Medicinal uses of the Asteraceae family in Zimbabwe: A historical and ecological perspective

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Review

Abstract

Background: Several plant species belonging to the Asteraceae family are widely used as sources of traditional medicines. The current study was aimed at providing a systematic review of ethnomedicinal, phytochemical and pharmacological properties of Asteraceae species used as sources of traditional medicines in Zimbabwe.

Methods: Information related to the ethnomedicinal, phytochemical and pharmacological properties of Asteraceae species was systematically collected using relevant keywords from online databases such as BioMed Central, Web of Science, Springerlink, Google Scholar, Scielo, PubMed, Science Direct, ACS Publications, Scopus and JSTOR, books, dissertations, theses, scientific reports and herbarium specimens.

Results: This study showed that 50 species are traditionally used to manage human and animal diseases in Zimbabwe. These species are used as traditional medicines against 51 medical conditions, mainly used in the treatment of gastro-intestinal problems (34 use reports) and respiratory problems (28 use reports). *Aspilia pluriseta*, *Baccharoides adoensis*, *Bidens pilosa, Brachylaena discolor* var. *rotundata*, *Dicoma anomala*, *Erythrocephalum zambesianum*, *Gymnanthemum amygdalinum*, *G. coloratum*, *Helichrysum caespititium*, *Inula glomerata*, *Laggera crispata*, *Linzia glabra*, *Lopholaena coriifolia*, *Schkuhria pinnata, Senecio coronatus*, *S. latifolius* and *Tagetes minuta* have the highest number of medicinal uses. Majority of the documented species are characterized by flavonoids (46.0%), terpenoids (44.0%), tannins (40.0%), alkaloids (34.0%), saponins (26.0%), essential oils (24.0%) and glycosides (20.0%).

Conclusions: Further phytochemical and pharmacological studies would be of great interest for assessment of ethnopharmacological properties of Asteraceae species used as sources of traditional medicines.

Keywords: Asteraceae, Compositae, herbal medicine, indigenous knowledge, natural compounds, Zimbabwe

Background

Mandal *et al.* (2018) defined medicinal plants as plant species that possess therapeutic properties or are species that are capable of exerting beneficial pharmacological effects on the human or animal body. Medicinal plants have been the basis of treatment and management of various diseases in traditional medicine as well as other forms of treatment from diverse cultures and indigenous knowledge systems of the world (Okoye *et al.* 2014). Several plant species have been utilized as medicines for thousands of years in African traditional pharmacopoeias (Devine 2022, Sifuna 2022), American traditional medicine (Geck *et al.* 2020, Redvers & Blondin 2020, Rojas *et al.* 2022), Australian traditional medicine (Oliver 2013, Bhuyan *et al.* 2022), Southeast Asian traditional medicine (Ahmad 2002, WHO 2020), Ayurvedic (Junaid *et al.* 2017, Mukherjee *et al.* 2017), Chinese traditional medicine (Liu *et al.* 2022, Xiong *et al.* 2022), European traditional medicine (Micke & Hühner 2009, Leonti & Verpoorte 2017), classical Arabic and North African traditional medicine (Azaizeh *et al.* 2008, Al Rawi *et al.* 2017, Dehyab *et al.* 2020). Therefore, medicinal plants are an important component of the traditional medicine which refers to the health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being (Fokunang *et al.* 2011, Dzoyem *et al.* 2013). Traditional medicines are important sources of natural products which serve as sources of pharmaceutical drugs and other health products (Van Wyk *et al.* 2013). According to Yeh *et al.* (2015) current ethnopharmacological research is focusing on the use of traditional medicines mainly because these strategies are widely used in improving primary health care of local communities. This is particularly important in sub-Saharan Africa where rural communities and those people living in marginalized areas are reliant on traditional medicine as their basic source of health care (Mander *et al.* 2007, Maroyi 2014).

The proportion of the population relying on traditional medicines in developing countries ranges from 60-80% (Ekor 2013, Sudha 2018, El Dahiyat *et al.* 2020, Musa *et al.* 2022). Research by Nyagumbo *et al.* (2022) showed that medicinal plants and plant-derived medicines are widely used in peri-urban, rural and marginalized areas of Zimbabwe and they are becoming increasingly popular as natural alternatives to synthetic chemicals. The plant family Asteraceae (Compositae) has contributed several plant species to traditional pharmacopoeia in Zimbabwe (Gelfand *et al.* 1985, Maroyi 2013, Chituku *et al.* 2022, Nyagumbo *et al.* 2022, Shopo *et al.* 2022). The Asteraceae often referred to as composite, daisy, aster or sunflower family, is one of the largest plant families with over 32000 accepted species divided into over 1900 genera and 13 subfamilies (*Panéro & Funk 2002, Panéro et al. 2014*). Members of the Asteraceae family are annual, biennial or perennial herbs, subshrubs, shrubs, occasionally scramblers or lianes, sometimes trees, rarely aquatic or epiphytes, sometimes succulent or spinescent (Leistner 2000, Koekemoer *et al.* 2014). Species belonging to the Asteraceae family are easily distinguished by the presence of a flowerhead or capitulum which consists of one or several flowers or florets which are surrounded by a series of protective bracts or involucre (Leistner 2000, Koekemoer *et al.* 2014). Botanically the position of the ovary, which is inferior and single-chambered is important in distinguishing the family (Palmer & Pitman, 1972, Manning 2007, 2009). Nearly all members of the Asteraceae family bear small, dry, seed-like fruits, often crowned with the pappus of hairs and occasionally drupes (Palmer & Pitman 1972, Manning 2007, 2009). The Asteraceae family exhibits cosmopolitan distribution, recorded in almost all of the biomes in the world at all altitudes, from coastal beaches to the highest seasonally snow-capped mountains except the Antarctica (Funk *et al.* 2005, Koekemoer *et al.* 2014).

The majority members of the Asteraceae family are culturally and economically important throughout the world, used as sources of traditional medicines, food, garden ornamentals and insecticides (Panda *et al.* 2019, Garcia-Oliveira *et al.,* 2021, Rolnik & Olas 2021). Many members of this family are widely studied for their bioactive chemical constituents such as chlorogenic acid, sesquiterpene lactones, benzofurans, diterpenes, flavonoids, pentacyclic triterpene alcohols, terpenoid essential oils, ligand, polyphenols, alkaloids, fatty acids, phenolic acids, tannins, iridoids and polyacetylenes (Heywood *et al.* 1977a,b, Calabria *et al.* 2009, Yaoita *et al.* 2012, Konovalov 2014, Benítez *et al.* 2021, Rolnik & Olas 2021). Pharmacological studies showed that some species exhibit potent anticancer, antioxidant, antibacterial, anti-fungal, anti-inflammatory, antiproliferative, wound-healing, anti-hemorrhagic, antipyretic, diuretic, hepatoprotective, anti-tussive, antiparasitic, insecticidal and antispasmodic activities, among others (Koc *et al.,* 2015, Carvalho *et al.* 2018; Panda & Luyten 2018, Cilia-López *et al.* 2021, Rolnik & Olas 2021). Therefore, extensive phytochemical and pharmacological evaluations of some of the utilized Asteraceae species can lead to discovery and development of novel pharmaceutical products, functional food ingredients and cosmetic products. Despite the discovery of several secondary metabolites in Asteraceae, this family attracted disproportionately little attention in the context of ethnopharmacological research (Panda *et al.* 2019). It is therefore, within this context that this study was undertaken aimed at exploring and documenting the ethnomedicinal knowledge of Asteraceae family in Zimbabwe. Such synthesis identifies knowledge gap on the therapeutic potential of the Asteraceae species and also provide helpful information on ethnopharmacological research areas that require further research.

Materials and Methods

Literature search on Asteraceae species used as traditional medicines in Zimbabwe was conducted from September 2021 to December 2022. This information was retrieved from different online databases such as BioMed Central, Web of Science, Springerlink, Google Scholar, Scielo, PubMed, Science Direct, ACS Publications, Scopus and JSTOR.

In addition, theses, dissertations, book chapters, books and scientific reports were retrieved from the libraries of the University of Fort Hare (UFH) in South Africa and the National Herbarium (SRGH) in Harare, Zimbabwe. Keywords and terminologies such as Zimbabwe, ethnobotany, ethno-medicine, ethno-pharmacology, indigenous, medicine, phytomedicine, traditional medicine, Zimbabwean Asteraceae, Zimbabwean Compositae, medicinal Asteraceae, medicinal Compositae, Zimbabwean traditional medicine, Asteraceae and Compositae were used to search for relevant articles as shown in the PRISMA flow diagram (Fig. 1). From each article, the following information was collected: scientific names of the plant species, growth form, plant part(s) used, method of preparation and medicinal uses. The medicinal use categories were classified following the Economic Botany Data Collection Standard (Cook, 1995). The scientific names of the Asteraceae species from original data sources were updated to recently accepted names according to the Plants of the World Online website (POWO, 2023). The distributional data of all the species were compiled from herbarium specimens housed at the National Herbarium of Zimbabwe (SRGH) in Harare. Each species' distribution in Zimbabwe is indicated by letters showing the floristic divisions used in the Flora Zambesiaca (after Pope & Pope 1998): northern region (N), western region (W), central region (C), eastern region (E) and southern region (S).

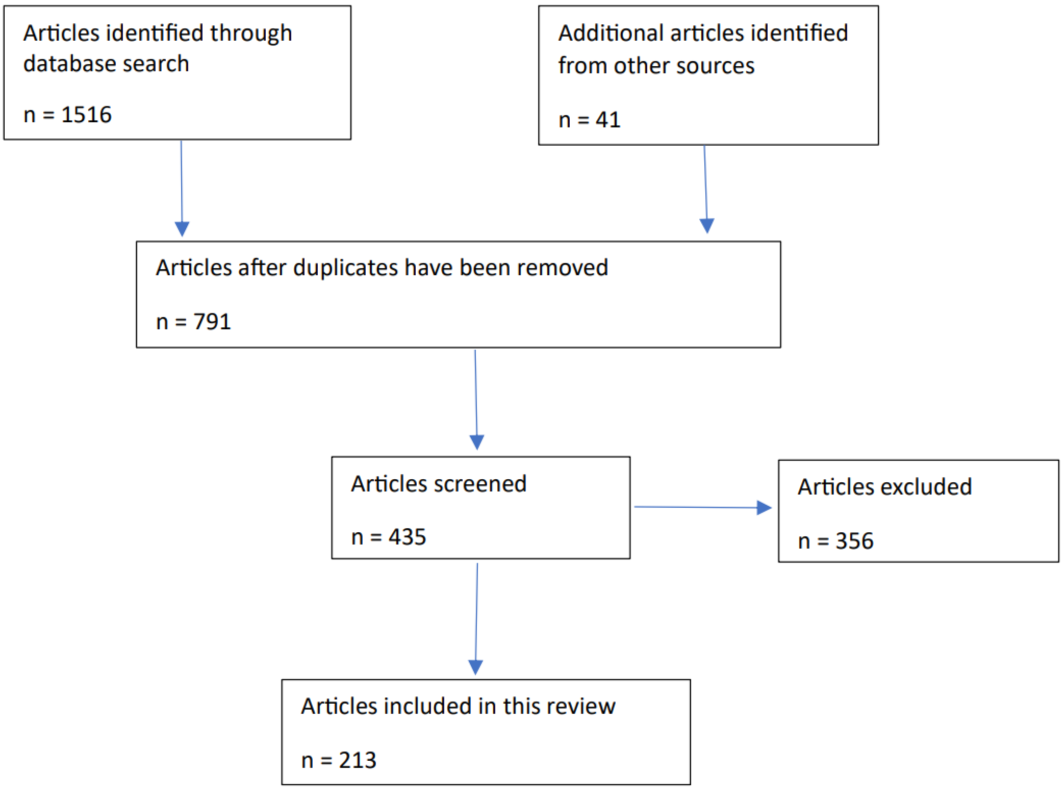


Figure 1. Flow diagram showing identification and screening of articles used in this review

Results and Discussion

Medicinal plant diversity

This study recorded 50 taxa traditionally used to manage and treat human and animal diseases in Zimbabwe (Table 1). Of these, 41 taxa are indigenous to Zimbabwe (82.0%), while 9 taxa are exotic (18.0%), either naturalized as weeds or cultivated in home gardens and agricultural fields as ornamentals, fodder or food plants. Species such as *Acanthospermum australe* (Loefl.) Kuntze, *Bidens biternata* (Lour.) Merr. & Sherff, *Bidens pilosa* L., *Centaurea benedicta* (L.) L., *Chromolaena odorata* (L.) R.M. King & H. Rob., *Schkuhria pinnata* (Lam.) Kuntze ex Thell., *Sonchus oleraceus* L., *Tagetes minuta* L. and *Tragopogon porrifolius* L. were introduced into the country as seed contaminant or as ornamental plants (Maroyi 2006, Randall 2017). But current research revealed that such exotic plant species are now a component of *materia medica*, playing an important role in the provision of primary health care to local communities in Zimbabwe. This is not surprising as previous research showed that in Bangladesh (Rahman & Roy 2014), Brazil (Alencar *et al.* 2010, 2014), Hawaii (Palmer 2004), India (Singh 2016), Kenya (Njoroge *et al.* 2004), South Africa (Semenya *et al.* 2012; Semenya & Maroyi 2018), South America (Bennett & Prance 2000) and Thailand (Nguanchoo *et al.* 2019) exotic plant species are receiving attention as components of traditional pharmacopoeia. Bennett & Prance (2000) argued that exotic plants cultivated as food and ornamental plants in South America were incorporated into indigenous herbal pharmacopoeia mainly because of their use-versality applications.

Table 1. Medicinal Asteraceae plants of Zimbabwe

Taxon and voucher	**Distribution[+]**	**Local names, E = English, N = Ndebele and S = Shona**	**Habit**	**Plant part used**	**Uses**	**References**
**Acanthospermum australe* (Loefl.) Kuntze, Leach 9740	NCE	**Creeping starbur** and **prostrate starbur** (E)	Herb	Roots	Abdominal pains	Gelfand *et al.* 1985
Artemisia afra Jacq. ex Willd.	NCES	None found[#]	Shrub	Leaves and roots	Fever, pneumonia, respiratory disorders and to drive away bad spirits	Gelfand *et al.* 1985, Nyagumbo *et al.* 2022
Aspilia pluriseta Schweinf. ex Engl., Cecil 43	NCE	**Dwarf aspilia** (E), **mukushamvura, mumharadzi** and **ruhwati** (S)	Herb	Leaves and roots	Abdominal pains, anorexia, body pains, delirium, diarrhoea, dilate birth canal, dyspnoea, increase blood, menstrual problems, oedema, pains during pregnancy, postpartum and respiratory disorders	Gelfand *et al.* 1985, Chituku *et al.* 2022, Nyagumbo *et al.* 2022
A. pluriseta	NCE	**Dwarf aspilia** (E), **mukushamvura, mumharadzi** and **ruhwati** (S)	Herb	Roots mixed with those of *Senecio* spp. and *S. retrorsus* DC.	Constipation and wounds	Gelfand *et al.* 1985
Aspilia spp.	NWCES	None found	Herb	Roots	Diarrhoea, expectorant, influenza and rheumatism	Harvey & Armitage 1961
Aspilia spp.	NWCES	None found	Herb	Roots mixed with those of *Ziziphus mucronata* Willd.	Rheumatism	Harvey & Armitage 1961
Baccharoides adoensis (Sch. Bip. ex Walp.) H. Rob., Shopo 51	NWCES	**Munyatera, munyamhunga** and **musikavakadzi** (S)	Shrub	Leaves and roots	Infertility in women, malaria, mental problems, respiratory disorders and stomach problems	Gelfand *et al.* 1985, Ngarivhume *et al.* 2015, Maroyi 2020a, Nyagumbo *et al.* 2022, Shopo *et al.* 2022
Berkheya radula (Harv.) De Wild., Pope 632	WCES	**Sun daisy** (E)	Herb	Testicles washed with root powder	Swollen testicles	Watt & Breyer-Brandwijk 1962, Herman & Condy 2007
B. zeyheri (Harv. & Sond.) Oliv. & Hiern, Chase 6432	NWCES	**Woodland sun daisy** (E)	Herb	Roots	Lucky charm, mental problems and warts	Gelfand *et al.* 1985

**Bidens biternata* (Lour.) Merr. & Sherff, Maroyi 2119	NWCES	**Yellow-flowered blackjack** (E)	Herb	Leaves and whole plant	Depressed fontanelle and wounds in mouth of infant	Wild *et al.* 1972, Gelfand *et al.* 1985
**B. pilosa* L., Shopo 90	NWCES	**Black-jack** (E) and **mutsine** (S)	Herb	Roots	Anaemia, hypertension, oral thrush, stomach pains, used during pregnancy and toothache	Wild *et al.* 1972, Maroyi 2017, Maroyi 2018a, Mawoza *et al.* 2019, Shopo *et al.* 2022
Brachylaena discolor DC. var. *discolor*, Pope 598	NWCES	None found	Tree	Leaves	Ulcers	Chigora *et al.* 2007, Maroyi 2013, Maroyi 2020b
B. discolor var. *rotundata* (S. Moore) Beentje, Mavi 52	NWCES	None found	Tree	Roots	Abdominal pains, menstrual problems, penile sores, syphilis and ulcers	Wild & Gelfand 1959, Gelfand *et al.* 1985, Chigora *et al.* 2007, Maroyi 2020b
B. huillensis O. Hoffm., Wild 1162	WS	None found	Tree	Roots	Malaria	Ngarivhume *et al.* 2015, Maroyi 2020c
Callilepis leptophylla Harv., Biegel 2405	NCE	None found	Shrub	Not specified	Cough, fever, pains during pregnancy and tonic	Watt & Breyer-Brandwijk 1962
**Centaurea benedicta* (L.) L., Biegel 1763	NCE	None found	Herb	Whole plant	Emetic	Watt & Breyer-Brandwijk 1962
C. praecox Oliv. & Hiern, Eyles 397	NC	None found	Herb	Whole plant	Epistaxis	Gelfand *et al.* 1985
**Chromolaena odorata* (L.) R.M. King & H. Rob., Chase 4539	N	**Siam weed** and **triffid weed** (E)	Climber	Roots	Wounds	Wild & Gelfand 1959

Dicoma anomala Sond., Shopo 80	NWCES	**Chifumuro** (S)	Herb	Roots	Abdominal pains, antidote, bilharzia, bladder weakness in women, blood pressure, body pains, cataracts, chest pains, colic, cough, diarrhoea, dilate birth canal, dizziness, gonorrhoea, high temperature, malaria, mental problems, nightmares in children, painful uterus, panacea, pneumonia, prolonged labour, respiratory disorders, sore throat, stomach problems and to drive away bad luck	Wild & Gelfand 1959, Chinemana *et al.* 1985, Gelfand *et al.* 1985, Ndamba *et al.* 1994, Mavi 1996, Chigora *et al.* 2007, Maroyi 2013, Panganai & Shumba 2016, Maroyi 2018b, Maroyi 2019a, Chituku *et al.* 2022, Nyagumbo *et al.* 2022, Shopo *et al.* 2022
Dicoma spp.	NWCES	None found	Herb	Roots	Bladder weakness, bronchitis and colic	Harvey & Armitage 1961
Erythrocephalum zambesianum Oliv. & Hiern, Biegel 1641	CE	**Red rays** (E)	Herb	Roots	Lucky charm, malaria, sexually transmitted infections (STIs) and human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) opportunistic infections	Gelfand *et al.* 1985, Ngarivhume *et al.* 2015, Chituku *et al.* 2022
E. zambesianum	CE	None found	Herb	Roots mixed with those of *Rubia cordifolia* L. and *Cassia abbreviata* Oliv.	Hydrocele	Gelfand *et al.* 1985
Geigeria spp.	NWCES	None found	Herb	Roots	Depressed fontanelle	Gelfand *et al.* 1985
Gerbera ambigua (Cass.) Schultz Bip., Swynnerton 1821	NWCES	**Yellow barberton daisy** and **yellow gerbera** (E)	Herb	Roots	Abdominal pains in infants and heart pains	Gelfand *et al.* 1985
G. viridifolia (DC.) Schultz Bip. ssp. *viridifolia*, Maroyi 2102	NCES	**Blushing daisy** and **white barberton daisy** (E)	Herb	Roots	Lucky charm	Gelfand *et al.* 1985

Gymnanthemum amygdalinum (Delile) Sch.Dip., Rand 495	NWCES	**Bitter-tea vernonia** and **tree vernonia** (E), **inyathelo** (N), **dembezeko, musikavakadzi, muzhozho** and **nyareru** (S)	Tree	Roots and whole plant	Abdominal pains, aphrodisiac, bilharzia, cough, diarrhoea, fever, gonorrhoea, infertility in women, menstrual problems, oedema, painful uterus, respiratory disorders, STIs, tonic, venereal diseases, weak joints, and endoparasites, general weakness and respiratory problems in livestock	Wild & Gelfand 1959, Gelfand *et al.* 1985, McGregor 1991, Ndamba *et al.* 1994, Mavi 1996, Kambizi & Afolayan 2001, Maroyi 2012, Maroyi 2019a, Nyagumbo *et al.* 2022
G. amygdalinum	NWCES	**Bitter-tea vernonia** and **tree vernonia** (E), **inyathelo** (N), **dembezeko, musikavakadzi, muzhozho** and **nyareru** (S)	Tree	Roots mixed with fruits of *Vigna unguiculata* (L.) Walp.	Bilharzia	Gelfand *et al.* 1985
G. coloratum (Willd.) H.Rob. & B.Kahn, Shopo 52	NWCES	**Lowveld tree vernonia** and **star-flowered bitter-tea** (E), **munyatera, musikavakadzi** and **rurimirwemombe** (S)	Tree	Roots	Bilharzia, cough, diarrhoea, fever, oedema, rheumatism and sterility in women, magical, tonic and STIs	Wild & Gelfand 1959, McGregor 1991, Maroyi 2019a, Maroyi 2020d, Shopo *et al.* 2022
G. glaberrimum (Welm. ex O. Hoffm.) H.Rob., Maroyi 2113	NCE	**Nyakashwa** (S)	Shrub	Roots	Depressed fontanelle, dropsy, menstrual problems and venereal diseases	Gelfand *et al.* 1985
Helichrysum caespititium (DC.) Sond., Mavi 73	CE	None found	Herb	Roots and whole plant	Depressed fontanelle, headache, respiratory disorders, STIs and ulcers	Gelfand *et al.* 1985, Maroyi 2019b, Nyagumbo *et al.* 2022
H. kraussii Schultz Bip., Maroyi, 2018	NWCES	**Curry bush** (E), **umawewana** (N), **mupumhanhuka, mutsvairo** and **rusakadzi** (S)	Shrub	Leaves, roots and whole plant	Cough, respiratory disorders, tuberculosis and to drive away bad spirits	Watt & Breyer-Brandwijk 1962, Gelfand *et al.* 1985, Nyagumbo *et al.* 2022
Hilliardiella aristata (DC.) H.Rob., Mavi 84	CES	**Chiwanika** (S)	Herb	Leaves and roots	Painful kidneys, malaria and protective charm	Gelfand *et al.* 1985, Kraft *et al.* 2003, Maroyi 2021a

H. oligocephala (DC.) H.Rob., Wild 1815	NWCES	None found	Herb	Flowers	Abdominal pains, bilharzia and rheumatism	Watt & Breyer-Brandwijk 1962, Gelfand *et al.* 1985, Maroyi 2020e
Inula glomerata Oliv. & Hiern, Chase 5871	NWCES	**Hare's ears** (E), **zeveratsuro** and **zheveratsuro** (S)	Herb	Roots	Abdominal pains, constipation, dilate birth canal, earache, infertility in women, lucky charm, pneumonia, respiratory disorders, tonic for premature babies and venereal diseases	Wild & Gelfand 1959, Gelfand *et al.* 1985, Nyagumbo *et al.* 2022
Lactuca inermis Forssk., Senderayi 233	NWCES	**Cape lettuce** and **wild lettuce** (E)	Herb	Roots	Abdominal pains and depressed fontanelle	Gelfand *et al.* 1985
L. lasiorhiza (O. Hoffm.) C. Jeffrey, Grosvenor 258	E	None found	Herb	Roots	Warts	Wild & Gelfand 1959
Laggera crispata (Vahl) Hepper & J.R.I Wood, Mavi 70	NWCES	None found	Herb	Leaves and roots	Abdominal pains, convulsions, epistaxis, fever, headache, heart problems, mental problems, painful legs, pneumonia, respiratory disorders, to fatten infants and to stop bed wetting	Gelfand *et al.* 1985, Nyagumbo *et al.* 2022
Launaea nana (Bak.) Chiov., Rutherford-Smith 36	NWCE	None found	Herb	Roots	Convulsions and warts	Gelfand *et al.* 1985
L. rarifolia (Oliv. & Hiern) Boulos var. *rarifolia*, Miller 4570	NWCE	None found	Herb	Roots	Oedema and warts	Wild & Gelfand 1959
Linzia glabra Steetz, Wild 1654	NWCES	**Cornflower vernonia** (E)	Herb	Leaves and roots	Abdominal pains, abortifacient, burns, gonorrhoea, infertility in women and red eyes	Gelfand *et al.* 1985, Sewani-Rusike 2010, Maroyi 2021b
L. glabra	NWCES	**Cornflower vernoni**a (E)	Herb	Roots mixed with those of *Boscia angustifolia* A. Rich.	Constipation	Gelfand *et al.* 1985, Maroyi 2019c

Lopholaena coriifolia (Sond.) Phillips & C.A.Sm., Chubb 413	WCS	**Small-leaved fluff-bush** (E), **chigunguru, mugakatombo, mukwiradundu** and **nyakatondo** (S)	Shrub	Roots	Abdominal pains, burns, convulsions, cough, diarrhoea with blood, measles, pneumonia and respiratory disorders	Gelfand *et al.* 1985, Nyagumbo *et al.* 2022
Macledium kirkii (Harv.) S.Ortiz ssp. kirkii, Swynnerton 444	NWCES	None found	Herb	Roots	Lucky charm and used against insect bites	Wild & Gelfand 1959, Gelfand *et al.* 1985
M. zeyheri (Sond.) S.Ortiz, Maroyi 1917	NCE	None found	Herb	Roots	Stomach problems	Watt & Breyer-Brandwijk 1962
Pleiotaxis eximia O.Hoffm. ssp. *eximia*, Chiparawasha 435	NWC	None found	Shrub	Roots	Lucky charm, painful arteries and veins, and ulcers	Gelfand *et al.* 1985
**Schkuhria pinnata* (Lam.) Kuntze ex Thell., Allcock 11	NWCES	**Dwarf marigold** (E) and **ruhwahwa** (S)	Herb	Leaves and whole plant	Abdominal pains, abortifacient, diarrhoea, gonorrhoea, impending blindness, stomach problems and STIs	Gelfand *et al.* 1985, Chigora *et al.* 2007, Maroyi 2013, Maroyi 2017, Maroyi,2018a
Senecio coronatus (Thunb.) Harv., Biegel 2013	NWCES	**Chipapari** and **runziwa** (S)	Herb	Roots	Abdominal pains, depressed fontanelle, lucky charm, menstrual problems, sore eyes and worms in the stomach	Gelfand *et al.* 1985
S. latifolius DC., Maroyi 1984	CES	**Noxious ragwort** (E)	Herb	Roots	Abdominal pains, constipation, dizziness, earache, painful uterus, postpartum, tonic for infants and venereal diseases	Harvey & Armitage 1961, Gelfand *et al.* 1985
S. retrorsus DC., Biegel 1794	NCE	None found	Herb	Roots mixed with those of *Senecio* spp. and *A. pluriseta*	Constipation and wounds	Gelfand *et al.* 1985
Senecio spp.	NCE	None found	Herb	Roots mixed with those of *S. retrorsus* and *A. pluriseta*	Constipation and wounds	Gelfand *et al.* 1985

Solanecio angulatus (Vahl) C.Jeffrey, Maroyi 2012	NCE	None found	Climber	Whole plant	Bladder and mental problems	Gelfand *et al.* 1985
**Sonchus oleraceus* L., Searle 115	NWCES	**Smooth sow-thistle** (E)	Herb	Leaves	Stomach problems	Chigora *et al.* 2007, Maroyi 2013
Stomatanthes africanus (Oliv. & Hiern) King & Robinson, Mavi 69	NWCES	None found	Herb	Roots	Aphrodisiac, bladder problems and wounds	Gelfand *et al.* 1985
**Tagetes minuta* L., Shopo 92	NWCES	**Khaki bush, Mexican marigold** and **stinking roger** (E) and **mutsvairo** (S)	Herb	Leaves	Constipation in both humans and animals, epistaxis, hiccups, to drive away bad spirits and wounds	Gelfand *et al.* 1985, Maroyi 2017, Maroyi 2018a, Shopo *et al.* 2022
**Tragopogon porrifolius* L., Biegel 1903	NWCES	None found	Herb	Flowers, leaves and roots	Toothache, ulcers and vaginal bleeding	Chituku et al., 2022

[*] = Exotic; [+] = Zimbabwe is divided into five floristic regions, i.e., N = northern, W = western, C = central, E = eastern and S = southern; [#] = None found means that no record of common name was found in literature or herbarium specimens

Seventeen species, i.e., *Aspilia pluriseta* Schweinf. ex Engl., *Baccharoides adoensis* (Sch. Bip. ex Walp.) H. Rob., *B. pilosa, Brachylaena discolor* var. *rotundata* (S. Moore) Beentje, *Dicoma anomala* Sond., *Erythrocephalum zambesianum* Oliv. & Hiern, *Gymnanthemum amygdalinum* (Delile) Sch.Dip., *G. coloratum* (Willd.) H.Rob. & B.Kahn, *Helichrysum caespititium* (DC.) Sond., *Inula glomerata* Oliv. & Hiern, *Laggera crispata* (Vahl) Hepper & J.R.I Wood, *Linzia glabra* Steetz, *Lopholaena coriifolia* (Sond.) Phillips & C.A.Sm., *S. pinnata, Senecio coronatus* (Thunb.) Harv., *S. latifolius* DC. and *T. minuta* have the highest number of medicinal uses in Zimbabwe (Fig. 2). Species documented in at least five independent ethnobotanical literature sources include the following: *B. adoensis, D. anomala, G. amygdalinum* and *S. pinnata* (Table 1; Fig. 2). The other medicinal applications of these 17 species in other countries are provided in monographs such as Traditional Medicine in Botswana (Hedberg & Staugård 1989), Medicinal Plants and Magical Plants of Southern Africa: An Annotated Checklist (Arnold *et al.* 2002), Plant Resources of Tropical Africa 11: Medicinal Plants 1 (Schmelzer & Gurib-Fakim 2008), Medicinal Plants of East Africa (Kokwaro 2009), Medicinal Plants of East Africa: An Illustrated Guide (Dharani & Yenesew 2010), Sesotho: Plant and Animal Names and Plants Used by the Basotho (Moffett 2010), Medicinal Plants of South Africa (Van Wyk *et al.* 2013) and Medicinal Plants of the World (Van Wyk & Wink 2017). Such analogies and differences in utilization of these species throughout their distributional ranges are important for analysis of their ethnopharmacological properties.

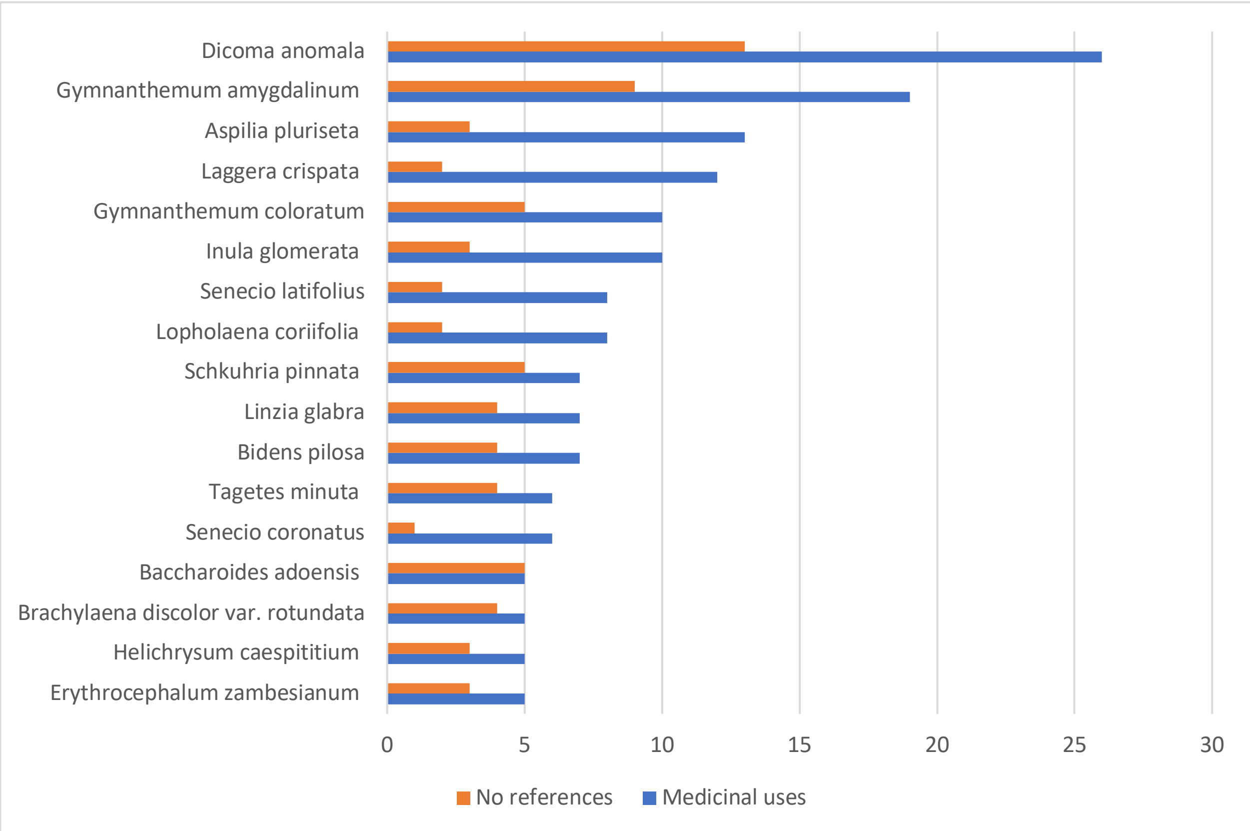
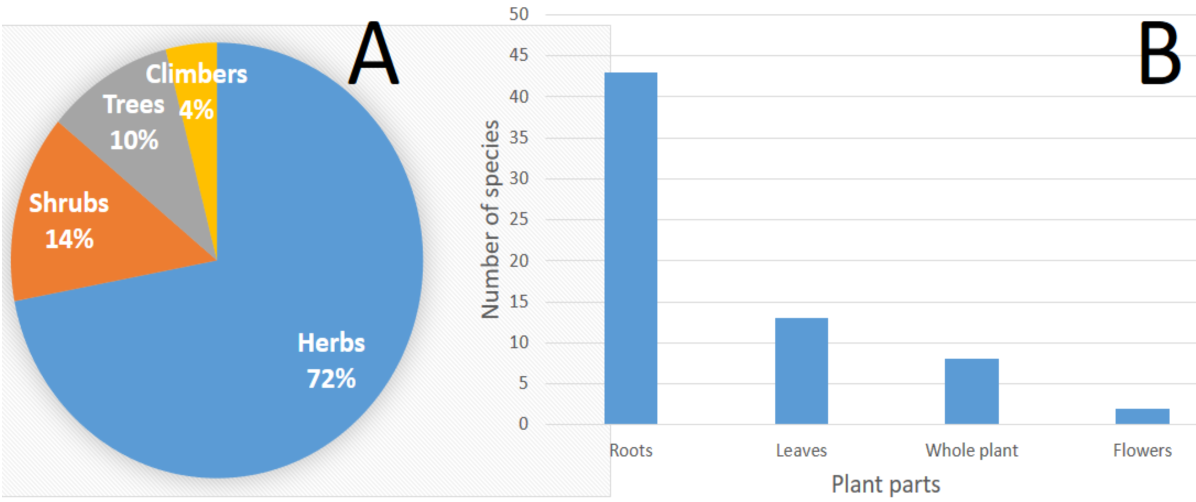


Figure 2. Numbers of medicinal uses and references of Asteraceae species used as traditional medicines in Zimbabwe

Research showed that some Asteraceae species are often used in combination with other species and such examples include mixing roots of *A. pluriseta* with those of *Senecio* spp. and *S. retrorsus* DC. as traditional medicine for constipation and wounds (Gelfand *et al.* 1985). The roots of *Aspilia* spp. are mixed with those of *Ziziphus mucronata* Willd. (family Rhamnaceae) as traditional medicine for rheumatism (Harvey & Armitage 1961). Similarly, the roots of *E. zambesianum* are mixed with those of *Rubia cordifolia* L. (family Rubiaceae) and *Cassia abbreviata* Oliv. (family Fabaceae) as traditional medicine for hydrocele (Gelfand *et al.* 1985). The roots of *G. amygdalinum* are mixed with fruits of *Vigna unguiculata* (L.) Walp. (family Fabaceae) as traditional medicine for bilharzia (Gelfand *et al.* 1985), while roots of *L. glabra* are mixed with those of *Boscia angustifolia* A.Rich. (family Capparaceae) as traditional medicine for constipation (Gelfand *et al.* 1985, Maroyi 2019c). Traditional healers and other community members often combine several plant species when treating both human and animal diseases in the belief that efficacy will be enhanced (Van Vuuren & Viljoen 2011). However, research by Meletiadis *et al.* (2010) showed that combining medicinal plants may also be dangerous when the interaction is antagonistic, since this may result in higher toxicity.

Growth habit and parts used

Herbs (72.0%), followed by shrubs (14.0%), trees (10.0%) and climbers (4.0%) are the primary sources of the medicinal Asteraceae species in Zimbabwe (Fig. 3A). The plant parts used for traditional medicine preparations are flowers, leaves, roots and whole plant parts (Fig. 3B). However, harvesting of roots of herbaceous plants for medicinal purposes is not sustainable as this practice threatens the survival of such plant species used as traditional medicines. This is particularly the case for the Asteraceae family where the majority of the utilized species are herbs (Fig. 3A). There are still gaps in available data on the conservation status of Asteraceae taxa in Zimbabwe (Mapaura & Timberlake 2002). This contrasts with research efforts in other Africa countries. For example, in South Africa, the Asteraceae family has the highest proportion of threatened taxa that are used as sources of traditional medicines (Williams *et al.* 2013). There is therefore, need to promote sustainable utilization and management of popular Asteraceae species such as *A. pluriseta*, *B. adoensis*, *B. pilosa*, *B. discolor* var. *rotundata*, *D. anomala*, *E. zambesianum*, *G. amygdalinum*, *G. coloratum*, *H. caespititium*, *I. glomerata*, *L. crispata*, *L. glabra*, *L. coriifolia*, *S. pinnata*, *S. coronatus*, *S. latifolius* and *T. minuta* (see Fig. 2).



represented in pie diagram and B: Plant parts used represented in bar chart

Use categories with high numbers of use reports

The 51 medical reports of the Asteraceae species in Zimbabwe (Tables 1 and 2) are classified into 17 major health disorder categories following the International Classification of Primary Care classification system (Cook 1995). Most use records are in the categories gastro-intestinal problems (34 use reports) and respiratory problems (28 use reports) (Table 2). Similarly, gastro-intestinal problems and respiratory problems (Table 2) are treated with the highest number of species. Some disease categories such as antenatal and postpartum, gastro-intestinal problems, malaria, reproductive problems, respiratory problems and sexually transmitted infections are among the ten major causes of death in Zimbabwe (Nyabani 2021). Research by Muchandiona (2013) showed that gastro-intestinal disorders and respiratory infections reported in several local councils in Zimbabwe are a result of poor solid waste management which has worsened in the country over the last three decades. Similarly, gastro-intestinal disorders, such as dysentery and diarrhoea are also a major concern in neighbouring countries such as Mozambique (Ribeiro *et al.* 2010, Bruschi *et al.* 2011, Barbosa *et al.* 2020) and South Africa (Semenya & Maroyi 2012, Maroyi 2016, Rankoana 2022).

Phytochemistry and pharmacological properties of Asteraceae species

The Asteraceae species used as sources of traditional medicines in Zimbabwe are rich in chemical constituents (Table 3). The majority of these species are characterized by flavonoids (46.0%), followed by terpenoids (44.0%), tannins (40.0%), alkaloids (34.0%), saponins (26.0%), essential oils (24.0%) and glycosides (20.0%) (Table 3). The majority of documented species present several proven pharmacological activities (Table 3) such as acetylcholinesterase, analgesic, anticancer, anticonvulsant, antidiabetic, anthelmintic, antihyperglycemic, antihypertensive, anti-inflammatory, antimalarial, antimicrobial, antinociceptive, antiplasmodial, antiprotozoal, antiproliferative, antipyretic, antitrypanosomal, antileishmanial, anti-ulcer, antioxidant, cytotoxicity, hepatocytotoxicity, hypoglycaemic, immunomodulatory and wound healing (Table 3). Research by Panda et al. (2019) showed that little ethnopharmacological evaluations have been conducted on Asteraceae species despite the fact that the family is characterized by several secondary metabolites. In addition to this, the relative importance of the Asteraceae species as medicinal plants is demonstrated by the fact that about 20% of the species documented in this study are commercially important in local, regional or international trade in east, southern and west Africa (Cunningham 1993, Williams *et al.* 2001, Dold & Cocks 2002, Kepe 2007, Moeng & Potgieter 2011, Setshogo & Mbereki 2011, Petersen *et al.* 2012, Van Wyk 2015, 2017, Meke *et al.* 2017, Rasethe *et al.* 2019, Barbosa *et al.* 2020). These species include *Artemisia afra* Jacq. ex Willd., *B. adoensis, B. discolor, D. anomala, Gerbera ambigua* (Cass.) Schultz Bip., *G. amygdalinum, Hilliardiella aristata* (DC.) H.Rob., *H. oligocephala* (DC.) H.Rob., *H. kraussii* Schultz Bip. and *S. coronatus*.

Table 2. Major disease categories and Asteraceae species used as traditional medicines in Zimbabwe

Disease category	Species	Use records
Antenatal and postpartum	13	15
Bilharzia	5	5
Charm and ritual	13	14
Fever and malaria	10	10
Gastro-intestinal problems	26	34
Mental problems	5	5
Oedema	5	5
Pregnancy	5	5
Reproductive problems in men	5	5
Reproductive problems in women	12	14
Respiratory problems	14	28
Rheumatism	5	5
Sexually transmitted infections	11	15
Skin problems	5	5
Tonic	5	5
Ulcers	5	5
Urinary problems	5	5
Wounds	5	5

Historical and ecological trends

Nine Asteraceae taxa used as sources of traditional medicines were recorded in Zimbabwe by Wild & Gelfand in 1959 (Fig. 4). Twelve additional taxa were reported between 1961 and 1972 by Harvey & Armitage (1961), Watt & Breyer-Brandwijk (1962) and Wild *et al.* (1972). A comprehensive study of the medicinal plants in Zimbabwe conducted by Gelfand *et al.* (1985) reported 34 taxa including 31 species that were reported for the first time (Fig. 5). The period between 1991 and 2022 was characterised by increased study of the Zimbabwean plants used as sources of traditional medicines (Fig. 4 and 5). Equally intriguing is the fact that *S. oleraceus* and *B. discolor* var. *discolor* were reported for the first time as sources of traditional medicines by Chigora *et al.* in 2007 (Table 1; Fig. 5). Other ethnobotanical studies which documented the medicinal uses of Asteraceae species in Zimbabwe included Chinemana *et al.* (1985), McGregor (1991), Ndamba *et al.* (1994), Mavi (1996), Kambizi & Afolayan (2001), Kraft *et al.* (2003), Herman & Condy (2007), Sewani-Rusike (2010), Maroyi (2012, 2013, 2017, 2018a,b, 2019a-c, 2020a-e, 2021a,b; Ngarivhume *et al.* (2015), Panganai & Shumba (2016), Mawoza *et al.* (2019), Chituku *et al.* (2022), Nyagumbo *et al.* (2022) and Shopo *et al.* (2022). An analyses of research findings from these studies showed that Asteraceae medicinal plants recorded several decades ago were also mentioned and documented in these recent ethnobotanical surveys. Despite interest in the medicinal properties of family Asteraceae having increased following publication of Gelfand *et al.* (1985), this work remains a comprehensive checklist available for the country, including details of 34 taxa.

Table 3 Phytochemistry and pharmacological properties of Fabaceae species used as traditional medicines in Zimbabwe

Species	Phytochemistry	Pharmacological activities	References
A. australe	Flavonoids, melampolides, saponins and tannins	Antibacterial, antioxidant and cytotoxicity	Sánchez *et al.* 2009, Mallmann *et al.* 2018
A. afra	Alkaloids, cardiac glycosides, essential oils, flavonoids, phenols, saponins, tannins and terpenoids	Antimicrobial, antiviral, anti-inflammatory, antimalarial and antioxidant	Patil *et al.* 2011, Muleya *et al.* 2014, Van de Venter *et al.* 2014, Adeogun *et al.* 2018, Falowo *et al.* 2019, Kane *et al.* 2019
A. pluriseta	Alkaloids, alkanes, anthraquinones, esters, fatty acid, flavonoids, phenolics and terpenoids	Antimicrobial, antiviral, antimalarial and cytotoxicity	Cos *et al.* 2002, Sesisubi *et al.* 2010, Kuria 2014, Kuria *et al.* 2015, Njeru & Muema 2020
B. adoensis	Alkaloids, flavonoids, cardiac glycosides, phenols, saponins, steroids, tannins and terpenoids	Antimicrobial, anti-inflammatory, antioxidant, antiplasmodial, antipyretic, antitrypanosomal, antileishmanial, anti-ulcer and cytotoxicity	Maroyi 2020a
B. radula	Sesquiterpene	None found*	Wenkert & Arrhenius, 1983
B. zeyheri	Bithienyl derivatives, lupeol and taraxasterol	None found	Bohlmann & Mohammadi 1983, Odeleye 2010
B. biternata	Alkaloids, flavonoids, cardiac glycosides, iridoids, saponins, steroids, tannins and terpenoids	Anti-malarial and antioxidant	Sukumaran *et al.* 2012, Zahara *et al.* 2015
B. pilosa	Chalcones, fatty acids, flavonoids, cardiac glycosides, phenolic acids, phytosterols and terpenoids	Antibacterial, antifungal, anticancer, antidiabetic, anti-inflammatory, antihyperglycemic, antioxidant, immunomodulatory, antimalarial and antihypertensive	Bartolome *et al.* 2013, Xuan & Khanh 2016
B. discolor var. discolor	Alkaloids, flavonoids, phenolics, saponins, sesquiterpene lactones, steroids, tannins and terpenoids	Anthelmintic, anticancer, antidiabetic, antibacterial, antifungal, anti-hyperglycaemic, antioxidant and cytotoxicity	Zdero & Bohlmann 1987, Adam 2017, Mellem 2018, Monjane *et al.* 2018, Maroyi 2020b
B. huillensis	Coumarins, essential oils, ketoalcohols and ketoaldehyde sesquiterpenes, sterols, tannins and triterpenes	Antibacterial, antifungal, antioxidant and antiprotozoal	Zdero *et al.* 1991, Motsei *et al.* 2003, Omosa *et al.* 2019, Maroyi 2020c
C. benedicta	Essential oils, flavonoids, lactones, tannins and terpenoids	Antimicrobial, anticancer, antidiabetic, anti-inflammatory, antioxidant, antinociceptive and wound healing	Tiwana *et al.* 2021
C. praecox	Alkaloids, essential oils, flavonoids, sesquiterpene lactones, steroids, tannins and triterpenes	Antibacterial	Aliyu *et al.* 2020
C. odorata	Anthraquinones, cardiac glycosides, flavonoids, saponins, steroids, tannins and terpenoids	Analgesic, anthelminthic, antibacterial, antifungal, anticonvulsant, anti-inflammatory, antioxidant, antiprotozoal, antipyretic, antispasmodic and cytotoxicity	Akinmoladun *et al.* 2007, Ngozi *et al.* 2009, Odutayo *et al.* 2017

D. anomala	Acetylenic compounds, flavonoids, phenols, phytosterols, saponins, tannins and triterpenes	Anthelmintic, anticancer, antimicrobial, anti-hyperglycemic, anti-inflammatory, antioxidant, anti-plasmodial and hepatoprotective	Becker *et al.* 2011, Munodawafa *et al.* 2016, Maroyi 2018b
G. ambigua	Tannins	Antimicrobial	Mthethwa 2009
G. amygdalinum	Alkaloids, anthraquinone, coumarins, cyanogenic glycosides, flavonoids, lignans, phenols, saponins, steroids, tannins and terpenes	Analgesic, anthelmintic, antibacterial, antifungal, antiviral, anticancer, antidiabetic, anti-inflammatory, antimalarial, antioxidant, antipyretic, immunomodulatory, hepatoprotective and hypoglycemic	Momoh *et al.* 2012, Chan *et al.* 2016, Alara *et al.* 2017, Tijjan *et al.* 2017, Danladi *et al.* 2018, Inusa *et al.* 2018, Asante *et al.* 2019, Kaur *et al.* 2019
G. coloratum	Alkaloids, anthocyanins, coumarins, essential oils, flavonoids, glycosides, phenols, quinones, saponins, steroids, tannins and terpenoids	Anthelmintic, antidiabetic, antimicrobial, anti-inflammatory, antimalarial, antioxidant, antiplasmodial, antiproliferative, cytotoxicity and hypoglycaemic	Maroyi 2020d
G. glaberrimum	Essential oils and lupeol	Antibacterial, antifungal and cytotoxicity	Abdullahi *et al.* 2017, Alhassan 2018, Gangas *et al.* 2021
H. caespititium	Phloroglucinol	Antibacterial, antifungal, antioxidant and cytotoxicity	Mamabolo *et al.* 2018, Maroyi 2019b
H. kraussii	Essential oils, flavonoids, phloroglucinol, pyrones and terpenoids	Antibacterial, antifungal, anti-inflammatory and antioxidant	Bremner & Meyer, 2000, Candy & Wright 1975, Candy *et al.* 1975, Jakupovic *et al.* 1989, Bougastos *et al.* 2003, Prinsloo & Meyer 2006, Legoale *et al.* 2013
H. aristata	Alkaloids, flavonoids, glaucolides, lactones, phenols, saponins, steroids, tannins and terpenoids	Antibacterial, antifungal, anti-inflammatory, antiplasmodial, antiprotozoal and cytotoxicity	Maroyi 2021a
H. oligocephala	Alkaloids, amino acids, flavonoids, glycosides, polyphenols, saponins, sesquiterpene lactones, steroids, tannins and triterpenoids	Acetylcholinesterase, antibacterial, antidiabetic, anti-inflammatory, antiplasmodial, antioxidant, antiprotozoal, anti-ulcer and cytotoxicity	Maroyi 2020e
I. glomerata	Alkaloids, flavonoids, tannins and terpenoids	Antioxidant	Ojo *et al.* 2021
L. inermis	Coumarins, phenolics, sesquiterpene lactones and terpenoids	None found	Michalska & Kisiel 2014
L. crispata	Essential oils, methyl esters, phenolics, sesquiterpenes and terpenoids	Antibacterial, antifungal and antioxidant	Ahmed *et al.* 1998, Kazembe & Nkomo 2012, Ololade *et al.* 2021
L. glabra	Alkaloids, flavonoids, glycosides, phenols, quinones, saponins, sesquiterpene lactones, steroids, tannins and terpenoids	Antibacterial, antifungal, antiviral and antihypertensive	Maroyi 2021b
L. coriifolia	Alkaloids, essential oils and flavonoids	Anti-inflammatory and antioxidant	Bohlmann & Wallmeyer 1982, Wijaya *et al.* 2012
M. zeyheri	Sesquiterpenes	Antibacterial, anti-inflammatory and antitumour	Van Der Merwe 2008

S. pinnata	Alkaloids, flavonoids, phenolics, sesquiterpene lactones and tannins	Antibacterial, anti-inflammatory and antioxidant	Kudumela *et al.* 2019, Masoko & Masiphephethu 2019
S. coronatus	Sesquiterpenes	None found	Bohlmann & Zdero 1982
S. latifolius	Alkaloids	Anticancer and hepatocytotoxicity	Steenkamp *et al.* 2001, Neuman *et al.* 2007
S. retrorsus	Alkaloids	None found	Manske 1931, De Waal 1939
S. angulatus	Alkaloids, coumarins, flavonoids, glycosides, phenolics, quinones, steroids and tannins	Antitrypanosomal, cytotoxicity and hepatoprotective	Nibret *et al.* 2008, Wolde *et al.* 2010, Saxena & Kumar 2020
S. oleraceus	Alkaloids, essential oils, flavonoids, phenolics, saponins and sesquiterpene lactones	Anti-cholinesterase, antidiabetic, anti-inflammatory and antioxidant	Miyase & Fukushima 1987, Teugwa *et al.* 2013, Li *et al.* 2017, Aissani *et al.* 2022
S. africanus	Anthraquinones, essential oils, tannins and terpenoids	Antibacterial	Babady-Bila *et al.* 2017, Ngezahayo *et al.* 2017
T. minuta	Essential oils	Antibacterial, antifungal, antiviral, antimalarial, anticancer and antioxidant	Shahzadi *et al.* 2010, Vázquez *et al.* 2011, Igwaran *et al.* 2017, Walia *et al.* 2020
T. porrifolius	Coumarins, essential oils, esters, fatty acids, flavonoids, phenolics, saponins and triterpenes	Anticancer, antioxidant and antiproliferative	Warashina *et al.* 1991, Zidorn *et al.* 2005, Formisano *et al.* 2010, Tenkerian 2011, Eruygur *et al.* 2020

[*] = None found means that no record of phytochemical properties were found in literature

The floristic region with the highest number of reports of medicinal Asteraceae species in Zimbabwe is the central region (48, 96.0%), followed by eastern (45, 90.0%), northern (42, 84.0%), southern (33, 66.0%) Zimbabwe, whilst western Zimbabwe (32, 64.0%) has the lowest number (Fig. 6). These figures corroborate an assertion by Mapaura & Timberlake (2004) that southern and western floristic regions are under-collected, as plant collectors tend to collect and study plants in the central plateau of Zimbabwe, that is the central, eastern and northern floristic regions of the country. Some plant collectors include ethnobotanical data on herbarium specimens which provide insights into the ways local communities interact with their plant resources. Pei *et al.* (2020) argued that ethnobotanical studies have the potential to bring together and integrate local and scientific knowledge to advance the cause of biocultural conservation. Therefore, information on medicinal uses of plant resources increases with more collecting and ethnobotanical research efforts.

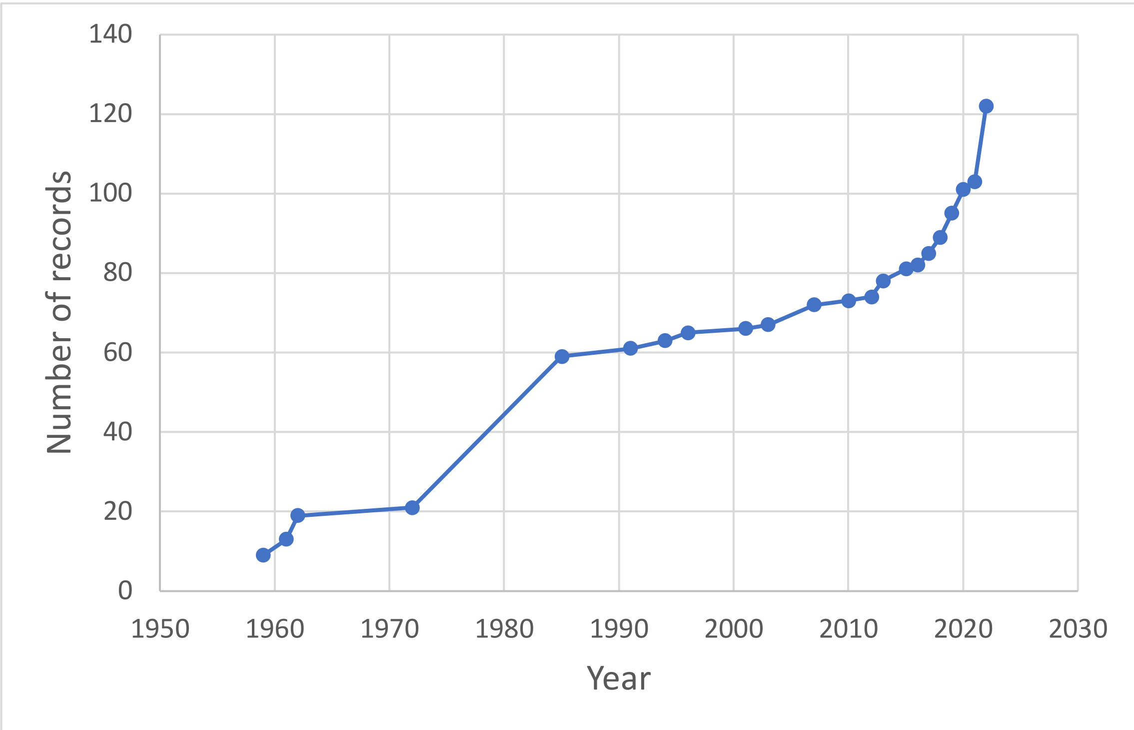


Figure 4. Temporal trends of medicinal Asteraceae taxa collections in Zimbabwe

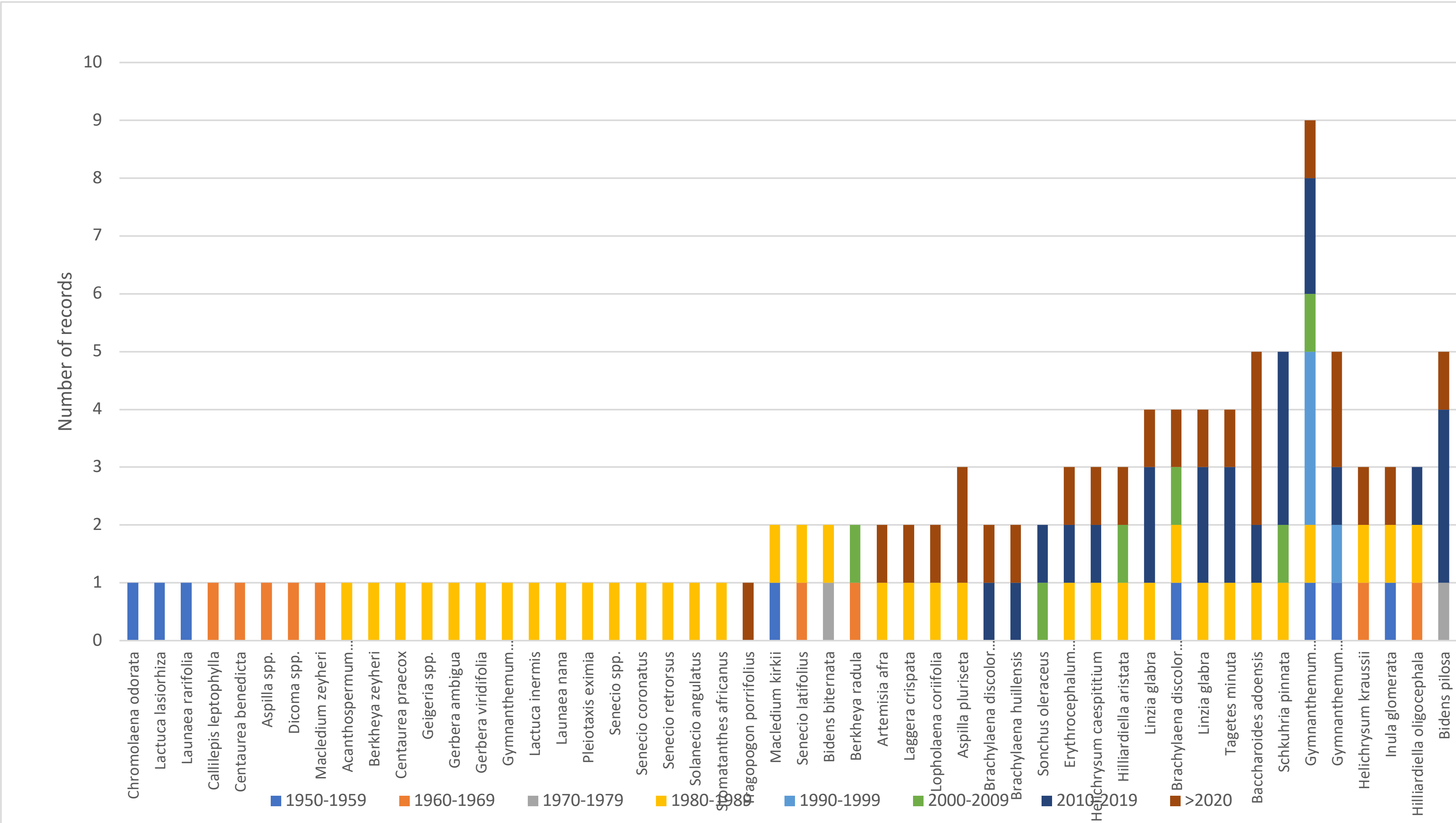


Figure 5. Spatial trends of medicinal Asteraceae taxa collections in Zimbabwe

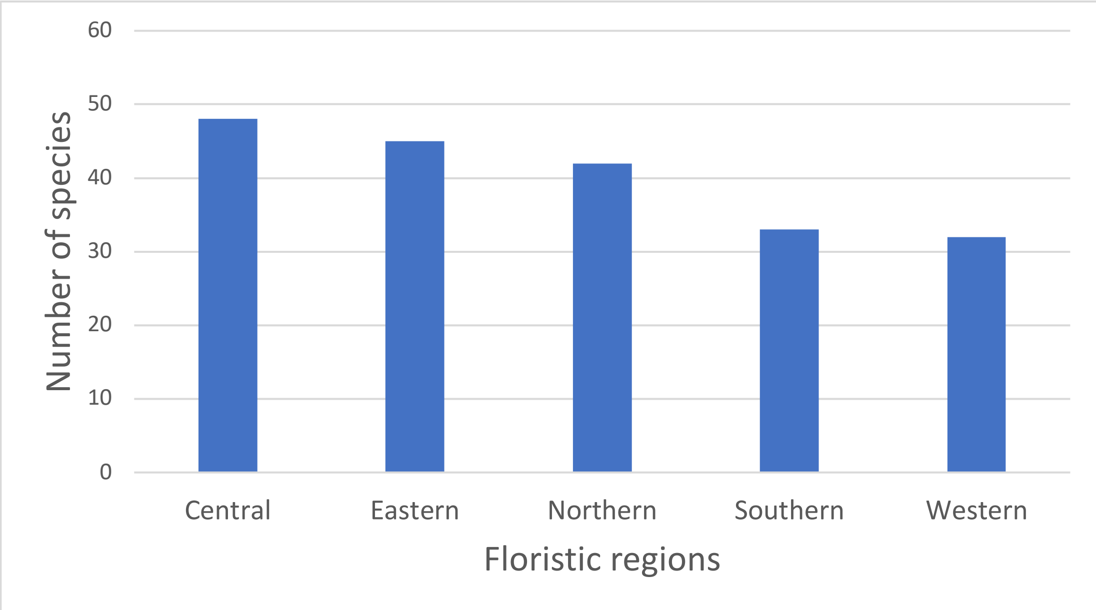


Figure 6. The distribution of the medicinal Asteraceae species in Zimbabwe

Conclusion

The catalogue of Asteraceae species used as sources of traditional medicines is important in trying to understand the value of plant resources in Zimbabwe. However, the documentation of ethnopharmacological properties of medicinal plant species in Zimbabwe is far from sufficient. It is here recommended that further ethnopharmacological research of Asteraceae species focusing on toxicological studies, *in vitro* and *in vivo* models, biochemical assays and pharmacokinetic studies should be undertaken. This field of study is currently under researched in Zimbabwe and there are few examples where medicinal uses, phytochemistry and pharmacological properties of medicinal plants have been fully evaluated.

Declarations

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Literature Cited

Abdullahi MI, Uba A, Yusuf AJ, Olowo-Okere A, Nasir I, Muntaka A, Alhassan AM, Bello SS, Alebiosu CO, Umar A, Yahaya M, Abubakar H. 2017. Comparative antimicrobial activity of fractions of *Vernonia glaberrima* against selected human pathogens. Journal of Pharmacy and Bioresources 14:169-174.

Adam SAE. 2017. Isolation and Identification of Antidiabetic Compounds from *Brachylaena discolor* DC. MSc Dissertation, University of KwaZulu-Natal, Pietermaritzburg.

Adeogun OO, Maroyi A, Afolayan AJ. 2018. Variation in the chemical composition of essential oils from *Artemisia afra* (Jacq) ex wild leaf obtained by different methods and the effect of oil extracts on *Artemia salina* L. Tropical Journal of Pharmaceutical Research 17(3):519-528.

Ahmad S. 2002. Traditional medicine in southeast Asia with special reference to Malaysia and Indonesia. In: Gerber R, Williams M (eds) Geography, Culture and Education. The GeoJournal Library, vol 71. Springer, Dordrecht, pp. 51-64.

Ahmed AA, El Seedi HR, Mahmoud AA, El Aziz A, El Douski A, Zeid IF, Bohlin L. 1998. Eudesmane derivatives from *Laggera crispata* and *Pluchea carolonesis*. Phytochemistry 49:2421-2424.

Aissani F, Grara N, Bensouici C, Bousbia A, Ayed H, Idris MHM, The LK. 2022. Algerian *Sonchus oleraceus* L.: A comparison of different extraction solvent on phytochemical composition, antioxidant properties and anti-cholinesterase activity. Advances in Traditional Medicine 22:383-394.

Akinmoladun AC, Ibukun EO, Dan-Ologe IA. 2007. Phytochemical constituents and antioxidant properties of extracts from the leaves of *Chromolaena odorata.* Scientific Research and Essay 2(6):191-194.

Al Rawi SN, Khidir A, Elnashar MS, Abdelrahim HA, Killawi AK, Hammoud MM, Fetters MD. 2017. Traditional Arabic and Islamic medicine: Validation and empirical assessment of a conceptual model in Qatar. BMC Complementary and Alternative Medicine 17(1):157.

Alara OR, Abdurahman NH, Mudalip SKA, Olalere OA. 2017. Phytochemical and pharmacological properties of *Vernonia amygdalina*: A review. Journal of Chemical Engineering and Industrial Biotechnology 2(1):80-96.

Alencar NL, Santoro FR, Albuquerque UP. 2014. What is the role of exotic medicinal plants in local medical systems? A study from the perspective of utilitarian redundancy. Revisita Brasileira de Farmacognosia 24:506-515.

Alencar NL, de Sousa TAA, de Amorim ELC, de Albuquerque UP. 2010. The inclusion and selection of medicinal plants in traditional pharmacopoeias-evidence in support of the diversification hypothesis. Economic Botany 64:68-79.

Alhassan AM. 2018. Phytochemical, Pharmacological Activity and Molecular Docking Investigations of *Tetracera indica* (Christm. & Panz.) Merr., *Averrhoa bilimbi* Linn. and *Gymnanthemum glaberrimum* (Welw. ex O.Hoffm.) H.Rob. PhD Thesis, International Islamic University Malaysia, Kuala Luphur.

Aliyu AB, Ibrahim MA, Mohammed A, Isah MB, Gangas P, Oyewale AO. 2020. Quorum sensing inhibition in *Chromobacterium violaceum*, antibacterial activity and GC-MS analysis of *Centaurea praecox* (Oliv. & Hiern) extracts. Letters in Applied NanoBioScience 9:1569-1577.

Arnold TH, Prentice CA, Hawker LC, Snyman EE, Tomalin M, Crouch NR, Pottas-Bircher C. 2002. Medicinal and Magical Plants of Southern Africa: An Annotated Checklist. Strelitzia, vol. 13. National Botanical Institute, Pretoria.

Asante DB, Henneh IT, Acheampong DO, Kyei F, Adokoh CK, Ofori EG, Domey NK, Adakudugu E, Tangella LP, Ameyaw EO. 2019. Anti-inflammatory, anti-nociceptive and antipyretic activity of young and old leaves of *Vernonia amygdalina*. Biomedicine and Pharmacotherapy 111:1187-1203.

Azaizeh H, Saad B, Cooper E, Said O. 82008. Traditional Arabic and Islamic medicine, a re-emerging health aid. Evidence-Based Complementary and Alternative Medicine. Volume 2008, Article ID340679

Babady-Bila P, Dinangayi DT, Tshibangu DS-T, Lengbiye E, Ngbolua JP, Tshimankinda PM. 2017. Chemical composition and *in vitro* antibacterial activity of essential oil from *Eupatorium africanum* Oliv. & Hiern. American Journal of Essential Oils and Natural Products 5(3):1-6.

Barbosa F, Hlashwayo D, Sevastyanov V, Chichava V, Mataveia A, Boane E, Cala A. 2020. Medicinal plants sold for treatment of bacterial and parasitic diseases in humans in Maputo city markets, Mozambique. BMC Complementary Medicine and Therapies 20:19

Bartolome AP, Villaseñor IM and Yang W-C. 2013. *Bidens pilosa* L. (Asteraceae): Botanical properties, traditional uses, phytochemistry, and pharmacology. Evidence-Based Complementary and Alternative Medicine. Volume 2013, Article ID 340215.

Becker JV, Van der Merwe MM, Van Brummelen AC, Pillay P, Crampton BG, Mmutlane EM, Parkinson C, Van Heerden FR, Crouch NR, Smith PJ, Mancama DT. 2011. *In vitro* anti-plasmodial activity of *Dicoma anomala* subsp. *gerrardii* (Asteraceae): Identification of its main active constituent, structure-activity relationship studies and gene expression profiling. Malaria Journal 10(1):1-11.

Benítez G, El-Gharbaoui A, Redouan FZ, Gonzalez-Tejero MR, Molero-Mesa J, Merzouki A. 2021. Cross-cultural and historical traceability of ethnomedicinal Asteraceae. Eastern Morocco and Eastern Andalusia: Two sides of a sea in 20 centuries of history. South African Journal of Botany 139:478-493.

Bennett BC, Prance GT. 2000. Introduced plants in the indigenous pharmacopoeia of Northern South America. Economic Botany 54:90-102.

Bhuyan DJ, Dissanayake IH, Jaye K, Chang D. 2022. Traditional and complementary medicine in Australia: Clinical practice, research, education, and regulation. International Journal of Ayurveda Research 3(1):16-29.

Bohlmann F, Zdero C. 1982. Germacrene derivatives and other sesquiterpenes from *Senecio* species and *Lordhowea insularis*. Phytochemistry 21:2537-2541.

Bohlmann F, Mohammadi S. 1983. A futher bithienyl derivative from *Berkhaya zeyheri*. Phytochemistry 22:2856-2857.

Bohlmann F, Wallmeyer M. 1982. Short reports: Furanoeremophilanes from *Lopholaena* species. Phytochemistry 21(8):2126-2127.

Bougatsos C, Meyer JJM, Magiatis P, Vagias C, Chinou IB. 2003. Composition and antimicrobial activity of the essential oils of *Helichrysum kraussii* Sch. Bip. and *H. rugulosum* Less. from South Africa. Flavour and Fragrance Journal 18(1):48-51.

Bremner PD, Meyer JJM. 2000. Prenyl-butyrylphloroglucinol and kaurenoic acid: Two antibacterial compounds from *Helichrysum kraussii*. South African Journal of Botany 66:115-117.

Bruschi P, Morganti M, Mancini M, Signorini MA. 2011. Traditional healers and laypeople: A qualitative and quantitative approach to local knowledge on medicinal plants in Muda (Mozambique). Journal of Ethnopharmacology 138:543-563

Calabria LM, Emerenciano VP, Scotti MT, Mabry TJ. 2009. Secondary chemistry of Compositae. In: Funk VA, Sussana A, Stuessy TF, Bayer RJ (eds). Systematics, Evolution and Biogeography of the Compositae. Vienna, Austra: International Association for Plant Taxonomy (IAPT). pp. 73-88.

Candy HA, Wright W. 1975. Helichrysoside: A new acylated flavonoid glycoside from *Helichrysum kraussii* Sch. Bip. Journal of the South African Chemical Institute 28:215-219.

Candy HA, Laing M, Weeks CM. 1975. The crystal structure of helichrysoside, a newacylated flavonoid glycoside from *Helichrysum kraussii*. Tetrahedron Letters 14: 1211-1214.

Carvalho Jr AR, Diniz RM, Suarez MAM, Figueiredo CSSS, Zagmignan A, Grisotto MAG, Fernandes ES, da Silva LCN. 2018. Use of some Asteraceae plants for the treatment of wounds: from ethnopharmacological studies to scientific evidences. Frontiers in Pharmacology 9:784.

Chan YS, Khoo KS, Sit NWW. 2016. Investigation of twenty selected medicinal plants from Malaysia for anti-Chikungunya virus activity. International Microbiology 19(3):175-182.

Chigora P, Masocha R, Mutenheri F. 2007. The role of indigenous medicinal knowledge (IMK) in the treatment of ailments in rural Zimbabwe: The case of Mutirikwi communal lands. Journal of Sustainable Development in Africa 9:26-43.

Chinemana F, Drummond RB, Mavi S, De Zoysa I. 1985. Indigenous plant remedies in Zimbabwe. Journal of Ethnopharmacology 14:159-172.

Chituku S, Nikodem C, Maroyi A. 2022. Use of herbal, complementary and alternative medicines among pregnant women in Makoni District, Zimbabwe. Latin American and Caribbean Bulletin of Medicinal and Aromatic Plants 21:631-645.

Cilia-López VG, Cariño-Cortés R, Zurita-Salinas LR. 2021. Ethnopharmacology of the Asteraceae family in Mexico. Botanical Sciences 99(3):455-486.

Cook FEM. 1995. Economic Botany Data Collection Standard. International Working Group on Taxonomic Databases for Plant Sciences (TDWG). Royal Botanic Gardens: Kew, Richmond.

Cos P, Hermans N, De Bruyne T, Apers S, Sindambiwe JB, Witvrouw M, De Clercq E, Berghe DV, Pieters L, Vlietinck AJ. 2002. Antiviral activity of Rwandan medicinal plants against human immunodeficiency virus type-1 (HIV-1). Phytomedicine 9(1):62-68.

Cunningham AB. 1993. African Medicinal Plants: Setting Priorities at the Interface between Conservation and Primary Health Care, People and Plants. Working Paper 1, UNESCO, Paris.

Danladi S, Hassan MA, Masa'ud IA, Ibrahim UI. 2018. *Vernonia amygdalina* Del: A mini review. Research Journal of Pharmacy and Technology 11(9):4187-4190.

Dehyab AS, Bakar MFA, Al Omar MK, Sabran SF. 2020. A review of medicinal plant of Middle East and North Africa (MENA) region as source in tuberculosis drug discovery. Saudi Journal of Biological Sciences 27:2457-2478

De Waal HL. 1939. The *Senecio* alkaloids, part 1: The isolation of isatidine from *Senecio retrorsus and Senecio isatideus*. Onderstepoort Journal of Veterinary Science and Animal Industry 12:155-163.

Devine SNO, Kolog EA, Atinga R. 2022. Toward a knowledge-based system for African traditional herbal medicine: A design science research approach. Frontiers in Artificial Intelligence 5:856705.

Dharani N, Yenesew A. 2010. Medicinal Plants of East Africa: An illustrated guide. Drongo Editing and Publishing, Nairobi.

Dold AP, Cocks ML. 2002. The trade in medicinal plants in the Eastern Cape Province, South Africa. South African Journal of Science 98:589-597.

Dzoyem JP, Tshikalange E, Kuete V. 2013. Medicinal plants market and industry in Africa. In: Medicinal Plant Research in Africa: Pharmacology and Chemistry. Kuete V (ed), Elsevier, London, pp. 859-890.

Ekor M. 2014. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Frontiers in Pharmacology 4:177.

El Dahiyat F, Rashrash M, Abuhamdah S, Farha RA, Babar Z. 2020. Herbal medicines: A cross-sectional study to evaluate the prevalence and predictors of use among Jordanian adults. Journal of Pharmaceutical Policy and Practice 13:2.

Eruygur N, Ucar E, Ataş M, Ergul M, Ergul M, Sozmen F. 2020. Determination of biological activity of *Tragopogon porrifolius* and *Polygonum cognatum* consumed intensively by people in Sivas. Toxicology Reports 7:59-66.

Falowo AB, Mukumbo FE, Muchenje V. 2019. Phytochemical constituents and antioxidant activity of *Artemisia afra* and *Bidens pilosa* essential oil in ground pork. Journal of Essential Oil Bearing Plants 22:176-186.

Fokunang CN, Ndikum V, Tabi OY, Jiofack RB, Ngameni B, Guedje NM, Tembe-Fokunang EA, Tomkins P, Barkwan S, Kechia F, Asongalem E, Ngoupayou J, Torimiro NJ, Gonsu KH, Sielinou V, Ngadjui BT, Angwafor F, Nkongmeneck A, Abena OM, Ngogang J, Asonganyi T, Colizzi V, Lohoue J, Kamsu-Kom. 2011. Traditional medicine: past, present and future research and development prospects and integration in the National Health System of Cameroon. African Journal of Traditional Complementary and Alternative Medicine 8(3):284-295.

Formisano C, Rigano D, Senatore F, Bruno M, Rosselli S. 2010. Volatile constituents of the aerial parts of white salsify (*Tragopogon porrifolius* L., Asteraceae). Natural Product Research 24:663-668.

Funk VA, Bayer RJ, Keeley S, Chan R, Watson L, Gemeinholzer B, Schilling E, Panero JL, Baldwin BG, Jacas NG, Susanna A, Jansen RK. 2005. Everywhere but Antarctica: Using a supertree to understand the diversity and distribution of the Compositae. Biologiske Skrifter 55:343-374.

Gangas P, Aliyu AB, Oyewale AO. 2021. GC-MS analysis and antibacterial effects of *Vernonia glaberrima* n-hexane extracts alone and in combination with standard antibiotics. Journal of Chemical Society of Nigeria 46:296-303

Garcia-Oliveira P, Barral M, Carpena M, Gullón P, Fraga-Corral M, Otero P, Prieto MA, Simal-Gandara J. 2021. Traditional plants from Asteraceae family as potential candidates for functional food industry. Food and Function 12:2850.

Geck MS, Cristians S, Berger-Gonza´lez M, Casu L, Heinrich M, Leonti M. 2020. Traditional herbal medicine in Mesoamerica: Toward its evidence base for improving universal health coverage. Frontiers in Pharmacology 11:1160.

Gelfand M, Mavi S, Drummond RB, Ndemera B. 1985. The Traditional Medical Practitioner in Zimbabwe: His Principles of Practice and Pharmacopoeia. Mambo Press, Gweru.

Harvey TEC, Armitage FB. 1961. Some herbal remedies and observations on the Nyanga of Matabeleland. The Central African Journal of Medicine 7:193-207.

Hedberg I, Staugård F. 1989. Traditional Medicine in Botswana: Traditional Medicinal Plants. Ipeleng Publishers, Gaborone.

Herman PPJ, Condy G. 2007. *Berkheya radula* (Asteraceae: Arctoteae). Flowering plants of Africa 60:128-132.

Heywood VH, Harbome JB, Turner BL. 1977a. The Biology and Chemistry of the Compositae. Volume I. University of Texas, Texas.

Heywood VH, Harbome JB, Turner BL. 1977b. The Biology and Chemistry of the Compositae. Volume 2. University of Texas, Texas.

Igwaran A, Iweriebor BC, Okoh SO, Nwodo UU, Obi LC, Okoh AI. 2017. Chemical constituents, antibacterial and antioxidant properties of the essential oil flower of *Tagetes minuta* grown in Cala community Eastern Cape, South Africa. BMC Complementary and Alternative Medicine 17:351.

Inusa A, Sanusi SB, Linatoc AC, Mainassara MM, Awawu JJ. 2018. Phytochemical analysis and antimicrobial activity of bitter leaf (*Vernonia amygdalina*) collected from Lapai, Niger State, Nigeria on some selected pathogenic microorganisms. Science World Journal 13(3):15-18.

Jakupovic J, Zdero C, Grenz M, Tsichritzis F, Lehmann L, Hashemi-Nejad SM, Bohlmann F. 1989. Twenty-one acylphloroglucinol and further constituents from South African *Helichrysum* species. Phytochemistry 28:1119-1131.

Junaid A, Anusooya D, Tamilselvi A, Suriani I, Rosliza AM. 2017. The concept of Ayurveda in medical science, an Indian traditional medicine: A review. International Journal of Public Health and Clinical Sciences 4(5):15-23

Kambizi L, Afolayan AJ. 2001. An ethnobotanical study of plants used for the treatment of sexually transmitted diseases (njovhera) in Guruve District, Zimbabwe. Journal of Ethnopharmacology 77:5-9.

Kane NF, Kyama MC, Nganga JK, Hassanali A, Diallo M, Kimani FT. 2019. Comparison of phytochemical profiles and antimalarial activities of *Artemisia afra* plant collected from five countries in Africa. South African Journal of Botany 125:126-133.

Kaur D, Kaur N, Chopra A. 2019. A comprehensive review on phytochemistry and pharmacological activities of *Vernonia amygdalina.* Journal of Pharmacognosy and Phytochemistry 8(3):2629-2636.

Kazembe TC, Nkomo S. 2012. Use of *Blumea alata, Bidens pilosa* and *Chenopodium ambrosioides* as mosquito repellents and mosquitocides. Bulletin of Environment Pharmacology and Life Sciences 1:59-66.

Keep T. 2007. Medicinal plants and rural livelihoods in Pondoland, South Africa: Towards an understanding of resource value. International Journal of Biodiversity Science and Management 3:170-183.

Koc S, Isgor BS, Isgor YG, Shomali Moghaddam N, Yildirim O. 2015. The potential medicinal value of plants from Asteraceae family with antioxidant defense enzymes as biological targets. Pharmaceutical Biology 53(5):746-751

Koekemoer M, Steyn HM, Bester SP. 2014. Guide to Plant Families of Southern Africa. Strelitzia 31. South African National Biodiversity Institute, Pretoria.

Kokwaro JO. 2009. Medicinal Plants of East Africa. University of Nairobi Press, Nairobi.

Konovalov DA. 2014. Polyacetylene compounds of plants of the Asteraceae family (review). Pharmaceutical Chemistry Journal 48:613-631.

Kraft C, Jennet-Siems K, Siems K, Jakupovic J, Mavi S, Bienzle U, Eich E. 2003. *In vitro* antiplasmodial evaluation of medicinal plants from Zimbabwe. Phytotherapy Research 17:123- 128.

Kudumela RG, Mazimba O, Masoko P. 2019. Isolation and characterisation of sesquiterpene lactones from Schkuhria pinnata and their antibacterial and anti-inflammatory activities. South African Journal of Botany 126:340-344.

Kuria JM. 2014. Efficacy of *Aspilia pluriseta* Schweinf in Cutaneous Wound Healing in a Mouse Model. Doctoral dissertation, University of Nairobi, Nairobi.

Kuria JM, Mbaria JM, Gathumbi PK, Kiama SG. 2015. Influence of *Aspilia pluriseta* Schweinf (Asteraceae) on the healing of dermal excision wounds (mouse model) and skin sensitization activity (guinea pig model). African Journal of Pharmacology and Therapeutics 4:112-117.

Legoale PB, Mashimbye MJ, Van Ree T. 2013. Anti-inflammatory and antioxidant flavonoids from *Helichrysum kraussii* and *H. odoratissimum* flowers. Natural Product Communications 8:1403-1404.

Leistner OA. 2000. Seed Plants of Southern Africa: Families and Genera. Strelitzia 10. National Botanical Institute, Pretoria

Leonti M, Verpoorte R. 2017. Traditional Mediterranean and European herbal medicines. Journal of Ethnopharmacology 199:161-167

Li Q, Dong DD, Huang QP, Li J, Du YY, Li B, Li HQ, Huyan T. 2017. The anti-inflammatory effect of *Sonchus oleraceus* aqueous extract on lipopolysaccharide stimulated RAW 2647 cells and mice. Pharmaceutical Biology 55(1):799-809.

Liu S, Matsuo T, Matsuo C, Abe T. 2022. Traditional Chinese medicines and prescriptions brought from China to Japan by a monk (Jianzhen, Japanese: Ganjin): A historical review. Compounds 2:267-284.

Mallmann R, Ethur EM, Bianchetti P, Faleiro D, Hoehne L, Goettert MI. 2018. Effectiveness of aqueous and hydroalcoholic extracts of *Acanthospermum australe* (Loefl.) Kuntze against diarrhea-inducing bacteria. Brazilian Journal of Biology 78(4):619-624.

Mamabolo MP, Muganza FM, Olivier MT, Olaokun OO, Nemutavhanani LD. 2018. Evaluation of antigonorrhea activity and cytotoxicity of *Helichrysum caespititium* (DC) Harv. whole plant extracts. Biology and Medicine 10:422.

Mandal SC, Mandal V, Konishi T. 2018. Natural Products and Drug Discovery: An Integrated Approach. Elsevier, Amsterdam.

Mander M, Ntuli L, Diederichs N, Mavundla K. 2007. Economics of the traditional medicine trade in South Africa. In: Harrison S, Bhana R, Ntuli A (eds), South African Health Review. Health Systems Trust, Durban, pp. 189-199.

Manning J. 2007. Field Guide to Fynbos. Struik Nature, Cape Town.

Manning J. 2009. Field Guide to Wild Flowers of South Africa, Lesotho and Swaziland. Struik Nature, Cape Town

Manske RHF. 1931. The alkaloids of *Senecio* species: i. The necines and necic acids from *S. retrorsus* and *S. jacobaea*. Canadian Journal of Research 5:651-659.

Mapaura A, Timberlake J. 2004. A Checklist of Zimbabwean Vascular Plants. Southern African Botanical Diversity Network Report No. 33, Pretoria.

Mapaura A, Timberlake J. 2002. Zimbabwe. In: Golding J. (eds), Southern African Plant Red Data Lists. Southern African Botanical Diversity Network Report No. 14, Pretoria, pp. 157-182.

Maroyi A. 2021a. *Hilliardiellia aristata*: Review of its medicinal uses, phytochemistry and pharmacological properties. Research Journal of Pharmacy and Technology 14(10):5563-5568.

Maroyi A. 2021b. Evaluation of pharmacological properties, phytochemistry and medicinal uses of *Linzia glabra* (Asteraceae). Research Journal of Pharmacy and Technology 14(3):1741-1746.

Maroyi A. 2020a. Review of pharmacological properties, phytochemistry and medicinal uses of *Baccharoides adoensis*. Journal of Pharmacy and Nutrition Sciences 10:230-238.

Maroyi A. 2020b. Review of phytochemistry, biological activities and therapeutic potential of *Brachylaena discolor*. International Journal of Research in Pharmaceutical Sciences 11(4):5626-5633.

Maroyi A. 2020c. A synthesis and review of ethnomedicinal uses, phytochemistry and biological activities of *Brachylaena huillensis* O. Hoffm. (Asteraceae). International Journal of Scientific and Technology Research 9:195-199.

Maroyi A. 2020d. *Gymnanthemum coloratum*: Review of its medicinal uses, phytochemistry and pharmacological properties. Journal of Pharmacy and Nutrition Sciences 10:196-204.

Maroyi A. 2020e. *Hilliardiella elaeagnoides*: Review of its medicinal uses, phytochemistry and pharmacological properties. Research Journal of Pharmacy and Technology 13(11):5539-5545.

Maroyi A. 2019a. **Use of ethnomedicinal herbs to treat and manage schistosomiasis in Zimbabwe: Past trends and future directions. In:** Martinez JL, Munoz-Acevedo A, Rai M (eds), Ethnobotany: Application of Medicinal Plants, CPC Press, London, **pp. 36-47**.

Maroyi, A., 2019b. *Helichrysum caespititium* (DC.) Harv.: Review of its medicinal uses, phytochemistry and biological activities. Journal of Applied Pharmaceutical Science 9(6):111-118.

Maroyi A. 2019c. A review of medicinal uses, phytochemistry and biological activities of *Boscia angustifolia*. Journal of Pharmaceutical Science and Research 11:3420-3428.

Maroyi A. 2018a. Ethnomedicinal uses of exotic plant species in south-central Zimbabwe. Indian Journal of Traditional Knowledge 17:71-77.

Maroyi A. 2018b. *Dicoma anomala* Sond.: A review of its botany, ethnomedicine, phytochemistry and pharmacology. Asian Journal of Pharmaceutical and Clinical Research 11(6):70-77.

Maroyi A. 2017. Exotic plants in indigenous pharmacopoeia of south-central Zimbabwe: Traditional knowledge of herbal medicines. Research Journal of Botany 12:46-52.

Maroyi A. 2016. Treatment of diarrhoea using traditional medicines: Contemporary research in South Africa and Zimbabwe. African Journal of Traditional Complementary and Alternative Medicine 13(6):5-10.

Maroyi A. 2014. Alternative medicines for HIV/AIDS in resource-poor settings: Insight from traditional medicines use in sub-Saharan Africa. Tropical Journal of Pharmaceutical Research 13(9):1527-1536.

Maroyi A. 2013. Traditional use of medicinal plants in south-central Zimbabwe: Review and perspectives. Journal of Ethnobiology and Ethnomedicine 9:31.

Maroyi A. 2012. Use of traditional veterinary medicine in Nhema communal area, Midlands Province, Zimbabwe. African Journal Traditional, Complementary and Alternative Medicine 9:315-322.

Maroyi A. 2006. A preliminary checklist of naturalized and introduced plants in Zimbabwe. Kirkia 18:177-247.

Masoko P, Masiphephethu MV. 2019. Phytochemical investigation, antioxidant and antimycobacterial activities of *Schkuhria pinnata* (Lam) Thell extracts against Mycobacterium smegmatis. Journal of Evidence-Based Integrative Medicine 24:1-8.

Mavi S. 1996. Medicinal plants and their uses in Zimbabwe. In: Norman H, Snyman I, Cohen M (eds.), Indigenous Knowledge and its Uses in Southern Africa. Human Sciences Research Council, Pretoria, pp. 67-73.

Mawoza T, Nhachi C, Magwali T. 2019. Prevalence of traditional medicine use during pregnancy, at labour and for postpartum care in a rural area in Zimbabwe. Clinics in Mother and Child Health 16:321.

McGregor J. 1991. Woodland Resources: Ecology, Policy and Ideology: An Historical Case Study of Woodland Use in Shurugwi Communal Area, Zimbabwe. PhD Thesis, Loughborough University of Technology, Loughborough.

Meke GS, Mumba RFE, Bwanali RJ, Williams VL. 2017. The trade and marketing of traditional medicines in southern and central Malawi. International Journal of Sustainable Development and World Ecology 24:73-87.

Meletiadis J, Pournaras S, Roilides E, Walsh TJ. 2010. Defining fraction inhibitory concentration index cut offs for additive interactions based on self-drug additive combinations, Monte Carlo simulation analysis, and *in vitro - in vivo* correlation data for antifungal drug combination against *Aspergillus fumigatus*. Antimicrobial Agents and Chemotherapy 54(2):602-609.

Mellem JJ. 2018. Isolation and Characterization of the Leaves of *Brachylaena discolor* Extract as an Anti-Diabetic Agent. PhD Thesis, Durban University of Technology, Durban

Michalska K, Kisiel W. 2014. Chemical constituents from *Lactuca inermis*, a wild African species. Biochemical Systematics and Ecology 55:104-106.

Micke O, Hübnera J. 2009. Traditional European medicine: After all, is Hildegard von Bingen really right? European Journal of Integrative Medicine 1:226.

Miyase T, Fukushima L. 1987. Studies on sesquiterpene glycosides from *Sonchus oleraceus* L. Chemical and Pharmaceutical Bulletin 35(7):2869-2874.

Moeng TE, Potgieter MJ. 2011. The trade of medicinal plants by muthi shops and street vendors in the Limpopo Province, South Africa. Journal of Medicinal Plants Research 5:558-564.

Moffett R. 2010. Sesotho Plant and Animal Names and Plants Used by the Basotho. Sun Press, Bloemfontein

Momoh MA, Muhamed U, Agboke AA, Akpabio EI, Osonwa UE. 2012. Immunological effect of aqueous extract of *Vernonia amygdalina* and a known immune booster called immunace® and their admixtures on HIV/AIDS clients: a comparative study. Asian Pacific Journal of Tropical Biomedicine 2(3):181-184.

Monjane JA, Capusiri D, Giménez A, Sterner O. 2018. Leishmanicidal activity of onopordopicrin isolated from the leaves of *Brachylaena discolor.* Tropical Journal of Natural Products Research 2(7):328-331.

Motsei ML, Lindsey KL, Van Staden J, Jäger AK. 2003. Screening of traditionally used South African plants for antifungal activity against *Candida albicans.* Journal of Ethnopharmacology 86:235-241.

Mthethwa NS. 2009. Antimicrobial Activity Testing of Traditionally Used Plants for Treating Wounds and Sores at Ongoye Area KwaZulu-Natal, South Africa. MSc Dissertation, University of Zululand, Kwadlangezwa.

Muchandiona A. 2013. Challenges and Opportunities in Solid Waste Management in Zimbabwe's Urban Councils. MSc Dissertation. University of Zimbabwe, Harare.

Mukherjee PK, Harwansh RK, Bahadur S, Banerjee S, Kar A. 2017. Evidence-based validation of Indian traditional medicine: Way forward. World Journal of Traditional Chinese Medicine 2:48-61.

Muleya E, Ahmed AS, Sipamla AM, Mtunzi FM, Mutatu W. 2014. Evaluation of anti-microbial, anti-inflammatory and anti-oxidative properties *Artemisia afra, Gunnera perpensa* and *Eucomis autumnalis*. Journal of Nutrition and Food Science 4(6):1-6.

Munodawafa T, Moyo S, Chipurura B, Chagonda L. 2016. Brine shrimp lethality bioassay of some selected Zimbabwean traditional medicinal plants. International Journal of Phytopharmacy 7(4):229-232.

Musa HH, Musa TH, Oderinde O, Musa IH, Shonekan OO, Akintunde TY, Onasanya AK. 2022. Traditional herbal medicine: overview of research indexed in the scopus database. Advances in Traditional Medicine. https://doi.org/10.1007/s13596-022-00670-2

Ndamba J, Nyazema N, Makaza N, Anderson C, Kaondera KC. 1994. Traditional herbal remedies used for the treatment of urinary schistosomiasis in Zimbabwe. Journal of Ethnopharmacology 42:125-132.

Neuman MG, Jia AY, Steenkamp V. 2007. *Senecio latifolius* induces *in vitro* hepatocytotoxicity in a human cell line. Canadian Journal of Physiology and Pharmacology 85:1063-1075.

Ngarivhume T, Van'T Klooster CIEA, De Jong JTVM, Van Der Westhuizen JH. 2015. Medicinal plants used by traditional healers for the treatment of malaria in the Chipinge district in Zimbabwe. Journal of Ethnopharmacology 159:224-237.

Ngezahayo J, Ribeiro SO, Fontaine V, Hari L, Stévigny C, Duez P. 2017. *In vitro* study of five herbs used against microbial infections in Burundi. Phytotherapy Research 31:1571-1578.

Ngozi IM, Ikewuchi CJ, Ikewuchi CC. 2009. Chemical profile of *Chromolaena odorata* L. (King and Robinson) leaves. Pakistan Journal of Nutrition 8(5):521-524.

Nguanchoo V, Wangpakapattanawong P, Balslev H, Inta A. 2019. Exotic plants used by the Hmong in Thailand. Plants 8:500.

Nibret E, Sporer F, Asres K, Wink M. 2008. Antitrypanosomal and cytotoxic activities of pyrrolizidine alkaloid-producing plants of Ethiopia. Journal of Pharmacy and Pharmacology 61:801-808.

Njeru SN, Muema JM. 2020. Antimicrobial activity, phytochemical characterization and gas chromatography-mass spectrometry analysis of *Aspilia pluriseta* Schweinf. extracts. Heliyon 6(10):e05195.

Njoroge NG, Bussmann WR, Gemmill B, Newton LE, Ngumi VW. 2004. Utilisation of weed species as sources of traditional medicines in central Kenya. Lyonia 7:71-87.

Nyabani P. 2021. Epidemiological transition and the dual burden of communicable and noncommunicable diseases in Zimbabwe. International Journal of Non-Communicable Diseases 6:166-171.

Nyagumbo E, Pote W, Shopo B, Nyirenda T, Chagonda I, Mapaya RJ, Maunganidze F, Mavengere WN, Mawere C, Mutasa I, Kademeteme E, Maroyi A, Taderera T, Bhebhe M. 2022. Medicinal plants used for the management of respiratory diseases in Zimbabwe: Review and perspectives potential management of COVID-19. Physics and Chemistry of the Earth 128:103232.

Odeleye OM. 2010. Investigation of Chemical Constituents, Antimicrobial and Antioxidant Activities, and Pharmacognostic Characters of the Leaves of *Momordica Foetida* and *Berkheya Bergiana*. PhD Thesis. University of Zululand, Kwadlangezwa.

Odutayo F, Ezeamagu C, Kabiawu T, Aina D, Mensah-Agyei G. 2017. Phytochemical screening and antimicrobial activity of *Chromolaena odorata* leaf extract against selected microorganisms. Journal of Advances in Medical and Pharmaceutical Sciences 13(4):1-9.

Ojo MC, Osunsanmi FO, Cele ND, Zharare GE, Mosa RA, Opoku AR. 2021. *In vitro* and *in vivo* antioxidant potentials of the methanolic crude extract from *Inula glomerata* Oliv. & Hiern (Asteraceae) and *Salacia kraussii* (Harv.) Harv (Celastraceae). Latin American and Caribbean Bulletin of Medicinal and Aromatic Plants 20(4):416-426.

Okoye TC, Uzor PF, Onyeto CA, Okereke EK. 2014. 18 - Safe African medicinal plants for clinical studies. In: Kuete V (eds), Toxicological Survey of African Medicinal Plants, Elsevier, Amsterdam, pp. 535-555.

Oliver SJ. 2013. The role of traditional medicine practice in primary health care within Aboriginal Australia: A review of the literature. Journal of Ethnobiology and Ethnomedicine 9:46.

Ololade ZS, Anuoluwa IA, Adeyemi AF, Uyaboerigha DI. 2021. Synergistic efficacy of phytochemical, antioxidant and bactericidal properties of the aerial essential oil of *Laggera crispata.* Pharmacognosy Journal 13(5):1304-1311.

Omosa LK, Amugune B, Mutai P, Karumu E, Mukungu N, Induli M, Kama-Kama F, Kuete V. 2019. Rapid screening using GIBEX screens-to-nature system of ethnomedicinal plants from Ngong Forest, Kenya for potency against infectious diseases and antioxidant activities: A qualitative study. Pharmacognosy Communication 9(2):59-74.

Palmer CT. 2004. The inclusion of recently introduced plants in the Hawaiian ethnopharmacopoeia. Econonic Botany 58:S280-S293.

Palmer E, Pitman N. 1972. Trees of Southern Africa Covering all Known Indigenous Species in the Republic of South Africa, South-West Africa, Botswana, Lesotho and Swaziland. AA Balkema, Cape Town.

Panda SK, Luyten W. 2018. Antiparasitic activity in Asteraceae with special attention to ethnobotanical use by the tribes of Odisha, India. Parasite 25:10

Panda SK, da Silva LCN, Sahal D, Leonti M. 2019. Editorial: Ethnopharmacological studies for the development of drugs with special reference to Asteraceae. Frontiers of Pharmacology 10:955

Panero JL, Funk VA. 2002. Toward a phylogenetic subfamilial classification for the Compositae (Asteraceae). Proceedings of the Biological Society of Washington 115:909-922.

Panéro JL, Freire SE, Ariza EL, Crozier BS, Barboza GE, Cantero JJ. 2014. Resolution of deep nodes yields an improved backbone phylogeny and a new basal lineage to study early evolution of Asteraceae. *Molecular Phylogenetics and Evolution 80(1):43-53.*

Panganai T, Shumba P. 2016. The African pitocin- a midwife's dilemna: The perception of women on the use of herbs in pregnancy and labour in Zimbabwe, Gweru. The Pan African Medical Journal 25:9.

Patil GV, Dass SK, Chandra R. 2011. *Artemisia afra* and modern diseases. Journal of Pharmacogenomics and Pharmacoproteomics 2:105.

Pei S, Alan H, Wang Y. 2020. Vital roles for ethnobotany in conservation and sustainable development. Plant Diversity 42:399-400.

Petersen LM, Moll EJ, Collins RJ, Hockings MT. 2012. A compendium of locally harvested biodiversity resources for informal economy trade within the City of Cape Town, South Africa. Ecology and Society 17:2.

Pope GV, Pope DG. 1998. Collecting Localities in the Flora Zambesiaca Area. Flora Zambesiaca Management Committee, Royal Botanic Gardens, Kew, Richmond.

POWO. 2023. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Available from: https://powo.science.kew.org, accessed on 21 February 2023.

Prinsloo G, Meyer JJM. 2006. In vitro production of phytoalexins by *Helichrysum kraussii*. South African Journal of Botany 72:482-483.

Rahman MH, Roy B. 2014. Population structure and curative uses of invasive plants in and around the protected forests of Bangladesh: A means of utilization of potential invasive species. Journal of Ecosystems Volume 2014, Article ID 249807.

Randall RP. 2017. A Global Compendium of Weeds. Department of Agriculture and Food Western Australia, Perth.

Rankoana SA. 2022. Indigenous plant-derived medicines used for gastrointestinal disorders in Limpopo province, South Africa. Social Sciences Humanities and Education Journal 3(2):242-251.

Rasethe MT, Semenya SS, Maroyi A. 2019. Medicinal plants traded by informal herbal medicine markets in the Limpopo province, South Africa. Evidence-Based Complementary and Alternative Medicine. Volume 2019, Article ID 2609532.

Redvers N, Blondin B. 2020. Traditional Indigenous medicine in North America: A scoping review. PLoS One 15(8):e0237531.

Ribeiro A, Romeiras MM, Tavares J, Faria MT. 2010. Ethnobotanical survey in Canhane village, district of Massingir, Mozambique: Medicinal plants and traditional knowledge. Journal of Ethnobiology and Ethnomedicine 6:33.

Rojas P, Jung-Cook H, Ruiz-Sánchez E, Rojas-Tomé IS, Rojas C, López-Ramírez AM, Reséndiz-Albor AA. 2022. Historical aspects of herbal use and comparison of current regulations of herbal products between Mexico, Canada and the United States of America. International Journal of Environmental Research and Public Health 19:15690.

Rolnik A, Olas B. 2021. The plants of the Asteraceae family as agents in the protection of human health. International Journal of Molecular Science 22:3009.

Sánchez M, Kramer F, Bargardi S, Palermo JA. 2009. Melampolides from Argentinean *Acanthospermum australe*. Phytochemistry Letters 2:93-95.

Saxena A, Kumar J. 2020. Phytochemical screening, metal-binding studies and applications of floral extract of *Sonchus oleraceus* as a corrosion inhibitor. Journal of Bio- and Tribo-Corrosion 6:55.

Schmelzer GH, Gurib-Fakim A. 2008. Plant Resources of Tropical Africa 11: Medicinal Plants 1. Backhuys Publishers, Leiden.

Sebisubi FM, Odyek O, Anokbonggo WW, Ogwal-Okeng J, Carcache-Blanco EJ, Ma C, Orjala J, Tan GT. 2010. Antimalarial activity of A*spilia pruliseta*, a medicinal plant from Uganda. Planta Medica 76:1870-1873.

Semenya SS, Maroyi A. 2018. Exotics plants used therapeutically by Bapedi traditional healers for respiratory infections and related symptoms in the Limpopo province, South Africa. Indian Journal of Traditional Knowledge 17:663-671.

Semenya SS, Maroyi A. 2012. Medicinal plants used by the Bapedi traditional healers to treat diarrhoea in the Limpopo Province, South Africa. Journal of Ethnopharmacology 144:395-401.

Semenya S, Potgieter M, Tshisikhawe M, Shava S, Maroyi A. 2012. Medicinal utilization of exotic plants by Bapedi traditional healers to treat human ailments in Limpopo province, South Africa. Journal of Ethnopharmacology 144:646-655.

Setshogo MP, Mbereki CM. 2011. Floristic diversity and use of medicinal plants sold by street vendors in Gaborone, Botswana. The African Journal of Plant Science and Biotechnology 5:69-74.

Sewani-Rusike CR. 2010. Plants of Zimbabwe used as anti-fertility agents. African Journal of Traditional Complementary and Alternative Medicine 7(3):253-257.

Shahzadi I, Hassan A, Khan UW, Shah MM. 2010. Evaluating biological activities of the seed extracts from *Tagetes minuta* L. found in Northern Pakistan. Journal of Medicinal Plants Research 4(20):2108-2112.

Shopo B, Mapaya RJ, Maroyi A. 2022. Ethnobotanical study of medicinal plants traditionally used in Gokwe South District, Zimbabwe. South African Journal of Botany 149:29-48.

Sifuna N. 2022. African traditional medicine: Its potential, limitations and challenges. Journal of Healthcare 5(1):141-150.

Singh AK. 2016. Exotic ancient plant introductions: part of Indian 'Ayurveda' medicinal system. Plant Genetic Resources: Characterization and Utilization 14(4):356-369.

Steenkamp V, Stewart MJ, Van der Merwe S, Zuckerman M, Crowther NJ. 2001. The effect of *Senecio latifolius* a plant used as a South African traditional medicine, on a human hepatoma cell line. Journal of Ethnopharmacology 78:51-58.

Sudha PS. 2018. Interface between traditional knowledge (TK) and human rights in realizing right to health and health care: An Indian perspective. Peace Human Rights Governance 2(3):331-345.

Sukumaran P, Nair AG, Chinmayee DM, Mini I, Sukumaran ST. 2012. Phytochemical investigation of *Bidens biternata* (Lour.) Merr. and Sheriff.: A nutrient-rich leafy vegetable from Western Ghats of India. Applied Biochemistry and Biotechnology 167:1795-1801.

Tenkerian CA. 2011. Anticancer and Antioxidant Effects of *Tragopogon porrifolius* Extract. MSc Dissertation. Lebanese American University, Lebanon.

Teugwa CM, Mejiato PC, Zofou D, Tchinda BT, Boyom FF. 2013. Antioxidant and antidiabetic profiles of two African medicinal plants: *Picralima nitida* (Apocynaceae) and *Sonchus oleraceus* (Asteraceae). BMC Complement Altern Med 13:175.

Tijjani MA, Mohammed GT, Alkali YT, Adamu TB, Abdurahaman FI. 2017. Phytochemical analysis, analgesic and antipyretic properties of ethanolic leaf extract of *Vernonia amygdalina* Del. Journal of Herbmed Pharmacology 6(3):95-99.

Tiwana G, Fua J, Lu L, Cheesman MJ, Cock IE. 2021. A review of the traditional uses, medicinal properties and phytochemistry of *Centaurea benedicta* L. Pharmacognosy Journal 13(3):798-812.

Van Der Merwe MM. 2008. Bioactive Sesquiterpenoids from *Dicoma anomala* subsp. *Gerrardii*. MSc Dissertation, University of KwaZulu Natal, Pietermaritzburg.

Van de Venter M, Pruissen M, Koekemoer T, Sowemimo A, Govender S. 2014. *In vitro* anti-HIV and-TB activities of *Annona muricata* and *Artemisia afra* extracts. Planta Medica 80(16):P1L29.

Van Vuuren SF, Viljoen A. 2011. Plant-based antimicrobial studies-methods and approaches to study the interaction between natural products. Planta Medica 77:1168-1182.

Van Wyk B-E. 2017. A review of African medicinal and aromatic plants. In Neffati M, Najjaa H, Máthé Á (Eds.), Medicinal and Aromatic Plants of the World: Africa. Volume 3. Springer, Dordrecht, pp. 19-60.

Van Wyk B-E. 2015. A review of commercially important African medicinal plants. Journal of Ethnopharmacology 176:118-134.

Van Wyk B-E, Wink M. 2017. Medicinal Plants of the World: An Illustrated Scientific Guide to Important Medicinal Plants and their Uses. Briza Publications, Pretoria.

Van Wyk BE, Van Oudtshoorn B, Gericke N. 2013. Medicinal Plants of South Africa. Briza Publications, Pretoria.

Vázquez AM, Demmel GI, Criado SG, Aimar ML, Cantero JJ, Rossi LI, Velasco MI. 2011. Phytochemistry of *Tagetes minuta* L. from Córdoba, Argentina: Comparative study between essential oil and HS-SPME analyses. Latin American and Caribbean Bulletin of Medicinal and Aromatic Plants 10:351-362.

Walia S, Mukhia S, Bhatt V, Kumar R, Kumar R. 2020. Variability in chemical composition and antimicrobial activity of *Tagetes minuta* L. essential oil collected from different locations of Himalaya. Industrial Crops and Products 150:112449.

Warashina T, Miyase T, Ueno A. 1991. Novel acylated saponins from *Tragopogon porrifolius*: Isolation and the structures of tragopogonsaponins A-R. Chemical and Pharmaceutical Bulletin 39:388-396.

Watt JW, Breyer-Brandwijk MG. 1962. The Medicinal and Poisonous Plants of Southern and Eastern Africa. E & S Livingstone Ltd, Edinburgh.

Wenkert E, Arrhenius ST. 1983. Direct stereocontrolled synthesis of isocomene. Journal of the American Chemical Society 105:2030-2033.

Wijaya S, Jin KT, Nee TK, Wiart C. 2012. *In vitro* 5-LOX inhibitory and antioxidant activities of extracts and compounds from the aerial parts of *Lopholaena coriifolia* (Sond.) E. Phillips & C.A. Sm. Journal of Complementary and Integrative Medicine 9, Article 11.

Wild H, Gelfand M. 1959. Some native herbal remedies at present in use in Mashonaland. The Central African Journal of Medicine 5:292-305.

Wild H, Mavi S, Biegel SM. 1972. A Southern Rhodesia Botanical Dictionary of Native and English Plant Names. Government Printer, Salisbury.

Williams VL, Victor JE, Crouch NR. 2013. Red Listed medicinal plants of South Africa: Status, trends, and assessment challenges. South African Journal of Botany 86:23-35.

Williams VL, Balkwill K, Witkowski ETF. 2001. A lexicon of plants traded in the Witwatersrand umuthi shops, South Africa. Bothalia 31:71-98.

Wolde T, Engidawork E, Asres K and Eregete W. 2010. Evaluation of hepatoprotective activities of *Satureja punctata* Benth Briq and *Solanecio angulatus* Vahl Jeffrey in ferric nitrillotriacetate induced hepatotoxicity in rats. Ethiopian Pharmaceutical Journal 28:63-74.

World Health Organization (WHO). 2020. Traditional medicine in the WHO South-East Asia Region: Review of progress 2014-2019. World Health Organization, Geneva.

Yeh ML, Lin KC, Chen HH, Wang YJ, Huang YC. 2015. Use of traditional medicine and complementary and alternative medicine in Taiwan: A multilevel analysis. Holistic Nursing Practice 29(2):87-95.

Yaoita Y, Kikuchi M, Machida K. 2012. Terpenoids and related compounds from plants of the family Compositae (Asteraceae). Natural Product Communication 7:533-538.

Xiong X, Jiang X, Lv G, Yuan J, Li M, Lu ZK. 2022. Evidence of Chinese herbal medicine use from an economic perspective: A systematic review of pharmacoeconomics studies over two decades. Frontiers of Pharmacology 13:765226.

Xuan TD, Khanh TD. 2016. Chemistry and pharmacology of *Bidens pilosa*: An overview. Journal of Pharmaceutical Investigation 46:91-132.

Zahara K, Bibi Y, Tabassum S, Mudrikah, Bashir T, Haider S, Araa A, Ajmal M. 2015. A review on pharmacological properties of *Bidens biternata*: A potential nutraceutical. Asian Pacific Journal of Tropical Diseases 5(8):595-599.

Zdero C, Bohlmann F. 1987. Sesquiterpene lactones from the genus *Brachylaena*. Phytochemistry 26:2597-2601.

Zdero C, Bohlmann F, Wasshausen DC. 1991. Guaianolides from *Brachylaena* species. Phytochemistry 30(11):3810-3811

Zidorn C, Lohwasser U, Pschorr S, Salvenmoser D, Ongania K-H, Ellmerer EP, Börner A, Stuppner H. 2005. Bibenzyls and dihydroisocoumarins from white salsify (*Tragopogon porrifolius* subsp. *porrifolius*). Phytochemistry 66:1691-1697.