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REVIEW ARTICLE

Medicinal plants used against poultry diseases in Zimbabwe: A systematic review

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

ABSTRACT

The current study was aimed at documenting ethnoveterinary medicines (EVMs) used against poultry diseases in Zimbabwe and local ecological knowledge (LEK) associated with the documented plant species. Information related to EVMs used against poultry diseases in Zimbabwe 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, and scientific reports. This study showed that 69 species are traditionally used to manage poultry diseases in Zimbabwe. Most of the plant species (79.01%) that are used in poultry treatment and management are wild and 29.0% are exotic, cultivated, or naturalized. These species are used against 22 medical conditions, mainly in the treatment and management of coccidiosis, Newcastle, cough, diarrhea, wounds, and ectoparasites. *Adenia gummifera*, *Aloe arborescens*, *Aloe chabaudii*, *Aloe greatheadii*, *Actaea spicata*, *Bobgunnia madagascariensis*, *Capsicum annuum*, *Capsicum frutescens*, *Cynanchum viminale,* and *Erythrina abyssinica* have the highest number of EVM uses. This review highlights the importance of EVMs for the healthcare of poultry in Zimbabwe. Therefore, detailed ethnopharmacological evaluations of the species focusing on their phytochemistry, pharmacological properties, toxicological evaluations, *in vivo* and clinical research investigations are recommended.

ARTICLE HISTORY

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Ethnoveterinary medicine; herbal medicine; indigenous knowledge; local ecological knowledge; natural compounds; Zimbabwe

Introduction

Poultry has been an important source of animal protein in the form of meat and eggs since antiquity [1]. The term poultry encompasses a wide range of domesticated birds including chickens, turkeys, guinea fowls, pigeons, ducks, and wild species such as ostriches and quails [1–3]. Chickens constitute about 90% of the poultry population and are, by far, the most important poultry species in all parts of the world [1,2]. Across centuries, the global rate of poultry consumption has been increasing, more so in developing countries [2,4]. This is attributed to genetic progress in poultry strains and a better understanding of the fundamentals of nutrition and disease control [2]. The key role of poultry in rural, peri-urban, and urban economies and way of life in Zimbabwe is well documented [3,5–11]. Poultry farming in Zimbabwe is more prevalent in urban and peri-urban areas where farmers carry out commercial poultry production to supplement their income [11,12]. Therefore, poultry production fulfills a wide range of economic and socio-cultural roles. However, the high incidence of diseases is one of the major constraints of poultry production systems in Zimbabwe [3,6–8,11]. Therefore, many farmers incorporate ethnoveterinary medicine (EVM) in the treatment and management of poultry diseases in Zimbabwe [11], indigenous knowledge, and traditional knowledge systems they have experimented with and used over the years. EVM is a holistic traditional or local system of livestock health management rooted in the people's culture, customs, and environmental conditions that keep their animals healthy and productive through traditional knowledge, skills, methods, medicinal plants, metaphysics, surgical procedures, technologies and teachings that are used in healing livestock [13,14]. There is a need to document local ecological knowledge (LEK) associated with EVM practices as it defines and maintains the cultural identity of the local community, establishing people–centered plant resource management with the potential of identifying novel pharmaceutical EVM health products [15]. Hedberg

Contact Alfred Maroyi ✉ amaroyi@ufh.ac.za ✉ Botany Department, University of Fort Hare, Private Bag X1314, Alice 5700, South Africa.

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and Staugärd [16] argued that the use of medicinal plants in any given society is based on the socio-culturally specific knowledge, accumulated in the tribal group through a continuous and century-long process of experimentation, and trial and error. Similarly, Chakale et al. [13] argued that EVM is often locally and culturally specific due to differences in disease epidemiology, culture, and biodiversity, and therefore, if not documented, this indigenous knowledge, skills, and experience accumulated over generations may become extinct because of migrations, urbanization, and technological development.

Therefore, analysis of archival data on EVMs used against poultry diseases in Zimbabwe is important as local communities in the country have developed a rich heritage of LEK over centuries which includes local beliefs and practices relating to poultry health. Research by Masimba et al. [8] showed that 95% of the households in Gutu District in southern Zimbabwe used EVMs in treating poultry diseases while 5% used a combination of EVMs and conventional drugs and none of the households relied on conventional medicines alone. Such LEK enables local communities to cope with social-ecological changes, thereby increasing the sustainability of their practices and fostering social-ecological resilience. Moreover, there is evidence that LEK is adaptive to the changes in the environment and is fluid with social-economic and cultural changes [17]. However, there is a paucity of documentation and scientific data on the merits of LEK associated with EVM practices in Zimbabwe. Joa et al. [18] argued that LEK and utilization of plant resources are linked through various socially shared aspects, such as values and norms, perceptions of natural resources, ecosystem goods and services, and livelihood strategies. It is within this context that this study was undertaken aimed at analyzing the archival data on EVMs used against poultry diseases in Zimbabwe. Therefore, the specific objectives of this study are to produce a comprehensive inventory of traditional practices, ailments, and diseases that afflict poultry, EVMs, plant parts used, preparation, and therapeutic value of the plant species associated with poultry health management in Zimbabwe.

Materials and Methods

A literature search on EVM, traditional practices, ailments and diseases that afflict poultry, plant parts used, preparation, and therapeutic value of the plant species associated with poultry health management in Zimbabwe was conducted from December 2022 to April 2023. The historical ethnobotanical research and how the LEK evolved over time were analyzed from the literature sources. Particular attention was also paid to changes in scientific plant names, diseases, and specific EVM and LEK. Therefore, 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, EVM, ethnobotany, LEK, ethnomedicine, ethnopharmacology, indigenous, medicine, phytomedicine, traditional medicine, and Zimbabwean traditional medicine were used to search for relevant articles. From each article, the following information was collected: scientific names of the plant species used, growth form, plant part(s) used, method of preparation, EVM uses, and LEK. The scientific names of the species used as EVM in Zimbabwe from original data sources were updated to recently accepted names according to the Plants of the World Online website [19] and the Flora of Zimbabwe databases (https://zimbabweflora.co.zw, accessed on 12 May 2023).

Results and discussion

Medicinal plant diversity and use patterns

This study recorded 69 taxa traditionally used to manage and treat poultry diseases in Zimbabwe (Table 1). Of these, 49 taxa are indigenous to Zimbabwe (71.01%), while 20 taxa are exotic (29.0%), either naturalized as weeds or cultivated in home gardens and agricultural fields as ornamentals, fodder, or food plants. Exotic species such as *Agave sisalana* Perrine, *Bidens pilosa* L., *Catharanthus roseus* (L.) G. Don; *Datura stramonium* L., *Dysphania ambrosioides* (L.) Mosyakin, *Euphorbia tirucalli* L., *Moringa oleifera* Lam., *R. communis* L., and *Senna didymobotrya* (Fresen.) H.S. Irwin & Barneby were introduced into the country as seed contaminants or as ornamental plants [20,21]. Species such as *Allium cepa* L., *Allium sativum* L., *Capsicum annuum* L., *Capsicum frutescens* L., *Citrus limon* (L.) Osbeck, *Morus alba* L., *Musa paradisiaca* L., *Nicotiana tabacum* L., *Passiflora edulis* Sims, *Solanum esculentum* L., and *Zea mays* L. were introduced into the country as food plants or agricultural crops [20,21]. The majority of the plant species (73.91%, n = 51) recorded in this study are from 13 families (Table 2). The other 18 families are represented by one species each. Plant families with the highest number of species are Fabaceae (11 species), Solanaceae (six species), Asphodelaceae, Asteraceae and Euphorbiaceae (five species each), Amaryllidaceae, Apocynaceae and Moraceae (three species each), Annonaceae, Olacaceae, Orchidaceae, and Passifloraceae and Rubiaceae (two species each) (Table 2). Among the recorded genera, those species belonging to *Aloe* L. with five species, *Euphorbia* L. with three species, *Allium* L., *Albizia* Durazz., *Annona* L., *Ficus* Tourn. ex L., *Senna* Mill., *Solanum* L., and *Ximenia* Plum. ex L. with two species each were the dominant taxa (Table 1).

Table 1. Plant species used as ethnoveterinary medicines against poultry diseases in Zimbabwe.

Species and family	Habit	Disease	Parts used and administration	Reference
A. gummifera (Harv.) Harms (Passifloraceae)	Climber	Blindness, coccidiosis, cough, flu, lethargy, and Newcastle	Whole plant parts added to drinking water	[11]
A. multiflorum Klotzsch (Apocynaceae)	Shrub	Diarrhea and eye problems	Tuberous root put in drinking water and sap applied on eyelids	[3,9,32]
**A. sisalana* Perrine (Asparagaceae)	Shrub	Coccidiosis, cough, flu, and Newcastle	Leaves added to drinking water	[3,11]
Albizia adianthifolia (Schumach.) W.Wight (Fabaceae)	Tree	Coccidiosis, diarrhea, and wounds	Bark and root powder added to drinking water	[3,6,8,9,33]
A. gummifera (J.F.Gmel.) C.A.Sm.	Tree	Coccidiosis, diarrhea, and respiratory problems	Bark powder added to drinking water	[3,6,8,9,34]
**A. cepa* L. (Amaryllidaceae)	Herb	Coccidiosis, diarrhea, lice, and respiratory problems	Bulb decoction sprinkled onto birds and fowl run	[3,8]
**A. sativum* L.	Herb	Coccidiosis, diarrhea, ectoparasites, and respiratory problems	Bulb decoction added to drinking water or sprinkled onto birds and fowl run	[3,7,8]
A. arborescens Mill. (Asphodelaceae)	Shrub	Coccidiosis, cough, diarrhea, ectoparasites, general weakness, lethargy, Newcastle, typhoid, weight loss, worms, and wounds	Crushed leaves added to drinking water or applied on wounds	[3,6,8,9,11,30–32]
A. chabaudii Schönland	Herb	Coccidiosis, cough, diarrhea, ectoparasites, fowl pox, general weakness, lethargy, Newcastle, respiratory problems, typhoid, weight loss, worms, and wounds	Crushed leaves added to drinking water or applied on wounds	[3,6,8–11,30–32]
A. excelsa A.Berger	Tree	Fowl pox and jaundice	Leaves put in drinking water	[35]
A. greatheadii Schönland	Herb	Coccidiosis, cough, diarrhea, ectoparasites, general weakness, lethargy, Newcastle, respiratory problems, typhoid, weight loss, worms, and wounds	Crushed leaves added to drinking water or applied on wounds	[3,6,8–11,30–32]
A. spicata L.f.	Shrub	Coccidiosis, cough, diarrhea, ectoparasites, general weakness, lethargy, Newcastle, typhoid, weight loss, worms, and wounds	Crushed leaves added to drinking water or applied on wounds	[3,6,8–11,30–32]
Aneilema hockii De Wild. (Commelinaceae)	Herb	Fleas	Branches placed in fowl run	[3,9,30]
Annona senegalensis Pers. (Annonaceae)	Shrub	Ectoparasites	Roots put in drinking water	[3]
A. stenophylla Engl. & Diels	Shrub	Ectoparasites	Leaves and roots put in drinking water	[3]
Aspilia pluriseta Schweinf. ex Engl. (Asteraceae)	Herb	Wounds	Ashes from the whole plant applied to wounds	[3,11,36]
Baccharoides adoensis (Sch.Bip. ex Walp.) H.Rob. (Asteraceae)	Shrub	Wounds	Crushed leaves applied on wounds	[3,11,36]
**B. pilosa* L. (Asteraceae)	Herb	Wounds	Crushed leaves applied on wounds	[3,11,36]
B. madagascariensis (Desv.) J.H.Kirkbr. and Wiersema (Fabaceae)	Tree	Coccidiosis, cough, flu, Newcastle, and weight loss	Pods put in drinking water	[3,11,34]
Bulbophyllum spp. (Orchidaceae)	Herb	Fractures	Bark tied around fracture	[3,30]
**C. annuum* L. (Solanaceae)	Shrub	Coccidiosis, cough, diarrhea, endoparasites, flu, Newcastle, and respiratory infections	Crushed fruits put in drinking water	[3,6,10,32]
**C. frutescens* L.	Shrub	Coccidiosis, cough, flu, Newcastle, and respiratory infections	Crushed fruits put in drinking water	[5–7,11]
Cassia abbreviata Oliv. (Fabaceae)	Shrub	Ectoparasites and lethargy	Bark put in drinking water	[3,11,34,35]

Continued

Species and family	Habit	Disease	Parts used and administration	Reference
**C. roseus* (L.) G.Don (Apocynaceae)	Shrub	Coccidiosis	Roots put in drinking water	[3,11]
Cissus quadrangularis L. (Vitaceae)	Climber	Coccidiosis, ectoparasites, and wounds	Stems decoction applied topically	[8,35]
**C. limon* (L.) Osbeck (Rutaceae)	Tree	Fowl pox	Fruit juice added to drinking water	[3,11]
Combretum hereroense Schinz (Combretaceae)	Tree	Coccidiosis	Not specified	[3,6]
Crinum macowanii Baker (Amaryllidaceae)	Herb	Helminthiasis	Tuber put in drinking water	[3,11]
Croton gratissimus Burch. (Euphorbiaceae)	Tree	Lice	Leaves and twigs used as bedding in fowl run	[32,35,37]
Cussonia arborea Hochst. ex A.Rich. (Araliaceae)	Tree	Coccidiosis	Bark powder put in drinking water	[3]
C. viminale (L.) L. (Apocynaceae)	Climber	Coccidiosis, diarrhea, endoparasites, gastro-intestinal problems, lethargy, and respiratory problems	Leaves and stems put in drinking water or used as feed	[3,6,8–11]
Dalbergia nitidula Welw. ex Baker (Fabaceae)	Tree	Wounds	Bark powder applied on wounds	[3,22,34]
**D. stramonium* L. (Solanaceae)	Herb	Wounds	Leaf extract applied on wounds	[3,11]
**Dysphania ambrosioides* (L.) Mosyakin (Amaranthaceae)	Herb	Ectoparasites	Whole plant material placed in fowl run	[3,11]
Eriospermum flagelliforme (Baker) J.C.Manning (Eriospermaceae)	Herb	Prophylaxis, improve egg production	Tubers put in drinking water	[3]
E. abyssinica Lam. (Fabaceae)	Tree	Blindness, coccidiosis, cough, diarrhea, flu, Newcastle, and wounds	Crushed bark put in drinking water	[3,8,11,34]
Euphorbia cooperi N.E.Br. ex A.Berger (Euphorbiaceae)	Shrub	Fleas	Smoke fowl run with branches	[32,37]
E. matabelensis Pax	Tree	Diarrhea, Newcastle, and respiratory problems	Crushed bark and stems put in drinking water	[3,8,37,38]
**E. tirucalli* L.	Tree	Lethargy	Whole plant parts put in drinking water	[11,37]
Ficus burkei (Miq.) Miq. (Moraceae)	Tree	Coccidiosis and diarrhea	Root powder put in drinking water	[3,6,9]
F. exasperata Vahl	Tree	Coccidiosis, diarrhea, and lice	Not specified	[8]
Gymnanthemum amygdalinum (Delile) Sch.Bip. (Asteraceae)	Tree	General weakness, respiratory problems, and worms	Leaves put in drinking water	[3,9,30,36]
G. coloratum (Willd.) H.Rob. and B.Kahn.	Tree	Fleas and lice	Whole plant parts placed in fowl run	[32,36]
Khaya anthotheca (Welw.) C.DC. (Meliaceae)	Tree	Fowl pox and lethargy	Pounded bark put in drinking water	[3,11]
Lannea schweinfurthii (Engl.) Engl. (Anacardiaceae)	Tree	Coccidiosis and prophylactic	Bark infusion administered orally	[3,6,39]
Lippia javanica (Burm.f.) Spreng. (Verbenaceae)	Shrub	Ectoparasites	Leaves, twigs, and whole plant placed in fowl run	[3,5,11,32,40]
**M. oleifera* Lam. (Moringaceae)	Tree	Coccidiosis and cough	Crushed leaves put in drinking water	[3,11]
**M. alba* L. (Moraceae)	Tree	Coccidiosis, cough, and flu	Leaves put in drinking water	[11]
**M. paradisiaca* L. (Musaceae)	Tree	Coccidiosis	Crushed roots put in drinking water	[3,9,11,30]
Myrothamnus flabellifolius Welw. (Myrothamnaceae)	Shrub	Coccidiosis and diarrhea	Root powder put in drinking water	[3,6,9]
**N. tabacum* L. (Solanaceae)	Shrub	Endoparasites, general weakness, and respiratory problems	Crushed leaves put in drinking water or applied topically	[3,9,10,32]
Parinari curatellifolia Planch. ex Benth. (Chrysobalanaceae)	Tree	Coccidiosis, diarrhea, and typhoid	Bark powder put in drinking water	[3,6,8,9]

Continued

Species and family	Habit	Disease	Parts used and administration	Reference
**P. edulis* Sims (Passifloraceae)	Climber	Coccidiosis, cough, and wounds	Pounded leaves put in drinking water	[3,11]
Psydrax livida (Hiern) Bridson (Rubiaceae)	Tree	Wounds	Crushed leaves applied topically	[3,8,9,30,32]
P. angolensis DC. (Fabaceae)	Tree	Sore eyes and wounds	Pounded bark was applied on wounds while sap applied to eyelids	[3,9,11,34,41]
**R. communis* L. (Euphorbiaceae)	Shrub	Ectoparasites	Seed ointment applied externally	[35,37]
**S. didymobotrya* (Fresen.) H. S. Irwin & Barneby (Fabaceae)	Shrub	Newcastle	Crushed leaves put in drinking water	[34]
S. singueana (Delile) Lock	Tree	Coccidiosis, cough, flu, and Newcastle	Pounded leaves put in drinking water	[3,11,34]
Sesamum angustifolium (Oliv.) Engl. (Pedaliaceae)	Herb	Newcastle	Crushed fruits put in drinking water	[3,9,30]
Solanum campylacanthum Hochst. and A.Rich. (Solanaceae)	Shrub	Ectoparasites, eye problems, and wounds	Crushed fruits and roots put in drinking water	[3,11,30,32]
**S. esculentum* L.	Herb	Eye problems, fowl pox, and wounds	Leaf sap applied topically	[3,6,8,9,11]
Strychnos cocculoides Baker (Loganiaceae)	Tree	Coccidiosis, cough, fowl pox, and Newcastle	Fruit sap added to drinking water	[3,11,32]
Tridactyle bicaudata (Lindl.) Schltr. (Orchidaceae)	Herb	Coccidiosis, flu, lethargy, and Newcastle	Pounded leaves put in drinking water	[3,11]
Vachellia karroo (Hayne) Banfi and Galasso (Fabaceae)	Tree	Fleas and mites	Roots put in a fowl run	[32,34]
Vangueria infausta Burch. (Rubiaceae)	Tree	Coccidiosis	Pounded leaves put in drinking water	[3,11]
Xeroderris stuhlmannii (Taub.) Mendonça and E.P.Sousa (Fabaceae)	Tree	Coccidiosis, diarrhea, and lethargy	Crushed bark put in drinking water	[3,9,11,30,32,34]
Ximenia americana L. (Olacaceae)	Tree	Fowl pox and wounds	Leaf sap applied topically	[11]
X. caffra Sond.	Tree	Fowl pox and wounds	Leaf sap applied topically	[3,11,41]
**Z. mays* L. (Poaceae)	Herb	Nervous symptoms	Seeds used as feed	[3]

* = Exotic; # = None found means that no record of the vernacular name was found in literature

Table 2. Plant families of utilized plant species with the largest number of species (with at least two species).

Family	Number of species	%
Fabaceae	11	15.94
Solanaceae	6	8.70
Asphodelaceae	5	7.25
Asteraceae	5	7.25
Euphorbiaceae	5	7.25
Amaryllidaceae	3	4.35
Apocynaceae	3	4.35
Moraceae	3	4.35
Annonaceae	2	2.90
Olacaceae	2	2.90
Orchidaceae	2	2.90
Passifloraceae	2	2.90
Rubiaceae	2	2.90

Ten species, that is, *Adenia gummifera* (Harv.) Harms, *Aloe arborescens* Mill., *Aloe chabaudii* Schönland, *Aloe greatheadii* Schönland, *Actaea spicata* L.f., *Bobgunnia madagascariensis* (Desv.) J.H.Kirkbr. and Wiersema, *C. annuum*, *C. frutescens*, *Cynanchum viminale* (L.) L., and *E. abyssinica* Lam. have the highest number of EVM uses against poultry diseases in Zimbabwe (Figure 1). The other medicinal applications of these species in other countries in tropical Africa are provided in monographs such as traditional medicine in Botswana [16], medicinal plants and magical plants of Southern Africa: An annotated checklist [22], Plant Resources of Tropical Africa 11: Medicinal Plants 1 [23,24], Medicinal Plants of East Africa [25], Medicinal Plants of East Africa: An Illustrated Guide [26], Sesotho: Plant and Animal Names and Plants Used by the Basotho [27], Medicinal Plants of South Africa [28] and Medicinal Plants of the World [29]. Such analogies and differences in the utilization of these species throughout their distributional ranges are important for the analysis of their ethnopharmacological properties.

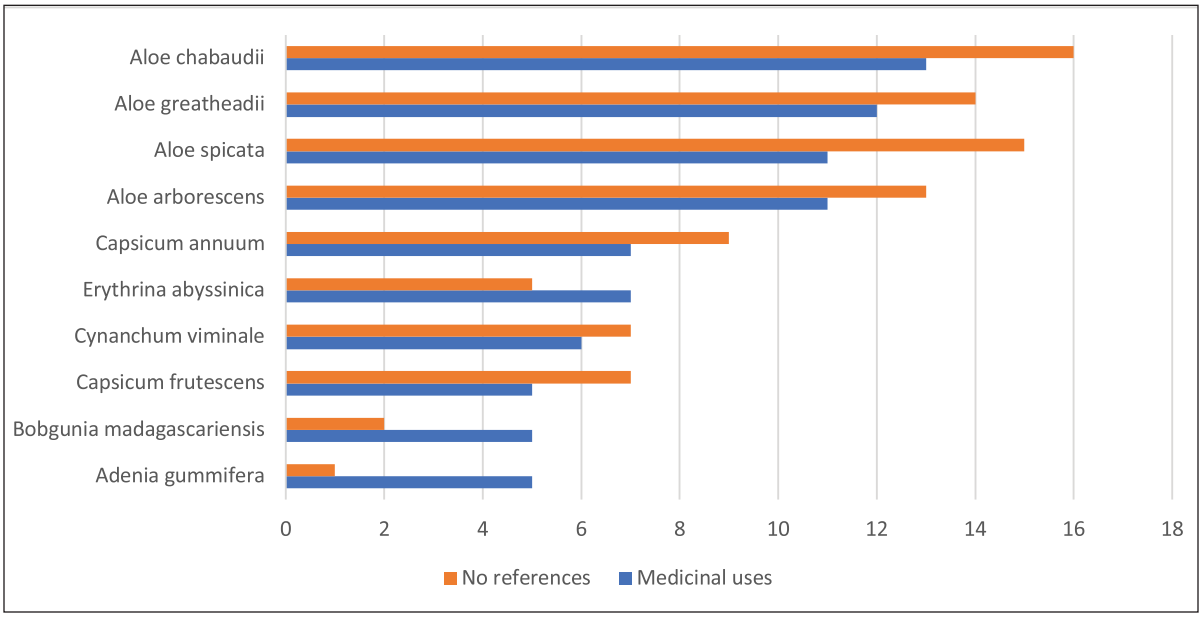

Figure 1. Numbers of ethnoveterinary medicinal uses and references of plant species used against poultry diseases in Zimbabwe.

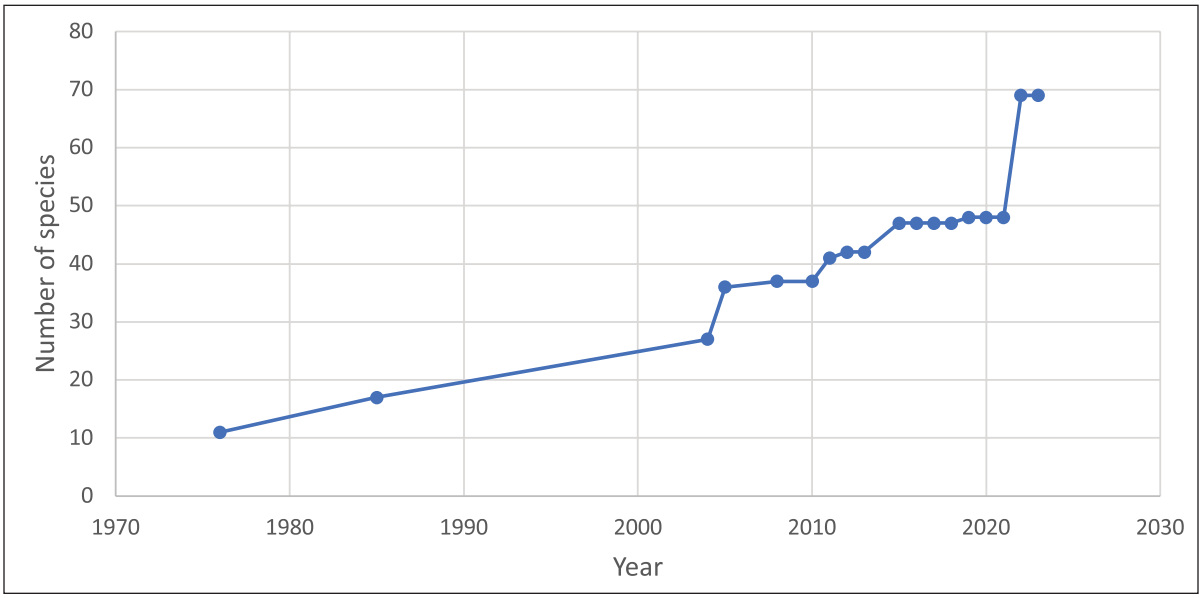

Figure 2. Temporal trends of plant species used as ethnoveterinary medicines against poultry diseases.

Eleven plant species used as EVMs against poultry diseases in Zimbabwe were recorded for the first time in 1976 and six additional species were recorded in 1985 (Figure 2). Twenty plant species used as EVMs against poultry diseases were reported between 2004 and 2008 while 10 species were reported between 2011 and 2019 (Figure 2). A comprehensive study focusing on plant species used as EVMs against poultry diseases conducted by Jambwa et al. [11] reported 36 taxa including 21 species that were reported for the first time (Figure 2). The period between 1976 to 2022 was characterized by increased study of the Zimbabwean plants used as sources of EVMs against poultry diseases (Figure 3). In recent years, there has been a growing interest in the use of EVMs in Zimbabwe, especially species that are used against poultry diseases as shown by increasing research focusing on this ethnobotanical

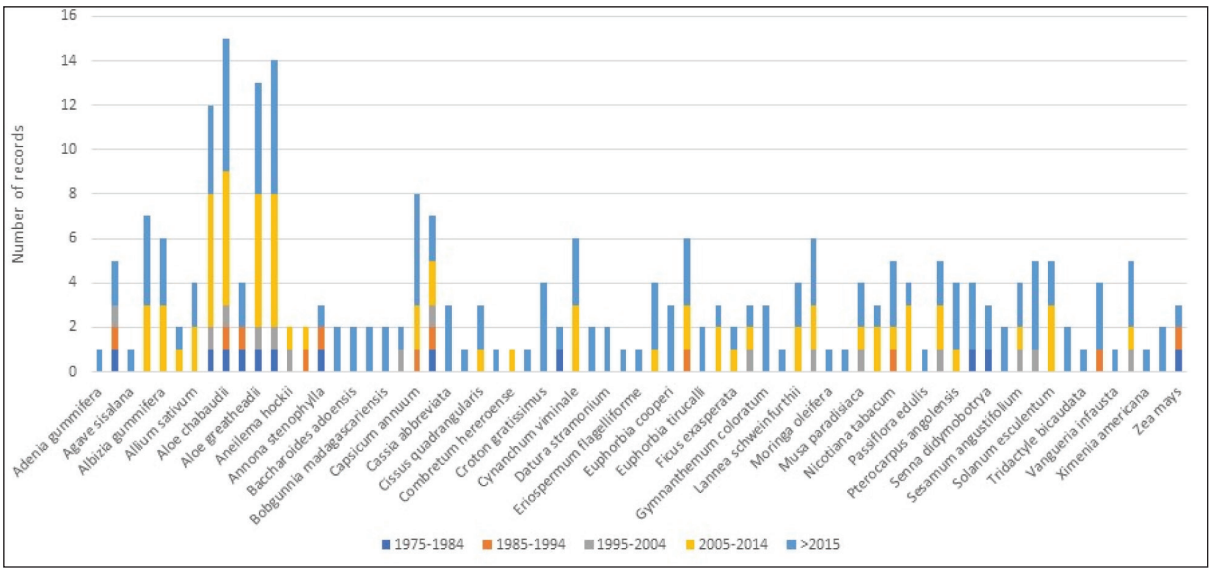

Figure 3. Spatial trends of plant species used as ethnoveterinary medicines against poultry diseases.

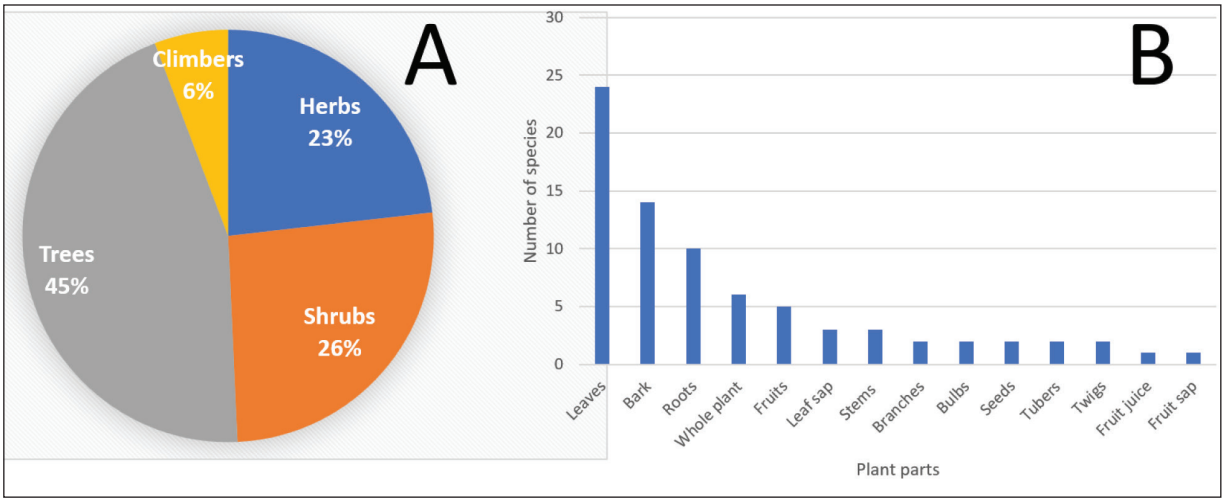

Figure 4. Characteristics of plants used as ethnoveterinary medicines against poultry diseases in Zimbabwe. (A) Growth habit as a pie diagram and (B) Plant parts used presented as a bar chart.

perspective [3,5–12,30,31]. Research by Mwale et al. [6] and Masimba et al. [8] showed that in Zimbabwe EVMs are gaining recognition at the expense of conventional medicines mainly because they are readily accessible, easy to prepare and administer, and also characterized by lower costs and apparent effectiveness as health products. Therefore, documentation of EVMs is important as this category of poultry health and pharmaceutical products offers more new options in the advancement of science and new insights into cheaper and readily available alternatives to animal health management. Moreover, EVMs are now regarded as an important paradigm shift associated with increasing demand for sustainable organic agricultural practices required for animal health management, particularly for commercial and resource-constrained rural farmers [3,11].

Trees (45.0%), followed by shrubs (26.0%), herbs (23.0%), and climbers (6.0%) are the primary sources of EMVs against poultry diseases in Zimbabwe (Figure 4A). The plant parts used for EMVs against poultry diseases are bark, bulbs, branches, fruits, fruit juice, fruit sap, leaf sap, leaves, roots, seeds, stems, tuber, twigs, and whole plant parts (Figure 4B). Five species (7.25%) that are used as primary sources of EMVs against poultry diseases are

Table 3. Major poultry disease categories.

Disease category	No. of species	%
Coccidiosis	33	47.83
Ectoparasites	20	29.00
Wounds	20	29.00
Diarrhea	18	26.09
Cough	15	21.74
Newcastle	14	20.29
Lethargy	11	15.94
Respiratory infections	11	15.94
Flu	10	14.49
Endoparasites	9	13.04
Fowl pox	8	11.59
Typhoid	7	10.14
General weakness	6	8.70
Weight loss	5	7.24

threatened with extinction in Zimbabwe [42]. These species include *A. spicata* which is categorized as Vulnerable (VUC1C2a), both *Adenium multiflorum* Klotzsch and *Tridactyle bicaudata* (Lindl.) Schltr. are categorized as Endangered, that is, ENA1ad and ENB1B2c, respectively [42]. Both *Ficus exasperata* Vahl and *Pterocarpus angolensis* DC. are categorized as Lower Risk (LR-nt), that is, the two species are close to qualifying for the Vulnerable category based on the IUCN 1994 Red Data List Categories. The major threats being faced by these species in Zimbabwe revolve around fragmented and reduction in population size as a result of a decline in area of occupancy, extent of occurrence and/or quality of habitat [42]. The other potential threats are associated with the over-collection of *P. angolensis* and *T. bicaudata* as the two species are sold in informal and formal herbal medicine markets as sources of traditional medicines in Gauteng and KwaZulu Natal provinces in South Africa [43].

Major use categories

About half of the recorded plant species (47.83%) are used to treat and manage coccidiosis while 20.29%–29.0% of the species are used against Newcastle, cough, diarrhea, wounds, and ectoparasites (Table 3). Minor poultry diseases or ailments treated by less than five medicinal plants included blindness, eye problems, fractures, gastro-intestinal problems, improved egg production, nervous system problems, and prophylaxis (Table 1). Research conducted in Botswana and Ethiopia revealed similar results with the majority of plant species used against Newcastle, cholera, typhoid, fowl pox, coccidiosis, ectoparasites, infectious coriza, and paralysis of chicken [44,45]. Similarly, a study by Simbizi et al. [46] found Newcastle, coccidiosis, fowl pox, infectious bronchitis, and influenza to be major poultry diseases in South Africa. Therefore, coccidiosis, Newcastle, cough, diarrhea, wounds, and ectoparasites are used categories that are relevant across all time periods in Zimbabwe as these diseases are associated with a high diversity of medicinal plant species that are continuously being used as EVMs.

Conclusion

This study confirmed the existence of vast LEK on EVMs used against poultry diseases in Zimbabwe. Results of this study showed that in Zimbabwe EVMs are gaining recognition and have the potential for advanced research aimed at the development of poultry health and pharmaceutical products that are environmentally friendly, safe, and affordable to commercial and resource-constrained rural farmers. Moreover, ethnoveterinary practices are more appealing to organic livestock farmers whose goal is to improve meat quality by producing meat without chemical residues [47,48]. The authors argued that the plant products used for animal health purposes are also less likely to become environmental pollutants, and therefore, EVM practices present a more environmentally friendly approach to animal health management [47,48]. Research by Chinsembu et al. [48] also showed that the utilization of plant extracts as EVMs is one of the alternative and most sustainable methods that is readily adaptable to rural communal livestock farming. However, there for advanced ethnopharmacological investigations of plant species used as EVMs, by isolating their active constituents, and assessing for in vitro and/or in vivo efficacy of the identified plant species against the targeted poultry diseases or ailments. Furthermore, toxicological evaluations should be conducted to ensure that the identified plant species are safe to use as EVMs.

However, there is a lack of alignment between EVM uses and existing phytochemical and biological screenings of the species, indicating the need for further ethnopharmacological evaluations [49]. The LEK on EVMs is under severe risk due to urbanization, deforestation, overgrazing, expanding agricultural fields, and over-exploitation of valuable plant species used as EVMs such as *A. spicata*, *A. multiflorum*, *T. bicaudata, F. exasperate,* and *P. angolensis* [42]. There is a need, therefore, to consider the cultivation of some plant species used as EVM in home gardens as a strategy to conserve the species as well as LEK associated with such species. Such a conservation strategy could play an important role in conserving the plant species and LEK associated with EVM but also revitalizing the relationship between humans and nature [50]. Although the existing research efforts are laudable, several areas of research on EVMs have been neglected. It is expected that

the identified research gaps will serve as a guide for future holistic research focusing on EVMs.

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List of abbreviations

SRGH: National Herbarium (SRGH) in Harare, Zimbabwe; South Africa

Author contributions

The author conceptualized the research and wrote the manuscript.

Conflict of interest

The author declares no conflict of interest

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