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INDIGENOUS PLANT-BASED ALTERNATIVES FOR TREATING CATTLE SKIN AILMENTS: A CASE STUDY FROM THE MNISI TRIBAL AUTHORITY OF MPUMALANGA PROVINCE, SOUTH AFRICA

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ABSTRACT
The study was carried out in the Mnisi Tribal Authority, Mpumalanga Province, South Africa, between August and October 2021. Ethno-veterinary data were collected using pre-structured questionnaires and field observations with cattle owners. The data were analyzed and summarized using descriptive statistics. Frequently mentioned plants belonged to the families Vitaceae (*Cissus quandrangularis*), Euphorbiaceae (*Synadenium cupulare*), Fabaceae (*Dichrostachys cinerea*), Solanaceae (*Nicotiana batacum*), Euphorbiacae (*Jatropha zayheri*), and Apocynaceae (*Sarcostemma viminate*). Antimicrobial susceptibility assays with ampicillin as positive control were carried out on extracts of *Synadenium cupulare* (aerial parts and leaves), *Dichrostachys cinerea* (seeds/ fruits), and *Cissus quadrangularis* (aerial parts and leaves). Aqueous extracts of S.*cupulare* (L) were the most effective against *E. faecalis* with the lowest MIC of 0.73 mg/ml, followed by aqueous extracts of *Dichrostachys cinerea* with an MIC of 1.36. Open wounds were the most common ailment (35%), followed by abscesses (23%) and abrasions (17%). Documenting Indigenous knowledge can be a basis for the development of sustainably used medicinal plants in the area and the validation of these plant preparations for veterinary use since the low cost of these preparations makes them useful for local communities.

Contribution/Originality: The potential of plant resources as remedies for cattle skin ailments was explored. Skin ailments have been cited by researchers as among the challenges faced by communal cattle farmers. The study explores the biochemical attributes of the plant resources to enhance the acceptability of these as alternatives for alleviating cattle skin ailments.

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1. INTRODUCTION
In South Africa, livestock production is estimated to occupy approximately 80% of agricultural land and contribute an estimated 40% to the national agricultural income (DAFF, 2018). Cattle production in South Africa is concentrated in the Eastern Cape, KwaZulu Natal, Free State, and Northwest provinces, while it is more sparsely distributed in Mpumalanga province due to wildlife border restrictions (DAFF, 2019). However, skin ailments such as sores, abscesses, inflammation-related lesions, and open wound infections as a result of bacterial, fungal, ectoparasitic, and viral pathogens contribute to economic losses among cattle farmers through reduced hide quality, reduced growth performance, reduced milk production, and reduced fertility (Tiwari et al., 2013). Due to its large surface area, the skin

is susceptible to chemical agents and various injuries that may be accompanied by the entrance of infective agents into the body. Furthermore, the abundance of folds, invaginations, and specialized niches on the skin support a wide range of microorganisms (Foster, 2012; Grice & Segre, 2011).

The application of chemoprophylactic disease control measures is associated with certain challenges, such as high costs and the inability of the majority of communal farmers to access such drugs. Mala, Lalouckova, and Skrivanova (2021) stated that cattle skin ailments of bacterial origin are among the factors promoting excessive antibiotic use, thereby contributing to the increased burden of antimicrobial resistance. Limoli, Jones, and Wozniak (2015) reported that the ability of some bacterial species, such as *Staphylococcus* spp., *Streptococcus* spp., and *Corynebacterium* spp., to form biofilms in chronic wounds results in higher antibiotic resistance and prevention of phagocytosis. Decreasing the rate of bacterial infections improves animal health, welfare, and food safety (Van Boeckel et al., 2015). Medicinal plants contain phytochemicals and can therefore be used as remedies for the treatment of cattle skin ailments without the risk of increasing bacterial antibiotic resistance. Limited knowledge about the efficacy of locally available medicinal plants has prompted ongoing research on chemical profiling and the plants' antipathogen activities. The present study explored the plants that are used to treat cattle skin ailments in the Mnisi Tribal Authority, Mpumalanga Province, South Africa.

2. MATERIALS AND METHODS

Cattle farmers from three villages in the Mnisi Tribal Authority (coordinates: 24°38'N, 31°20'S), Mpumalanga Province, South Africa, were selected to participate in a cross-sectional study. According to Census South Africa (2011), approximately 80% of the area's inhabitants are of the Tsonga ethnic group. The Tsonga ethnic group is known for its wealthy cattle ownership, as well as the use of traditional herbal medicines to treat livestock ailments. As Tsongas have traditionally been cattle farmers for several generations, knowledge about managing the cattle and their diseases is passed from generation to generation, with the diagnosis of the majority of cattle ailments being based on examining the animals for symptoms.

The study adopted a standard questionnaire-based survey for ethnobotanical investigations (Jain, 1999). Sixty-six cattle farmers from the Mnisi Tribal Authority who had traditional knowledge of plant-based medicines were the study participants. Bryman and Bell's (2007) model of population sampling was used to calculate the required sample size from each of the three villages. The authors collected information about the use of medicinal plants by interviewing informants from the community in the local language (Xitsonga), both in their settlements and in the remote places where they graze their cattle. Of the 66 informants, 38 were men, and 28 were women. The ages of the informants ranged from 18 to 90 years. The questionnaire was used to collect descriptive responses about various skin ailments prevalent among livestock in the study area, the plant taxa names (vernacular names), their parts used, modes of preparation and form of use (fresh or dried), other ingredients (other plants used), and application methods. Plants that were popular among the informants (identified through their Xitsonga names) as remedies for cattle skin ailments were collected for further identification and laboratory-based validation (Table 2). Voucher specimens of the plants were deposited at the University of Limpopo Larry Leach herbarium (UNIN) for future reference. Ethical clearance to conduct the study was obtained from the University of Limpopo Turfloop Research and Ethics Committee (UL-TREC/150/2020: PG).

Minimal inhibitory concentration (MIC) was determined via two-fold serial dilution methods (Fabry, Okemo, & Ansorg, 1998). Rekha, Kulandhaivel, and Hridhya (2018) defined MIC as the lowest concentration of antimicrobial agents that inhibit the growth of microbial pathogens. Four bacterial strains that are used as a reference by the Microbiology Laboratory, Department of Biochemistry, Microbiology and Biotechnology, University of Limpopo, were used for the MIC assays. These were *Pseudomonas aeruginosa* (ATCC 25619), *Escherichia coli* (ATCC 25922), *Staphylococcus aureus* (ATCC 25923), and *Enterococcus faecalis* (ATCC 29212). These bacterial species were chosen for the MIC assays as they are often isolated from skin lesions and other common infections in cattle (Mala et al., 2021).

Data from the field survey was entered into the Microsoft Excel (2016) computer package and coded and analyzed using Statistical Package for Social Scientists (SPSS). Results from the laboratory analyses were expressed as mean ± standard deviation (SD) of three replicates, and sample means were separated using Duncan's Multiple Range tests SAS version 9.4.

3. RESULTS AND DISCUSSION

The informants of the study comprised 66 cattle farmers. The majority of the informants were male (57.6%) and the predominant group was 36-55 years old. The demographic profile of the informants is presented in Table 1. Mthi et al. (2020) reported 69% male participation in communal cattle farming. Montshwe (2006) reported that in the communal areas of South Africa, the agricultural sector is generally still male-dominated. The predominant age group, 36-55 years, comprised 46.9% of the sample, compared to 49% for the same age group in Mthi et al.'s (2021) sample for their study carried out in the Eastern Cape province. In our study, youth participation (18-35 years) represented 30.4% in comparison with the 32.7% of youth participation in livestock farming reported by Mthi et al. (2021). The authors attributed this low proportion to the poor status of agricultural output in Africa's rural areas due to a lack of government support. Adefalu, Adekunle, Oladipo, Adisa, and Fatoye (2009) observed that in most developing countries, the bulk of agricultural production efforts is left in the hands of aged farmers, and they presently constitute the major farming population in Southern Africa. This scenario is not sustainable since the elders' agricultural productivity cannot meet the rapidly growing population's food needs (Kwenye & Sichone, 2016).

Table 1. Demographic profile of the informants (n=66).

Variables	Number	Frequencies (%)
Gender		
Male(s)	38	57.6
Female(s)	28	42.4
Age		
18-25	3	4.6
26-35	17	25.8
36-55	31	46.9
55-90	15	22.7
Level of education		
Primary	8	12.1
Secondary	21	31.8
Post-Matric	31	46.9
Informal	15	22.7
Livestock ownership		
Cattle	43	65.2
Goats	9	13.6
Poultry	11	16.7
Sheep	3	4.5
Sources of EVMs Knowledge		
Family member	38	57.6
Farmers' forums	3	4.5
Traditional healers	11	16.7
Social media	6	9.1
Local radio station	8	12.1

Table 2 presents the cattle skin ailments most frequently reported in the study area. Open wounds (mbanga yopfuleka) were the most frequent (35%), followed by abscesses (xifezana/bofi) with 23%. Soyelu and Masika (2009) reported that wounds were the most prevalent ailment (84.3%) in a study conducted in the Eastern Cape province, South Africa. These authors attributed this to the high level of parasitic infestations (especially ticks) and poor management practices. In addition, cattle wounds can be caused by castration, wire cuts, as well as fighting among cohorts. The wounds predispose the animals to abscesses. This is comparable to the scenario in our study area, where the animals were generally raised with an ineffective and poorly managed dipping system that compounds the challenge of tick infestations. However, Maroyi (2011) reported a lower occurrence rate (21.3%) of septic wounds in cattle. The same author reported that two plant families, Fabaceae and Solanaceae, were the most utilized in treatment. Luseba and Tshisikwane (2013) reported the use of a plant belonging to the Meliaceae family for cattle wound treatment. The plants that were mentioned as remedies for the treatment of cattle skin ailments in our study have also been reported in the literature as containing antimicrobial properties as follows: *Cissus quadrangularis* and *Jatropha zeyheri* (Chakale, Mwanza, & Aremu, 2021) and *Synadenium cupulare* (McGaw & Eloff, 2008).

Table 2. Frequency of cattle skin ailments reported by the study informants (n=66).

Skin ailment	Local name	Frequency	Percentage
Open wounds	Mbanga yopfuleka	23	35%
Abscesses	Xifezana/Bofi	15	23 %
Abrasions	Thshumuka	11	17%
Sores	Swilondza	7	10%
Lumps	Bundu	5	7.5%
Warts	Nhlungu/Tintsupa	5	7.5%

Informants revealed the use of a variety of medicinal plants that are prevalent in the study area to treat cattle skin ailments. Table 3 contains the collected data on the medicinal plants used in the study area as well as their preparation methods. Luseba and Van der Merwe (2006) reported the anti-inflammatory effects of *Cissus quandrangularis*, which have made this plant species popular for use in the treatment of cattle skin ailments in the Limpopo and North-West provinces. *Dichrostachys cinerea* was reported to be popular amongst the Tsonga tribe as a remedy for wounds and other livestock infections. *Synadenium cupulare* (latex and aerial parts) was reportedly used for the treatment of lumps and other livestock ailments among the Vhenda tribe (Luseba & Tshisikwane, 2013). In the present study, water was used as the solvent of extraction, in line with reports by Mathabe, Nikolova, Lall, and Nyazema (2006) and Suleiman (2009), which recommended the use of water for extraction in laboratory setups since most livestock farmers regard water as an important ingredient when preparing their remedies.

Table 3. Plant species used by the informants from the study area to treat common cattle skin ailments.

Family name/plant name	Local name	Common Name	Parts used	Ailments treated	Preparations	Method of administration	Habitat
Vitaceae: *Cissus quadrangularis*	Nyangala	Veldgrape	Aerial &leaves	Open wounds and lumps	Fresh leaves/ stem crushed, add water and red soil	Applied topically on the affected skin area	Home gardens
Euphorbiaceae: *Synadenium cupulare*	Mdleve	Dead men's tree	Latex, leaves & aerial parts	Open wounds and sores	Latex from aerial parts used as a paste as well as crushed fresh leaves	Applied topically on the affected skin area	Natural habitats and home gardens
Fabacea: *Dichrostachys cinerea*	Ndhzenga	Sickelbush	Fruits/seeds	Open wounds, lumps, and abscesses	Dry seeds/fruits crushed and ground to powder	Applied topically as a paste on the affected skin area	Natural habitats
Solanaceae: *Nicotiana batacum*	Fole	Tobacco leaves	Leaves	Sores, warts, lumps	Fresh leaves crushed and salt added	Applied topically as a paste on the affected skin area	Home gardens
Euphorbiaceae: *Jatropha zayheri*	Neta	Physic nut	Aerial parts	Warts	Fresh/dry roots crushed and ground to powder	Applied topically as a paste on the affected skin area	Natural habitats
Apocynaceae: *Sarcostemma viminate*	Xidomeja	Caustic bush	Roots and aerial parts	Abscesses and foot root	Aerial parts ground	Applied topically on the affected skin area	Natural habitats

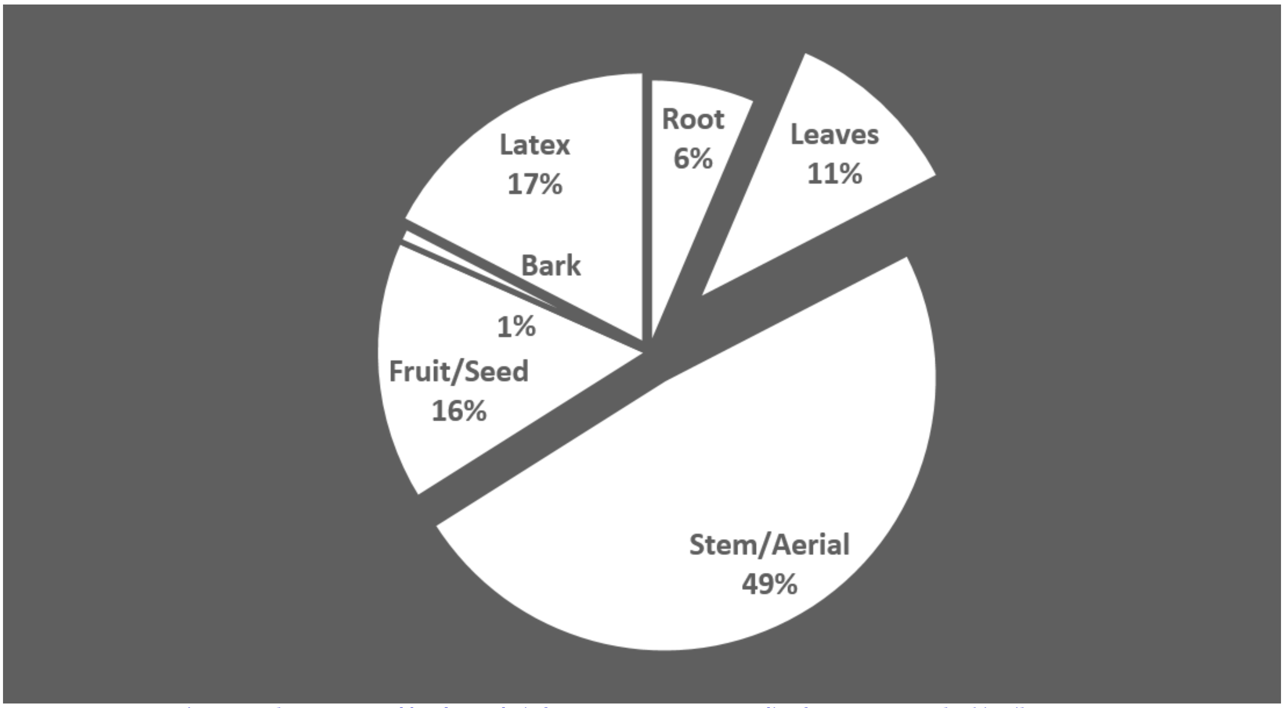

Figure 1. Plant parts used by the study informants to prepare remedies for common cattle skin ailments.

Farmers prepared the remedies using different parts of the plants. Figure 1 shows the popularity of the various plant parts among the informants. Phytochemical constituents of the plant extracts are presented in Table 4. Extracts of all the plant species tested negative for alkaloids, while extracts of *C. quandrangularis* and *S. cupulare* (L) tested negative for tannins and saponins, respectively. Thin-layer chromatography assays were carried out to determine total phenolics, tannins, and flavonoids in the extracts of the plant species collected during the field survey. Extracts of all the plant species investigated in this study tested positive for flavonoids. Flavonoids constitute the largest class of polyphenolic compounds, with more than 4,000 structurally unique flavonoids previously identified in various plant sources, such as vegetables, fruits, and plant-derived beverages, such as tea and wine. Generally, polyphenols have strong antibacterial activity against Gram-positive bacteria such as *Staphylococcus aureus* and Gram-negative bacteria such as *E. coli* bacteria, probably due to different mechanisms of action, among which the most convincing involves the aggregatory effect on all bacterial cells (Cushnie & Lamb, 2011; Daglia, 2012). This could partly explain why all the extracts in our study displayed some activity against pathogenic bacteria when tested. For this reason, they seem to be a suitable natural remedy for bacterial pathogens. Notwithstanding the observation that *Cissus quadrangularis* had the highest composition of flavonoids compared to the other plant species investigated in this study, extracts of this plant had the second-highest average MIC value (2.03 mg/ml) after that of *Synadenium cupulare* (aerial parts). This could possibly be due to the very low tannin content reported for this plant species.

Table 4. Phytochemical constituents of the plant extracts.

Phytochemical constituents	C.quandrangularis	S.cupulare (A)	S.cupulare (L)	D.cinerea
Saponins	+	+	-	+
Terpanol	+	+	+	+
Phlobatannin	+	+	+	+
Tannins	-	+	+	+
Cardic glycoside	+	+	+	+
Flavonoids	+	+	+	+
Steroids	+	+	+	+
Alkaloids	-	-	-	-

Note: (+) = Presence, (-) = Absence.

All the plant species analyzed in the present study possessed phytochemicals. Phytochemicals are naturally present in plants and show biological significance by playing an essential role against various pathogens and microbes through bactericidal or bacteriostatic mechanisms (Assob et al., 2011; Mehni et al., 2014). The results of the phytochemical constituent analysis indicated that most of the plant extracts tested positive for alkaloids, while the extracts of *C. quadrangularis* and *S. cupulare* tested negative for tannins and saponins, respectively. Given the trends observed in the phytochemical constituents of the extracts, it is not surprising that these plants showed potency toward the microbials that were used in the study. Flavonoids form complexes with bacterial proteins. Terpenoids, tannins, steroids, and saponins have also been reported to confer antimicrobial properties.

Table 5. Quantification of secondary metabolites (mg/gm) in the plant extracts using water as solvent.

Plant	Flavonoids	Phenolics	Tannins
C. quandrangularis	51.1 ± 1.2	17.4 ± 1.69	13.8 ± 1.2
S. cupulare (aerial parts)	21.0 ± 10.3	43.5 ± 6.7	47.9 ± 0.4
S. cupulare (leaves)	31.0 ± 24.3	54.0 ± 6.3	13.0 ± 1.9
D. cinerea	39.7 ± 0.3	33.9 ± 27.2	21.8 ± 13.6

Table 5 contains information on the levels of secondary metabolites in the plant extracts using water as a solvent. The results are presented in mg/g. Extracts of *S. cupulare (*L) had the lowest average MIC value of 0.73 mg/ml against *E. faecalis*, while *S. cupulare (A)*, *C. quandrangularis*, and *D. cinerea* had average MIC values of 2.5 mg/ml for the different solvents when used against *E. coli*, *S. aureus*, and *P. aeruginosa*, as shown in Table 6.

Table 6. Minimum Inhibitory Concentration (MIC) for plants tested.

Plant name	MIC S. aureus (water extract) mg/ml	MIC P. aeruginosa (water extract) mg/ml	MIC E. faecalis (water extract) mg/ml	MIC E. coli (water extract) mg/ml
Synadenium cupulare (leaves)	2.08	1.67	0.73	2.08
Synadenium cupulare (aerial parts)	1.67	2.5	1.87	2.5
Cissus quadrangularis	2.08	2.08	1.46	2.5
Dichrostachys cinerea	1.77	2.08	1.36	1.46
Amphotericin B (control)	0.03	0.02	0.03	0.08

The results of the present study showed that plant extracts of *C. quandrangularis* had moderate antioxidant activity against all the pathogens tested. The lowest average MIC was 0.73 mg/ml, which was recorded for the extracts of *S. cupulare* (L) against *E. faecalis*. Previous studies have reported similar trends in MIC values (Ndhlovu & Masika, 2017). *Escherichia coli* isolates required the highest average MIC (2.14) with respect to the extracts of the plant species that were investigated in this study. However, the extracts of the plants in question showed some good inhibitory potential against *Staphylococcus aureus*. *Staphylococcus* species constitute a major group of bacteria inhabiting the skin of cattle. Animals are considered potential sources of infection and dissemination of this bacterial species to the environment (Daaloul-Jedidi, Soudani, & Messadi, 2016). Generally, the antimicrobial activity of tannins against Gram-positive and Gram-negative bacteria has been reported. The mechanisms proposed thus far to explain tannin antimicrobial activity include inhibition of extracellular microbial enzymes, deprivation of the substrates required for microbial growth, direct action on microbial metabolism through inhibition of oxidative phosphorylation, and metal ion deprivation or the formation of complexes with the cell membrane of bacteria causing morphological changes in the cell wall and increasing membrane permeability (Scalbert, 1991). Furthermore, tannins have been reported to display anti-biofilm effects. For example, tannic acid inhibited biofilm formation in the pathogenic bacteria *S. aureus* and *E. coli* (Hancock, Dahl, Vejborg, & Klemm, 2010; Payne et al., 2013). However, in contrast to these reports regarding tannins, *Synadenium cupulare* (aerial parts), which demonstrated the highest concentration of tannins, had the highest average MIC value of 2.14 mg/ml. This observation might be explained by the presence of a high concentration of saponins in extracts of this plant species, as reported in our study. In general, the effect of saponins on bacteria is often weak (Korchowiec et al., 2015). Due to their amphiphilic nature, saponins show a wide range of biological activities, such as cytotoxic, anticancer, insecticidal, molluscicidal, anti-inflammatory, antifungal, antiviral, and antibacterial activities (Mbaveng et al., 2018). Regarding antimicrobial activity, this group of phytochemicals inhibits the growth of Gram-positive and Gram-negative bacteria, yeasts, and molds. The antibacterial mechanism of saponins against bacteria is not completely understood (Saboora, Sajjadi, Mohammadi, & Fallahi, 2019). It seems that saponins can interact with the bacterial outer membrane, increasing its permeability. There are inconsistent reports on the activity of glycosidic and aglycone forms of saponins. It has been shown that bacterial enzymes could decrease the antibacterial effect of saponins through the hydrolysis of sugar chains (Saboora et al., 2019). Avato et al. (2006) reported that the aglycone component of saponins had antibacterial activities and that the sugar chains are not critical to this activity, whereas (Khan, Naqvi, & Naqvi, 2012) proved that the presence of sugar chains is important for the biological effects of the extracts. However, research conducted with *E. coli* demonstrated that oleanolic acid (OA), a known triterpenoid saponin, can also moderately affect efflux pumps, which can directly interfere with the viability of this bacterial species (Martins et al., 2011).

4. CONCLUSION

This study has shown that traditional medicine, mainly involving the use of medicinal plants, plays a significant role in meeting the livestock healthcare needs of the Tsonga ethnic group in the Mnisi Tribal Authority. The documented knowledge of the cattle farmers in the study area could be used to manage livestock healthcare systems and improve livelihoods. However, there is a need to emphasize toxicity level testing to prevent the use of lethal or sublethal doses.

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