

EVALUATION OF MEDICINAL USES, PHYTOCHEMISTRY AND PHARMACOLOGICAL PROPERTIES OF *AFROASTER HISPIDA* (ASTERACEAE)

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Abstract

Afroaster hispida is a perennial herb widely used as traditional medicine in southern Africa. The current study critically reviewed the medicinal uses, phytochemistry and pharmacological properties of *A. hispida*. A systematic review of the literature studies was carried out to document the medicinal uses, phytochemistry and pharmacological properties of *A. hispida*. The results of the current study are based on literature survey conducted using various search engines such as Web of Science, Elsevier, Pubmed, Google scholar, Springer, Science Direct, Scopus, Taylor and Francis, and pre-electronic sources such as books, book chapters, scientific journals and other grey literature obtained from the University library. This study revealed that *A. hispida* is used mainly as colic, emetic, and traditional medicine for anthrax, fever, gastro-intestinal problems, headache, hysteria, psychiatric problems, respiratory infections, sexually transmitted infections, sores and wounds. Pharmacological research identified alkaloids, amino acids, anthocyanins, coumarins, flavonoids, glycosides, phenols, phlobatannins, saponins, sterols, tannins and terpenoids. The crude extracts of *A. hispida* exhibited acetylcholinesterase enzyme inhibition, antibacterial, antifungal and anti-inflammatory activities. *Afroaster hispida* should be subjected to detailed phytochemical, pharmacological and toxicological evaluations aimed at correlating its medicinal uses with its phytochemistry and pharmacological activities.

Keywords: *Afroaster hispida*, *Aster bakerianus*, Asteraceae, Compositae, herbal medicine, indigenous knowledge, southern Africa

1. Introduction

Afroaster hispida (Thunb.) J.C. Manning & Goldblatt (Figure 1) is a perennial herb belonging to the Asteraceae, Compositae, daisy, composite, aster or sunflower family. *Afroaster* J.C. Manning & Goldblatt is a genus of 18 herbaceous perennial species which naturally occurs from Tanzania to southern Africa characterized by scabrid or barbellate pappus bristles [1]. *Afroaster hispida* is characterized by roughly hairy, one to several annual stems growing up to 75 cm high developing from a perennial woody rootstock [2]. The leaves of *A. hispida* are lanceolate in shape with revolute and slightly toothed margins, roughly hairy and three to five-veined from the base. The flower heads of *A. hispida* are yellow with blue or white rays. *Afroaster hispida* has been recorded in from South Africa to Tanzania in rocky grassland at an altitude ranging from sea level to 2285 m above sea level [1-3]. *Afroaster hispida* is closely related to *A. pleiocephalus* (Harv.) J.C. Manning & Goldblatt and *A. serrulatus* (Harv.) J.C. Manning & Goldblatt but can be distinguished from these species by the presence of hairs on the bracts around the flower head [4,5]. The synonyms associated with the name *A. hispida* include *Calendula hispida* Thunb., *Felicia asper* Burt Davy, *Leysera pilosella* Thunb., *Diplopappus natalensis* Sch. Bip., *D. asper* Less., *Aster bakerianus* Burt Davy ex C.A. Sm., *A. hispidus* (Thunb.) Baker, *A. asper* J.M. Wood & M.S. Evans, *A. asper* Schönland, *A. grauii* Lippert, *A. bakerianus* Burt Davy ex C.A. Sm. subsp. *albiflorus* W. Lippert, *A. bakerianus* Burt Davy ex C.A. Sm. subsp. *intermedius* W. Lippert, *A. bakerianus* Burt Davy ex C.A. Sm. subsp. *angustifolius* W. Lippert, *A. bakerianus* Burt Davy ex C.A. Sm. subsp. *ovalis* W. Lippert and *A. bakerianus* Burt Davy ex C.A. Sm. subsp. *septentrionalis* W. Lippert [1,3]. It is common in recent publications to see authors using synonym of *A. hispida*, particularly *A. bakerianus* [2,3,6-8].



Figure 1: *Afroaster hispida* growing in rocky habitat after fire [9]

Afroaster hispida is a valuable medicinal plant in southern Africa and an overview of its botanical description, active ingredients, pharmacological effects and distribution are outlined in the monograph “medicinal plants of South Africa” [5]. Moreover, the roots of *A. hispida* are traded as sources of traditional medicines in informal herbal medicine markets in Gauteng and KwaZulu Natal provinces in South Africa [10,11]. *Afroaster hispida* is a component of a commercial herbal mixture or traditional herbal tonic known as “*imbiza ephuzwato*” made from a mixture of 21 plant species such as *Afroaster hispida* (roots), *Tetradenia riparia* (Hochst.) Codd (leaves), *Zanthoxylum capense* (Thunb.) Harv. (roots), *Corchorus asplenifolius* Burch. (roots), *Rubia cordifolia* L. (roots), *Watsonia densiflora* Bak. (corms), *Cyrtanthus obliquus* (L.f.) Aiton (bulb), *Vitellariopsis marginata* (N.E. Br.) Aubrév (roots), *Ledebouria* spp. (bulbs), *Drimia elata* Jacq. (bulbs), *Stephania abyssinica* (Quart.-Dill. & A. Rich.) Walp. (roots), *Gomphocarpus fruticosus* (L.) W.T. Aiton (roots), *Eriosema cordatum* E. Mey. (roots), *Gunnera perpensa* L. (rhizomes), *Fusifilum physodes* (Jacq.) Raf. ex Speta (bulbs), *Momordica balsamina* L. (leaves), *Gnidia kraussiana* Meisn. var. *kraussiana* (roots), *Scadoxus puniceus* (L.) Friis & Nordal (bulb), *Hypericum aethiopicum* Thunb. (leaves, stems), *Acokanthera oppositifolia* (Lam.) Codd (roots) and *Lycopodium clavatum* L. (whole plant) [7,12]. *Imbiza ephuzwato* is a multipurpose traditional medicine sold in informal street herbal medicine markets, herbal medicine shops, supermarkets and pharmacies. The herbal mixture is used as a detoxifying and energizing tonic to clear skin infections, used as aphrodisiac, and traditional medicine for tonsillitis, bladder, kidney and urinary problems, back pain, constipation, diabetes mellitus, pneumonia, gastro-intestinal problems, high blood pressure, menstrual problems, stress and arthritis [7]. It is therefore, within this context that this study was undertaken aimed at reviewing the medicinal uses, phytochemistry and pharmacological properties of *A. hispida*.

2. Materials and methods

Several electronic databases were searched which included Web of Science, Elsevier, Pubmed, Google scholar, Springer, Science Direct, Scopus, Taylor and Francis. Additional information was obtained from pre-electronic sources such as books, book chapters, scientific journals and other grey literature obtained from the University library. The relevant terms *Afroaster hispida* and widely used synonym *Aster bakerianus* were paired with keywords such as “medicinal uses of *Afroaster hispida* or *Aster bakerianus*”, “phytochemicals of *Afroaster hispida* or *Aster bakerianus*”, “biological activities of *Afroaster hispida* or *Aster bakerianus*”, “pharmacological properties of *Afroaster hispida* or *Aster bakerianus*”, “ethnobotany of *Afroaster hispida* or *Aster bakerianus*”, and various other synonyms and common names of the plant species. The ultimate goal of this search was to explore articles that investigated the medicinal uses, phytochemical and pharmacological properties of *A. hispida*. A total of 40 articles published between 1954 and 2021 matched the inclusion criteria and were included in this review (Figure 2).

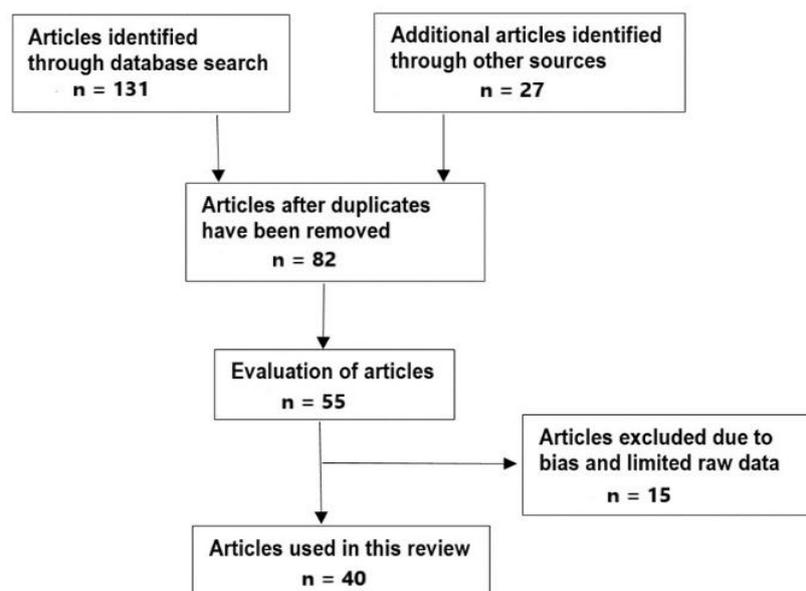


Figure 2. Flow chart showing the number of research publications used in this study

3. Results and discussion

3.1 Medicinal uses of *Afroaster hispida*

The root decoctions or infusions of *A. hispida* are mainly used as colic, emetic, and traditional medicine for anthrax, fever, gastro-intestinal problems, headache, hysteria, psychiatric problems, respiratory infections, sexually transmitted infections, sores and wounds (Table 1; Figure 3). Other medicinal applications of the root decoctions or infusions of *A. hispida* recorded in two countries and supported by at least two literature records include charm and rituals [6,13,14], earache [15,16] and epileptic fits [17,18].

Table 1: Medicinal uses of *Afroaster hispida*

Medicinal uses	Parts used and preparation	Country	References
Anthelmintic	Root decoction taken orally	South Africa	[6,19,20]
Anthrax	Roots mixed with those of <i>Leobordea lanceolata</i> (E. Mey.) B.-E. Van Wyk & Boatwr. and taken orally as decoction	Lesotho and South Africa	[6,13,14,21,22]
Back pain	Root decoction taken orally	Lesotho and South Africa	[16-18]
Charm and rituals (protection)	Roots mixed with those of <i>Helichrysum callicomum</i> Harv. and <i>H. rugulosum</i> Less. and given as enema	Lesotho and South Africa	[6,13,14]
Colic	Roots mixed with those of <i>H. callicomum</i> and <i>H. rugulosum</i> and given as enema	Lesotho and South Africa	[6,14,15,21,22]
Earache	Root decoction applied topically	Lesotho and South Africa	[15,16]
Emetic	Root decoction taken orally	Lesotho and South Africa	[5,6,19,22,23]
Epileptic fits	Root decoction taken orally	Lesotho and South Africa	[17,18]
Eye infections	Root infusion applied topically	South Africa	[6,14,15,22]
Fever	Roots mixed with those of <i>L. lanceolata</i> and taken orally	Lesotho and South Africa	[6,13-15,21]
Gastro-intestinal problems (bloating, diarrhoea, stomachache, stomach complaints and stomach pains)	Root decoction taken orally	Lesotho and South Africa	[2,5-7,15,18,21-26]
Headache	Root decoction taken orally	Lesotho and South Africa	[2,6,7,13-15,18,21-23,27-29]
Hysteria and psychiatric problems	Root infusion taken orally	Lesotho and South Africa	[6,14-16,22]
Impotence	Root infusion taken orally	South Africa	[16]
Internal parasites	Root decoction taken orally	South Africa	[2,5,7,15,22,23]
Nose infections	Root infusion applied topically	South Africa	[16,30]
Piles	Root infusion applied topically	South Africa	[25]
Purgative	Root decoction taken orally	South Africa	[5,15,19,22,23]
Respiratory infections (asthma, blocked nose, chronic cough, colds, flu and sore throat)	Root decoction taken orally	Lesotho and South Africa	[5-7,14-16,21,22,25,27,28,31,32]
Cough	Roots mixed with those of <i>Cucumis hirsutus</i> Sond. and taken orally	South Africa	[6,22,24]
Sexually transmitted infections (syphilis and venereal diseases)	Root decoction applied topically	Lesotho and South Africa	[5-7,13-15,21,22,29,32,33]
Skin diseases	Root decoction applied topically	Lesotho	[6,13,15]
Scabies	Root mixed with those of <i>Scabiosa columbaria</i> L. and applied topically	Lesotho	[14,34]
Snake bite	Root decoction applied topically	South Africa	[5-7,14,15,19,22,25,28,31,32]

Sores and wounds	Root decoction applied topically	Eswatini, Lesotho and South Africa	[2,6,15,16,35-37]
Sterility in women	Root infusion taken orally	Lesotho	[15,38]
Sunken fontanelle	Root infusion applied topically	South Africa	[6,32]
Tonic for pregnant women	Root infusion taken orally	Lesotho	[14,15,38]
Tonsillitis	Root infusion taken orally	Lesotho	[21]
Urinary problems (bladder and kidneys)	Root decoction taken orally	South Africa	[6,8,14,15,16,22]
Wasting diseases of infants	Root infusion taken orally	Lesotho	[6,13-15]

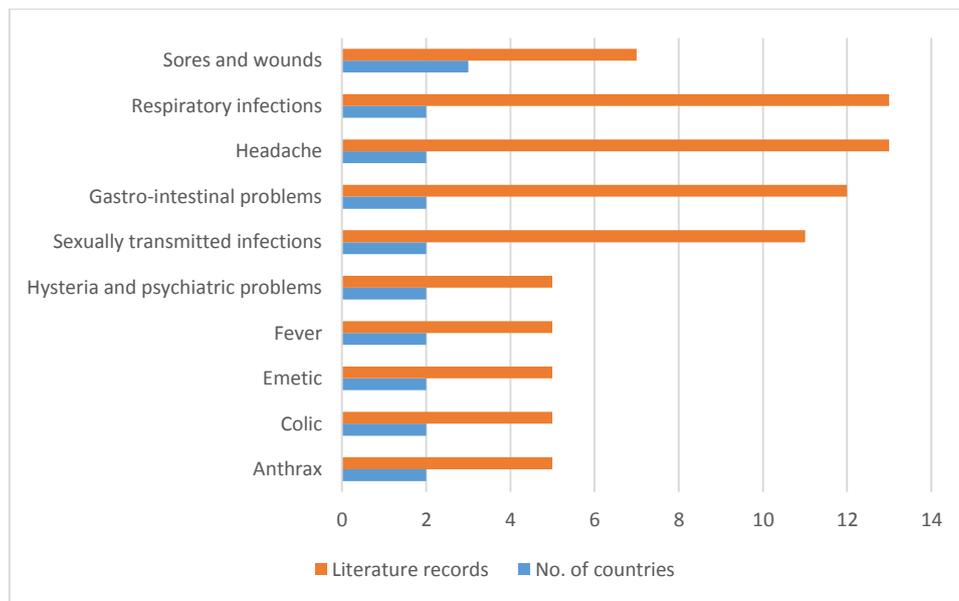


Figure 3: Herbal medicine uses of *Afroaster hispida* in southern Africa

3.2 Phytochemistry of *Afroaster hispida*

A variety of chemical compounds have been isolated and identified from *A. hispida* (Table 2; Figure 3). These phytochemical compounds identified from the aerial parts and roots of *A. hispida* include alkaloids, amino acids, anthocyanins, coumarins, flavonoids, glycosides, phenols, phlobatannins, saponins, sterols, tannins and terpenoids (Table 2).

Table 2: Phytochemical compounds isolated from *Afroaster hispida*

Compound	Plant part	Reference
6,7-dihydroxy-6,7-dihydro-cis-ocimene	Aerial parts	[39]
Aldehyde	Roots	[39]
Alkaloids	Roots	[22]
Amino acids	Roots	[22]
Anthocyanins	Roots	[22]
Betacyanins	Roots	[22]
Coumarins	Roots	[22]
ent-16-kauren-18-oic-acid	Roots	[40]
ent-16-kauren-19-oic-acid	Roots	[40]
ent-kauren-19-al	Roots	[39]
ent-kaurenic acid	Roots	[39]
Euphone	Roots	[39]
Flavonoids	Roots	[22]
Friedelin	Roots	[39,40]
Glycosides	Roots	[22]
γ-humulene	Roots	[39]

Phenols	Roots	[22]
Phlobatannins	Roots	[22]
Reducing sugars	Roots	[22]
Saponins	Roots	[22]
Squalene	Roots	[39]
Sterols	Roots	[22]
Tannins	Roots	[22]
Terpenoids	Roots	[22]

3.3 Pharmacological properties of *Afroaster hispida*

The following biological activities have been reported from the leaves and roots of *A. hispida*: acetylcholinesterase enzyme inhibition [7], antibacterial [7,8,29,33], antifungal [7,33] and anti-inflammatory [7,22] activities.

3.3.1 Acetylcholinesterase enzyme inhibition activities

Ndhlala et al. [7] evaluated the acetylcholinesterase enzyme inhibitory activities of dichloromethane, petroleum ether, 80% ethanol and water extracts of *A. hispida* roots using the enzyme isolated from electric eels with galanthamine (20.0 µM) as a positive control. The water extracts exhibited good acetylcholinesterase enzyme inhibition activities with percentage inhibition of 75.0% in comparison to inhibition of 89.9% exhibited by the positive control [7].

3.3.2 Antibacterial activities

Shale et al. [29] evaluated the antibacterial activities of aqueous, hexane and methanol extracts of *A. hispida* leaves and roots against *Staphylococcus epidermis*, *Klebsiella pneumoniae*, *Micrococcus luteus*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Escherichia coli* and *Staphylococcus aureus* using the disc-diffusion assay with neomycin (200.0 µg/ml to 500.0 µg/ml) as a positive control. The extracts exhibited activities with their inhibition zones ranging from 0.3 to 0.8 [29]. Ndhlala et al. [7] evaluated the antibacterial activities of dichloromethane, petroleum ether, 80% ethanol and water extracts of *A. hispida* roots against *Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumoniae* and *Escherichia coli* using the microdilution method with neomycin as a positive control. The extracts exhibited activities against tested pathogens with minimum inhibitory concentration (MIC) values ranging from 0.8 mg/mL to >12.5 mg/mL [7]. Baloyi et al. [8] evaluated the antibacterial activities of aqueous, dichloromethane, ethyl acetate, hexane and methanol extracts of *A. hispida* roots against *Escherichia coli*, *Serratia marcescens*, *Proteus mirabilis*, *Staphylococcus aureus*, *Chromobacterium violaceum* and *Pseudomonas aeruginosa* using the broth dilution assay with ciprofloxacin (0.06 mg/mL) as a positive control. The ethyl acetate and methanol extracts exhibited activities against *Staphylococcus aureus*, *Chromobacterium violaceum* and *Pseudomonas aeruginosa* with MIC values ranging from 1.0 mg/mL to 4.0 mg/mL [8]. Seleteng-Kose et al. [33] evaluated the antibacterial activities of the aqueous and dichloromethane and methanol (1:1) extracts of *A. hispida* roots against *Neisseria gonorrhoeae*, *Gardnerella vaginalis* and *Oligella ureolytica* using the micro-dilution assay with ciprofloxacin (0.01 mg/ml) as a positive control. The extracts exhibited activities against the tested pathogens with MIC values ranging from 3.0 mg/ml to >8.0 mg/ml [33].

3.3.3 Antifungal activities

Ndhlala et al. [7] evaluated the antifungal activities of dichloromethane, petroleum ether, 80% ethanol and water extracts of *A. hispida* roots against *Candida albicans* (ATCC 10231) using the microdilution method with amphotericin B as a positive control. The extracts exhibited activities against the tested pathogen with MIC and minimum fungicidal concentrations (MFC) values ranging from 1.6 mg/mL to >12.5 mg/mL [7]. Seleteng-Kose et al. [33] evaluated the antifungal activities of the aqueous and dichloromethane and methanol (1:1) extracts of *A. hispida* roots against *Candida albicans* (ATCC 10231) using the micro-dilution assay with amphotericin B as a positive control. The aqueous and dichloromethane and methanol (1:1) extracts exhibited activities against the tested pathogen with MIC values of >8.0 mg/ml and 4.0 mg/ml, respectively [33].

3.3.4 Anti-inflammatory activities

Ndhlala et al. [7] evaluated the anti-inflammatory activities of dichloromethane, petroleum ether, 80% ethanol and water extracts of *A. hispida* roots using cyclooxygenase (COX-1 and COX-2) inhibitory bioassays with indomethacin (5.0 µM) as a positive control. The dichloromethane and petroleum ether extracts showed percentage inhibition ranging from 60.0% to 80.0% for both COX-1 and COX-2 in comparison to 64.2% to 68.5% exhibited by the positive control [7]. Similarly, Magama et al. [22] evaluated the anti-inflammatory activities of crude extracts of *A. hispida* at doses of 100.0 mg/kg, 200.0 mg/kg and 400.0 mg/kg body weight using the carrageenan-induced rat paw oedema assay with indomethacin (10.0 mg/kg body weight) as positive

control. The extracts induced time and dose-dependent inhibitory activities against carrageenan-induced acute peripheral inflammation in the rat paw and these activities were comparable to activities exhibited by the positive control [22].

4. Conclusion

The present review summarizes the ethnomedicinal uses, phytochemistry and pharmacological properties of *A. hispida*. The historical traditional usage of *A. hispida* as herbal medicine in southern Africa calls for detailed phytochemical and pharmacological studies aimed at correlating its documented ethnomedicinal uses with the phytochemical and pharmacological properties of the species. There is need for clinical and toxicological evaluations of both crude extracts and phytochemical compounds associated with *A. hispida*.

Conflict of interest

No conflict of interest is associated with this work.

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