Ethnoveterinary survey of medicinal plants used for the management of respiratory and dermatological infections in livestock by Bapedi people of Sekhukhune, Limpopo Province, South Africa

Jacobus Kori Madisha, Lyndy Joy McGaw*

Phytomedicine Programme, Department of Paraclinical Sciences, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort 0110, South Africa

***Corresponding author**. Tel: +2712 529 8351; E-mail address: lyndy.mcgaw@up.ac.za

Abstract

Ethnoveterinary medicine is extensively used to manage livestock ailments in many rural areas in Africa, particularly in areas where access to orthodox veterinary healthcare is limited, but it remains poorly documented. Indigenous knowledge of plants used to treat livestock respiratory and dermatological infections of livestock was investigated in the Sekhukhune district of Limpopo Province, South Africa. Using semi-structured interviews and questionnaires, ethnoveterinary data were collected from 5 farmers and 30 traditional healers. During the survey, we identified 24 plant species from 15 families traditionally used to treat various veterinary diseases such as pneumonia, bronchitis and influenza, as well as chronic conditions including chronic obstructive pulmonary disease, wounds, boils, abscesses and skin irritation. Three ethnobotanical indices (informant consensus factor (ICF), use-value (UV), and relative frequency of citation (RFC) were used for the quantitative analysis of data. The plant preparations were given to the livestock orally for respiratory ailments and topically for dermatological disorders. The most commonly used plant parts were leaves (91%), bark (25%) and roots (29%), and in many cases more than one plant part was used to prepare the remedies. *Eucalyptus camaldulensis* was the most preferred species for respiratory infections with UV and RFC of 1. *Aloe marlothii, Malva parviflora, Citrus limon, Aloe zebrina* and *Aloe globuligemma* were also widely used species for both types of infections. Some medicines were used for more than one disease, most likely because they have a broad spectrum of action and are widely available. This provides motivation for exploring the use of such medications

in primary livestock healthcare systems in the country to reduce the cost of orthodox treatments.

Keywords: dermatological, ethnoveterinary medicine, indigenous knowledge, medicinal plants, respiratory, veterinary ailments

1. Introduction

In South African agriculture, livestock play a key role in the lives of farmers, providing farm power, rural transport, manure, fuel, milk and meat (Chakale et al., 2022). However, livestock productivity in developing countries is relatively poor owing to insufficient availability of feed, widespread disease and poor availability of veterinary health care services (Chakale et al., 2022). Lack of veterinary and transportation facilities, prohibitive cost of treatments and side effects of several allopathic drugs have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of livestock, particularly in terms of respiratory and dermatological ailments (McGaw et al., 2008). Ethnoveterinary medicine (EVM) plays an essential role in animal production and livelihood development in many poor rural areas and is frequently the only option for farmers to treat their sick animals (McGaw et al., 2020). The term "ethnoveterinary" has been defined as "local people's beliefs and indigenous knowledge and practice used for the treatment of animal diseases" (Mathias, 2004). Ethnoveterinary practices are generally passed on verbally from one generation to the next, particularly by livestock owners, motivating the need for documentation of this knowledge (McGaw et al., 2020).

Respiratory diseases have several causes, often following the presence of microorganisms in the environment which generally attack animals with nutritional deficiencies, or those that are weak or immunologically compromised (Semenya et al., 2013, Mahwasane et al., 2013). To treat respiratory disease, people from many regions around the world use traditional medicine which enables them to meet some of their needs in terms of animal health care.

The skin is the largest organ of the body providing protection from the external surroundings (Sharma and Joshi, 2004). Skin ailments in animals include bacterial and fungal infections, ulcers, bruises and sprains, inflammation, burns, sores, ringworm, eczema and skin eruptions (Sharma and Joshi, 2004). Apart from these afflictions, there are various allergic and other

conditions which attack the skin. These include eczema of various kinds and mite infestations such as scabies, which not only compromise health of animals but are also of zoonotic importance (Mabogo, 1990).

In the rural Sekhukhune area of the Limpopo Province, South Africa, veterinary professionals as well as state sponsored animal health care are available but not easily accessible, as is the case for many similar rural areas (McGaw et al., 2020). Ethnoveterinary medicine (EVM) is a continuing practice in this area due to pressure caused by lack of other options relating to animal health care. There is limited research on the medicinal plants used to treat respiratory and dermatological infections in livestock in Sekhukhune, although several surveys have taken place in the Vhembe district of Limpopo (McGaw et al., 2020; Chakale et al., 2022). Previous ethnobotanical surveys conducted in the Sekhukhune area recommended further research with larger sample sizes (Semenya and Potgieter, 2014; Mogale et al., 2019).

Recording of traditional knowledge of ethnoveterinary medicinal plants and their use by indigenous communities is not only useful for conservation of cultural traditions and biodiversity but also for community healthcare and drug development in the present and future (Hassan et al., 2014; Yirga, 2010). Documentation of indigenous knowledge and evaluation of the use of plants for a variety of purposes assumes significance, not just to retain it, but also to make it available for future use despite rapid socio-economic and cultural changes that are taking place (Mabombo et al., 2003). The present study was initiated with the aim of identifying knowledgeable persons, i.e., elderly learned farmers and experienced traditional healers, and to document their knowledge on the utilization of ethnoveterinary medicinal plants in Bapedi culture of the Sekhukhune District in the Limpopo Province of South Africa. The focus was placed on recording remedies used for treating respiratory and dermatological ailments in animals as these are important livestock afflictions commonly treated with ethnoveterinary medicine.

2. Materials and methods

2.1 Description of study area and population

The study was conducted in five local municipalities of the Sekhukhune district municipality in Limpopo Province, South Africa (Figure 1). Geographically, the Sekhukhune district lies between 24°50′S and 29°50′E. It is located in the south east part of Limpopo Province, and covers an area of 13 528 km^2, making it the largest district in the province. The surveyed

district is inhabited by Black African (98.6%), Coloured (0.1%), Indian/Asian (0.2%) and White (1.0%) people. Black people are mostly Sepedi-speaking Bapedi people (82.2%) with other languages including Ndebele (4.4%), Zulu (3.3%), Tsonga (2.0%) and others. The Bapedi ethnic group constitutes the largest cultural group in the Limpopo Province (South Africa), comprising 57% of the total provincial population (Limpopo Provincial Government, 2012). The study was restricted to the area around Sekhukhune to ensure that the interviewed participants were Sepedi-speaking.

A large portion of the district is identified as rural area (Limpopo Provincial Government, 2012). The high floristic diversity of the region coupled with high unemployment rates has resulted in a heavy reliance on natural resources such as plants to meet livelihood needs (Semenya et al., 2013). The vegetation of the district has been classified as semi-arid savanna (Acocks, 1988; Mucina and Rutherford, 2006). It is characterized by a mixture of trees, shrubs and grasses. This type of vegetation has provided a diverse flora with numerous medicinal plants that the local people have used to treat many illnesses. The ethnic groups use herbal medication either alone or in combination with orthodox medicines for the treatment of several infections (Sharma and Joshi, 2004; Sharma, 2019).

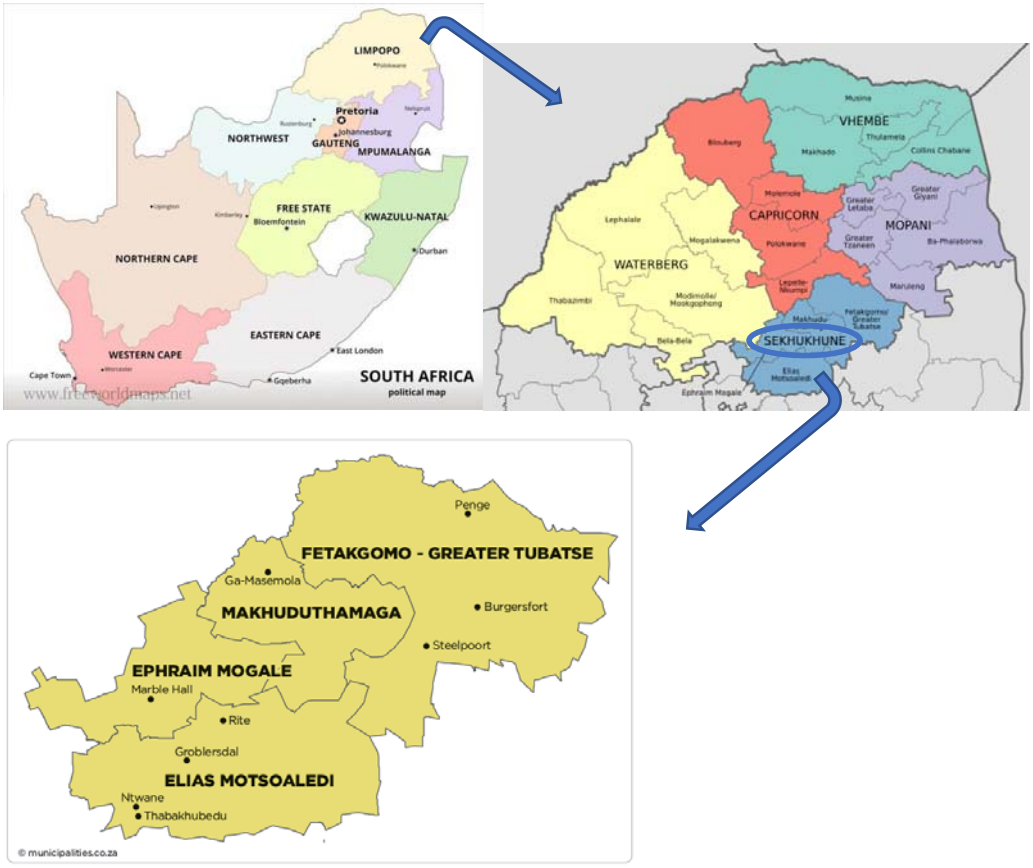

Figure 1. South Africa (top left, www.freeworldmaps.net), Limpopo province (top right, https://commons.wikimedia.org/) and Sekhukhune District Municipality (bottom, www.municipalities.co.za)

2.2 Ethnoveterinary survey

An ethnoveterinary field survey was conducted from 1 April 2021 to 30 September 2021 in the fourteen villages of the Sekhukhune district municipality, South Africa (Figure 1). The snowball method was used to recruit and screen appropriate participants (Patton, 1990; Chakale et al., 2022). Thirty-five participants (71% male and 29% female) were purposively selected to participate in the study. The age of participants ranged from 36 to 100 and the participants consisted of indigenous knowledge holders (traditional healers), farmers, and livestock herders. The experience and knowledge of participants on the theme of the study, and their interest in participating, were used as the inclusion criteria (Patton, 1990; Chakale et al., 2022). Face-to-face interviews using a semi-structured interview guide prepared in English and translated to Sepedi (local language) were used to collect data, after presenting the rationale of the study to the participants, and data were consequently translated to English. The data collection questionnaire was divided into three sections

to obtain required information, and two phases were followed to collect data. The first phase was interviews, and the second involved a field walk and the collection of plants. Following the recommendations by Chakale et al. (2022), responses of participants that contradicted each other were not considered for analysis. The data generated from individual interviews were cross-checked with other participants in the same villages to obtain reliable information in the study area.

The Faculty of Veterinary Sciences Research Ethics Committee, as well as the Faculty of Humanities Research Ethics Committee (University of Pretoria, South Africa) approved the study (Ethics approval number: REC029-19). Traditional authorities in the Sekhukhune district municipality granted permission and access to conduct the study in the communities and collect sample specimens for identification in the fourteen villages. Prospective participants were approached to seek their consent to participate in the study following detailed and clear explanation on the purpose of the research. Field observations were conducted in study areas to collect the plants mentioned during interviews. Plants were identified by participants and collected by researchers during field walks.

2.3. Plant identification and processing of voucher specimens

Plant voucher specimens were collected, either in the field together with participants (ideally), together with knowledgeable guides, or from dried specimens that participants had stored for later use. These were collected, pressed and transported using a mobile plant press, and were identified and deposited by Ms Magda Nel in the HGWJ Schweickerdt Herbarium, University of Pretoria.

2.4 Data analysis

The indigenous knowledge data were collected and analysed statistically using different quantitative indices to analyse the importance of medicinal plants and participants' knowledge about categories of respiratory and dermatological infections. These included Use Value (UV), Informant (Participant) Consensus Factor (ICF) and Relative Frequency of Citation (RFC).

2.4.1 Use value (UV)

Use value is calculated to assess all probable usage of plant species. UV of plants gives a quantitative analysis for plant citation. UV describes the relative importance of plant flora recognized locally, and was analysed according to Umair et al. (2017).

UV =u/N

Where u is the total participants stating various uses of a plant and N is whole number of participants. UV is usually (1) if the number of usages is greater, and (0) if the usage report for plant species is less. UV does not deliver any data on the single or multiple uses of plant species.

2.4.2 Relative frequency of citation (RFC)

FC is used for evaluating the most preferred plants or more highly used plant species.

$RFC = FC/N \quad (0 < RFC < 1)$

Where RFC is denoted by relative frequency of citation, and FC is the number of participants who mentioned the plant species, and N is the total number of participants (Leonti, 2022).

2.4.3 Participant/Informant Consensus Factor (ICF)

The Participant (Informant) Consensus Factor (ICF) value was calculated using the formula:

$ICF=(Nur-Nt)/(Nur-1)$

Where Nur is the number of use report of participants for each respiratory infection (SI), and Nt is the number of taxa used for a specific respiratory infection (RI) (Trotter and Logan, 1986).

3. Results and discussion

3.1 Socio-demographic characteristics of participants

It is important to discuss ethnopharmacological use of plants in terms of the sociocultural background of the people living in the area and using the plants (Heinrich et al., 2018) so as to contextualise the relationship between the people and the plants. In this study, 35 participants consisting of 30 herbalists, four retirees and one housewife were selected from 14 villages of the Sekhukhune district, Limpopo Province, South Africa. The majority (71%) of traditional healers were males (Table 1). More than half of the participants were between 58 and 79 years old, which was concerning as few young knowledge-holders were available for interview. Education levels were generally low with 29% of the participants having no formal education.

Males cited more plant species as being used than females. This might be a residual effect of the higher number of male (25) participants interviewed and a high number of females (15) not traceable during interview times. Participants also mentioned that, in their Bapedi culture,

males were often responsible for the well-being of the livestock while females have a greater burden of housekeeping work, which results in lower levels of EVM knowledge. However, it should be noted that one widowed participant had vital knowledge by citing nine plant species, nearly two plants for each of the four ailments she cited.

Traditional remedies were little known to the younger generation, but the elders had greater knowledge on how to cure livestock problems. In surveys done with Tsonga and Xhosa speaking people, males above the age of 40 were the most knowledgeable age group in terms of the use of plants as ethnoveterinary medicine (Luseba and Van der Merwe, 2006, Maphosa and Masika, 2010). The younger generation (21 to 36) years generally had no knowledge about EVM which is most likely due to lack of interest and intentions to migrate to urban areas (Luseba and Van der Merwe, 2006).

Table 1. Demographic data of participants

Parameters		Participants(N)	% of total
Gender	Female	10	29
	Male	25	71
Age	36–46	3	8
	47–57	6	17
	58–68	7	20
	69–79	11	32
	80-90	6	17
	90-100	2	6
Education	No formal Education	10	29
	Primary	13	37
	Secondary	7	20
	Tertiary	2	6
	Others	3	8
Collaboration with modern medicine	Collaboration	15	43
	No collaboration	20	57
Occupation	Herbalists	30	86
	Retirees	4	11
	Housewives	1	3
Residence	Urban	3	9
	Rural	32	91
Marital status	Single	13	37
	Married	15	44
	Widowed	6	17
	Divorced	1	2

3.2. Plants identified for treating livestock respiratory and dermatological complaints

One of the most important sources of income for rural populations in the Sekhukhune district is livestock raising. Africa is rich in natural sources, including medicinal plants, and most of the inhabitants in remote areas have limited economical sources so they rely on locally available plants for their animal health care needs. The current ethnoveterinary survey recorded nine types of respiratory illness/associated symptoms (asthma, tuberculosis, fever, cough, influenza, pneumonia, bronchitis, tonsillitis and anthrax) and ten dermatological infections (including scabies, bacterial and fungal infections, inflammation and sores) in livestock. The participants used 24 different medicinal plant species belonging to 15 families to treat both respiratory and dermatological infections. All 24 plant species were used to treat more than one ailment. Most of the species were used to treat coughing and wounds. About 20% of the 24 plant species were known by at least ten participants.

The local population often did not consult traditional healers or the local veterinary surgeon for treating animals. Five traditional healers were prepared to identify no more than five medicinal plants and their uses. These healers informed the researcher that they were unwilling to divulge information about certain medicinal plants, the properties of which they considered to be very powerful. They clearly wished to keep this knowledge to themselves as something belonging to their own private domain. The ability to use plants of such purported potency apparently serves as these healers' speciality trade marks in their communities, conferring upon them the status of being the best among their peers. A few participants reported that some of the plant remedies, if overdosed could induce death, dizziness, diarrhoea, skin irritations and vomiting when overdosed. *Aloe marlothii* was reported to induce diarrhoea by the participants.

It has been noted that lack of uniformity in ethnobotanical surveys in similar areas emphasize the necessity for enhanced geographical coverage of surveyed areas to assist in unravelling regional differences in plants used (Mogale et al., 2019). Additionally, it has been recommended that ideal field studies should last more than a year to allow for a more comprehensive listing of plant remedies used to cure seasonal ailments among other aspects (Weckerle et al., 2018). However, this is often not possible owing to time and financial constraints.

3.3. Habitat and families of medicinal plants

In the present study, trees (54.16%) were the most commonly used life form by the participants for ethnoveterinary medicine against respiratory and dermatological infections. This was followed by shrubs (41.66%) and herbs (8.33%). Factors such as availability throughout the season of the year, shape, smell, colour and size of plants may be attributed to the choice of plants used for treatment. Ethnoveterinary use of plants often differs across regions and countries. In the study area, the dominance of trees in the preparation of remedies is likely to be owing to profuse growth and easy availability in the wild compared to other life forms.

Families representing the highest number of plant species for the indigenous ethnoveterinary medicines were the Asphodelaceae with 4 species, followed by the Fabaceae and Euphorbiaceae (3 species each) and Anacardiaceae with 2 species, while the remaining families were represented by 1 species each (Table 2). The higher distribution and richness of medicinal plant species from the aforementioned families is probably owing to their dominance in the area. The Asphodelaceae, Euphorbiaceae and Fabaceae were previously reported to be the most widely used families in ethnoveterinary medicine (McGaw et al., 2020). Similar studies have been reported where participants mostly used members of the Euphorbiaceae for the preparation of EVM for the management of diverse livestock infections (Njoroge, and Bussmann, 2006; Khunoana et al., 2019). Furthermore, the extensive use of plants from these prevailing families might be linked to strong traditional beliefs, accessibility, ease of harvesting and storage. However, the trend for plant families utilised to cure livestock infections in the selected communities differs from those used in other locations in South Africa (Masika et al., 2000; Luseba and Van der Merwe, 2006; Maphosa and Masika, 2010).

Table 2. Medicinal plants used to treat livestock respiratory and wound infections in animals, with details of the frequency of citation (FC), relative frequency of citation (RFC), use value (UV) and participant or informant consensus factor (ICF)

Family	Scientific name, vernacular name (if available), voucher number	Life form	Parts used	Ailment treated	Number of uses (FC)	Use value (UV)	ICF	RFC
Aizoaceae	*Carpobrotus edulis* (L.) N.E.Br. subsp. *edulis.* Leplomo la go naba. PRU0130660	Herb	Leaves	TB/BS	31	0.89	0.23	0.89
Anacardiaceae	*Sclerocarya birrea* (A.Rich.) Hochst. Morula. PRU0130636	Tree	Bark/leaves	Cough/SE	25	0.70	0.04	0.70
Anacardiaceae	*Schinus molle* L. Thoba. PRU0130651	Tree	Bark/leaves	Fever/BS	26	0.74	0.08	0.74
Asphodelaceae	*Aloe cryptopoda* Baker PRU0130648	Shrub	Leaves	Influenza/BS	12	0.33		0.33
Asphodelaceae	*Aloe globuligemma* Pole-Evans Kgogopa. PRU0130662	Shrub	Leaves	Influenza, TB, BS	33	0.94	0.28	0.94
Asphodelaceae	*Aloe marlothii* A.Berger subsp. *marlothii.* Kgokgophaya goema. PRU0130665	Shrub	Leaves	Coughs, TB, BS	34	0.98	0.30	0.98
Asphodelaceae	*Aloe zebrina* Baker PRU0130631	Shrub	Leaves/roots	BS/ Cough	34	0.98	0.30	0.98

Asteraceae	*Conyza bonariensis* (L.) Cronquist PRU0130655	Herb	Leaves	SE /Fever	24	0.68	0	0.68
Asteraceae	*Tagetes minuta* L. Khakibos. PRU0130654	Herb	Leaves	Cough/BS	31	0.89	0.23	0.89
Cannabaceae	*Cannabis sativa* L. Motekwane. PRU0130650	Herb	Leaves	SE,BS,F,R,E,B, TB	34	0.98	0.30	0.98
Euphorbiaceae	*Euphorbia cooperi* N.E.Br. ex A. Berger PRU0130658	Tree	Leaves/latex	Coughs, Influenza, Asthma/SE	7	0.21	0	0.21
Euphorbiaceae	*Euphorbia schinzii* Pax PRU0130647	Shrub	Leaves/latex	Fever/BS	15	0.42	0	0.42
Euphorbiaceae	*Euphorbia tirucalli* L. Mtlhoko PRU0130664	Tree	Bark/leaves /latex	SE,BS,F,E,R,B, TB	28	0.8	0.14	0.80
Fabaceae	*Elephantorrhiza elephantina* (Burch.) Skeels Moshitsane. PRU0130632	Tree	Root/leaves	Cough/ Influenza,BS	32	0.91	0.25	0.91
Fabaceae	*Peltophorum africanum* Sond. Mosehla. PRU0130633	Tree	Roots/bark	Fever/Cough/BS	25	0.71	0.041	0.71
Fabaceae	*Senna didymobotrya* (Fresen.) H.S.Irwin & Barneby Moroteladitshoshi wa go ema. PRU0130649	Shrub	Leaves/flowers	BS,E,.Fever	32	0.91	0.25	0.91

Malvaceae	*Malva parviflora* L. Jikalelanga. PRU0130661	Herb	Roots/leaves	Cough,BS	33	0.94	0.28	0.94
Musaceae	*Musa x paradisiaca* L. Mobanana. PRU0130640	Tree	Leaves/fruit	SE,BS,U,E,R,B, Fever	29	0.83	0.18	0.83
Myrtaceae	*Eucalyptus camaldulensis* Dehnh Mopilikom PRU0130638	Tree	Bark/leaves	SE,BS,U,R,B,TB	35	1	0.32	1
Olacaceae	*Ximenia caffra* Sond. Morokologa PRU0130637	Tree	Roots/leaves	Fever/SE	30	0.86	0.21	0.86
Papaveraceae	*Argemone ochroleuca* Sweet PRU0130639	Herb	Bark/leaves/ fruit	Fever/Cough SI,BS,U,E,R,SC	25	0.72	0.041	0.72
Pedaliaceae	*Dicerocaryum eriocarpum* (Decne.) J.Abels. Lepate. PRU0130643	Herb	Leaves/fruit	Fever,SE,SE,SC	31	0.89	0.22	0.89
Rutaceae	*Citrus limon* (L.) Osbeck Suru. PRU0130635	Tree	Fruits/peel	Cough/BS	33	0.94	0.28	0.94
Solanaceae	*Datura stramonium* L. PRU0130642	Herb	Roots/leaves	Influenza, U, BS, I, S	33	0.94	0.28	0.94

Dermatological abbreviations: S=scabies bacterial and fungal infections, U=ulcers, BS=bruises and sprains, I=inflammation, B=burns, SC=sore census, f= feet, R=ringworm, E=eczema, SE=skin eruptions

Respiratory: Asthma, TB=tuberculosis, fever, cough, influenza, pneumonia, bronchitis, tonsillitis and anthrax

3.4 Plant parts used for ethnoveterinary medicine

The most frequently used plant parts were leaves (22, or 91%), followed by roots (7, or 29%), bark (6, or 25%), fruits (3, or 12.5%), and flowers (1, or 4.2%). Throughout the world, ethnic communities commonly use leaves for the preparation of herbal ethnoveterinary medicine. The most sustainable use of plants to ensure viability is to use leaves to avoid the threat of extinction as the use of root and tuber parts can threaten medicinal plant populations or species viability (Tabuti et al., 2010). The usage of certain plant parts implies that these portions have the most therapeutic potential, although biochemical testing is required as well as pharmaceutical screening for confirmation (Hassan et al., 2014).

3.5 Collection sites

Plants were mostly harvested from roadsides (41%), followed by abandoned land (23%), disturbed habitats (15%), home gardens (10%), mountains (8%) and rivers (3%) as sources of medicinal plants (Figure 2). The high proportion of roadside collection indicates easy access for harvesting. This is because most of the native species used to treat infections are collected from the communal lands and are scarce and declining (Semenya et al., 2013). Bapedi indigenous peoples prefer collecting from communal lands because of their generally easy access, and there is little or no control.

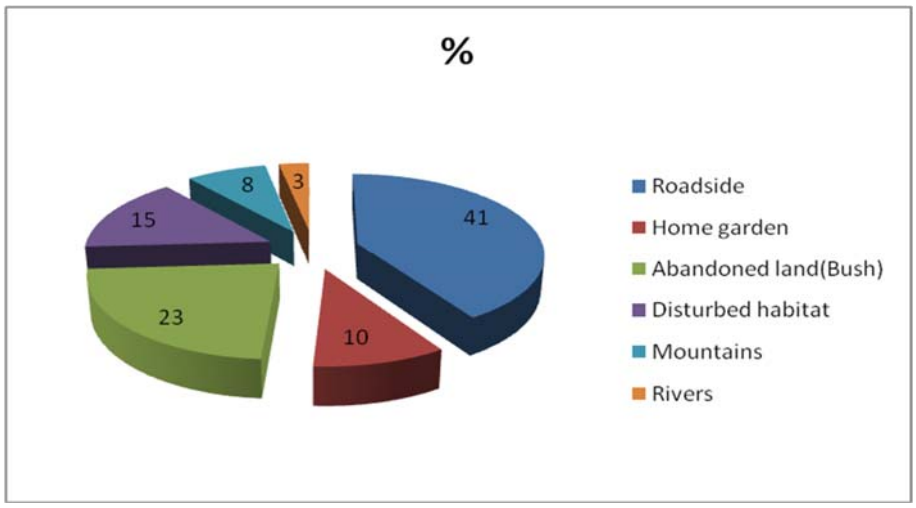

Figure 2. Collection sites of plants with ethnoveterinary use in Sekhukhuneland, Limpopo, South Africa

Home garden plants were not only used for medicinal purposes and for food, but also for aesthetic value such as for ornamentals and shade. For instance, *Ximenia caffra*, *Musa x paradisiaca*,

Sclerocarya birrea and *Citrus limon* were also cultivated for their nutritious fruits. Species such as *Carpobrotus edulis* and *Schinus molle* were used for ornamental value and for shade, respectively. Therefore, roadsides and home gardens serve as alternate medicinal plant sources. *Malva parviflora* and *Cannabis sativa* were found in disturbed habitats. Semenya et al. (2012) noted that 68.5% of medicinal plants in the province of Limpopo were found near homes (roadside) as weeds or as cultivated plants in home gardens (ornamental or food plants). Moeng (2010) recommended that communities develop management plans for collection sites, while encouraging a value system that promotes respect for the environment and sustainable utilisation of natural resources, as this will result in *in situ* conservation of plant diversity.

3.6 Ethnobotanical indices

It has been noted that quantitative ethnobotanical indices often fail to demonstrate the true importance of plant use because the reasons for which plants are valued cannot be adequately described by formulations of such indices (Leonti, 2022). Therefore, the indices reported in this study should merely serve as an indication of the importance of the use of different species, while more significance should be placed on the primary data.

3.6.1 Use Value (UV)

The local population's choice to use certain medicinal species more than others to treat different respiratory and dermatological infections is confirmed by the use-value index (UV). The high score of this index reflects the importance of the plant in the study area population. The use value (UV) results are presented in Table 2. *Eucalyptus camaldulensis* was the most highly used plant species by the local population to treat respiratory and dermatological infections with a high use value (UV = 1), followed by *Cannabis sativa, Aloe marlothii*, *Aloe zebrina* (UV = 0.98), *Malva parviflora, Citrus limon, Datura stramonium* and *Aloe globuligemma* (UV = 0.94).

3.6.2 Participant/informant consensus factors (ICF)

The number of use-reports revealed that the most treated ailments were wounds (19 species) and coughing (10 species), followed by fever with 9 species and TB with 6 species. The highest ICF values were cited for wounds and coughing, with *Eucalyptus camaldulensis* (1), *Cannabis sativa* (0.98), *Aloe marlothii* (0.98) *Aloe zebrina* (0.98), *Malva parviflora* (0.94), *Citrus limon* (0.94), *Datura stramonium* (0.94), *Aloe globuligemma* (0.94) and

Elephantorrhiza elephantina (0.91) being the most frequently used species. *Eucalyptus camaldulensis* was the most preferred species for respiratory infections with the highest use-report number of 35 (number of uses, Table 2) and *Aloe marlothii, Malva parviflora, Citrus limon, Aloe zebrina* and *Aloe globuligemma* were the most preferred and most readily available species for both infections where leaves were administered to animals by forced feeding. Plant species with high ICF value provide motivation for further pharmacological investigations (Chakale et al., 2022).

3.6.3 Relative frequency of citation (RFC)

The RFC represents the prominent species used for respiratory and dermatological related infections based on the ratio between the number of participants (FC) reporting use of a plant and the overall number of participants in the research survey. RFC ranged from 0 to 1 and we classified all species into 3 groups: RFC 0 to 0.35 (3 species); RFC 0.357 to 0.714 (5 species); RFC 0.714 to 1 (16 species) (Table 2). According to these ethnoveterinary records, the majority of plants in the third group were reported with high medicinal potential. The highest RFC values were recorded for *Eucalyptus camaldulensis, Cannabis sativa, Aloe marlothii*, *Aloe zebrina*, *Datura stramonium*, *Aloe globuligemma, Malva parviflora, Citrus limon* and *Elephantorrhiza elephantina* which were the most frequently used species used for wounds, coughing, fever and TB. *Elephantorrhiza burkei* and *Elephantorrhiza elephantina* have been previously reported to be used in ethnoveterinary medicine in the Limpopo province, albeit in a different district (Mongalo and Makhafola, 2018). Other species with high RFC species were *Carpobrotus edulis, Tagetes minuta, Dicerocaryum eriocarpum* and *Musa x paradisiaca.*

3.7 Individual versus combination use

Preparations of the remedies constituted 8 individual extracts from 8 species, and 27 combinations were recorded from 12 species across different municipalities (Table 3).

Table 3. Most common combinations of plant species used in ethnoveterinary medicine

	Elias Motswaledi	**Ephraim Mogale**	**Tubatse**	**Fetakgomo**	**Makhuduthamaga**
TB	*Aloe marlothii +Eucalyptus camaldulensis / Cannabis sativa*	*Aloe marlothii +Eucalyptus camaldulensis / Cannabis sativa*	*Aloe marlothii +Eucalyptus camaldulensis / Cannabis sativa*	*Aloe marlothii +Cannabis sativa*	*Aloe marlothii+ Cannabis sativa*
Fever	*Datura stramonium+ Aloe marlothii/ Peltophorum africanum*	*Aloe cryptopoda Aloe marlothii/ Peltophorum africanum*	*Aloe globuligemma +Citrus limon/ Peltophorum africanu*	*Malva parviflora +Datura stramonium/ Peltophorum africar*	*Ximenia caffra + Euphorbia schinzii/ Peltophorum africanum*
Wounds	*Dicerocaryum eriocarpu +Euphorbia tirucalli*	*Euphorbia tirucalli + Ximenia caffra*	*Dicerocaryum eriocarpum +Euphorbia tirucalli*	*Dicerocaryum eriocarpum +Euphorbia tirucalli*	*Dicerocaryum eriocarpum +Euphorbia tirucalli*
Flu	*Sclerocarya birrea + Peltophorum africanum*	*Sclerocarya birrea+ Argem ochroleuca*	*Sclerocarya birrea+ Musa x paradisiaca*	*Sclerocarya birrea+ Euphorbia cooperi*	*Dicerocaryum eriocarpum+ Euphorbia tirucalli*
Cough	*Dicerocaryum eriocarpu Ximenia caffra + Datura stramonium*	*Dicerocaryum eriocarpum/ Ximenia caffra+ Aloe cryptopoda*	*Dicerocaryum eriocarpum/ Ximenia caffra + Euphorbia tirucalli*	*Dicerocaryum eriocarpum/ Ximenia caffra + Aloe cryptopoda*	*Dicerocaryum eriocarpum/ Ximenia caffra + Datura stramonium*

Species that were used individually include *Datura stramonium, Aloe globuligemma*, *Elephantorrhiza elephantina*, *Carpobrotus edulis, Tagetes minuta, Dicerocaryum eriocarpum* and *Musa x paradisiaca.* Other species including *Eucalyptus camaldulensis, Cannabis sativa, Aloe marlothii, Malva parviflora* and *Citrus limon* were used individually and in combinations for infections. Only prominent combinations and common or well-known combinations were recorded, due to unwillingness by the participants to share knowledge. Traditional health practitioners prefer combinations generally as they say it prevents further infection and reduces toxicity in those plant that have toxicity. Traditional health practitioners around the world have relied on combinational therapy to enhance efficacy of treatments (van Vuuren and Viljoen, 2011).

3.8 Mode of preparation and dosage

In traditional herbal medicine systems, herbal remedies are prepared in several ways which usually vary based upon the plant utilized and, sometimes, what condition is being treated. In

this study, preparation methods used involved infusions (hot teas, 29%), decoctions (boiled teas, 32%), tinctures (alcohol/water extracts, 15%), and macerations (cold-soaking, 24%). All oral preparations were administered with a tin cup (300 ml) for goats/sheep and two litres for large animals like cows or donkeys. The preferred vehicle for administration of pounded/powdered oral medicine was in warm water. Alternatively, it was cooked and allowed to cool down and mixed with food or administered as feed. Application of medication was done only twice a day as animals in rural settings move from where they are kept at night to roam freely before returning late in the afternoon. The participants reported that powder and juice was administered orally as a method of choice that would not destroy active compounds, ultimately resulting in high efficacy. Different routes were used in administration of herbal preparations. For dermatological ailments, topical applications contributed 61% of the total species, followed by herbal sprays (28%) and paste (11%). For external application, vaseline, paraffin and oil were used to reduce friction during application of the remedy. In respiratory infections the most common administration was the oral route 92%, followed by smoke inhalation 7% and the least common, as a snuff with 1%. The medicinal remedies were taken until the animals' health showed improvement of symptoms, perceived as independent indicators of successful treatment of respiratory and dermatological ailments.

3.9 Cultivation of plant species

From visits to the homes of the participants, species such as *Cannabis sativa, Malva parviflora, Citrus limon, Carpobrotus edulis, Sclerocarya birrea* and *Schinus molle* were noted as some of the plant species grown in at least 10 homes. However, other authors reported most of the plant species found as part of a garden to be used only as food supplements and ornamental plants (Mongalo and Makhafola, 2018). In our study, some plant species such as *Cannabis sativa* and *Malva parviflora* are used as medicine to treat a variety of human and animal illnesses. When asked why only those particular species are being cultivated, most participants believe that the plant species are used more often than others and are gradually declining in their natural environment. However, some healers believed that some plant species are believed to be efficient in treating infections only when collected from the wild. Such healers further stated that plant species in the wild are natural and have a stronger power that comes from gods and the wind. Only four elderly farmers stated that some are alien plants brought from other countries giving this reason for why they are planted at home. It was believed that they are not so powerful in healing as there is no link to the ancestors.

5. Conclusions

The practice of ethnoveterinary medicine is an age-old practice in South Africa, and plays a critical role in rural livestock healthcare. This study documented 24 plants from 15 families used by traditional healers and farmers for respiratory and dermatological infections in livestock from two areas in the Sekhukhune municipality (Limpopo Province). Leaves were the most popular plant parts for use in preparing remedies, and plant species were used either singly or in combination. Oral and topical applications were preferred for respiratory and dermatological treatments respectively. This study increases the archive of documented plants for further *in vivo* investigations of their efficacy and safety. It also serves to highlight the popularity of certain species in traditional medicine, which is important for future conservation of useful plant species.

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Authors' contributions

JKM conducted the ethnoveterinary study, performed the analysis and wrote the manuscript. LJM supervised the research, provided funding and facilities and edited the manuscript. Both authors read the final manuscript and agreed to its submission.

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Availability of data and materials

All data relevant to the study are presented in this manuscript.

Ethics approval and consent to participate

The study was approved by the University of Pretoria Research Ethics Committee (Faculties of Veterinary Sciences and Humanities, approval number REC 029-19). Verbal consent was recorded from participants before interviews as most of the participants were illiterate.

Competing interests

The authors declare that they have no competing interests.

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