhizomatous herbs, subshrubs, shrubs, rarely trees or climbers, sometimes with stinging or sharply pointed hairs. The genus *Pouzolzia* Gaudich consists of approximately 35 to 40 species [21] distributed throughout the tropical world. The genus name *Pouzolzia* is in honour of Pierre Marie Casimir de Pouzolz of Nimes (1785-1858), a French botanist, plant collector and writer of the French Flora [22]. The species name "*mixta*" means mixed, perhaps in reference to the bi-coloured leaves (Figure 1). Two infraspecific taxa are recognized, *P. mixta* var. *mixta* and *P. mixta* var. *shirensis* (Rendle) Friis & Wilmot-Dear [23]. The synonyms of *P. mixta* include P. arabica Deflers, P. baronii Leandri, P. fruticosa Engl., P. huillensis Hiern, P. hypoleuca Wedd. and P. shirensis Rendle [23]. The English common names of *P.*

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mixta include soap nettle, snuggle-leaf and soap bush [22]. *Pouzolzia mixta* is a many-stemmed shrub or sometimes a small and soft-wooded tree reaching 4 metres in height [22]. The bark of *P. mixta* is dark, red-brown in colour, smooth with a slimy sap and the branches are usually velvety. The leaves of *P. mixta* are simple, stipulate, alternate, entire, heart-shaped or egg-shaped, pointed, usually widest towards the round or notched base. The leaves are ovate, soft-textured, dark green and somewhat rough above, silvery white-felted below, prominently three-veined with entire margin (Figure 1). The flowers occur in axillary clusters, small in size, greenish-white in colour with male and female flowers often intermixed. The fruit is a nut, small and enclosed in a persistent perianth tube. *Pouzolzia mixta* has been recorded in open woodland, wooded ravines, thickets and sheltered among boulders on rocky koppies in Angola, Botswana, Eswatini, Ethiopia, Madagascar, Malawi, Mozambique, Namibia, South Africa, South Sudan, Sudan, Tanzania, Uganda, Yemen, Zambia and Zimbabwe [22].

Ethnobotanical and ethnopharmacological uses

Pouzolzia mixta is used as culinary herb in African and Asian countries [20]. The leaves are cooked to provide a popular green vegetable, often mixed with *Obetia tenax* (N.E.Br.) Friis and *Corchorus tridens* L. [20]. Phytochemical analyses showed that *P. mixta* has considerable amounts of important nutrients and minerals (Table 1).

The bark of *P. mixta* is fibrous and is used as rope, twine or string. *Pouzolzia mixta* is cultivated in the fishing villages in Malawi where local communities make fishing nets from the bark which is strong and long-lasting in water [22]. *Pouzolzia mixta* was extensively used for fishing nets in Malawi before nylon nets were adopted [20]. The crushed leaves of *P. mixta* are soapy and have been used as a soap substitute to wash hands and clothes [1,20]. The sap of *P. mixta* is traditionally used for sealing cracks in milk vessels in southern Africa [22]. The leaves of *P. mixta* are an important browse for livestock and game particularly during the dry season and severe droughts [27]. *Pouzolzia mixta* is also used as ornamental and bee forage [20].

Pouzolzia mixta is used as a source of traditional medicines in Botswana, Malawi, Mozambique, Namibia, South Africa, Tanzania and Zimbabwe, that is, 43.75% of the countries where the species is indigenous (Table 2). *Pouzolzia mixta* is used to treat and manage 48 human and 13 animal diseases and ailments (Table 2). In Zimbabwe, *P. mixta* is over-collected as herbal medicine [28].

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Biological activities of *Pouzolzia mixta*

The following pharmacological properties have been documented from the leaf, root and stem extracts of *P. mixta*: antibacterial, antifungal, antiviral, anti-diabetic, anti-fertility and antioxidant activities.

Antibacterial activities

Rabe and Van Staden [34] evaluated the antibacterial activities of water and methanol extracts of *P. mixta* leaves, roots and stems against *Staphylococcus aureus, Staphylococcus epidermis, Bacillus subtilis, Escherichia coli* and *Klebsiella pneumoniae* using the agar diffusion and dilution methods with neomycin as the positive control. The extracts showed activities against *Staphylococcus aureus, Staphylococcus epidermis* and *Bacillus subtilis* with the minimum inhibition concentration (MIC) values ranging from 2.0 mg/ml to 4.0 mg/ml [34]. Samie *et al.* [37] evaluated the antibacterial activities of acetone and methanol extracts of *P. mixta* leaves, roots and stems *against Aeromonas hydrophila, Bacillus cereus, Bacillus pumilus, Bacillus subtilis, Enterobacter cloacae, Enterococcus fecalis, Escherichia coli, Klebsiella pneumoniae, Pantoea agglomerans, Proteus mirabilis, Pseudomonas aeruginosa, Salmonella cholerae-suis, Serratia marcescens, Staphylococcus aureus* and *Shigella flexneri* using the disc diffusion and the micro-dilution methods with gentamicin as a positive control. The extracts exhibited activities against most of the pathogens with MIC values ranging from 6.0 mg/ml to >12.0 mg/ml [37]. McGaw *et al.* [55] evaluated the antibacterial activities of aqueous, methanol and hexane extracts of *P. mixta* leaves and stems against *Enterococcus faecalis, Escherichia coli, Pseudomonas aeruginosa* and *Staphylococcus aureus* using the serial microplate dilution method with neomycin as the positive control. The extracts exhibited activities with MIC values ranging from 6.3 mg/ml to >12.5 mg/ml [55]. Samie *et al.* [38] evaluated the antibacterial activities of methanol and water extracts of *P. mixta* leaves, roots and stems against *Campylobacter* isolates using microdilution method and the extracts exhibited activities [38].

Antifungal activities

Samie *et al.* [39] evaluated the antifungal activities of acetone and hexane extracts of *P. mixta* leaves against *Candida albicans, Cryptococcus neoformans* and *Candida krusei* using the agar diffusion and the microdilution methods with nystatin and flucytosine as positive controls. The extracts exhibited activities against the tested pathogens with the MIC values ranging from 3.75 mg/ml to >7.5 mg/ml [39]. Samie and Mashau [40] evaluated the antifungal activities of methanol extracts of *P. mixta* leaves, roots and stems against *Fusarium verticillioides, Fusarium oxysporum, Fusarium nygamai, Fusarium graminearum* and *Fusarium proliferatum*

using the hole plate diffusion and the microdilution methods with nystatin as positive control. The extract exhibited activities against the tested pathogens with MIC values ranging from 0.95 mg/ml to >7.5 mg/ml [40].

Antiviral activities

McGaw *et al.* [56] evaluated antiviral activities of acetone extracts of *P. mixta* leaves using antiviral assay against the sensitive feline herpesvirus type 1 and the extract exhibited activities causing a reduction in viral growth [56].

Anti-diabetic activities

Phaswane [25] evaluated the anti-diabetic activities of acetone, aqueous and dichloromethane extracts of *P. mixta* using the alpha-glucosidase enzyme assay with acarbose as a positive control. The extracts exhibited activities with half maximal concentration (IC_{50}) values ranging from 409.80 µg/ml to 514.60 µg/ml [25].

Anti-fertility activities

Sewani-Rusike [26] evaluated the antifertility effects of aqueous and ethanolic extracts of *P. mixta* roots by testing the contraceptive, postcoital, estrogenic, anti-implantation and in vitro oxytocic activities using adult female Sprague Dawley rats. The aqueous and ethanolic extracts of *P. mixta* roots exhibited contraceptive, estrogenic, oxytocic and postcoital activities [26].

Antioxidant activities

Phaswane [25] evaluated the antioxidant activities of acetone, aqeuous and dichloromethane extracts of *P. mixta* using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical, beta-carotene and linoleic acid assays with the butylated hydroxytoluene (BHT) as positive control. The extracts exhibited activities with IC_{50} values ranging from 13.73 µg/ml to 76.66 µg/ml [25].

Toxicity activities

Sewani-Rusike [26] evaluated the acute toxicity activities of aqueous and ethanolic extracts of *P. mixta* roots by administering oral doses of 2000 and 4000 mg/kg body weight of either extract to both female and male adult Sprague Dawley rats after fasting overnight with saline as a positive control. The animals were observed over 72 hours for behavioural changes and mortality. The plant extracts were not toxic in rats upto a dose of 2000 mg/kg body weight [26].

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CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

Local communities rely on plant species for their livelihood, sustenance, social stability and security. *Pouzolzia mixta* is associated with enormous indigenous knowledge about its traditional uses, particularly how the species has been utilized in therapy within the traditional *materia medica* in east and southern Africa. Therefore, the present review summarizes the biological and medicinal properties of *P. mixta.* Detailed studies focusing on phytochemical evaluations including toxicological, in vivo and clinical studies to corroborate the traditional medical applications of the species are recommended. Therefore, future research should focus on the molecular modes or mechanisms of action, pharmacokinetics and physiological pathways for specific extracts of the species including identification of the bioactive compounds of the species and their associated pharmacological activities.

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Table 1: Phytochemical and nutritional properties of *Pouzolzia mixta*

Phytochemical and nutritional	Plant part	Value	Reference
Alkaloids	Leaves	-	[25]
Ascorbic acid	Leaves	11.61 mg/100g	[25]
Calcium	Leaves	3560.00 mg/100g	[25]
β-carotene	Leaves	3.52 mg/100g	[25]
Cellulose	Fibre	66.7%	[20]
Copper	Leaves	3.95 mg/100g	[25]
Glycosides	Leaves and roots	-	[25,26]
5-hydroxytryptamine	Leaves	-	[24]
Iron	Leaves	15.28 mg/100g	[25]
Flavonoids	Leaves and roots	2.36 mg CE/g	[24-26]
Magnesium	Leaves	708.66 mg/100g	[25]
Manganese	Leaves	11.61 mg/100g	[25]
Phenolics	Leaves	3.72 mg GAE/g	[25]
Phosphorus	Leaves	477.33 mg/100g	[25]
Polypeptides	Roots	-	[26]
Potassium	Leaves	1312.00 mg/100g	[25]
Steroids	Leaves	-	[25]
Tannins	Leaves and roots	-	[25,26]
Zinc	Leaves	2.77 mg/100g	[25]

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Table 2: Medicinal uses of *Pouzolzia mixta*

Medicinal use	Plant parts used	Country	Reference
Abortifacient	Root powder	South Africa and Zimbabwe	[1,29,30]
Aphrodisiac	Roots	Malawi, Mozambique, South Africa and Zimbabwe	[1,20,29,30]
Aphrodisiac	Root bark or stem mixed with *Albizia antunesiana* Harms, *Elephantorrhiza goetzei* (Harms) Harms, *Mondia whitei* (Hook.f.) Skeels, *Ozoroa insignis* Delile and *Senna singueana* (Delile) Lock	Zimbabwe	[31]
Abscess	Roots	South Africa	[32]
Back pain	Roots mixed with *Celosia trigyna* L., *Entada rheedei Spreng*., *Glycyrrhiza glabra L., Haemanthus albiflos Jacq.* and *Ocotea bullata* (Burch.) Baill.	South Africa	[33]
Biliousness	Not specified	South Africa	[20,24]
Boils	Roots	South Africa	[32]
Burns	Root paste	South Africa, Tanzania and Zimbabwe	[1,20,29,30,34,35]
Cleansing	Leaves	South Africa	[30]
Constipation	Bark or roots	South Africa and Zimbabwe	[1,20,29,30]
Contraceptive	Roots	South Africa and Zimbabwe	[1,20,26,29,30]
Depressed fontanelle	Roots	Zimbabwe	[20,29]
Diarrhoea	Leaves, roots or stems	South Africa	[20,36-39]
Digestive system diseases	Leaves	South Africa	[25]
Dilate birth canal	Roots	Botswana, South Africa and Zimbabwe	[1,20,25,28-30,36]
Dysentery	Leaves, roots or stems	South Africa	[30,37-41]
Eczema	Roots	South Africa	[32]
Enema	Roots mixed with *Trichilia emetica* Vahl	South Africa	[24]

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Epilepsy	Roots	Tanzania	[42]
Eye problems	Leaves	Zimbabwe	[43]
Fever	Not specified	South Africa	[41]
Fractures	Roots	Zimbabwe	[35]
General body health	Not specified	South Africa	[37,38]
General debility	Bark mixed with *Erythrina latissima* E.Mey.	South Africa	[44]
Good luck	Roots	Botswana and Malawi	[2,29,41]
Headache	Bark mixed with *E. latissima*	South Africa	[44]
Impotence	Roots	Malawi	[45]
Increase blood	Roots	Malawi	[45]
Infantile acropustulosis	Roots	South Africa	[32]
Infertility in women	Roots	South Africa and Zimbabwe	[1,20,25,29,30]
Kidney diseases	Leaves	South Africa	[25]
Magical purposes	Roots	South Africa and Zimbabwe	[36,41]
Measles	Leaves	Zimbabwe	[20,43]
Pearly penile papules	Roots	South Africa	[32]
Protective charm against evil spirits	Not specified	South Africa	[41]
Protective charm	Planted in homesteads to prevent lightening attacks	Zimbabwe	[27]
Retained placenta	Bark, leaves or roots	South Africa and Zimbabwe	[1,20,25,29,30,41]
Ritual	Not specified	Namibia	[46]
Sexually transmitted disease	Roots	South Africa and Zimbabwe	[8]
Suturing	Bark strips and root fibre used for stitching wounds	South Africa and Zimbabwe	[1,20,24,29,30,34,41]
Tonic	Roots	Zimbabwe	[35]
Tuberculosis	Roots	South Africa	[47,48]
Ulcers	Leaves	Malawi	[49]

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Uterine pain	Root powder	South Africa and Zimbabwe	[1,20,25,29,30]
Vagina lubricant	Roots	South Africa and Zimbabwe	[1,29,30]
Venereal diseases	Root powder	South Africa and Zimbabwe	[1,20,25,29,30,34]
Weakness in men	Root powder	Botswana	[2,41]
Wounds	Bark and roots	South Africa and Zimbabwe	[8,24,35,41]
Ethnoveterinary medicine			
Bloat	Leaves, roots and stems	South Africa and Zimbabwe	[50-52]
Bone fractures, injuries and wounds	Stems used as bandages	Zimbabwe	[27,52]
Constipation	Roots	South Africa and Zimbabwe	[29,53]
Diarrhoea	Roots	South Africa	[53]
Dystocia in cattle	Cattle drenched using bark or root infusion	Zimbabwe	[27,29,52]
Flea eradication	Roots mixed with *Drimia sanguinea* (Schinz) Jessop, *Hypoxis hemerocallidea* Fisch, C.A.Mey. & Avé-Lall., *Peltophorum africanum* Sond., *Senna italica* Mill. and *Sesamum senecioides* (Klotzsch) Byng & Christenh.	South Africa	[54]
Heart problems	Roots mixed with *Aloe vera* (L.) Burm.f. and *H. hemerocallidea*	South Africa	[54]
Prevent abortion	Roots mixed with *Boophone disticha* (L.f.) Herb., *H. hemerocallidea* and *Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm.	South Africa	[50]
Retained placenta	Bark, leaves, roots or stems	Botswana, South Africa and Zimbabwe	[29,50-53]
Snake bite	Stems	Zimbabwe	[52]
Uterus cleansing	Roots	South Africa	[54]
Vaginal discharge	Leaves, roots and stems	South Africa	[50,52]

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