A Review of Ethnoveterinary Knowledge, Biological Activities and Secondary Metabolites of Medicinal Woody Plants Used for Managing Animal Health in South Africa

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Abstract: Globally, the use of ethnoveterinary medicine as remedies for animal health among different ethnic groups justify the need for a systematic exploration to enhance their potential. In addition, the increasing popularity and utilisation of woody plants remain common in traditional medicine, which may be attributed to their inherent benefits. The current review was aimed at analysing ethnoveterinary surveys, biological activities, and secondary metabolites/phytochemical profiles of the woody plants of South Africa. Eligible literature (period: 2000 to 2020) were retrieved from different databases such as Google Scholar, PubMed, Sabinet, and Science Direct. Based on the inclusion and exclusion criteria, 20 ethnoveterinary surveys were eligible and were subjected to further analysis. We identified 104 woody plant species from 44 plant families that are used in the treatment of different diseases in animals, particularly cattle (70%) and goats (20%). The most mentioned (with six citations) woody plants were Terminalia sericea Burch, ex DC and Ziziphus mucronata Willd., which were followed by plants with five (Cussonia spicata Thunb., Pterocarpus angolensis DC and Vachellia karroo (Hayne) Banfi & Galasso) or four (Acokanthera oppositifolia (Lam.) Codd, Cassia abbreviata Oliv., and Strychnos hemingii Gilg) individual mentions. The most dominant families were Fabaceae (19%), Apocynaceae (5.8%), Rubiaceae (5.8%), Anacardiaceae (4.8%), Combretaceae (4.8%), Euphorbiaceae (4.8%), Malvaceae (4.8%), Rhamnaceae (4.8%), and Celastraceae (3.8%). Bark (33%), leaves (29%), and roots (19%) were the plant parts dominantly used to prepare remedies for ethnoveterinary medicine. An estimated 20% of woody plants have been screened for antimicrobial, anthelmintic, antioxidant, and cytotoxicity effects. Phytochemical profiles established a rich pool of valuable secondary metabolites (phenolic, flavonoids and condensed tannins) that may be responsible for the exerted biological activities. Overall, the significant portion of woody plants lacking empirical evidence on their biological effects indicates a major knowledge gap that requires more research efforts.

Keywords: antibacterial; antioxidant; ethnoveterinary; Fabaceae; livestock diseases; retained placenta

1. Introduction

Globally, many animals, especially cattle, goats, and horses, play diverse role in human life, ranging from being a source of food, income and cultural wealth, touristic attraction, and job creation [1-6]. The rearing of animals is well-embedded in the culture of many ethnic groups, which justifies the popularity of indigenous knowledge and practice for managing the health and well-being of animals [5,7-11]. Relative to ethnobiology/ethnobotany,
this is currently considered as a distinct field known as ethnoveterinary medicine, a word coined by the American anthropologist Constance McCorkle [12]. It is defined as “the systematic study and application of folk knowledge and beliefs, practices that relate to any aspects of animal health” [13]. Based on increasing evidence [6,14], the field has the capacity to develop into a huge industry in the future. Although animal species and plant species are utilised in ethnoveterinary medicine, the latter is often more popular among many ethnic groups globally [5,11]. Particularly in South Africa, the importance of plants for the management of animal health and well-being cannot be over-emphasized [15].

South Africa has a huge flora diversity and is recognised as a mega-diverse country with three global biodiversity hotspots [16]. The country has an estimated 24,000 species distributed among 368 families, which accounts for approximately 10% of the world’s flora [17]. As a result, South Africans have tapped into the healing powers of these floras since time immemorial, and this knowledge has been retained and has continuously evolved through generations [18]. In some cases, the choice of plants is based on an indigenous experimental process, cultural beliefs, and the biodiversity in a particular area [19–22].

In Africa, woody plants (trees and shrubs) are an important defining feature of the landscapes [20,23]. They are widely recognised for their diverse uses by humans since ancient times [20,24,25]. Particularly in traditional medicine, woody plant species have essential roles that are easily exemplified, as they represent about 65% of the top 51 most important African medicinal plants [26]. Recent studies from different African countries including South African have reiterated the vital role of woody plants in human and animal healthcare as well as the need for more concerted efforts for their conservation [25,27–30]. An important attribute of woody plants is the wide range of their organs (leaves, bark, roots, fruits, and flowers) that is available for use as remedies in folk medicine [25,27]. Relative to herbaceous plants with short life cycles, woody plants are often dominant in ecosystems, thereby making them apparent to foraging animals and for utilisation by humans [20,21]. In the current review, we aim to provide an appraisal on the existing ethnoveterinary knowledge, biological activities, and secondary metabolites/phytochemical profiles of woody plants used for managing animal health in South Africa. The review is expected to identify existing research gap(s) in an attempt to explore the potential of woody plants as an alternative remedy for managing animal health.

2. Materials and Methods

The literature search strategy was facilitated using keywords such as woody plants, ethnoveterinary medicine, livestock, and animal health. In addition, phytochemical, antioxidant, phenolic, and antibacterial effect were examples of terms used to generate data for the biological activity and phytochemical aspects of this review. These keywords were used singly and in combination to identify suitable literature from several databases, namely Google Scholar, Pubmed, Science Direct, and Sabinet. We focused on peer-reviewed papers published from 2000 to 2020 on South African woody plants.

Screening of the research outputs from the databases was conducted in two stages. Firstly, the title and abstract of the papers were screened against the inclusion criteria. A publication needed to provide the Latin name for the woody plant to be eligible for inclusion. Articles reporting on ethnoveterinary uses, biological activities, and phytochemical analyses of the woody plants fulfilled the inclusion criteria (e.g., specified time duration, woody species, and South African studies). Review papers and studies not involving South African medicinal woody plants were excluded. Based on the selection criteria, 20 papers were selected and were analysed in order to generate an inventory of woody plants (Table 1). Subsequently, analyses on plant families, mode of preparation, plant parts used to treat animals/livestock diseases, biological activities, and phytochemicals were conducted. Based on the significance of scientific names [31,32], the botanical names were validated via multi-databases, such as PlantZAfrica (http://pza.sanbi.org/ (accessed on 29 September 2021)), The Plant List (http://www.theplantlist.org/) (accessed
on 29 September 2021)), and The World Flora Online (http://www.worldfloraonline.org/ (accessed on 29 September 2021)).

Table 1. An overview of ethnoveterinary surveys with evidence on the use of woody plants in South Africa from 2000–2020.

| Reference                      | Province         | Documented Plants | Documented Woody Plants | Method of Survey/Interview | Number of Participants |
|--------------------------------|------------------|-------------------|-------------------------|---------------------------|------------------------|
| Chitura et al., [33]           | Limpopo          | 11                | 10                      | Structured questionnaire   | 180                    |
| Dold and Cocks [34]            | Eastern Cape     | 53                | 42                      | Questionnaire and field interview | Not specified          |
| Kambizi [35]                   | Eastern Cape     | 22                | 19                      | Semi-structured interview  | Not specified          |
| Khunoana et al., [36]          | Eastern Cape     | 11                | 9                       | Semi-structured interview  | 50                     |
| Luseba and Tshisikhawhe [37]   | Limpopo          | 34                | 22                      | Focus group discussion     | 37                     |
| Luseba and Van der Merwe [38]  | Limpopo          | 19                | 12                      | Individual and group interview | Not specified          |
| Magwede et al., [39]           | Limpopo          | 27                | 14                      | Open-ended questions and semi-structured questionnaire | 42                     |
| Mahlo [40]                     | Limpopo          | 5                 | 4                       | Not specified              | Not specified          |
| Maphosa and Masika [41]        | Eastern Cape     | 28                | 20                      | Structured questionnaire and general conversation | 30                     |
| Mkwanazi et al., [42]          | KwaZulu-Natal    | 5                 | 4                       | Structured questionnaire   | Not specified          |
| Moichwanete et al., [43]       | North West       | 25                | 18                      | Face-to-face, semi-structured interview | 15                    |
| Moyo and Masika [44]           | Eastern Cape     | 2                 | 2                       | Structured questionnaire   | 59                     |
| Mthi et al., [45]              | Eastern Cape     | 6                 | 6                       | Semi-structured questionnaire, observations and guided field trip | 48                     |
| Mwale and Masika [46]          | Eastern Cape     | 9                 | 7                       | Structured questionnaire   | 54                     |
| Ndou [47]                      | North West       | 31                | 17                      | Semi structured face-to-face interview | 21                    |
| Ramovha and Van Wyk [48]       | Limpopo          | 20                | 10                      | Semi-structured interview  | Not specified          |
| Rwodzi [49]                    | Eastern Cape     | 10                | 8                       | Questionnaire              | 60                     |
| Sanhokwe et al., [50]          | Eastern Cape     | 9                 | 8                       | Structured questionnaire   | 53                     |
| Soyelu and Masika [51]         | Eastern Cape     | 13                | 11                      | Structured questionnaire   | 53                     |
| Van der Merwe et al., [52]     | North West       | 45                | 24                      | Detailed interview         | 28                     |
3. Results and Discussion

3.1. Overview of Eligible Literature and Ethnoveterinary Studies

The eligible studies were conducted in five of the nine provinces in South Africa. These included the Eastern Cape (45%), Limpopo (30%), North West (15%) Mpumalanga (5%), and KwaZulu-Natal (5%) provinces (Table 1). The majority of these aforementioned provinces are regarded as predominantly rural-based, which may explain the continuous dependence on woody plants for veterinary needs. In a recent review of the ethnoveterinary plants of South Africa, McGaw et al., [15] indicated a similar distribution pattern relating to the use of medicinal plants as remedies for animals/livestock in South Africa. In Pakistan, a rich ethnoveterinary knowledge was recorded in communities residing in remote areas with limited access to conventional veterinary services, which often forced the inhabitants to rely on the natural resources within their immediate environment to meet the health needs of their livestock [14].

The data collection methods included the use of questionnaires, interviews, field observations, and Rapid Rural Appraisal (Table 1). Data on ethnoveterinary medicine was collected from diverse participants such as farmers, cattle headers, indigenous knowledge holders, and traditional healers. In terms of number, the number of participants ranged from 15 [43] to 180 [33] while about 30% of the studies had no indication of the sample size involved in the ethnobotanical survey. Given that the primary focus of these surveys was not on woody plants, varying portions (11–100%) of woody species were identified in the recorded plants (Table 1). In the survey in the Eastern Cape by Dold and Cocks [34], approximately 40% of the 53 recorded plants with ethnoveterinary value were woody plant species. A similar trend was evident in other ethnoveterinary surveys in the Eastern Cape [35,41,51] and Limpopo [48] provinces. In North West province, the portion of woody plants ranged from 26% [47,52] to 32% [43]. In an attempt to understand the basis for the selection and utilisation of plants by local communities, several theories and hypotheses exist [53]. In the current situation, the ecological apparency hypothesis likely accounts for the use of woody plants for ethnoveterinary medicine among local communities. Even though South Africa is recognized as being rich in biodiversity and diverse vegetation-types, it remains highly susceptible due to rapid development, habitat loss, and overexploitation [16]. Increasing evidence supported the dynamic nature of the existing vegetation in South Africa, which is associated with the effects of climate change [54]. On this basis, it is often difficult to predict the pattern for the use of woody plants in ethnoveterinary medicine.

3.2. Inventory of Woody Plants with Ethnoveterinary Uses

The high reliance on plants for managing livestock/animals among local communities, especially in developing countries, remains a common trend [14,55]. This popularity has often been attributed to the limited access to conventional veterinary drugs and the existence of vast indigenous knowledge for managing livestock in rural communities [47,56,57]. Several studies have revealed that traditional medicines are mostly used because they are regarded as effective and readily available as well as accessible. As often indicated by participants in ethnoveterinary surveys, dependence on traditional medicines is common because western veterinary facilities are inaccessible and are too costly for resource-poor livestock farmers [34,37,45].

Based on the 20 eligible studies from the literature, we generated 104 woody plants with diverse ethnoveterinary uses in South Africa (Table 2). *Terminalia sericea* Burch. Ex DC and *Ziziphus mucronata* Willd were the most common plants, with six mentions. Furthermore, *Cussonia spicata* Thunb., *Pterocarpus angolensis* DC., and *Vachellia karroo* (Hayne) Banfi & Galasso (five citations) and *Cassia abbreviata* Oliv. and *Strychnos henningsii* Gilg (four citations) were popular within the 20 analysed studies from the literature. On the other hand, the majority (86%, i.e., 89 plants) of the 104 woody plants had limited (1–2) mentions.
Table 2. Inventory of woody plants used for ethnoveterinary purposes among communities in South Africa. Botanical names were validated using PlantZAfrica (http://pza.sanbi.org/ (accessed on 29 September 2021)), The Plant List (http://www.theplantlist.org/ (accessed on 29 September 2021)), and The World Flora Online (http://www.worldfloraonline.org/ (accessed on 29 September 2021)). Syn = synonym; ns = not specified.

| Plant Species                      | Family          | Common Name     | Method of Preparation and Administration                                                                 | Plant Part Used | Animal Treated | Disease/Health Condition | Reference                  |
|------------------------------------|-----------------|-----------------|-----------------------------------------------------------------------------------------------------------|-----------------|-----------------|----------------------------|----------------------------|
| *Acokanthera oppositifolia* (Lam.) Codd | Apocynaceae     | Bushman’s Poison | Leaves are boiled for 10 min, strained, and left to stand overnight                                       | Leaves          | Sheep, goats   | Heartwater                 | Dold and Cocks [34]        |
| *Acokanthera oppositifolia* (Lam.) Codd | Apocynaceae     | Bushman’s Poison | Decoction                                                                                                 | Leaves          | Goats           | Gastrointestinal parasites | Maphosa and Masika [41]   |
| *Acokanthera oppositifolia* (Lam.) Codd | Apocynaceae     | Bushman’s Poison | Leaves crushed with water and administered orally                                                        | Leaves          | Cattle          | Paratyphoid (*Goso*)       | Mthi et al., [45]          |
| *Acokanthera oppositifolia* (Lam.) Codd | Apocynaceae     | Bushman’s Poison | Decoction; ground leaves are boiled, cooled, and administered by drenching the animals. Dose with 1 L bottle for adults and a 300 mL bottle for kids | Leaves          | Goats           | Helminths, ticks           | Sanhokwe et al., [50]      |
| *Afrocarpus falcatus* (Thunb.) C.N.Page | Podocarpaceae   | Outeniqua yellowwood | Decoction                                                                                                 | Leaves          | Dogs            | Distemper                  | Dold and Cocks [34]        |
| *Albizia* sp.                      | Fabaceae        | Xisitana         | Root skin is infused in water and is left overnight                                                        | Roots           | Cattle          | Swollen stomach            | Khunoana et al., [36]      |
| *Azima tetracantha* Lam.           | Salvadoraceae   | Beehanger        | Dried and ground root is bottled in cold water                                                              | Root            | Cattle          | Dystocia                   | Dold and Cocks [34]        |
| *Balanites maughamii* Sprague      | Zygophyllaceae  | Torchwood        | Decoction                                                                                                 | Leaves          | Cattle          | Diarrhoea                  | Mahlo [40]                 |
| *Balanites maughamii* Sprague      | Zygophyllaceae  | Torchwood        | Ground leaves are mixed with cold water                                                                    | Leaves          | Cattle          | Diarrhoea                  | Van der Merwe et al., [52] |
| *Bauhinia thonningii* Schum. (Syn: *Piliostigma thonningii* (Schumach.) Milne-Redh.) | Fabaceae        | Camel’s foot     | Decoction                                                                                                 | Leaves          | Cattle          | Diarrhoea                  | Mahlo [40]                 |
| *Bolusanthus speciosus* (Bolus) Harms | Fabaceae        | Tree wisteria    | Pounded roots are immersed in water                                                                        | Roots           | Cattle          | Retained placenta          | Luseba and Tshisikhawwe [37] |
Table 2. Cont.

| Plant Species                        | Family              | Common Name       | Method of Preparation and Administration                                                                 | Plant Part Used | Animal Treated | Disease/Health Condition                                      | Reference                      |
|--------------------------------------|---------------------|-------------------|------------------------------------------------------------------------------------------------------------|-----------------|----------------|---------------------------------------------------------------|--------------------------------|
| *Brachylaena ilicifolia* (Lam.) E. Phillips & Schweick. | Asteraceae          | Bitterblaar       | Leaves are mixed with leaves of *Leucas capensis* (Benth.) Engl. and sap of *Aloe ferox* Mill and boiled      | Leaves          | Lambs          | Diarrhoea                                                     | Dold and Cocks [34]               |
| *Breonadia salicina* (Vahl) Hepper & J.R.I.Wood | Rubiaceae           | Transvaal teak    | Maceration                                                                                                 | Bark            | Cattle         | General intestinal diseases and retained placenta             | Mahlo [40]                     |
| *Burchellia bubaline* (L.f.) Sims     | Rubiaceae           | Wild pomegranate  | ns                                                                                                         | Leaves          | ns             | Heartwater                                                   | Kambizi [35]                   |
| *Cadaba aphylla* (Thunb.) Wild        | Capparaceae         | leafless cadaba, leafless wormbush, black storm | Root decoction: Combined with roots of *Ziziphus zeyheriana*, *Senna italica*, and *Dicoma galpinii* | Root            | ns             | Blood cleansing and pains (sores, fractures)                  | Ndou [47]                      |
| *Calpurnia aurea* (Aiton) Benth.      | Fabaceae            | Common calpurnia  | Infusion                                                                                                   | Leaves          | Cattle         | Maggot-infested wounds                                       | Soyelu and Masika [51]          |
| *Capparis sepiaria* L.               | Capparaceae         | Cape Capers       | Infusion                                                                                                   | Roots           | Goats          | Gastro-intestinal parasites                                  | Maphosa and Masika [41]         |
| *Carissa bispinosa* (L.) Desf. ex Brenan | Apocynaceae         | Forest num-num    | Bulb is ground and mixed with water                                                                        | Roots, bulb     | Cattle         | Calving difficulties                                         | Luseba and Tshisikhawe [37]     |
| *Cassia abbreviata* Oliv.             | Fabaceae            | Sjambok pod       | Bark infusion                                                                                               | Bark            | Cattle         | Retained placenta                                            | Chitura et al., [33]             |
| *Cassia abbreviata* Oliv.             | Fabaceae            | Sjambok pod       | Ground bark is soaked in water overnight or boiled                                                         | Bark            | ns             | Worm infestation                                             | Luseba and Van der Merwe [38]   |
| *Cassia abbreviata* Oliv.             | Fabaceae            | Sjambok pod       | Ground bark is mixed with water                                                                            | Bark            | Cattle         | Wounds                                                       | Magwede et al., [39]            |
| *Cassia abbreviata* Oliv.             | Fabaceae            | Sjambok pod       | Bark infusion or decoction                                                                                   | Bark, root bark| Cattle         | Redwater                                                     | Ramovha and Van Wyk [48]        |
| *Cassine aethiopica* Thunb. (Syn: *Mystroxylon aethiopicum* (Thunb.) Loes.) | Celastraceae        | Kooboo-berry      | Bark is grated and boiled for 20 min                                                                        | Bark            | Cattle         | Heartwater                                                   | Dold and Cocks [34]             |
| *Centella asiatica* (L.) Urb.         | Apiaceae            | Varkoortjie       | Decoction                                                                                                  | Bark            | Goats          | Helminths                                                    | Sanhokwe et al., [50]           |
| Plant Species                  | Family       | Common Name          | Method of Preparation and Administration | Plant Part Used | Animal Treated | Disease/Health Condition                                                                 | Reference                        |
|-------------------------------|--------------|----------------------|-------------------------------------------|------------------|----------------|------------------------------------------------------------------------------------------|----------------------------------|
| *Cephalanthus natalensis*     | Rubiaceae    | Strawberry bush      | Infusion                                  | Leaves           | Cattle         | Eye problem                                                                              | Luseba and Tshisikhawe [37]      |
| *Cissampelos capensis* L.f.   | Menispermaceae| Davidjies ns         | ns                                        | Roots            | ns             | Skin problems, wounds                                                                     | Kambizi [35]                     |
| *Clutia pulchella* L.         | Peraceae     | Lightning bush       | Decoction                                 | Roots            | Cattle         | Gall                                                                                      | Khunoana et al., [36]            |
| *Coddia rudis* (E.Mey. ex. Harv.) Verdc. | Rubiaceae    | Small bone apple     | ns                                        | Leaves           | Leaves         | Skin problems (eliminates ticks)                                                          | Kambizi [35]                     |
| *Combretum collinum* Presen   | Combretaceae | Bicoloured bushwillow| ns                                        | Bark             | Cattle         | Constipation                                                                             | Chitura et al., [33]             |
| *Combretum microphyllum* Klotzsch. | Combretaceae | Flame creeper        | Infusion or decoction                      | Roots            | Cattle         | Redwater                                                                                 | Ramovha and Van Wyk [48]         |
| *Combretum molle* R.Br ex G.Don | Combretaceae | Velvet bushwillow    | Infusion                                  | Leaves           | Cattle         | Gut conditions—diarrhoea. Worm infestation. Breeding problems, difficult calving           | Luseba and Tshisikhawe [37]      |
| *Combretum paniculatum* Vent. | Combretaceae | Burning bush         | Decoction                                 | Root bark        | Cattle         | For fertility problems                                                                   | Luseba and Van der Merwe [38]    |
| *Croton gratissimus* Burch. (Syn: *Croton gratissimus Burch. var gratissimus*) | Euphorbiaceae | lavender croton, lavender fever berry | Dried leaves are crushed and mixed with supplement feed | Leaves           | ns             | Fertility enhancement in livestock                                                       | Ndou [47]                        |
| *Croton gratissimus* Burch. (Syn: *Croton gratissimus Burch. var gratissimus*) | Euphorbiaceae | Lavender fever berry  | ns                                        | Leaves           | Cattle         | Pneumonia                                                                                 | Van der Merwe et al., [52]       |
| *Curtisia dentata* (Brum. f.) C.A.Smith | Curtisiaceae | Assegai              | Bark, together with the bark of *Rapanea melanophloeos* (L.) Mez, is boiled for 30 min | Bark             | Cattle         | Heartwater                                                                                | Dold and Cocks [34]              |
Table 2. Cont.

| Plant Species                    | Family           | Common Name       | Method of Preparation and Administration                                                                 | Plant Part Used | Animal Treated | Disease/Health Condition                                                                 | Reference                |
|----------------------------------|------------------|-------------------|------------------------------------------------------------------------------------------------------------|-----------------|----------------|-------------------------------------------------------------------------------------------|--------------------------|
| *Cussonia spicata* Thunb.        | Araliaceae       | Cabbage-tree      | Mixed with leaves of *Olea europaea* L. subsp. *africana* (Mill.) P.S.Green to produce concoction or decoction | Leaves          | Cattle         | Bloody urine after calving (endometritis and/or vaginitis)                                  | Dold and Cocks [34]      |
| *Cussonia spicata* Thunb.        | Araliaceae       | Cabbage-tree      | ns                                                                                                         | Bark            | ns             | Heartwater                                                                               | Kambizi [35]             |
| *Cussonia spicata* Thunb.        | Araliaceae       | Cabbage-tree      | Infusion                                                                                                   | Bark            | Goats          | Gastro-intestinal parasites                                                                | Maphosa and Masika [41]  |
| *Cussonia spicata* Thunb.        | Araliaceae       | Cabbage-tree      | Ground bark is soaked overnight and dose at 300 mL                                                        | Bark            | Goats          | Helmenthis                                                                                | Sanhokwe et al., [50]    |
| *Dalbergia obovata* E.Mey.       | Fabaceae         | Climbing flat bean| Leaves and bark crushed and mixed with water                                                                | Leaves, bark    | Cattle         | Paratyphoid (*Goso*)                                                                      | Mthi et al., [45]        |
| *Dichrostachys cinerea* (L.)     | Fabaceae         | Sicklebush        | Dried fruit is made into powder                                                                             | Fruit           | Sheep, goats   | Wounds                                                                                   | Chitura et al., [33]     |
| **Ebenaceae**                     |                  | **Bluebush**      | Ground leaves are mixed with water and apply on the affected area                                           | Leaves          | Cattle         | Ticks                                                                                     | Luseba and Tshisikhawe [37]|
| *Diospyros lycioides* Desf.      | *Ebenaceae*      | **Bluebush,** Karoo blue bush | Ground leaves are mixed with water and apply on the affected area                                           | Leaves          | Cattle         | Wounds                                                                                   | Magwede et al., [39]     |
| *Diospyros mespiliformis* Hochst. ex A.DC. | *Ebenaceae*     | African ebony     | Ground bark is mixed with hippopotamus fat; dosed and also rubbed into vagina                              | Bark            | ns             | For milk production                                                                      | Luseba and Van der Merwe [38]|
| *Diospyros mespiliformis* Hochst. ex A.DC. | *Ebenaceae*     | African ebony     | Ground roots are mixed with warm but not boiling water to yield an infusion                                | Roots           | Cattle         | Redwater                                                                                   | Ramovha and Van Wyk [48] |
Table 2. Cont.

| Plant Species                        | Family            | Common Name    | Method of Preparation and Administration | Plant Part Used | Animal Treated | Disease/Health Condition | Reference                              |
|--------------------------------------|-------------------|----------------|-------------------------------------------|-----------------|-----------------|--------------------------|-----------------------------------------|
| Dombeya rotundifolia (Hochst.) Planch.| Malvaceae         | Wild pear      | Ground leaves/flowers are mixed with chicken feed | Leaves, flowers | Chicken         | Newcastle disease        | Luseba and Van der Merwe [38]           |
| Dombeya rotundifolia (Hochst.) Planch.| Malvaceae         | Wild pear      | Decoction                                  | Leaves          | Cattle          | Diarrhoea                | Mahlo [40]                              |
| Ehretia rigida (Thunb.) Druce        | Boraginaceae      | Puzzle bush    | Decoction                                  | Roots           | Cattle          | Eating problems          | Luseba and Tshisikhawe [37]             |
| Ehretia rigida (Thunb.) Druce        | Boraginaceae      | Puzzle bush    | ns                                         | Roots           | Cattle          | Fractures                | Van der Merwe et al., [52]              |
| Elaeodendron transvaalense (Burtt Davy) R.H.Archer | Celastraceae     | Bushveld saffron | Ground fruits are mixed with water           | Fruit           | Cattle          | Worms                    | Luseba and Tshisikhawe [37]             |
| Elaeodendron transvaalense (Burtt Davy) R.H.Archer | Celastraceae     | Spike-Thorn    | ns                                         | Bark            | Cattle          | Diarrhoea                | Van der Merwe et al., [52]              |
| Elephantorrhiza burkei Benth.        | Fabaceae          | Elephant-root  | Ground bulb (or bark) is mixed with water   | Bark, roots     | Cattle          | Diarrhoea                | Luseba and Tshisikhawe [37]             |
| Englerophytum magnalis montanum (Sond.) T.D.Penn | Sapotaceae       | Transvaal milkplum | ns                                         | Roots           | Cattle          | Fertility enhancement    | Van der Merwe et al., [52]              |
| Erythrina caffra Thunb.              | Fabaceae          | Coast coral tree | ns                                         | Bark            | ns              | Heartwater               | Kambizi [35]                           |
| Erythrina lysistemon Hutch.          | Fabaceae          | Common coral tree | Fresh bark is crushed into pulp and juice is applied | Bark            | Cattle          | Wounds                   | Magwede et al., [39]                   |
| Euphorbia cupularis Boiss.           | Euphorbiaceae     | Crying tree    | Milky latex is applied on third eyelid and on the skin of the limping leg | Milky latex | ns              | Eye infection and blackquarter | Luseba and Van der Merwe [38]           |
| Euphorbia umbellata (Pax) Bruyns     | Euphorbiaceae     | African milk bush | Milky sap applied directly on the area between the eye and ear | Stem            | Cattle          | Eye problem              | Khunoana et al., [36]                  |
| Ficus sp.                            | Moraceae          | ns             | ns                                         | Bark            | ns              | Wounds                   | Kambizi [35]                           |
| Plant Species                  | Family       | Common Name         | Method of Preparation and Administration                                                                 | Plant Part Used | Animal Treated | Disease/Health Condition | Reference                          |
|-------------------------------|--------------|---------------------|-------------------------------------------------------------------------------------------------------------|-----------------|-----------------|--------------------------|------------------------------------|
| Garcinia livingstonei T. Anderson | Clusiaceae  | African mangosteen  | Juice from fresh leaves is squeezed                                                                         | Leaves          | Cattle          | Eye problems             | Luseba and Tshisikhawe [37]       |
| Grewia damine Gaertn. (Syn. Grewia bicolor Juss.) | Malvaceae    | White raisin        | Stem branches are cut into sticks used as lashes                                                            | Sticks          | Cattle          | Redwater                 | Ramovha and Van Wyk [48]          |
| Grewia flava DC.              | Malvaceae    | Brandybush, wild currant | Root decoction combined with root of Ziziphus zeyheriana and given orally                                    | root            | cattle          | Diarrhoea                | Ndou [47]                         |
| Grewia flava DC.              | Malvaceae    | Brandybush, wild currant | ns                                                                                                         | Roots           | Cattle          | Fertility enhancement    | Van der Merwe et al., [52]        |
| Grewia occidentalis L.         | Malvaceae    | Crossberry          | Infusion is prepared with the leaves of Olea europaea subsp. africana and Zanthoxylum capense and sap of Aloe ferox | Leaves          | ns              | Gallsickness             | Dold and Cocks [34]               |
| Grewia occidentalis L.         | Malvaceae    | Crossberry          | Decoction                                                                                                   | Bark            | Goats           | Gastro-intestinal parasites | Maphosa and Masika [41]          |
| Grewia occidentalis L.         | Malvaceae    | Crossberry          | Infusion                                                                                                     | Leaves          | Cattle          | Wounds                   | Soyleu and Masika [51]            |
| Gymnosporia sp.                | Celastraceae | Xihlangwa           | Root skin infused in water and left overnight                                                               | Roots           | Cattle          | Black quarter and diarrhoea | Khunoana et al., [36]             |
| Harpephyllum caffrum Bernh.    | Anacardiaceae| Wild plum           | ns                                                                                                          | Bark            | ns              | Skin problems            | Kambizi [35]                      |
| Harpephyllum caffrum Bernh.    | Anacardiaceae| Wild plum           | Decoction                                                                                                    | Bark            | Goats           | Gastro-intestinal parasites | Maphosa and Masika [41]          |
| Heteromorpha arborescens (Spreng.) Cham. & Schldl. | Apiaceae     | Parsley tree        | Ground root powder is mixed with cold or warm water to yield an infusion                                     | Root            | Cattle          | Redwater                 | Ramovha and Van Wyk [48]          |
| Hippobromus pauciflorus (L-f) Radlk. | Sapindaceae | Bastard horsewood   | Bark is mixed with the bark of Protorhus longifolia and is grated and boiled for 10 min                    | Bark            | Cattle          | Heartwater and diarrhoea | Dold and Cocks [34]               |
| Plant Species | Family | Common Name | Method of Preparation and Administration | Plant Part Used | Animal Treated | Disease/Health Condition | Reference |
|---------------|--------|-------------|------------------------------------------|-----------------|----------------|-------------------------|-----------|
| *Hippobromus pauciflorus* (L.f) Radlk. | Sapindaceae | Bastard horsewood | Infusion | Leaves | Cattle | Wounds | Soyelu and Masika [51] |
| *Holarrhena pubescens* Wall. ex G.Don | Apocynaceae | Conessi | Crushed roots are mixed with hot water to yield an infusion or are cooked to produce a decoction | Root | Cattle | Redwater | Ramovha and Van Wyk [48] |
| *Hyperacanthus amoenus* (Sims) Bridson | Rubiaceae | Thorny gardenia | Maceration | Bark | Cattle | Relieving pain, loss of appetite, and general ailments | Mahlo [40] |
| *Jatropha curcas* L. | Euphorbiaceae | Physic nut | Crushed (1–2) seeds are mixed with water for drenching | Seeds | Cattle, goats | Constipation | Luseba and Van der Merwe [38] |
| *Jatropha curcas* L. | Euphorbiaceae | Physic nut | Sliced root is cooked to produce a decoction | Root, tuber | Cattle | Redwater | Ramovha and Van Wyk [48] |
| *Maerua angolensis* DC. | Capparaceae | Bead-bean | Ground leaves are mixed with water. Fresh leaves are squeezed to extract juice | Leaves | Cattle | Eating disorder, drought tonic, eye problems, wounds | Luseba and Tshisikhawwe [37] |
| *Maytenus peduncularis* (Sond.) Loes. | Celastraceae | Blackwood | Root-bark is made into a paste | Root-bark | Cattle | Fractures | Chitura et al., [33] |
| *Maytenus peduncularis* (Sond.) Loes. | Celastraceae | Blackwood | ns | Leaves | Goats | Ticks | Mkwanazi et al., [42] |
| *Milletta grandis* (E.Mey) Skeels | Fabaceae | Umzimbeet | Soak the leaves in cold water | Leaves | Chicken | Internal parasites | Mwale and Masika [46] |
| *Noltea africana* (L.) Rchb. f. | Rhamnaceae | Soap bush | Ground into powder | Roots | Goats | Womb cleansing; fertility | Rwodzi [49] |
| *Ochna holstii* Engl. | Ochnaceae | Common forest ochna | Leaves and branches boiled for 2 h, 1 litre is given once daily for 3 days | Leaves | Goats, sheep, cattle | Wounds | Luseba and Tshisikhawwe [37] |
| *Ochna holstii* Engl. | Ochnaceae | Common forest ochna | Leaves are ground and boiled | Leaves, twigs, bark | Cattle | Wounds | Magwede et al., [39] |
| *Ocotea bullata* (Burch.) E. Meyer in Drege | Lauraceae | Stinkwood | Decoction | Bark | Goats | Gastrointestinal parasites | Maphosa and Masika [41] |
### Table 2. Cont.

| Plant Species | Family | Common Name                  | Method of Preparation and Administration                                                                 | Plant Part Used | Animal Treated | Disease/Health Condition                                                                                     | Reference              |
|---------------|--------|------------------------------|----------------------------------------------------------------------------------------------------------|-----------------|----------------|-----------------------------------------------------------------------------------------------------------|------------------------|
| Olea europaea subsp. cuspidata (Wall. & G.Don) Cif. (Syn: Olea europaea L. subsp. africana (Mill.) P.S.Green) | Oleaceae | Wild olive                   | Bark infusion. Leaves together with *Cussonia spicata* root. Mixture of *Zanthoxylum capense* leaves, *Grewia occidentalis* leaves, and *Aloe ferox* sap | Bark, leaves     | Goats, cattle    | Diarrhoea in goats. Bloody urine after calving (endomitritis and vaginitis in cattle). Treating gallsickness in cattle | Dold and Cocks [34]    |
| Olea europaea subsp. cuspidata (Wall. & G.Don) Cif. (Syn: Olea europaea L. subsp. africana (Mill.) P.S.Green) | Oleaceae | Wild olive                   | Crushed bark is soaked in warm water                                                                       | Bark            | Cattle         | Black quarter (Ciko)                                                                                        | Mthi et al., [45]      |
| Osyris lanceolata Hoscht. & Steud | Santalaceae | Rock tannin-bush | Maceration                                                                                                          | Bulb            | Cattle         | Retained placenta, alleviation of pain and internal bleeding                                               | Moichwanetse et al., [43] |
| Ozoroa paniculosa (Sond.) R.Fern. & A.Fern. (Syn: Ozoroa paniculosa (Sond.) R.Fern. & A.Fern. var. paniculosa) | Anacardiaceae | Common resin tree | ns                                                                                                                   | Bark, root bark | Cattle         | Diarrhoea, redwater, sweating sickness                                                                     | Van der Merwe et al., [52] |
| Peltophorum africanum Sond. | Fabaceae | Weeping wattle                | Bark is ground into powder                                                                                        | Bark            | Cattle         | Wounds                                                                                                   | Magwede et al., [39]   |
| Peltophorum africanum Sond. | Fabaceae | Weeping wattle                | Poultice                                                                                                           | Leaves and bulb | Cattle         | Retained placenta, diarrhoea, and removal of blood clots from the skin                                       | Moichwanetse et al., [43] |
| Peltophorum africanum Sond. | Fabaceae | Weeping wattle                | ns                                                                                                                   | Bark, root bark | Cattle         | Tonic, diarrhoea                                                                                           | Van der Merwe et al., [52] |
| Philenoptera violacea (Klotzsch) Schrire | Fabaceae | Apple-leaf                    | Bark is ground and infused in water overnight                                                                      | Bark            | Cattle         | Gall, diarrhoea, and general ailments                                                                     | Khunoana et al., [36]  |
| Plant Species                      | Family            | Common Name     | Method of Preparation and Administration                                                                 | Plant Part Used | Animal Treated | Disease/Health Condition | Reference                           |
|-----------------------------------|-------------------|-----------------|-----------------------------------------------------------------------------------------------------------|-----------------|-----------------|--------------------------|-------------------------------------|
| *Philenoptera violacea* (Klotzsch) Schrire | Fabaceae         | Apple-leaf      | Bark is boiled in water                                                                                   | Bark            | Cattle          | Wounds                  | Magwede et al., [39]               |
| *Philenoptera violacea* (Klotzsch) Schrire | Fabaceae         | Apple-leaf      | Bark is cooked or soaked in cold water to produce a red decoction/infusion                               | Stem and root-bark | Cattle          | Redwater                | Ramovha and Van Wyk [48]           |
| *Phoenix reclinata* Jacq.         | Arecacea          | Wild date palm  | Roots are mixed with *Arctotis arctotoides* leaves and boiled, warm liquid is used                       | Roots            | Sheep, goats    | Footrot                 | Dold and Cocks [34]                |
| *Pittosporum viridiflorum* Sims   | Pittosporaceae    | Cheesewood      | Infusion                                                                                                  | Bark            | Goats           | Gastrointestinal parasites | Maphosa and Masika [41]           |
| *Pittosporum viridiflorum* Sims   | Pittosporaceae    | Cheesewood      | Decoction                                                                                                 | Roots            | Chicken         | Wounds                  | Soyelu and Masika [51]             |
| *Pouzolzia mixta* Solms           | Urticaceae        | Soap-nettle     | Poultice                                                                                                  | Roots            | Cattle          | Retained placenta and uterus cleansing | Moichwanetse et al., [43]         |
| *Protorhus longifolia* (Bernh.) Engl. | Anacardiaceae     | Red beech       | Mixed with bark of *Hippobromus pauciflorus* and boiled for 20 min                                        | Bark            | Cattle          | Heartwater and diarrhoea | Dold and Cocks [34]                |
| *Prunus persica* (L.) Batsch       | Rosaceae          | Peach tree      | Decoction                                                                                                 | Leaves           | Lamb, goats     | Diarrhoea                | Dold and Cocks [34]                |
| *Prunus persica* (L.) Batsch       | Rosaceae          | Peach tree      | Ground to pulp and mixed with hot paper and liquid                                                        | Leaves           | ns              | Wounds                  | Magwede et al., [39]               |
| *Pterocarpus angolensis* DC.       | Fabaceae          | Paddle-wood     | Stem bark infusion                                                                                       | Bark            | Cattle          | Maggot-infested wounds  | Soyelu and Masika [51]             |
| *Pterocarpus angolensis* maprounefolia Pax | Phyllanthaceae   | Kudu berry      | Ground bark is mixed with water                                                                          | Bark            | Cattle          | Drought tonic           | Luseba and Tshisikhawwe [37]       |
| *Ptaeroxylon oblouquim* (Thunb.) Radlk. | Ptaeroxylaceae   | Sneezewood      | Decoction                                                                                                 | Leaves           | Goats           | Gastro-intestinal parasites | Maphosa and Masika [41]           |
| *Ptaeroxylon oblouquim* (Thunb.) Radlk. | Ptaeroxylaceae   | Sneezewood      | Crushed and soaked in cold water overnight (infusion)                                                    | Bark            | Cattle          | Ticks                   | Moyo and Masika [44]               |
| *Ptaeroxylon oblouquim* (Thunb.) Radlk. | Ptaeroxylaceae   | Sneezewood      | Crush bark is mixed with used oil to form paste. Leaf decoction                                          | Bark, leaves     | Cattle          | Wounds and myiasis      | Soyelu and Masika [51]             |

Table 2. Cont.
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| Plant Species                  | Family       | Common Name       | Method of Preparation and Administration | Plant Part Used | Animal Treated | Disease/Health Condition                                      | Reference                                |
|--------------------------------|--------------|-------------------|------------------------------------------|-----------------|----------------|--------------------------------------------------------------|------------------------------------------|
| *Pterocarpus angolensis* DC.   | Fabaceae     | Paddle-wood       | Soak the bark in water                    | Bark            | Cattle         | Mali and not eating                                         | Luseba and Tshisikhawe [37]            |
| *Pterocarpus angolensis* DC.   | Fabaceae     | Paddle-wood       | Chopped bark is soaked in cold water after the water has changed to reddish boil for 30–60 min | Bark            | ns             | General illness, unthriftiness, gallsickness, intestinal worms, blackquarter | Luseba and Van der Merwe [38]          |
| *Pterocarpus angolensis* DC.   | Fabaceae     | Paddle-wood       | Bark is ground to pulp                    | Bark, root bark | Cattle         | Wounds                                                      | Magwede et al., [39]                   |
| *Rapanea melanophloeos* (L.) Mez (Syn: *Myrsine melanophloeos* (L.) R.Br. ex Sweet) | Primulaceae  | Cape Beech        | Mixed with bark of *Curtisia dentata* and boiled for 30 min | Bark            | Cattle         | Heartwater                                                  | Dold and Cocks [34]                   |
| *Rauvolfia caffra* Sond.       | Apocynaceae  | Quinine tree      | Applied as powder on wounds               | Bark            | Cattle         | Wounds                                                      | Magwede et al., [39]                   |
| *Rhamnus prinoides* L’Hér.     | Rhamnaceae   | Dogwood           | Infusion                                  | Roots           | Goats          | Twin or triplets production                                 | Rwodzi [49]                            |
| *Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm. | Vitaceae     | Northern bushman’s grape | Bark is cooked or imbibed in cold water to produce a red decoction/infusion | Bark            | Cattle         | Redwater                                                   | Ramovha and Van Wyk [48]              |
| *Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm. | Vitaceae     | Northern bushman’s grape | Tuber is boiled in water for 15 min       | Tubers          | Goats, sheep   | Diarrhoea                                                  | Dold and Cocks [34]                   |
| *Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm. | Vitaceae     | Northern bushman’s grape | Leaves are boiled                          | Leaves          | Cattle         | Lumpy skin disease                                         | Luseba and Tshisikhawe [37]            |
| *Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm. | Vitaceae     | Northern bushman’s grape | ns                                        | Tubers          | Cattle         | Heartwater, redwater internal parasites                    | Van der Merwe et al., [52]            |
| *Rothmannia capensis* Thunb    | Rubiaceae    | Wild gardenia     | Decoction                                 | Roots           | Cattle         | Eating problem                                              | Luseba and Tshisikhawe [37]            |
| *Rothmannia capensis* Thunb    | Rubiaceae    | Wild gardenia     | Fresh fruits are grounded to pulp         | Fruit           | ns             | Wounds                                                      | Magwede et al., [39]                   |
Table 2. Cont.

| Plant Species | Family            | Common Name     | Method of Preparation and Administration | Plant Part Used | Animal Treated | Disease/Health Condition | Reference                        |
|---------------|-------------------|-----------------|------------------------------------------|-----------------|----------------|--------------------------|-----------------------------------|
| *Schotia brachypetala* Sond. | Fabaceae         | African walnut  | Ground bark is boiled in water           | Bark            | Cattle         | Foot and mouth diseases, black quarter, and general ailments | Khunoana et al., [36]              |
| *Schotia brachypetala* Sond. | Fabaceae         | African walnut  | Bark, preferably from the root, is cooked to make a decoction | Bark, root bark | Cattle         | Redwater                 | Ramovha and Van Wyk [48]          |
| *Schotia latifolia* Jacq.      | Fabaceae         | Bush Boerbean   | Decoction                                | Bark            | Goats          | Gastro-intestinal parasites | Maphosa and Masika [41]           |
| *Sclerocarya birrea* (A.Rich.) Hochst. | Anacardiaceae    | Marula          | Bark is soaked in cold water to yield an infusion or is cooked to produce a decoction | Bark            | Cattle         | Redwater                 | Ramovha and Van Wyk [48]          |
| *Searsia lancea* (L.f.) F.A.Barkley (Syn: *Rhus lancea* L.f.) | Anacardiaceae | Karee           | ns                                       | Roots           | Cattle         | Diarrhoea and fractures | Van der Merwe et al., [52]        |
| *Secamone filiformis* (L.f) J.H.Ross | Apocynaceae      | ns              | Stem is ground and mixed with cold water | Stem            | Cattle         | Diarrhoea                | Dold and Cocks [34]               |
| *Senna petersiana* (Bolle) Lock | Fabaceae         | Monkey pod      | Leaves are soaked                        | Leaves          | Goats          | General illnesses        | Luseba and Tshisikhawwe [37]       |
| *Senna petersiana* (Bolle) Lock | Fabaceae         | Monkey pod      | Ground root powder is mixed with warm water to yield an infusion | Root            | Cattle         | Redwater                 | Ramovha and Van Wyk [48]          |
| *Sideroxylon inerme* L.        | Sapotaceae       | White milkwood  | Bark is crushed and boiled for 20 min    | Bark            | Cattle         | Redwater                 | Dold and Cocks [34]               |
| *Solanum aculeastrum* Dunal    | Solanaceae       | Goat bitter-apple| Fresh fruits are ground to pulp          | Fruit           | ns             | Wounds                   | Magwede et al., [39]              |
| *Spirostachys africana* Sond.  | Euphorbiaceae    | Tamboti         | Bark is ground to pulp                   | Bark            | Cattle         | Wounds                   | Magwede et al., [39]              |
| *Spirostachys africana* Sond.  | Euphorbiaceae    | ns              | Wood                                     | Cattle          |                | Sweating sickness         | Van der Merwe et al., [52]        |
| Plant Species | Family         | Common Name   | Method of Preparation and Administration                                                                                                                                                                                                 | Plant Part Used | Animal Treated       | Disease/Health Condition                                                                 | Reference                  |
|---------------|----------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------|------------------------------------------------------------------------------------------|----------------------------|
| Strychnos decussata (Pappe) Gilg. | Loganiaceae | Cape teak     | Bark is crushed and soaked in water for 20 min, after which the infusion is strained                                                                                                                                                    | Bark             | Cattle               | Roundworms                                                                              | Dold and Cocks [34]       |
| Strychnos henningsii Gilg | Loganiaceae | Red bitter berry | Resin                                                                                                                                                                                                                                 | ns               | Cattle, sheep, goats | Arthritis                                                                               | Chitura et al., [33]      |
| Strychnos henningsii Gilg | Loganiaceae | Red bitter berry | Bark is soaked for 20 min and strained                                                                                                                                                                                                  | Bark             | Cattle               | Heartwater and diarrhoea                                                                | Dold and Cocks [34]       |
| Strychnos henningsii Gilg | Loganiaceae | Red bitter berry | Decoction                                                                                                                                                                                                                           | Bark             | Goats                | Gastro-intestinal parasites                                                           | Maphosa and Masika [41]   |
| Strychnos henningsii Gilg | Loganiaceae | Red bitter berry | ns                                                                                                                                                                                                                                    | Bark             | Cattle               | Paratyphoid (Goso)                                                                      | Mthi et al., [45]         |
| Tabernaemontana elegans Stapf | Apocynaceae | Toad tree       | Crushed or in tact roots are soaked in water to yield an infusion or are cooked to produce a decoction                                                                                                                                  | Roots            | Cattle               | Redwater                                                                               | Ramovha and Van Wyk [48]  |
| Tarchonanthus camphoratus L. | Asteraceae | Camphor bush   | Maceration                                                                                                                                                                                                                           | Leaves           | Cattle               | Retained placenta and pain alleviation                                                 | Moichwanetse et al., [43] |
| Tarchonanthus camphoratus L. | Asteraceae | Camphor bush   | Leaf infusion, oral route: The leaves of the plant are put in drinking water                                                                                                                                                           | Leaves           | ns                   | To prevent cold                                                                        | Ndou [47]                  |
| Terminalia sericea Burch. ex DC. | Combretaceae | Silver cluster-leaf | Ground roots are mixed with water to apply on the ticks and wounds. Roots are boiled and given to the animal                                                                                                                           | Roots            | Cattle               | Ticks and wounds, diarrhoea                                                            | Luseba and Tshisikhawwe [37] |
| Terminalia sericea Burch. ex DC. | Combretaceae | Silver cluster-leaf | Ground leaves are mixed with water and applied on the wound and are covered with cattle dung                                                                                                                                         | Leaves           | Cattle               | Wounds                                                                                 | Luseba and Van der Merwe [38] |
| Terminalia sericea Burch. ex DC. | Combretaceae | Silver cluster-leaf | Roots are ground to pulp and mixed with water                                                                                                                                                                                          | Roots            | Cattle               | Wounds and ticks                                                                       | Magwede et al., [39]      |
| Terminalia sericea Burch. ex DC. | Combretaceae | Silver cluster-leaf | Poultice                                                                                                                                                                                                                                | Leaves           | Cattle               | Retained placenta and uterus cleansing                                                  | Moichwanetse et al., [43] |
| Plant Species                  | Family           | Common Name               | Method of Preparation and Administration                                                                 | Plant Part Used | Animal Treated | Disease/Health Condition                      | Reference                        |
|-------------------------------|------------------|---------------------------|-----------------------------------------------------------------------------------------------------------|-----------------|----------------|-----------------------------------------------|-----------------------------------|
| *Terminalia sericea* Burch. ex DC. | Combretaceae     | Silver cluster-leaf       | Root-bark is soaked in cold water to yield an infusion, or dried bark is ground to a powder and is mixed with water | Roots, bark     | Cattle         | Redwater                                     | Ramovha and Van Wyk [48]          |
| *Terminalia sericea* Burch. ex DC. | Combretaceae     | Silver cluster-leaf       | ns                                                                                                        | Roots           | Cattle         | Diarrhoea                                    | Van der Merwe et al., [52]        |
| *Trema orientalis* (L.) Blume  | Cannabaceae      | Pigeonwood                | Ground leaves are mixed with water                                                                      | Leaves          | Cattle, goats, sheep | Eye problems and gallsickness              | Luseba and Tshisikhawe [37]       |
| *Triumfetta sonderi* Ficalho & Hiern | Malvaceae        | Sonders truimfetta        | ns                                                                                                        | Root-bark       | Cattle         | Retained placenta                           | Van der Merwe et al., [52]        |
| *Turraea obtusifolia* Hochst.  | Meliaceae        | Small honeysuckle tree    | Crushed leaves are applied directly on the wounds                                                        | Leaves          | Goats, sheep, cattle | Wounds                                     | Luseba and Tshisikhawe [37]       |
| *Vachellia karroo* (Hayne) Banfi & Galasso (Syn: Acacia karroo) | Fabaceae         | Sweet thorn               | Bark is chopped into small pieces and boiled                                                              | Bark            | Goats, sheep   | Diarrhoea and intestinal parasites           | Dold and Cocks [34]               |
| *Vachellia karroo* (Hayne) Banfi & Galasso (Syn: Acacia karroo) | Fabaceae         | Sweet thorn               | Maceration                                                                                               | Bulb            | Cattle         | Retained placenta and bacterial infections   | Moichwanetse et al., [43]         |
| *Vachellia karroo* (Hayne) Banfi & Galasso (Syn: Acacia karroo) | Fabaceae         | Sweet thorn               | Leaves are crushed and mixed with Madubula                                                               | Leaves          | Cattle         | Wounds and myiasis                          | Soyelu and Masika [51]            |
| *Vachellia karroo* (Hayne) Banfi & Galasso (Syn: Acacia karroo) | Fabaceae         | Sweet thorn               | ns                                                                                                        | Bark            | Cattle         | Fractures and diarrhoea                     | Van der Merwe et al., [52]        |
| *Vachellia karroo* (Hayne) Banfi & Gallaso (Syn: Acacia karroo)  | Fabaceae         | Sweet thorn               | For external coaptation of simple bone fractures (*thobega*)                                               | Thorn, bark     | ns             | Fracture repair and splints for fracture repair | Ndou [47]                        |
Table 2. Cont.

| Plant Species                  | Family       | Common Name          | Method of Preparation and Administration | Plant Part Used | Animal Treated | Disease/Health Condition         | Reference                        |
|-------------------------------|--------------|----------------------|------------------------------------------|------------------|----------------|----------------------------------|----------------------------------|
| *Vachellia tortilis* (Forssk.) Galasso & Banfi (Syn: *Acacia tortilis*) | Fabaceae     | Umbrella thorn ns    | ns                                       | Branch tips      | Cattle         | Diarrhoea                        | Van der Merwe et al., [52]       |
| *Volkameria glabra* (E.Mey.) Mabb. & Y.W.Yuan (Syn: *Clerodendrum capense* D.Don ex Steud.) | Lamiaceae    | Tinderwood ns         | ns                                       | Leaves ns        | Worms           |                                  | Kambizi [35]                     |
| *Withania somnifera* (L.) Dunal | Solanaceae   | winter cherry ns      | Tuber infusion combined with roots of *Solanum lichtensteinii* and *Bulbine abyssinica*, oral route | Tubers ns        | Internal sores |                                  | Ndou [47]                        |
| *Xanthocercis zambesiaca* (Baker) Dumaz-le-Grand | Fabaceae     | Nyala tree            | Ground bark is given to cattle for eating disorders. Ground bark is mixed with salt or leaves are soaked for 12 h | Bark, leaves ns  | Cattle         | Eating problem and diarrhoea     | Luseba and Tshisikhawe [37]       |
| *Xanthocercis zambesiaca* (Baker) Dumaz-le-Grand | Fabaceae     | Nyala tree            | Ground bark is applied topically         | Bark ns          | Wounds          |                                  | Magwede et al., [39]             |
| *Ximenia americana* L. var. microphylla Welw. ex Oliv. | Olacaceae    | Tallowwood            | Root-bark is powdered                     | Root bark        | Cattle sheep, goats | Wounds                         | Luseba and Tshisikhawe [37]       |
| *Ximenia americana* L. var. microphylla Welw. ex Oliv. | Olacaceae    | Tallowwood            | ns                                       | Roots ns         | Cattle          | Internal parasites               | Van der Merwe et al., [52]       |
| *Zanthoxylum capense* (Thunb.) Harv. | Rutaceae     | Small knobwood ns     | Infusion prepared *Grewia occidentalis*, *Olea europaea* subsp. *africana* leaves and *Aloe ferox* sap | Leaves ns        | Cattle         | Gallsickness                     | Dold and Cocks [34]              |
| *Zanthoxylum capense* (Thunb.) Harv. | Rutaceae     | Small knobwood        | Decoction                                 | Roots            | Goats           | Gastro-intestinal parasites      | Maphosa and Masika [41]          |
| *Ziziphus mucronata* Willd. | Rhamnaceae   | Buffalo thorn         | Leaf paste                               | Leaves           | Cattle          | Mastitis                         | Chitura et al., [33]             |
| Plant Species                          | Family         | Common Name       | Method of Preparation and Administration                                      | Plant Part Used  | Animal Treated | Disease/Health Condition | Reference                           |
|--------------------------------------|----------------|-------------------|-------------------------------------------------|------------------|----------------|--------------------------|-------------------------------------|
| *Ziziphus mucronata* Willd.          | Rhamnaceae     | Buffalo thorn     | Bark is soaked in water while leaves are ground into pulp | Bark and leaves  | ns             | Wound                   | Magwede et al., [39]               |
| *Ziziphus mucronata* Willd.          | Rhamnaceae     | Buffalo thorn     | Infusion                                         | Roots            | Goats          | Gastro-intestinal parasites | Maphosa and Masika [41]           |
| *Ziziphus mucronata* Willd.          | Rhamnaceae     | Buffalo thorn     | Poultice                                         | Roots            | Cattle         | Retained placenta        | Moichwanetse et al., (2020)        |
| *Ziziphus mucronata* Willd.          | Rhamnaceae     | Buffalo thorn     | Crushed leaves and soft branches poultice: crushed and placed on a hard abscess | Leaves, branches | ns             | Abscess ripening         | Ndou [47]                          |
| *Ziziphus mucronata* Willd.          | Rhamnaceae     | Buffalo thorn     | ns                                               | Leaves, roots    | Cattle         | Fertility enhancement, sores and burns | Van der Merwe et al., [52]         |
| *Ziziphus oxyphylla* Edgew (Syn: *Ziziphus acuminata* Royle) | Rhamnaceae     | Pointed-leaf jujube | Poultice                                         | Roots            | Cattle         | Retained placenta and increase stimulation for separating retained placenta | Moichwanetse et al., [43]          |
| *Ziziphus zeyheriana* Son.           | Rhamnaceae     | Dwarf buffalo-thorn | ns                                               | Root-stock       | ns             | Diarrhoea internal parasites. General ailments | Luseba and Van der Merwe [38]      |
| *Ziziphus zeyheriana* Son.           | Rhamnaceae     | Dwarf buffalo-thorn | Root decoction: Combined with roots of *Cadaba aphylla*, *Senna italica* and *Dicoma galpinii*. Root decoction combined with root of *Helichrysum caespititium*. Root decoction combined with root of *Grewia flava*, oral route. The sick calf is given about half a litre of the decoction orally | Roots            | Cattle         | Blood cleansing, pains (from sores, fractures), calf diarrhoea | Ndou [47]                          |
In terms of plant families (Figure 1), most of the identified plants were from the Fabaceae (19%), Apocynaceae (5.8%), Rubiaceae (5.8%), Anacardiaceae (4.8%), Combretaceae (4.8%), Euphorbiaceae (4.8%), Malvaceae (4.8%), Rhamnaceae (4.8%), and Celastraceae (3.8%) families. Even though 44 families were recorded, the majority (estimated 64%) of the families were represented by one woody plant. Based on the analysis of approximately 4576 vascular plants representing 192 families (from the 254 African families) with medicinal value in sub-Saharan African, the dominance of Fabaceae remains evident in African traditional medicine [58]. Furthermore, Fabaceae was the most represented plant family for plants used against cattle diseases in South Africa [59].

![Figure 1. Frequency of the 44 families of woody plants used in South African ethnoveterinary medicine. # = number of mention.](image)

Plant parts used to prepare herbal remedies included bark, leaves, fruits, roots, and flowers (Figure 2). However, the most commonly used plant parts for remedy preparations were bark (33%) followed by leaves (29%) and roots (19%). The dominance of plant parts such as bark and roots may not be sustainable overtime, as their indiscriminate harvesting is often of great conservation concerns for the survival of the plant [26]. Thus, conscious efforts remain essential to ensure good harvesting practices and the long-term sustainability of these valuable woody plants.

3.3. Overview of Animals/Livestock and Diseases

As shown in Figure 3, cattle were the major (61%) animal/livestock treated with the woody plants. In South Africa, the importance of cattle among different cultural groups cannot be overemphasized [1,59]. Van der Merwe et al., [52] documented the use of ethnoveterinary medicinal plants in cattle by the Setswana-speaking people in the Madikwe
area of the North West Province. The most important diseases treated were retained placenta, diarrhoea, fractures, fertility enhancement, general gastrointestinal problems, and pneumonia. A high proportion of the woody plants were used for diarrhoea. Some of the plants documented during the study are used elsewhere in the Eastern Cape to treat different livestock diseases. These include *Vachellia karroo*, *Vachellia tortils*, *Cussonia spicata*, *Rhoicissus tridentata*, and *Ziziphus mucronata*.

**Figure 2.** Distribution of different parts of woody plants used in the preparation of ethnoveterinary remedies in South Africa. Others denote parts such as seeds, fruits, flowers, and twigs. \( n = 184 \).

**Figure 3.** Distribution of animals identified in ethnoveterinary surveys for woody plants in South Africa. \( n = 189 \).
3.4. In Vitro Biological Screening of Woody Plants

The increasing incidence of drug resistance in most pathogenic bacteria and parasites that cause economic loss in animals/livestock production calls for the development of new sources for medication [60,61]. Among the 104 woody plants with ethnoveterinary uses in South Africa (Table 2), approximately 20% were screened for their relevant biological activities (e.g., antibacterial, anthelmintic, and antioxidant) and safety (cytotoxicity) level. However, the current review included woody plants that have been screened for biological activities without evidence of their ethnoveterinary use in South Africa. This approach may increase the success rate of bio-prospecting for therapeutic woody plants for ethnoveterinary needs in South Africa [62]. As highlighted by Eloff [63], no statistically significant difference was observed in the antimicrobial activity of plants with ethnobotanical knowledge when compared to randomly selected plants. Hence, the most promising biological activity may not correlate with the most popular plants with existing ethnobotanical knowledge [62,64].

3.4.1. Antibacterial Activity

Even though the antibacterial effects of 39 woody plants were reported (Table 3), approximately 56% of the 39 plants lacked ethnoveterinary applications in the eligible studies that were recorded (Tables 1 and 2). In terms of the assay-type, approximately 95% of the studies were conducting using the micro-plate dilution method, which is considered as a more robust and reliable assay relative to agar diffusion [63,64]. Based on the recorded antibacterial activity (Table 3), Gram-positive bacteria were more dominant (57% of the 14 organisms) than Gram-negative bacterial strains. Although a diverse range of bacterial strains was tested, the relevance and justification for their selection were unclear in most of the studies. Researchers need to be cognizant of the bacteria type in order to demonstrate the clinical relevance of the anti-bacterial effect of the tested plant extracts [64,65].

On the basis on the number of reports, five woody plants namely Alsophila dregei (Kunze) R.M.Tryon, Cussonia spicata Thunb, Indigofera frutescens L.f., Leucosidea sericea Eckl. and Zeyh, and Maesa lanceolata Forssk were the most studied woody plants in terms of their antibacterial effects (Table 3). The most noteworthy (MIC = 20–40 µg/mL) antibacterial effect (exerted against Bacillus anthracis) was demonstrated by acetone extracts of Bolusanthus speciosus (Bolus) Harms, Morus mesozygia Stapf, and Maesa lanceolata Forssk [66]. Likewise, Salmonella typhimurium was highly susceptible (MIC = 40 µg/mL) to acetone extracts from Crotalaria capensis leaves [67]. Furthermore, the acetone extract from Maesa lanceolata leaves exerted a broad-spectrum antibacterial effect by significantly (MIC = 160–630 µg/mL) inhibiting both Gram-positive (Enterococcus faecalis, Staphylococcus aureus) and Gram-negative (Escherichia coli, Pseudomonas aeruginosa, Salmonella typhimurium) bacterial strains [68]. Similar broad-spectrum antibacterial activity was demonstrated by the acetone leaf extracts of Indigofera frutescens L.f. (MIC = 80–310 µg/mL) and Leucosidea sericea (MIC = 20–80 µg/mL), as indicated by different authors [67–69].

Leaves/aerial parts (77%) and bark (17%) were the most common parts of the woody plants that were evaluated for their antibacterial activity. Remarkable differences in the antibacterial effect of woody plant parts were evident in Leucosidea sericea [69], Schotia brachypetala Sond, Searsia lancea (L.f.) F.A.Barkley (Rhhus lanceas), and Ziziphus mucronata Willd [70]. Particularly in Schotia brachypetala and Ziziphus mucronata, the leaf extracts had remarkable antibacterial effects against the tested bacterial strains while the bark extracts were ineffective. Furthermore, the type of solvent used for extracting the plant parts strongly influenced the resultant antibacterial response (Table 3). Despite the popularity of water as the most commonly used solvent in traditional medicine, water extracts often exhibit weaker antibacterial effects relative to many organic solvents [63].
Table 3. Examples of in vitro antibacterial activity of woody plants with ethnoveterinary applications in South Africa. # Plant species: denotes woody plants with ethnoveterinary uses in Table 2; MIC—minimum inhibitory concentration, ns—not specified.

| # Plant Species            | Plant Part | Solvent               | Test System                      | Test Organism                                      | Positive Control                  | Findings                                                                 | Reference        |
|----------------------------|------------|-----------------------|----------------------------------|-----------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------|------------------|
| Acokanthera oppositifolia  | Leaves     | Petroleum ether, dichloromethane, ethanol, and water | Serial microplate dilution       | *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* | Neomycin (0.39–1.56 µg/mL)       | All extract had no noteworthy (MIC > 1 mg/mL) antibacterial effect        | Aremu et al., [71] |
| Alsophila dregei (Kunze) R.M.Tryon (Syn: Cyathea dregei) | Leaves     | Acetone               | Serial microplate dilution       | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Gentamicin ≤ 0.02 mg/mL          | Moderate antibacterial activity with MIC = 0.63 mg/mL                     | Adamu et al., [68] |
| Alsophila dregei (Kunze) R.M.Tryon (Syn: Cyathea dregei) | Leaves, roots | Petroleum ether, dichloromethane, ethanol, and water | Serial microplate dilution       | *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* | Neomycin (0.39–1.56 µg/mL)       | Petroleum ether and ethanol root extracts had noteworthy antibacterial activity (MIC < 1 mg/mL) against Gram-positive bacteria | Aremu et al., [71] |
| Apodytes dimidiata E.Mey. ex Arn. | Leaves     | Acetone               | Serial microplate dilution       | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Gentamicin ≤ 0.02 mg/mL          | Moderate antibacterial activity with MIC = 0.31 mg/mL against *Staphylococcus aureus* and *Pseudomonas aeruginosa* | Adamu et al., [68] |
| Baphia racemosa (Hochst.) Baker | Leaves     | Acetone               | Serial microplate dilution       | *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium* | Gentamicin = 0.2–1.56 µg/mL       | Noteworthy effect against *Enterococcus faecalis* (MIC = 160 µg/mL) and *Staphylococcus aureus* (MIC = 310 µg/mL) | Dzoyem et al., [67] |
| Berchemia zeyheri (Sond.) Grubov | Bark       | Hexane, methanol, and water | Serial microplate dilution method | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Neomycin (0.78–25 µM)            | *Staphylococcus aureus* was susceptible (MIC < 1 mg/mL) to hexane and methanol extracts | McGaw et al., [70] |
| # Plant Species | Plant Part | Solvent | Test System | Test Organism | Positive Control | Findings | Reference |
|-----------------|------------|---------|-------------|---------------|------------------|----------|-----------|
| # Bolusanthus speciosus (Bolus) Harms | Leaves | Acetone | Serial microplate dilution | Bacillus anthracis | Gentamicin = 0.0002 mg/mL | MIC = 0.04 mg/mL | Elisha et al., [66] |
| # Calpurnia aurea (Aiton) Benth. | Leaves | Acetone | Serial microplate dilution | Bacillus anthracis | Gentamicin = 0.0002 mg/mL | MIC = 0.31 mg/mL | Elisha et al., [66] |
| Clausena anisata (Willd.) Hook.f. ex. Benth. | Leaves | Acetone | Serial microplate dilution | Escherichia coli, Enterococcus faecalis, Pseudomonas aeruginosa, and Staphylococcus aureus | Gentamicin ≤ 0.02 mg/mL | Noteworthy antibacterial activity (MIC = 0.16–0.31 mg/mL) | Adamu et al., [68] |
| Combretum caffrum Eckl. & Zeyh.) Kuntze | Bark | Acetone, methanol, and water | Agar plate | Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus cereus, Bacillus pumilus, Bacillus subtilis, Micrococcus kristinae, Klebsiella pneumonia, Serratia marcescens, and Enterobacter cloacae | ns | Methanol extract inhibited both Gram-positive and Gram-negative bacteria ranging from 0.5–5 mg/mL. Acetone extract mainly inhibited (MIC = 0.5 mg/mL) Gram-positive bacterial strains. Water extract showed activity against five Gram-positive and one Gram-negative bacteria | Masika and Afolayan [72] |
| Cremaspora triflora (Thonn.) K.Schum. | Leaves | Acetone | Serial microplate dilution | Bacillus anthracis | Gentamicin = 0.0002 mg/mL | MIC = 0.16 mg/mL | Elisha et al., [66] |
| Crotalaria capensis Jacq. | Leaves | Acetone | Serial microplate dilution | Staphylococcus aureus, Enterococcus faecalis, Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa, and Salmonella typhimurium | Gentamicin = 0.2–1.56 μg/mL | Noteworthy effect against Enterococcus faecalis (MIC = 80 μg/mL) and Salmonella typhimurium (MIC = 20 μg/mL) | Dzoyem et al., [67] |
| # Plant Species | Plant Part | Solvent | Test System | Test Organism | Positive Control | Findings | Reference |
|-----------------|------------|---------|-------------|---------------|------------------|----------|-----------|
| # Cussonia spicata Thunb. | Bark | Methanol and dichloromethane | Serial microplate dilution | Escherichia coli, Pseudomonas aeruginosa, and Staphylococcus aureus | Neomycin = 0.1 mg/mL | No noteworthy antibacterial activity | Luseba et al., [73] |
| # Cussonia spicata Thunb. | Root | Hexane, methanol, and water | Serial microplate dilution | Escherichia coli, Enterococcus faecalis, Pseudomonas aeruginosa, and Staphylococcus aureus | Neomycin (0.78–25 µM) | No noteworthy (MIC > 1 mg/mL) antibacterial effects for all of the tested extracts | McGaw et al., [70] |
| Dalbergia nitidula Baker | Leaves | Acetone | Serial microplate dilution | Staphylococcus aureus, Enterococcus faecalis, Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa, and Salmonella typhimurium | Gentamicin = 0.2–1.56 µg/mL | Noteworthy effect against Bacillus cereus (MIC = 80 µg/mL) | Dzoyem et al., [67] |
| # Dombeya rotundifolia (Hochst.) Planch. | Aerial part | Hexane, methanol, and water | Serial microplate dilution | Escherichia coli, Enterococcus faecalis, Pseudomonas aeruginosa, and Staphylococcus aureus | Neomycin (0.78–25 µM) | Methanol extract had noteworthy (MIC = 0.4 mg/mL) antibacterial effect against Gram-positive bacteria | McGaw et al., [70] |
| Elaeodendron croceum (Thunb.) DC. | Leaves | Acetone | Serial microplate dilution | Bacillus anthracis | Gentamicin = 0.0002 mg/mL | MIC = 0.31 mg/mL | Elisha et al., [66] |
| Erythrina caffra Thunb. | Leaves | Acetone | Serial microplate dilution | Staphylococcus aureus, Enterococcus faecalis, Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa, and Salmonella typhimurium | Gentamicin = 0.2–1.56 µg/mL | Noteworthy effect against Enterococcus faecalis (MIC = 80 µg/mL) | Dzoyem et al., [67] |
| # Euphorbia cupularis Boiss. Synadenium cuplare | Stem/leaves | Hexane | Serial microplate dilution | Escherichia coli, Enterococcus faecalis, Pseudomonas aeruginosa, and Staphylococcus aureus | Neomycin (0.78–25 µM) | Hexane extract showed a weak inhibition against two Gram-positive bacteria | McGaw et al., [70] |
| #     | Plant Species                               | Plant Part | Solvent          | Test System                  | Test Organism                                      | Positive Control     | Findings                                                      | Reference          |
|-------|---------------------------------------------|------------|------------------|------------------------------|----------------------------------------------------|----------------------|----------------------------------------------------------------|--------------------|
| 6     | *Heteromorpha arborescens* (Spreng.) Cham. & Schltdl. | Leaves     | Acetone          | Serial microplate dilution   | *Bacillus anthracis*                               | Gentamicin = 0.0002 mg/mL | MIC = 0.16 mg/mL                                              | Elisha et al., [66] |
|       | *Heteromorpha trifoliata* (H.L.Wendl.) Eckl. & Zeyh | Leaves     | Acetone          | Serial microplate dilution   | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Gentamicin ≤ 0.02 mg/mL | Moderate antibacterial activity with MIC = 0.63 against two Gram-negative bacteria | Adamu et al., [68] |
| 7     | *Hippobromus pauciflorus* (L.f.) Radlk.      | Aerial part | Hexane, methanol, and water | Serial microplate dilution   | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Neomycin (0.78–25 µM) | Methanol extracts had noteworthy antibacterial effect (MIC = 0.2 mg/mL) against *Staphylococcus aureus* | McGaw et al., [70] |
|       | *Indigofera frutescens* L.f. (Syn: *Indigofera cylindrica* DC.) | Leaves     | Acetone          | Serial microplate dilution   | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Gentamicin ≤ 0.02 mg/mL | Noteworthy antibacterial effect (MIC = 0.08–0.31 mg/mL) against the four bacterial strains | Adamu et al., [68] |
|       | *Indigofera frutescens* L.f. (Syn: *Indigofera cylindrica* DC.) | Leaves     | Acetone          | Serial microplate dilution   | *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium* | Gentamicin = 0.2–1.56 µg/mL | Noteworthy effect against *Salmonella typhimurium* (MIC = 40 µg/mL) | Dzoyem et al., [67] |
|       | *Leucosidea sericea* Eckl. & Zeyh.          | Leaves     | Acetone          | Serial microplate dilution   | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Gentamicin ≤ 0.02 mg/mL | Noteworthy antibacterial effect (MIC = 0.02–0.08 mg/mL) against the four bacterial strains | Adamu et al., [68] |
| # Plant Species            | Plant Part          | Solvent                  | Test System                      | Test Organism                                                                 | Positive Control | Findings                                                                                     | Reference |
|---------------------------|---------------------|--------------------------|----------------------------------|-------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------|-----------|
| *Leucosidea sericea* Eckl. & Zeyh. | Leaves, stem | Petroleum ether, dichloromethane, ethanol, water | Serial microplate dilution | *Bacillus subtilis,* *Staphylococcus aureus,* *Escherichia coli,* and *Klebsiella pneumonia* | Neomycin (0.39–1.56 µg/mL) | Majority of the solvent extracts from the leaves had noteworthy antibacterial effect (MIC = 0.025–0.78 mg/mL) against all four bacterial strains. Stem organic solvent extracts had remarkable MIC (0.39–0.78 mg/mL) against Gram-positive bacteria | [69]      |
| *Lonchocarpus nelsii* (Schinz) Heering & Grimme | Leaves | Acetone | Serial microplate dilution | *Staphylococcus aureus,* *Enterococcus faecalis,* *Bacillus cereus,* *Escherichia coli,* *Pseudomonas aeruginosa,* and *Salmonella typhimurium* | Gentamicin = 0.2–1.56 µg/mL | Noteworthy effect against *Enterococcus faecalis* and *Salmonella typhimurium* (MIC = 80 µg/mL) | Dzoyem et al., [67] |
| *Maesa lanceolata* Forssk. | Leaves | Acetone | Serial microplate dilution | *Escherichia coli,* *Enterococcus faecalis,* *Pseudomonas aeruginosa,* and *Staphylococcus aureus* | Gentamicin ≤ 0.02 mg/mL | Noteworthy antibacterial effect (MIC = 0.02–0.08 mg/mL) against the four bacterial strains | Adamu et al., [68] |
| *Maesa lanceolata* Forssk. | Leaves | Acetone | Serial microplate dilution | *Bacillus anthracis* | Gentamicin = 0.0002 mg/mL | MIC = 0.02 mg/mL | Elisha et al., [66] |
| *Melia azedarach* L. | Leaves | Acetone | Serial microplate dilution | *Escherichia coli,* *Enterococcus faecalis,* *Pseudomonas aeruginosa,* and *Staphylococcus aureus* | Gentamicin ≤ 0.02 mg/mL | Noteworthy antibacterial effect (MIC = 0.16–0.63 mg/mL) against the four bacterial strains | Adamu et al., [68] |
Table 3. Cont.

| # Plant Species                  | Plant Part | Solvent          | Test System                  | Test Organism                                                                 | Positive Control | Findings                                                                 | Reference                |
|---------------------------------|------------|------------------|------------------------------|-------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------|--------------------------|
| # Millettia grandis (E.Mey.) Skeels | Leaves     | Acetone          | Serial microplate dilution   | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Gentamicin $\leq 0.02$ mg/mL | Moderate antibacterial activity with MIC = 0.31 mg/mL against four bacteria | Adamu et al., [68]       |
| Morus mesozygia Stapf           | Leaves     | Acetone          | Serial microplate dilution   | *Bacillus anthracis*                                                          | Gentamicin = 0.0002 mg/mL | MIC = 0.04 mg/mL                                                         | Elisha et al., [66]       |
| # Pittosporum viridiflorum Sims | Leaves     | Acetone          | Serial microplate dilution   | *Bacillus anthracis*                                                          | Gentamicin = 0.0002 mg/mL | MIC = 0.08 mg/mL                                                         | Elisha et al., [66]       |
| Podalyria calyptrata (Retz.) Willd. | Leaves     | Acetone          | Serial microplate dilution   | *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium* | Gentamicin = 0.2–1.56 $\mu$g/mL | Noteworthy effect against *Salmonella typhimurium* (MIC = 160 $\mu$g/mL) | Dzoyem et al., [67]       |
| # Pterocarpus angolensis DC.     | Bark       | Dichloromethane and 90% methanol | Serial microplate dilution | *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Neomycin = 0.1 mg/mL | Moderate antibacterial activity with MIC = 0.31 mg/mL against *Staphylococcus aureus* | Luseba et al., [73]       |
| Salix mucronata subsp. capensis (Thunb.) Immelman (Salix capensis) | Bark       | Acetone, methanol, and water | Agar plate                    | *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus cereus*, *Bacillus pumilus*, *Bacillus subtilis*, *Micrococcus kristinae*, *Klebsiella pneumonia*, *Serratia marcescens*, and *Enterobacter cloacae* | ns                | Acetone and methanol extracts inhibited both Gram-positive and Gram-negative bacteria ranging from 0.5 to 5 mg/mL | Masika and Afolayan [72] |
| # Plant Species | Plant Part | Solvent          | Test System                          | Test Organism                                                      | Positive Control          | Findings                                                                 | Reference     |
|-----------------|------------|------------------|--------------------------------------|-------------------------------------------------------------------|---------------------------|--------------------------------------------------------------------------|---------------|
| # Schotia brachypetala Sond. | Bark, leaves | Hexane, methanol, and water | Serial microplate dilution | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Neomycin (0.78–25 µM) | Bark methanol extract had noteworthy antibacterial effect (MIC = 0.1–0.2 mg/mL) against two Gram-positive bacterial strains. Leaf methanol extract had noteworthy antibacterial effect (MIC = 0.2–0.4 mg/mL) against two Gram-positive bacterial strains | McGaw et al., [70] |
| # Sclerocarya birrea (A. Rich.) Hochst. | Leaves | Hexane, methanol, and water | Serial microplate dilution | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Neomycin (0.78–25 µM) | Methanol extract had noteworthy antibacterial effect (MIC = 0.1–0.4 mg/mL) against two Gram-positive bacterial strains | McGaw et al., [70] |
| # Searsia lancea (L.f.) F.A.Barkley (Rhus lanceas) | Bark, leaves | Hexane, methanol, and water | Serial microplate dilution | *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* | Neomycin (0.78–25 µM) | Bark methanol extract had noteworthy antibacterial effect (MIC = 0.2 mg/mL) against two Gram-positive bacterial strains. Leaf methanol extract had noteworthy MIC (0.2 mg/mL) against *Staphylococcus aureus* | McGaw et al., [70] |
| Virgilia divaricata Adamson | Leaves | Acetone | Serial microplate dilution | *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium* | Gentamicin = 0.2–1.56 µg/mL | Noteworthy effect against *Bacillus cereus* and *Salmonella typhimurium* (MIC = 80 µg/mL) | Dzoyem et al., [67] |
| # Plant Species                          | Plant Part | Solvent      | Test System                  | Test Organism                                      | Positive Control                  | Findings                                                                                     | Reference        |
|-----------------------------------------|------------|--------------|------------------------------|----------------------------------------------------|----------------------------------|---------------------------------------------------------------------------------------------|-----------------|
| *Volkameria glabra* (E. Mey.) Mabb. &   | Leaves     | Acetone      | Serial microplate dilution   | *Escherichia coli*, *Enterococcus faecalis*,      | Gentamicin ≤ 0.02 mg/mL          | Noteworthy antibacterial effect (MIC = 0.31–0.63 mg/mL) against two Gram-negative bacterial strains | Adamu et al., [68] |
| Y. W. Yuan (Syn: *Clerodendrum glabrum*)|            |              |                              | *Pseudomonas aeruginosa*, and *Staphylococcus aureus* |                    |                                                                                             |                  |
| *Xylium torreana* Brenan               | Leaves     | Acetone      | Serial microplate dilution   | *Staphylococcus aureus*, *Enterococcus faecalis*, | Gentamicin = 0.2–1.56 μg/mL      | Noteworthy effect against *Bacillus cereus* and *Salmonella typhimurium* (MIC = 160 μg/mL)  | Dzoyem et al., [67] |
|                                         |            |              |                              | *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium* |                    |                                                                                             |                  |
| *Zanthoxylum capense* (Thunb.) Harv.    | Leaves     | Acetone      | Serial microplate dilution   | *Escherichia coli*, *Enterococcus faecalis*,      | Gentamicin ≤ 0.02 mg/mL          | Noteworthy antibacterial effect (MIC = 0.31 mg/mL) against *Enterococcus faecalis* and *Pseudomonas aeruginosa* | Adamu et al., [68] |
|                                         |            |              |                              | *Pseudomonas aeruginosa*, and *Staphylococcus aureus* |                    |                                                                                             |                  |
| *Ziziphus mucronata* Willd.             | Bark, leaves | Hexane, methanol, and water | Serial microplate dilution | *Escherichia coli*, *Enterococcus faecalis*,      | Neomycin (0.78–25 μM)           | Bark extracts had no noteworthy antibacterial effect (MIC > 1 mg/mL) against all of the tested bacterial strains. Leaf methanol extracts had noteworthy antibacterial effect (MIC = 0.2 mg/mL) against *Staphylococcus aureus* | McGaw et al., [70] |
3.4.2. Anthelmintic Activity

As highlighted by Aremu et al., [74], evaluating anthelmintic potential is often conducted using (i) developmental and behavioural assays (DBA) and (ii) colorimetric assays (CA). Following treatment and incubation with plant extracts, the assays measure the survival and/or reproductive potential (DBA) or metabolic response using the appropriate marker (CA). A total of 48 woody plants have been tested for their anthelmintic activity, which was mainly (90%) assessed using DBA (Table 4). However, only 42% of these woody plants had existing indigenous knowledge related to the management of animal health among local communities in South Africa. *Alsophila dregei* (Kunze) R.M.Tryon, *Leucosidea sericea*, and *Sclerocarya birrea* were identified as the most commonly evaluated woody plants in terms of their anthelmintic effect. Using predefined anthelmintic effect categories [69], the organic solvent extracts of *Leucosidea sericea* had high (minimum lethal concentration, MLC = 0.26–0.52 mg/mL) anthelmintic activity against *Caenorhabditis elegans* [69]. Likewise, Fouche et al., [75] demonstrated that *Maerua angolensis* stem extract exerted 65% inhibition, which was noteworthy among all of the evaluated woody plants. Furthermore, extracts from *Heteromorpha trifoliata*, *Maesa lanceolate*, and *Leucosidea sericea* using an egg hatch assay (e.g., of DBA) exhibited significant anthelmintic activity against *Haemonchus contortus* and killed 100% of the parasites when administered at the dosages of 12.50, 6.25, and 3.13 mg/mL [76]. Fouche et al., [75] investigated the acetone extracts of various woody plants for their anthelmintic activity against *Haemonchus contortus*, and the stem of *Maerua angolensis* had a mean inhibition rate of 65%, which was noteworthy compared to the other plants tested and included in the review.

*Caenorhabditis elegans* (63%), *Haemonchus contortus* (35%), and *Trichostrongylus colubriformis* (2%) have been the widely used organisms for assessing the anthelmintic effects of woody species (Table 4). In recent times, the use of free-living nematodes, particularly, have remained common due to their inherent benefits [74,77,78]. *Caenorhabditis elegans* is regarded as the best representative of a large phylum that contains several parasites [78]. However, the use of *Caenorhabditis elegans* as a test organism has resulted in limited success in terms of the discovery of valuable new leads [62,77,79]. Hence, *Caenorhabditis elegans* should only serve as a screening tool for the rapid identification of promising plant extracts that will be further subjected to more appropriate test model(s).

The type of solvents used for plant extraction has a critical influence on the anthelmintic effect of woody plants (Table 4). For instance, the ethyl acetate extract of *Combretum apiculatum* exhibited strong lethality, killing 70–80% of nematodes (*Caenorhabditis elegans*) while the water extract had a 10–20% killing rate at 1 mg/mL [80]. Furthermore, *Searsia lancea* hexane extract had higher (50%) in vitro anthelmintic activity against *Caenorhabditis elegans* than the methanol and water extracts did [70]. The in vitro anthelmintic efficacy of several woody plants against *Caenorhabditis elegans* revealed that ethanol extracts possessed higher anthelmintic activity than water extracts [71].

Contrary to the majority of studies focusing on a single test organism (Table 4), Shai et al., [81] evaluated the anthelmintic activity of *Curtisia dentata* against parasitic (*Trichostrongylus colubriformis* and *Haemonchus contortus*) and the free-living (*Caenorhabditis elegans*) nematodes. The acetone and dichloromethane extracts were active against all of the nematodes at concentrations as low as 160 µg/mL. This finding clearly highlights the anthelmintic potential of *Curtisia dentata*, which requires further experiments, especially in terms of its in vivo response.
Table 4. Examples of anthelmintic effects of woody plants with ethnoveterinary applications in South Africa. # Plant species: denotes woody plants with ethnoveterinary uses in Table 2; $^*$ Assay type: CA—colourimetric assay, DBA—developmental and behavioral assay; * Findings: EHA—egg hatch assay; LDT—larval development test; MLC—minimum lethal concentration.

| # Plant Species | Solvent | $^*$ Assay Type | Plant-Part | Parasite | Positive Control | * Findings | Reference |
|-----------------|---------|----------------|-----------|----------|------------------|------------|-----------|
| *Acokanthera oppositifolia* (Lam.) Codd | Petroleum ether, dichloromethane, ethanol, and water | CA | Leaves, twigs | *Caenorhabditis elegans* | Levamisole (40 µg/mL) | Petroleum ether and ethanol leaf extracts had noteworthy MLC (0.52 mg/mL) | Aremu et al., [71] |
| *Alsophila dregei* (Kunze) R.M.Tryon (*Cyathea dregei*) | Petroleum ether, dichloromethane, ethanol, and water | CA | Leaves, roots | *Caenorhabditis elegans* | Levamisole (40 µg/mL) | Dichloromethane and ethanol leaf extracts had noteworthy MLC (0.52 mg/mL) | Aremu et al., [71] |
| *Alsophila dregei* (Kunze) R.M.Tryon (*Cyathea dregei*) | Acetone | DBA | Leaves | *Haemonchus conortus* | Albendazole (0.008–25 µg/mL) | EC$_{50}$ = 17.64 mg/mL (EHA), 17.93 mg/mL (LDT) | Adamu et al., [76] |
| *Apodytes dimidiata* | Acetone | DBA | Leaves | *Haemonchus conortus* | Albendazole (0.008–25 µg/mL) | EC$_{50}$ = 5.7 mg/mL (EHA), 4.13 mg/mL (LDT) | Adamu et al., [76] |
| *Berchemia zeyheri* | Hexane, methanol, and water | DBA | Bark | *Caenorhabditis elegans* | Levamisole (10 µg/mL) | Methanol extract had moderate (30%) lethality at 2 mg/mL | McGaw et al., [80] |
| *Brachylaena discolor* | Acetone | DBA | Leaves | *Haemonchus conortus* | Albendazole (0.008–25 µg/mL) | EC$_{50}$ = 3.55 mg/mL (EHA), 17.23 mg/mL (LDT) | Adamu et al., [76] |
| *Calpurnia aurea* | Acetone | DBA | Leaves/flowers, stem | *Haemonchus conortus* | Albendazole (100% at 0.008–25 µg/mL) | EHA inhibition = 27% (leaves/flowers), 32% (stem) | Fouche et al., [75] |
| *Clausena anisata* | Acetone | DBA | Leaves | *Haemonchus conortus* | Albendazole (0.008–25 µg/mL) | EC$_{50}$ = 1.8 mg/mL (EHA), 2.07 mg/mL (LDT) | Adamu et al., [76] |
| *Combretum apiculatum* Sond. Subsp. *Apiculatum* | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Ethyl acetate extract had 70–80% lethality at 1 mg/mL | McGaw et al., [80] |
| *Combretum bracteosum* (Hochst.) Engl. & Diels | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | No activity observed | McGaw et al., [80] |
| # Plant Species | Solvent | $ ^* $ Assay Type | Plant-Part | Parasite | Positive Control | * Findings | Reference |
|-----------------|---------|------------------|------------|----------|-----------------|-----------|-----------|
| *Combretum celastroides* Welw ex Laws subsp. Celastroides | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | No activity observed | McGaw et al., [80] |
| *Combretum collinum* Fresen | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone extract had 10–20% lethality at 0.5 and 1 mg/mL | McGaw et al., [80] |
| *Combretum edwardsii* Exell | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone and ethyl acetate extracts had 10–20% lethality at 1 mg/mL | McGaw et al., [80] |
| *Combretum erythrophyllum* (Burch.) Sond. | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone and ethyl acetate extracts had 10–20% lethality at 1 mg/mL | McGaw et al., [80] |
| *Combretum hereroense* Schinz | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone extract had 20–30% lethality at 1 mg/mL | McGaw et al., [80] |
| *Combretum imberbe* Wawra | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone extract had 20–30% lethality at 1 mg/mL | McGaw et al., [80] |
| *Combretum kraussii* Hochst. (Syn: *Combretum nelsonii*) | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone extract had 20–30% lethality at 0.5 mg/mL | McGaw et al., [80] |
| # *Combretum microphyllum* | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone and ethyl acetate extracts had 10–20% lethality at 0.5 and 1 mg/mL | McGaw et al., [80] |
| *Combretum mkuzense* J.D.Carr & Retief | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | Acetone extract had 20–30% lethality at 1 mg/mL | McGaw et al., [80] |
| *Combretum moggi* Exell | Ethyl acetate, acetone, and water | DBA | Leaves | *Caenorhabditis elegans* | Levamisole | No activity observed | McGaw et al., [80] |
Table 4. Cont.

| # Plant Species          | Solvent                              | $ Assay Type | Plant-Part | Parasite                      | Positive Control | * Findings                                                                 | Reference          |
|--------------------------|--------------------------------------|--------------|------------|-------------------------------|------------------|-----------------------------------------------------------------------------|-------------------|
| # Combretum molle R.Br. ex. G.Don | Ethyl acetate, acetone, and water | DBA          | Leaves     | Caenorhabditis elegans        | Levamisole       | Acetone extract had 20–30% lethality at 1 mg/mL                             | McGaw et al., [80] |
| Combretum mossambicense (Klotzsch) Engl. | Ethyl acetate, acetone, and water | DBA          | Leaves     | Caenorhabditis elegans        | Levamisole       | Acetone extract had 20–30% lethality at 1 mg/mL                             | McGaw et al., [80] |
| Combretum padoides Engl.  | Ethyl acetate, acetone, and water    | DBA          | Leaves     | Caenorhabditis elegans        | Levamisole       | No activity observed                                                        | McGaw et al., [80] |
| # Combretum paniculatum Vent. | Ethyl acetate, acetone, and water | DBA          | Leaves     | Caenorhabditis elegans        | Levamisole       | Acetone extract had 10–20% lethality at 0.5 mg/mL                            | McGaw et al., [80] |
| Combretum petrophilum Retief | Ethyl acetate, acetone, and water | DBA          | Leaves     | Caenorhabditis elegans        | Levamisole       | Acetone extract had 10–20% lethality at 0.5 mg/mL                            | McGaw et al., [80] |
| Combretum woodii         | Ethyl acetate, acetone, and water    | DBA          | Leaves     | Caenorhabditis elegans        | Levamisole       | No activity observed                                                        | McGaw et al., [80] |
| Combretum zeyheri        | Ethyl acetate, acetone, and water    | DBA          | Leaves     | Caenorhabditis elegans        | Levamisole       | No activity observed                                                        | McGaw et al., [80] |
| # Curtisia dentata       | Dichloromethane and acetone          | DBA          | Leaves     | Caenorhabditis elegans, Haemonchus contortus, Trichostrongylus colubriformis | Levamisole (10 µg/mL) | Acetone extracts had the highest inhibition at 2.5 mg/mL after 2 h and 7 days of incubation. Both extracts inhibited the highest motility at 1.25–2.5 (Haemonchus contortus) and 0.63–2.5 mg/mL (Trichostrongylus colubriformis) | Shai et al., [81] |
| # Cussonia spicata       | Hexane, methanol, and water          | DBA          | Roots      | Caenorhabditis elegans        | Levamisole (10 µg/mL) | No noteworthy activity                                                      | McGaw et al., [70] |
| # Plant Species         | Solvent                   | $\text{Assay Type}$ | Plant-Part | Parasite                | Positive Control | * Findings                                      | Reference          |
|-------------------------|---------------------------|---------------------|------------|-------------------------|------------------|-------------------------------------------------|--------------------|
| *Dombeya rotundifolia*  | Hexane, methanol, and water | DBA                 | Aerial parts | *Caenorhabditis elegans* | Levamisole (10 \(\mu\)g/mL) | Water extract had 20% lethality at 1 and 2 mg/mL | McGaw et al., [70] |
| *Euphorbia cupularis*   | Hexane, methanol, and water | DBA                 | Stem/leaves | *Caenorhabditis elegans* | Levamisole (10 \(\mu\)g/mL) | No noteworthy activity                            | McGaw et al., [70] |
| *Ficus sycomorus*       | Acetone                   | DBA                 | Bark/stem, stem | *Haemonchus contortus* | Albendazole (100% at 0.008–25 \(\mu\)g/mL) | EHA inhibition = 25% (bark/stem), 21% (stem) | Fouche et al., [75] |
| *Heteromorpha trifoliata* | Acetone                   | DBA                 | Leaves     | *Haemonchus contortus* | Albendazole (0.008–25 \(\mu\)g/mL) | \(EC_{50} = 0.62\) mg/mL (EHA), 0.64 mg/mL (LDT) | Adamu et al., [76] |
| *Hippobromus pauciflorus* | Hexane, methanol, and water | DBA                 | Aerial parts | *Caenorhabditis elegans* | Levamisole (10 \(\mu\)g/mL) | Hexane extract had 50% lethality at 2 mg/mL       | McGaw et al., [70] |
| *Indigofera frutescens* | Acetone                   | DBA                 | Leaves     | *Haemonchus contortus* | Albendazole (0.008–25 \(\mu\)g/mL) | \(EC_{50} = 7.11\) mg/mL (EHA), 7.58 mg/mL (LDT) | Adamu et al., [76] |
| *Leucosidea sericea*    | Acetone                   | DBA                 | Leaves     | *Haemonchus contortus* | Albendazole (0.008–25 \(\mu\)g/mL) | \(EC_{50} = 1.08\) mg/mL (EHA), 1.27 mg/mL (LDT) | Adamu et al., [76] |
| *Leucosidea sericea*    | Petroleum ether, dichloromethane, ethanol, and water | CA                  | Leaves, stem | *Caenorhabditis elegans* | Levamisole (40 \(\mu\)g/mL) | Petroleum ether, dichloromethane, and ethanol leaf extracts had noteworthy anthelmintic effect (MLC = 0.26–0.52 mg/mL) | Aremu et al., [69] |
| *Maerua angolensis*     | Acetone                   | DBA                 | Stem, leaves | *Haemonchus contortus* | Albendazole (100% at 0.008–25 \(\mu\)g/mL) | EHA inhibition = 65% (stem), 25% (leaves)         | Fouche et al., [75] |
| *Maesa lanceolata*      | Acetone                   | DBA                 | Leaves     | *Haemonchus contortus* | Albendazole (0.008–25 \(\mu\)g/mL) | \(EC_{50} = 0.72\) mg/mL (EHA), 1.68 mg/mL (LDT) | Adamu et al., [76] |
| *Melia azedarach*       | Acetone                   | DBA                 | Leaves     | *Haemonchus contortus* | Albendazole (0.008–25 \(\mu\)g/mL) | \(EC_{50} = 6.24\) mg/mL (EHA), 10.96 mg/mL (LDT) | Adamu et al., [76] |
| *Milletia grandis*      | Acetone                   | DBA                 | Leaves     | *Haemonchus contortus* | Albendazole (0.008–25 \(\mu\)g/mL) | \(EC_{50} = 5.57\) mg/mL (EHA), 6.11 mg/mL (LDT) | Adamu et al., [76] |
Table 4. Cont.

| # Plant Species                      | Solvent                     | $^5$ Assay Type | Plant-Part | Parasite         | Positive Control | * Findings                                                                 | Reference                  |
|--------------------------------------|-----------------------------|----------------|------------|------------------|------------------|---------------------------------------------------------------------------|---------------------------|
| # Schotia brachypetala Sond          | Hexane, methanol, and water | DBA            | Leaves, bark | Caenorhabditis elegans | Levamisole (10 µg/mL) | All solvent extracts from bark had 10% at 2 mg/mL. Hexane extract from leaves had 10% lethality at 2 mg/mL. | McGaw et al., [70]         |
| # Sclerocarya birrea                 | Acetone                     | DBA            | Fruit      | Haemonchus contortus | Albendazole (100% at 0.008–25 µg/mL) | EHA inhibition = 28%                                                     | Fouche et al., [75]        |
| # Sclerocarya birrea                 | Hexane, methanol, and water | DBA            | Bark       | Caenorhabditis elegans | Levamisole (10 µg/mL) | Methanol extract had 40% lethality at 2 mg/mL.                            | McGaw et al., [70]         |
| # Searsia lancea (Syn: Rhus lancea)  | Hexane, methanol, and water | DBA            | Leaves, bark | Caenorhabditis elegans | Levamisole (10 µg/mL) | Hexane extracts had 50% (leaves) and 40% (bark) lethality at 2 mg/mL.    | McGaw et al., [70]         |
| # Senna petersiana                   | Petroleum ether, dichloromethane, ethanol, and water | CA            | Leaves      | Caenorhabditis elegans | Levamisole (40 µg/mL) | Ethanol extract = 0.52 mg/mL.                                             | Aremu et al., [71]         |
| Strychnos mitis                     | Acetone                     | DBA            | Leaves      | Haemonchus contortus | Albendazole (0.008–25 µg/mL) | $EC_{50} = 16.56 \text{ mg/mL (EHA), 16.94 mg/mL (LDT)}$                  | Adamu et al., [76]         |
| # Tabernaemontana elegans           | Acetone                     | DBA            | Leaves      | Haemonchus contortus | Albendazole (100% at 0.008–25 µg/mL) | EHA inhibition = 47%                                                     | Fouche et al., [75]        |
| # Volkameria glabra (Syn: Clerodendrum glabrum) | Acetone                     | DBA            | Leaves      | Haemonchus contortus | Albendazole (0.008–25 µg/mL) | $EC_{50} = 1.48 \text{ mg/mL (EHA), 12.97 mg/mL (LDT)}$                  | Adamu et al., [76]         |
| # Zanthoxylum capense                | Acetone                     | DBA            | Leaves      | Haemonchus contortus | Albendazole (0.008–25 µg/mL) | $EC_{50} = 13.26 \text{ mg/mL (EHA), 13.64 mg/mL (LDT)}$                  | Adamu et al., [76]         |
| # Ziziphus mucronata                 | Hexane, methanol, and water | DBA            | Bark, leaves | Caenorhabditis elegans | Levamisole (10 µg/mL) | No noteworthy activity                                                    | McGaw et al., [70]         |
3.4.3. Antioxidant Activity

Antioxidants are free radical scavengers and often possess the ability to reverse or repair the damage caused by free radicals in animal cells [82]. Recently, there has been increasing interest in determining the antioxidant potential of plants used for medicinal purposes [83]. It is generally known that damages caused by reactive oxygen species are often a contributing factor to many diseases [84]. As shown in Table 5, the antioxidant potential of the 24 woody plants have mainly been evaluated via in vitro assays including ABTS—2,2′-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid), DPPH—1,1-diphenyl-2-picryl-hydrazyl, and FRAP—ferric reducing antioxidant power. Relative to the inventory in Table 2, only six woody plants show antioxidant activity.

Given that these bio-analytical assays differ in terms of reaction mechanisms, oxidant, and target species as well as reaction conditions [82], it is often beneficial to evaluate plant extracts in multi-assays. Based on the DPPH assay, the most promising \(EC_{50}<5\,\mu\text{g/mL}\) antioxidant activity was exerted by woody plants such as *Alsophila dregei*, *Apodytes dimidiata*, *Brachylaena discolor*, *Burkea africana*, *Clausena anisata*, *Combretanum zeyheri*, *Milletia grandis*, *Strychnos nisinis*, *Volkameria glabra*, and *Zanthoxylum capense*. Similar noteworthy antioxidant effects was observed in the ABTS assay for *Burkea africana* and *Combretum zeyheri* [85]. However, moderate antioxidant activity ranging from 68–579 \(\mu\text{g/mL}\) was demonstrated among the eight evaluated woody plants. These aforementioned antioxidant tests were in vitro-based, thereby limiting the clinical relevance of the current findings. Hence, it will be pertinent to establish the in vivo antioxidant activity of woody plants with noteworthy response.

Table 5. Examples of in vitro antioxidant effect of woody plants used for ethnoveterinary medicine in South Africa. # Plant species: denotes woody plants with ethnoveterinary uses in Table 2. ABTS—2,2′-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid), DPPH—1,1-diphenyl-2-picryl-hydrazyl, FRAP—ferric reducing antioxidant power, TEAC—trolox equivalent antioxidant assay.

| # Plant Species | Assay Type | Plant Part | Findings | Reference |
|-----------------|------------|------------|----------|-----------|
| *Alsophila dregei* (Kunze) R.M.Tryon (Syn: *Cyathea dregei*) | DPPH | Leaves | \(EC_{50} = 3\,\mu\text{g/mL}\) | Adamu et al., [68] |
| *Alsophila dregei* (Kunze) R.M.Tryon (Syn: *Cyathea dregei*) | ABTS | Leaves | 0.4 TEAC | Adamu et al., [68] |
| *Apodytes dimidiata* E.Mey. ex. Arn. | DPPH | Leaves | \(EC_{50} = 3.5\,\mu\text{g/mL}\) | Adamu et al., [68] |
| *Apodytes dimidiata* E.Mey. ex. Arn. | ABTS | Leaves | 0.3 TEAC | Adamu et al., [68] |
| *Brachylaena discolor* DC. | DPPH | Leaves | \(EC_{50} = 2.6\,\mu\text{g/mL}\) | Adamu et al., [68] |
| *Brachylaena discolor* DC. | ABTS | Leaves | 0.2 TEAC | Adamu et al., [68] |
| *Burkea africana* Hook. | DPPH | Leaves | \(IC_{50} = 3.55\,\mu\text{g/mL}\) | Dzoyem and Eloff [85] |
| *Burkea africana* Hook. | ABTS | Leaves | \(IC_{50} = 3.21\,\mu\text{g/mL}\) | Dzoyem and Eloff [85] |
| *Burkea africana* Hook. | FRAP | Leaves | \(IC_{50} = 231.07\,\mu\text{g Fe (II)/g}\) | Dzoyem and Eloff [85] |
| *Clausena anisata* (Willd.) Hook.f. ex. Benth. | DPPH | Leaves | \(EC_{50} = 2.5\,\mu\text{g/mL}\) | Adamu et al., [68] |
| *Clausena anisata* (Willd.) Hook.f. ex. Benth. | ABTS | Leaves | 0.2 TEAC | Adamu et al., [68] |
| *Combretum zeyheri* Sond. | DPPH | Leaves | \(IC_{50} = 3.52\,\mu\text{g/mL}\) | Dzoyem and Eloff [85] |
| *Combretum zeyheri* Sond. | ABTS | Leaves | \(IC_{50} = 4.64\,\mu\text{g/mL}\) | Dzoyem and Eloff [85] |
| *Combretum zeyheri* Sond. | FRAP | Leaves | \(IC_{50} = 95.98\,\mu\text{g Fe (II)/g}\) | Dzoyem and Eloff [85] |
| *Dalbergia nitidula* Welw. ex. Baker | DPPH | Leaves | \(IC_{50} = 9.31\,\mu\text{g/mL}\) | Dzoyem et al., [67] |
| *Dalbergia nitidula* Welw. ex. Baker | ABTS | Leaves | \(IC_{50} = 21.3\,\mu\text{g/mL}\) | Dzoyem et al., [67] |
| # *Englerophytum magalismontanum* (Sond.) T.D.Penn | DPPH | Leaves | \(IC_{50} = 10.8\,\mu\text{g/mL}\) | Dzoyem and Eloff [85] |
| # *Englerophytum magalismontanum* (Sond.) T.D.Penn | ABTS | Leaves | \(IC_{50} = 12.22\,\mu\text{g/mL}\) | Dzoyem and Eloff [85] |
| Plant Species                        | Assay Type | Plant Part | Findings          | Reference                     |
|-------------------------------------|------------|------------|-------------------|-------------------------------|
| # *Englerophytum magalismontanum*   | FRAP       | Leaves     | IC<sub>50</sub> = 76 µg Fe (II)/g | Dzoyem and Eloff [85]         |
| T.D.Penn                            |            |            |                   |                               |
| # *Erythrina caffra* Thunb.         | DPPH       | Leaves     | IC<sub>50</sub> = 268.6 µg/mL | Dzoyem et al., [67]           |
| # *Erythrina caffra* Thunb.         | ABTS       | Leaves     | IC<sub>50</sub> = 173.28 µg/mL | Dzoyem et al., [67]           |
| # *Eucla undulata* Thunb.           | DPPH       | Leaves     | 31.66 µg/mL       | Dzoyem and Eloff [85]         |
| # *Eucla undulata* Thunb.           | ABTS       | Leaves     | 32.67 µg/mL       | Dzoyem and Eloff [85]         |
| # *Eucla undulata* Thunb.           | FRAP       | Leaves     | 274.19 µg Fe (II)/g | Dzoyem and Eloff [85]         |
| *Heteromorpha trifoliata* (H.L.Wendl.) Ekcl. & Zeyh. | DPPH | Leaves | EC<sub>50</sub> = 4.36 µg/mL | Adamu et al., [68]           |
| # *Indigofera frutescens* L.f.      | DPPH       | Leaves     | EC<sub>50</sub> = 0 µg/mL | Adamu et al., [68]           |
| # *Indigofera frutescens* L.f.      | ABTS       | Leaves     | 0.5 TEAC          | Adamu et al., [68]           |
| # *Indigofera frutescens* L.f.      | DPPH       | Leaves     | IC<sub>50</sub> = 22.31 µg/mL | Dzoyem et al., [67]           |
| # *Indigofera frutescens* L.f.      | ABTS       | Leaves     | IC<sub>50</sub> = 134.64 µg/mL | Dzoyem et al., [67]           |
| # *Jatropha curcas* L.              | DPPH       | Leaves     | IC<sub>50</sub> = 137.08 µg/mL | Dzoyem and Eloff [85]         |
| # *Jatropha curcas* L.              | ABTS       | Leaves     | IC<sub>50</sub> = 115.23 µg/mL | Dzoyem and Eloff [85]         |
| # *Jatropha curcas* L.              | ABTS       | Leaves     | IC<sub>50</sub> = 0.2 TEAC | Adamu et al., [68]           |
| # *Jatropha curcas* L.              | FRAP       | Leaves     | IC<sub>50</sub> = 68.17 µg Fe (II)/g | Dzoyem and Eloff [85]         |
| *Leucaena leucocephala* (Lam.) de Wit | DPPH     | Leaves     | IC<sub>50</sub> = 9.86 µg/mL | Dzoyem and Eloff [85]         |
| # *Maesa lanceolata* Forssk.        | DPPH       | Leaves     | IC<sub>50</sub> = 1.4 µg/mL | Adamu et al., [68]           |
| # *Maesa lanceolata* Forssk.        | ABTS       | Leaves     | 1.2 TEAC          | Adamu et al., [68]           |
| # *Melia azedarach* L.              | DPPH       | Leaves     | EC<sub>50</sub> = 3.3 µg/mL | Adamu et al., [68]           |
| # *Melia azedarach* L.              | ABTS       | Leaves     | 0.8 TEAC          | Adamu et al., [68]           |
| # *Milletia grandis* (E.Mey.) Skeels | DPPH     | Leaves     | EC<sub>50</sub> = 4.6 µg/mL | Adamu et al., [68]           |
| # *Milletia grandis* (E.Mey.) Skeels | ABTS     | Leaves     | 0.6 TEAC          | Adamu et al., [68]           |
| # *Morus mesozygia* Stapf           | DPPH       | Leaves     | IC<sub>50</sub> = 15.85 µg/mL | Dzoyem and Eloff [85]         |
| # *Morus mesozygia* Stapf           | ABTS       | Leaves     | IC<sub>50</sub> = 271.86 µg/mL | Dzoyem and Eloff [85]         |
| # *Morus mesozygia* Stapf           | FRAP       | Leaves     | IC<sub>50</sub> = 127.34 µg Fe (II)/g | Dzoyem and Eloff [85]         |
| # *Philenoptera nelsii* (Schinz) Schrire (Lonchocarpus nelsii) | DPPH    | Leaves     | IC<sub>50</sub> = 247.7 µg/mL | Adamu et al., [68]           |
| # *Philenoptera nelsii* (Schinz) Schrire (Lonchocarpus nelsii) | ABTS    | Leaves     | IC<sub>50</sub> = 41.39 µg/mL | Adamu et al., [68]           |
| # *Strychnos mittis* S.Moore        | DPPH       | Leaves     | EC<sub>50</sub> = 3.5 µg/mL | Adamu et al., [68]           |
| # *Strychnos mittis* S.Moore        | ABTS       | Leaves     | 0.3 TEAC          | Adamu et al., [68]           |
| # *Uapaca nitida* Müll.Arg.         | DPPH       | Leaves     | IC<sub>50</sub> = 125.86 µg/mL | Dzoyem and Eloff [85]         |
| # *Uapaca nitida* Müll.Arg.         | ABTS       | Leaves     | IC<sub>50</sub> = 28.81 µg/mL | Dzoyem and Eloff [85]         |
| # *Uapaca nitida* Müll.Arg.         | FRAP       | Leaves     | IC<sub>50</sub> = 177.32 µg Fe (II)/g | Dzoyem and Eloff [85]         |
### Table 5. Cont.

| # Plant Species | Assay Type | Plant Part | Findings | Reference |
|-----------------|------------|------------|----------|-----------|
| *Volkameria glabra* (E. Mey.) Mabb. & Y. W. Yuan (Syn: Clerodendrum glabrum) | DPPH | Leaves | EC$_{50}$ = 3.5 µg/mL | Adamu et al., [68] |
| *Volkameria glabra* (E. Mey.) Mabb. & Y. W. Yuan (Syn: Clerodendrum glabrum) | ABTS | Leaves | 0.5 TEAC | Adamu et al., [68] |
| *Zanthoxylum capense* (Thunb.) Harv. | DPPH | Leaves | EC$_{50}$ = 4 µg/mL | Adamu et al., [68] |
| *Zanthoxylum capense* (Thunb.) Harv. | ABTS | Leaves | 0.4 TEAC | Adamu et al., [68] |

#### 3.4.4. Cytotoxicity

The safety of medicinal plants remains essential toward the drive to incorporate these valuable natural resources as part of healthcare for animals. Evidence of the cytotoxicity levels for 39 woody plants were recorded in the current review (Table 6). Approximately 51% of these woody plants have explicit applications in South African ethnoveterinary medicine (Table 2). Particularly, the safety of different organs from three plants namely Calpurnia aurea, Maesa lanceolata, and Sclerocarya birrea were assessed in more than one study [66,70,75,76].

According to the United States National Cancer Institute (NCI), the criteria for the cytotoxicity of crude extracts, extracts with an LC$_{50}$ value that is less than 20 µg/mL are classified as cytotoxic. On this basis, *Apodytes dimidiate*, *Brachylaena discolor*, *Calpurnia aurea*, *Elaeodendron croceum*, *Maesa lanceolata*, and *Strychnos mitis* exerted varying degrees of cytotoxicity (LC$_{50}$ = 3.32–19.9 µg/mL), and caution needs to be taken during their utilisation for ethnoveterinary medicine [66,67,76]. Furthermore, McGaw et al., [70] assessed the cytotoxicity activity of the hexane, methanol, and water extracts of the selected woody plants against the larvae of *Artemia salina* (brine shrimp). From the results, the water extracts from *Searsia lancea* and *Ziziphus mucronata* leaves displayed strong lethality to the tested organism. On the other hand, moderate cytotoxicity was demonstrated by the acetone and water extracts of *Vachellia nilotica* bark against Vero monkey cell assays, and these extracts exhibited toxic effects on the cells with LC$_{50}$ = 33.2 µg/mL and LC$_{50}$ = 27.8 µg/mL, respectively. This was closely-followed by the acetone extracts from *Tetradenia riparia*, leaf with LC$_{50}$ = 51.3 µg/mL [86].

#### 3.5. Phytochemical Analysis of Plants Used for Ethnoveterinary Purposes

Phytochemical screening is important when investigating medicinal plants given that bioactive compounds can be responsible for their resultant biological activities [87,88]. In particular, the phenolic compounds in plants serve as defense mechanisms against pathogens and may be explored for therapeutic purposes [89]. The 20 woody plants recorded exhibit a diverse range of phytochemicals (Table 7), an indication of their potential benefits as ethnoveterinary medicine. For instance, 12 selected woody plant extracts had a rich source of phenols that ranged from 100 to 428 mg GAE/g, and *Lippia javanica* had the highest phenolic content while *Englerophytum magaliesmontanum* had the lowest content [85]. In addition, the flavonoid content varied from 6–159 mg QE/g, as contained in *Ehretia rigida* (lowest) and *Leucaena leucocephala* (highest). Olaokun et al., [90] quantified the total phenolic and flavonoid contents in *Curtisia dentata* and *Pittosporum viridiflorum*. The results indicated that *Curtisia dentata* extract yielded the higher phenolics (125.12 mg/g GAE) and flavonoids (27.69 mg/g GAE) compared to the extract from *Pittosporum viridiflorum*. 

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**Table 5. Cont.**

| # Plant Species | Assay Type | Plant Part | Findings | Reference |
|-----------------|------------|------------|----------|-----------|
| *Volkameria glabra* (E. Mey.) Mabb. & Y. W. Yuan (Syn: Clerodendrum glabrum) | DPPH | Leaves | EC$_{50}$ = 3.5 µg/mL | Adamu et al., [68] |
| *Volkameria glabra* (E. Mey.) Mabb. & Y. W. Yuan (Syn: Clerodendrum glabrum) | ABTS | Leaves | 0.5 TEAC | Adamu et al., [68] |
| *Zanthoxylum capense* (Thunb.) Harv. | DPPH | Leaves | EC$_{50}$ = 4 µg/mL | Adamu et al., [68] |
| *Zanthoxylum capense* (Thunb.) Harv. | ABTS | Leaves | 0.4 TEAC | Adamu et al., [68] |
Table 6. Cytotoxic activity of woody plants used for ethnoveterinary purposes in South Africa. # Plant species: denotes woody plants with ethnoveterinary uses in Table 2; * Test system: MTT—3–5-dimethyl thiazol-2-yl-2, 5-diphenyl tetrazolium bromide.

| # Plant Species            | Solvent          | Plant Part       | * Test System                                                                                     | Positive Control                  | Findings                                                | Reference         |
|---------------------------|------------------|------------------|--------------------------------------------------------------------------------------------------|----------------------------------|--------------------------------------------------------|-------------------|
| Alsophila dregei (Syn: Cyathea dregei) | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Berberine chloride               | LC\(_{50}\) = 0.00332 mg/mL                             | Adamu et al., [76] |
| Apodytes dimidiata        | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Berberine chloride               | LC\(_{50}\) = 0.00396 mg/mL                             | Adamu et al., [76] |
| Berchemia zeyheri         | Hexane, methanol, and water | Bark            | Brine shrimp lethality/toxicity using *Artemia salina*                                          | Podophyllotoxin (7 µg/mL)        | Water extract had the highest lethal effect (LC\(_{50}\) = 3.9 mg/mL) | McGaw et al., [70] |
| # Bolusanthus speciosus   | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Doxorubicin = 1.76 µg/mL        | LC\(_{50}\) = 52.8 µg/mL                               | Elisha et al., [66] |
| Brachylaena discolor      | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Berberine chloride               | LC\(_{50}\) = 0.00752 mg/mL                             | Adamu et al., [76] |
| # Calpurnia aurea         | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Doxorubicin = 1.76 µg/mL        | LC\(_{50}\) = 13.6 µg/mL                               | Elisha et al., [66] |
| # Calpurnia aurea         | Acetone          | Leaves/flowers, stem | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Doxorubicin (2.97 µg/mL)        | Leaves/flowers, LC\(_{50}\) = 166.63 µg/mL, Stem LC\(_{50}\) = 223.97 µg/mL | Fouche et al., [75] |
| Clausena anisata          | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Berberine chloride               | LC\(_{50}\) = 0.17186 mg/mL                             | Adamu et al., [76] |
| Cremaspora triflora       | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Doxorubicin = 1.76 µg/mL        | LC\(_{50}\) = 57.4 µg/mL                               | Elisha et al., [66] |
| # Cussonia spicata        | Hexane, methanol, and water | Roots           | Brine shrimp lethality/toxicity using *Artemia salina*                                          | Podophyllotoxin (7 µg/mL)        | Water extract had the highest lethal effect (LC\(_{50}\) = 2.6 mg/mL) | McGaw et al., [70] |
| Dalbergia nitidula        | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Doxorubicin (2.29 µg/mL)        | LC\(_{50}\) = 51.28 µg/mL                              | Dzoyem et al., [67] |
| # Dombeya rotundifolia    | Hexane, methanol, and water | Aerial part     | Brine shrimp lethality/toxicity using *Artemia salina*                                          | Podophyllotoxin (7 µg/mL)        | All extracts had no lethal effect                        | McGaw et al., [70] |
| Elaeodendron croceum (Thunb.) DC. | Acetone          | Leaves           | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells                          | Doxorubicin = 1.76 µg/mL        | LC\(_{50}\) = 5.2 µg/mL                               | Elisha et al., [66] |
Table 6. Cont.

| # Plant Species | Solvent       | Plant Part         | * Test System                                         | Positive Control                  | Findings                                | Reference               |
|-----------------|---------------|--------------------|-------------------------------------------------------|-----------------------------------|-----------------------------------------|-------------------------|
| Erythrina caffra| Acetone       | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Doxorubicin (2.29 µg/mL)          | LC\textsubscript{50} = 19.93 µg/mL              | Dzoyem et al., [67]     |
| Euphorbia cupularis (Syn: Synadenium cupulare) | Hexane, methanol, and water | Aerial part | Brine shrimp lethality/toxicity using \textit{Artemia salina} | Podophyllotoxin (7 µg/mL) | All extracts had no lethal effect | McGaw et al., [70]     |
| Ficus sycomorus | Acetone       | Bark/stem, stem    | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Doxorubicin (2.97 µg/mL)          | LC\textsubscript{50} = 172.94 µg/mL (bark/stem), LC\textsubscript{50} = 48.74 µg/mL (stem) | Fouche et al., [75]     |
| Heteromorpha arborescens | Acetone | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Doxorubicin = 1.76 µg/mL          | LC\textsubscript{50} = 81.0 µg/mL                | Elisha et al., [66]     |
| Heteromorpha trifoliata | Acetone | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Berberine chloride               | LC\textsubscript{50} = 0.04252 mg/mL             | Adamu et al., [76]      |
| Hippobromus pauciflorus | Acetone, methanol, and water | Aerial part | Brine shrimp lethality/toxicity using \textit{Artemia salina} | Podophyllotoxin (7 µg/mL) | All extract had no lethal effect | McGaw et al., [70]     |
| Indigofera cylindrica | Acetone | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Doxorubicin (2.29 µg/mL)          | LC\textsubscript{50} = 77.59 µg/mL              | Dzoyem et al., [67]     |
| Indigofera frutescens | Acetone | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Berberine chloride               | LC\textsubscript{50} = 0.1044 mg/mL              | Adamu et al., [76]      |
| Leucosidea sericea | Acetone | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Berberine chloride               | LC\textsubscript{50} = 0.0515 mg/mL             | Adamu et al., [76]      |
| Lonchocarpus nelsii | Acetone | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Doxorubicin (2.29 µg/mL)          | LC\textsubscript{50} = 81.09 µg/mL              | Dzoyem et al., [67]     |
| Maerua angolensis | Acetone       | Stem, leaves       | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Doxorubicin (2.97 µg/mL)          | LC\textsubscript{50} = 180.64 µg/mL (stem), LC\textsubscript{50} = 73.76 µg/mL (leaves) | Fouche et al., [75]     |
| Maesa lanceolata | Acetone       | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Berberine chloride               | LC\textsubscript{50} = 0.01577 mg/mL             | Adamu et al., [76]      |
| Maesa lanceolata | Acetone       | Leaves             | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells | Doxorubicin = 1.76 µg/mL          | LC\textsubscript{50} = 0.38 µg/mL               | Elisha et al., [66]     |
| # Plant Species          | Solvent, Plant Part                  | * Test System                                                                 | Positive Control          | Findings                  | Reference          |
|-------------------------|--------------------------------------|--------------------------------------------------------------------------------|----------------------------|---------------------------|--------------------|
| Melia azedarach         | Acetone, Leaves                      | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells         | Berberine chloride         | LC<sub>50</sub> = 0.14466 mg/mL | Adamu et al., [76] |
| # Milletia grandis      | Acetone, Leaves                      | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells         | Berberine chloride         | LC<sub>50</sub> = 0.05336 mg/mL | Adamu et al., [76] |
| Morus mesozygia         | Acetone, Leaves                      | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells         | Doxorubicin = 1.76 µg/mL   | LC<sub>50</sub> = 40.7 µg/mL  | Elisha et al., [66] |
| # Pittosporum viridiflorum | Acetone, Leaves                  | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells         | Doxorubicin = 1.76 µg/mL   | LC<sub>50</sub> = 54.6 µg/mL  | Elisha et al., [66] |
| # Pterocarpus angolensis | Hexane, methanol, Bark, leaves       | Brine shrimp lethality/toxicity using *Artemia salina*                          | Podophyllotoxin (7 µg/mL)  | All extracts had no lethal effect. Hexane and methanol extracts from the leaves had the highest lethal effect (LC<sub>50</sub> = 3.6–3.8 mg/mL) | McGaw et al., [70] |
| # Sclerocarya birrea     | Acetone, Fruit                       | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells         | Doxorubicin (2.97 µg/mL)   | LC<sub>50</sub> = 214.79 µg/mL | Fouche et al., [75] |
| # Sclerocarya birrea     | Hexane, methanol, Bark               | Brine shrimp lethality/toxicity using *Artemia salina*                          | Podophyllotoxin (7 µg/mL)  | All extracts had no lethal effect | McGaw et al., [70] |
| # Searsia lancea (Rhus lancea) | Hexane, methanol, Bark, leaves       | Brine shrimp lethality/toxicity using *Artemia salina*                          | Podophyllotoxin (7 µg/mL)  | Water extract from the bark (LC<sub>50</sub> = 3.9 mg/mL) and leaves (LC<sub>50</sub> = 0.6 mg/mL) had the highest toxic effect | McGaw et al., [70] |
| Strychnos mitis         | Acetone, Leaves                      | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells         | Berberine chloride         | LC<sub>50</sub> = 0.01721 mg/mL | Adamu et al., [76] |
| # Tabernaemontana elegans | Acetone, Leaves                  | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells         | Doxorubicin (2.97 µg/mL)   | LC<sub>50</sub> = 32.35 µg/mL  | Fouche et al., [75] |
| # Plant Species          | Solvent                  | Plant Part            | * Test System                                                                 | Positive Control          | Findings                                                                                   | Reference |
|-------------------------|--------------------------|-----------------------|-------------------------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------------------------|-----------|
| # *Tetradenia riparia*  | Acetone and water        | Flowers, leaves       | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells        | Doxorubicin (5.4326 µM)   | LC<sub>50</sub>, flowers = 0.0823 mg/mL (acetone), 0.1784 mg/mL (water); leaves = 0.0513 mg/mL (acetone), 0.2738 mg/mL (water) | Sserunkuma et al., [86] |
| # *Vachellia nilotica*  | Acetone and water        | Bark, leaves          | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells        | Doxorubicin (5.4326 µM)   | LC<sub>50</sub>, bark = 0.0332 mg/mL (acetone), 0.0278 mg/mL (water); leaves = 0.2187 mg/mL (acetone), 0.0686 mg/mL (water) | Sserunkuma et al., [86] |
| *Virgilia divaricata*   | Acetone                  | Leaves                | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells        | Doxorubicin (2.29 µg/mL)  | LC<sub>50</sub> = 30.08 µg/mL                                                              | Dzoyem et al., [67] |
| # *Volkameria glabra*   | Acetone                  | Leaves                | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells        | Berberine chloride        | LC<sub>50</sub> = 0.04251 mg/mL                                                            | Adamu et al., [76] |
| # *Zanthoxylum capense* | Acetone                  | Leaves                | Tetrazolium-based colorimetric MTT assay using Vero monkey kidney cells        | Berberine chloride        | LC<sub>50</sub> = 0.02095 mg/mL                                                            | Adamu et al., [76] |
| # *Ziziphus mucronata*  | Hexane, methanol and water| Bark, leaves          | Brine shrimp lethality/toxicity using *Artemia salina*                        | Podophyllotoxin (7 µg/mL) | Bark extracts had no lethal effect. Hexane extract of leaves had LC<sub>50</sub> = 0.9 mg/mL | McGaw et al., [70] |
Table 7. Phytochemical analysis (based on spectrophotometric method) of woody plants used in ethnoveterinary medicine.

# Plant species: denotes woody plants with ethnoveterinary uses in Table 2; GAE—gallic acid equivalents, TPC—total phenolic content, TFC—total flavonoid content, CT—condensed tannin, GC—gallotannin content, LCE—leucocyanidin equivalents, CTE—catechin equivalents, QE—quercetin equivalents.

| # Plant Species | Plant Part | Extract  | Findings | Reference |
|-----------------|------------|----------|----------|-----------|
| # Acokanthera oppositifolia | Leaves, twigs | 50% Methanol | TPC = 2.5 and 7.2 mg GAE/g, GC = 2 µg and 5.2 µg GAE/g, CT = 0.005% and 0.12% LCE/g, TFC = 0.002 and 0.001 mg CTE/g | Aremu et al., [71] |
| # Burkea africana | Leaves | Acetone | TPC = 14.39 mg GAE/g | Dzoyem and Eloff [85] |
| # Combretum zeyheri | Leaves | Acetone | TPC = 3.29 mg GAE/g | Dzoyem and Eloff [85] |
| # Curtisia dentata | Stem bark | Acetone | TPC = 8.94 mg GAE/g, GC = 2 µg and 5.2 µg GAE/g, CT = 0.005% and 0.12% LCE/g, TFC = 0.002 and 0.001 mg CTE/g | Olaokun et al., [90] |
| # Dalbergia nitidula | Leaves | Acetone | TPC = 1.51 mg GAE/g | Dzoyem et al., [67] |
| # Englerophytum magalismontanum | Leaves | Acetone | TPC = 0.86 mg GAE/g | Dzoyem and Eloff [85] |
| # Erythrina caffra | Leaves | Acetone | TPC = 150.82 mg/g GAE, TFC = 72.8 mg QE/g | Dzoyem et al., [67] |
| # Eucla undulata | Leaves | Acetone | TPC = 234.56 mg/g GAE, TFC = 64.36 mg QE/g | Dzoyem and Eloff [85] |
| # Indigofera frutescens (Indigofera cylindrical) | Leaves | Acetone | TPC = 125.12 mg/g GAE, TFC = 27.69 mg QE/g | Dzoyem et al., [67] |
| # Jatropha curcas | Leaves | Acetone | TPC = 100.89 mg/g GAE, TFC = 68.43 mg QE/g | Dzoyem and Eloff [85] |
| # Leucaena leucocephala | Leaves | Acetone | TPC = 129.78 mg/g GAE, TFC = 35.16 mg QE/g | Dzoyem and Eloff [85] |
| # Leucosidea sericea | Leaves, stem | 50% Methanol | TPC = 36.66 and 6.4 mg GAE/g, GC = 29.32 and 5.12 µg GAE/g, CT = 0.46 and 0.47% LCE/g, TFC = 0.66 and 0.26 mg CTE/g | Aremu et al., [69] |
| # Lippia javanica (Burm.f) Spreng | Leaves | Acetone | TPC = 130.12 mg GAE/g | Dzoyem and Eloff [85] |
| # Morus mesozygia | Leaves | Acetone | TPC = 427.53 mg/g GAE, TFC = 80.72 mg QE/g | Dzoyem and Eloff [85] |
| # Philenoptera nelsii (Lonchocarpus nelsii) | Leaves | Acetone | TPC = 258.4 mg/g GAE, TFC = 159.61 mg QE/g | Dzoyem et al., [67] |
| # Pittosporum viridiflorum Sims | Stem bark | Acetone | TPC = 181.49 mg/g GAE, TFC = 13.75 mg QE/g | Olaokun et al., [90] |
| # Senna petersiana | Leaves | 50% Methanol | TPC = 5 mg GAE/g, GC = 4 µg GAE/g, CT = 0.18% LCE/g, TFC = 0.1 mg CTE/g | Aremu et al., [71] |
| # Uapaca nitida | Leaves | Acetone | TPC = 26.08 mg/g GAE, TFC = 20.31 mg QE | Dzoyem and Eloff [85] |
| # Virgilia divaricata Adamson | Leaves | Acetone | TPC = 137.3 mg/g GAE, TFC = 15.3 mg QE/g | Dzoyem et al., [67] |
| Ziziphus rivularis Codd | Leaves | Acetone | TPC = 182.79 mg/g GAE, TFC = 46.88 mg QE/g | Dzoyem and Eloff [85] |
In recent times, increasing evidence from several studies on polyphenolic compounds from medicinal plants support their biological and pharmaceutical importance in maintaining animal health and overall productivity [91]. For example, betulinic acid and lupeol were successfully isolated from *Curtisia dentata* [81], which is one of the woody plants recorded in our inventory (Table 2). Subsequently, both compounds demonstrated a moderate degree of an anthelmintic effect (200 and 1 000 µg/mL) against parasitic nematodes. However, the relatively higher concentration required for the compounds to be effective limits their clinical relevance as an anthelmintic for livestock.

4. Conclusions

The current review entailed an overview of the role and contributions of woody plants in ethnoveterinary medicine in South Africa. We highlighted the richness of South Africa’s flora as a medicinal resource and the effectiveness of woody plants used in ethnoveterinary medicine. *Terminalia sericea* and *Ziziphus mucronata* were the most commonly utilised woody plants based on existing indigenous knowledge. The extensive utilisation of some plant parts (e.g., bark and roots) remain a major concern due to the potential detrimental effects of the indiscriminate harvesting of such parts may have on the survival and sustainability of the woody plants. The majority (80%) of woody plants with indigenous knowledge related to their applications in the management of animal health remain poorly evaluated in terms of their biological efficacy and phytochemical composition. Nevertheless, some of the woody plants (e.g., *Alsophila dregei, Cussonia spicata, Indigofera frutescens, Leucosidea sericea*, and *Maesa lanceolata*) have demonstrated promising biological activities, mainly in antibacterial and anthelmintic assays. Given the predominantly in vitro based assays currently being utilised, there is an urgent need to evaluate woody plants with promising biological effect in appropriate in vivo models. The test organisms need to have direct relevance to prevailing health challenges facing livestock in rural areas where the use of woody plants have been widely documented. In terms of the phytochemical profiles, South African woody plants have a rich pool of chemicals with potential therapeutic effects.

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References

1. Comaroff, J.L.; Comaroff, J. Goodly beasts, beastly goods: Cattle and commodities in a South African context. Am. Ethnol. 1990, 17, 195–216. [CrossRef]
2. Mapiye, O.; Chikwanha, O.C.; Makombe, G.; Dzama, K.; Mapiye, C. Livelihood, food and nutrition security in Southern Africa: What role do indigenous cattle genetic resources play? Diversity 2020, 12, 74. [CrossRef]
3. Suroowan, S.; Javeed, F.; Ahmad, M.; Zafar, M.; Noor, M.J.; Kayani, S.; Javed, A.; Mahomoodally, M.F. Ethnoveterinary health management practices using medicinal plants in South Asia—A review. Vet. Res. Commun. 2017, 41, 147–168. [CrossRef]
4. Lams, C.; Sant, C.; Georges, K. Ethnoremedies used for horses in British Columbia and Trinidad and Tobago. In Ethnoveterinary Medicine: Present and Future Concepts; McGaw, L.J., Abdalla, M.A., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 57–71. [CrossRef]
5. Borges, A.K.M.; Barboza, R.R.D.; Souto, W.M.S.; Alves, R.R.N. Natural remedies for animal health in Latin America. In Ethnoveterinary Medicine: Present and Future Concepts; McGaw, L.J., Abdalla, M.A., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 311–344. [CrossRef]
6. Mayer, M.; Zbinden, M.; Vogl, C.R.; Iveneyer, S.; Meier, B.; Amorena, M.; Maeschli, A.; Hamburger, M.; Walkenhorst, M. Swiss ethnoveterinary knowledge on medicinal plants—A within-country comparison of Italian speaking regions with north-western German speaking regions. J. Ethnobiol. Ethnomed. 2017, 13, 1. [CrossRef]
7. Galaty, J.G. Being “Maasai”; being “People-of-cattle”: Ethnic shifters in East Africa. Am. Ethnol. 1982, 9, 1–20. [CrossRef]
8. Kazancı, C.; Oruç, S.; Mosulishvili, M. Ethnoveterinary and fodder plants used among transhumant communities around Georgia-Turkey border, in the Western Lesser Caucasus. Ethnobot. Res. Appl. 2021, 21, 28. [CrossRef]
9. McCorkle, C.M. Back to the future: Lessons from ethnoveterinary RD&E for studying and applying local knowledge. Agric. Hum. Values 1995, 12, 50–80. [CrossRef]
10. Khan, K.; Rahman, I.U.; Calixto, E.S.; Ali, N.; Iaz, F. Ethnoveterinary therapeutic practices and conservation status of the medicinal flora of Chamla valley, Khyber Pakhtunkhwa, Pakistan. Front. Vet. Sci. 2019, 6, 122. [CrossRef] [PubMed]
11. Shrubok, A. Belarusian ethnoveterinary medicine: Ritual practices and traditional remedies. In Ethnoveterinary Medicine: Present and Future Concepts; McGaw, L.J., Abdalla, M.A., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 375–390. [CrossRef]
12. Zorloni, A. Toward a better understanding of African ethnoveterinary medicine and husbandry. In Ethnoveterinary Medicine: Present and Future Concepts; McGaw, L.J., Abdalla, M.A., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 151–172. [CrossRef]
13. McCorkle, C.M. An introduction to ethnoveterinary research and development. J. Ethnobiol. 1986, 6, 129–149. [CrossRef]
14. Aziz, M.A.; Khan, A.H.; Pieroni, A. Ethnoveterinary plants of Pakistan: A review. J. Ethnobiol. Ethnomed. 2020, 16, 25. [CrossRef] [PubMed]
15. McGaw, L.J.; Famuyide, I.M.; Khunoana, E.T.; Aremu, A.O. Ethnoveterinary botanical medicine in South Africa: A review of research from the last decade (2009 to 2019). J. Ethnopharmacol. 2020, 257, 112864. [CrossRef] [PubMed]
16. Hoveka, L.N.; van der Bank, M.; Davies, T.J. Evaluating the performance of a protected area network in South Africa and its implications for megadiverse countries. Biol. Conserv. 2020, 248, 108577. [CrossRef]
17. Germishuizen, G.; Meyer, N. Plants of Southern Africa: An Annotated Checklist; National Botanical Institute Pretoria: Pretoria, South Africa, 2003.
18. Van Staden, J. Ethnobotany in South Africa. J. Ethnopharmacol. 2008, 119, 329–330. [CrossRef]
19. Da Silva, T.C.; da Silva, J.M.; Ramos, M.A. What factors guide the selection of medicinal plants in a local pharmacopoeia? A case study in a rural community from a historically transformed atlantic forest landscape. Evid.-Based Complement. Altern. Med. 2018, 2018, 2519212. [CrossRef]
20. Muleiba, I.; Yessoufou, K.; Rampedi, I.T. Testing the non-random hypothesis of medicinal plant selection using the woody flora of the Mpumalanga Province, South Africa. Environ. Dev. Sustain. 2021, 23, 4162–4173. [CrossRef]
21. De Albuquerque, U.P.; Farias Paiva de Lucena, R. Can apparency affect the use of plants by local people in tropical forests? Interciencia 2005, 30, 506–510.
22. Douwes, E.; Crouch, N.R.; Edwards, T.J.; Mulholland, D.A. Regression analyses of southern African ethnomedicinal plants: Informing the targeted selection of bioprospecting and pharmacological screening subjects. J. Ethnopharmacol. 2008, 119, 356–364. [CrossRef]
23. Daru, B.H.; Berger, D.K.; Wyk, A.E. Opportunities for unlocking the potential of genomics for African trees. New Phytol. 2016, 210, 772–778. [CrossRef]
24. Venter, F.; Venter, J.-A. Making the Most of Indigenous Trees; Briza Publications: Pretoria, South Africa, 2002.
25. Van Wyk, A.S.; Prinsloo, G. A review of the ethnobotanical uses, pharmacology, toxicology, management and cultivation of selected South African protected multi-purpose tree species. S. Afr. J. Bot. 2019, 124, 258–269. [CrossRef]
26. Moyo, M.; Aremu, A.O.; Van Staden, J. Medicinal plants: An invaluable, dwindling resource in sub-Saharan Africa. J. Ethnopharmacol. 2015, 174, 595–606. [CrossRef] [PubMed]
27. Yaoitcha, A.S.; Houehanou, T.D.; Fandohan, A.B.; Houinato, M.R.B. Prioritization of useful medicinal tree species for conservation in Wari-Maro Forest Reserve in Benin: A multivariate analysis approach. For. Policy Econ. 2015, 61, 135–146. [CrossRef]
28. Yirgu, A.; Mohammed, K.; Geldenhuys, C.J. Useful medicinal tree species of Ethiopia: Comprehensive review. *S. Afr. J. Bot.* 2019, 122, 291–300. [CrossRef]

29. Ahoyo, C.C.; Houéhanou, T.D.; Yoaïtcha, A.S.; Prinz, K.; Gléle Kakai, R.; Sinsin, B.A.; Houinato, M.R.B. Traditional medicinal knowledge of woody species across climatic zones in Benin (West Africa). *J. Ethnopharmacol.* 2021, 265, 113417. [CrossRef] [PubMed]

30. Van Andel, T.; Myren, B.; van Onselen, S. Ghana’s herbal market. *J. Ethnopharmacol.* 2012, 140, 368–378. [CrossRef]

31. Rivera, D.; Allkin, R.; Obón, C.; Alcaraz, F.; Verpoort, R.; Heinrich, M. What is in a name? The need for accurate scientific nomenclature for plants. *J. Ethnopharmacol.* 2014, 152, 393–402. [CrossRef]

32. Weckerle, C.S.; de Boer, H.J.; Puri, R.K.; van Andel, T.; Bussmann, R.W.; Leonti, M. Recommended standards for conducting and reporting ethnopharmacological field studies. *J. Ethnopharmacol.* 2018, 210, 125–132. [CrossRef]

33. Chitura, T.; Muvhali, P.; Shai, K.; Mushonga, B.; Kandiwa, E. Use of medicinal plants by livestock farmers in a local municipality in Vhembe district, South Africa. *Appl. Ecol. Environ. Res.* 2018, 16, 6589–6605. [CrossRef]

34. Dold, A.P.; Cocks, M.L. Traditional veterinary medicine in the Alice district of the Eastern Cape Province, South Africa. *S. Afr. J. Sci.* 2001, 97, 375–379.

35. Kambizi, L. Indigenous plants for ethnoveterinary uses in the Pondoland, South Africa. In Proceedings of the XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes: V World Congress on Medicinal and Aromatic Plants and International Symposium on Plants, as Factories of Natural Substances, Edible and Essential Oils, Brisbane, QLD, Australia, 17 August 2014; pp. 309–314.

36. Khunoana, E.T.; Madikizela, B.; Erhabor, J.O.; Nkadimeng, S.M.; Arnot, L.F.; Van Wyk, I.; McGaw, L.J. A survey of plants used to treat livestock diseases in the Mnisi community, Mpmalanga, South Africa, and investigation of their antimicrobial activity. *S. Afr. J. Bot.* 2019, 126, 21–29. [CrossRef]

37. Luseba, D.; Tshisikhawe, M. Medicinal plants used in the treatment of livestock diseases in Vhembe region, Limpopo province, South Africa. *J. Med. Plants Res.* 2013, 7, 593–601.

38. Luseba, D.; Van der Merwe, D. Ethnoveterinary medicine practices among Tsonga speaking people of South Africa. *Onderstepoort J. Vet. Res.* 2006, 73, 115–122. [CrossRef]

39. Magwede, K.; Tshisikhawe, M.P.; Luseba, D.; Bhat, R.B. Ethnobotanical survey of medicinal plants used in treatment of ticks. *Int. J. Exp. Biol.* 2013, 83, 155–165.

40. Mahlo, S.M. Antibacterial Activity of Selected Plants Used in Ethnoveterinary Medicine. Master’s Thesis, University of Limpopo (Turfloop Campus), Turfloop, South Africa, 2006.

41. Maphosa, V.; Masika, P.J. Ethnoveterinary uses of medicinal plants: A survey of plants used in the ethnoveterinary control of gastro-intestinal parasites of goats in the Eastern Cape Province, South Africa. *Pharm. Biol.* 2010, 48, 697–702. [CrossRef] [PubMed]

42. Mkwanazi, M.V.; Ndlela, S.Z.; Chimonyo, M. Utilisation of indigenous knowledge to control ticks in goats: A case of KwaZulu-Natal Province, South Africa. *Trop. Anim. Health Prod.* 2020, 52, 1375–1383. [CrossRef] [PubMed]

43. Moichwanetse, B.I.; Ndhlovu, P.T.; Sedupane, G.; Aremu, A.O. Ethno-veterinary plants used for the treatment of retained placenta and associated diseases in cattle among Dinokana communities, North West Province, South Africa. *S. Afr. J. Bot.* 2020, 132, 108–116. [CrossRef]

44. Moyo, B.; Masika, P.J. Tick control methods used by resource-limited farmers and the effect of ticks on cattle in rural areas of the Eastern Cape Province, South Africa. *Trop. Anim. Health Prod.* 2009, 41, 517–523. [CrossRef] [PubMed]

45. Mthi, S.; Rust, J.; Morgenthal, T.; Moyo, B. An ethno-veterinary survey of medicinal plants used to treat bacterial diseases of livestock in three geographical areas of the Eastern Cape Province, South Africa. *J. Med. Plants Res.* 2018, 12, 240–247.

46. Mwale, M.; Masika, P.J. Ethno-veterinary control of parasites, management and role of village chickens in rural households of Centane district in the Eastern Cape, South Africa. *Trop. Anim. Health Prod.* 2009, 41, 1685–1693. [CrossRef] [PubMed]

47. Ndu, R.V. A Study of Ethnoveterinary medicine in the North West Province, South Africa. Master’s Thesis, North-West University, Mmabatho, South Africa, 2018.

48. Ramovha, L.I.; Van Wyk, A.E. Ethnoveterinary practices of the Vhavenda, South Africa, in the treatment of redwater (*mali*) in cattle. *Indilinga Afr. J. Indig. Knowl. Syst.* 2016, 15, 314–327.

49. Rwodzi, M. Alternative Remedies Used by Resource-Limited Farmers in the Treatment and Manipulation of the Reproductive System of Non-Descript Goats in the Eastern Cape Province, South Africa. Master’s Thesis, University of Fort Hare, Alice, South Africa, 2014.

50. Sanhokwe, M.; Mupangwa, J.; Masika, P.J.; Maphosa, V.; Muchenge, V.; Masika, P.J. Medicinal plants used to control internal and external parasites in goats. *Onderstepoort J. Vet. Res.* 2016, 83, a1016. [CrossRef]

51. Soyelu, O.T.; Masika, P.J. Traditional remedies used for the treatment of cattle wounds and myiasis in Amatola Basin, Eastern Cape Province, South Africa. *Onderstepoort J. Vet. Res.* 2009, 76, 393–397. [CrossRef] [PubMed]

52. Van der Merwe, D.; Swan, G.E.; Botha, C.J. Use of ethnoveterinary medicinal plants in cattle by Setswana-speaking people in the Madikwe area of the North West Province of South Africa. *J. S. Afr. Vet. Assoc.* 2001, 72, 189–196. [CrossRef] [PubMed]

53. Gaoe, O.G.; Cae, M.A.; Bond, M.; Hart, G.; Seyler, B.C.; McMillen, H. Theories and major hypotheses in ethnobotany. *Econ. Bot.* 2017, 71, 269–287. [CrossRef]
54. Hyvärinen, O.; Timm Hoffman, M.; Reynolds, C. Vegetation dynamics in the face of a major land-use change: A 30-year case study from semi-arid South Africa. *Afr. J. Range Forage Sci.* 2019, 36, 141–150. [CrossRef]

55. Yirga, G.; Teferi, M.; Gidey, G.; Zerabruk, S. An ethnoveterinary survey of medicinal plants used to treat livestock diseases in Sehati-Samre district, Northern Ethiopia. *Afr. J. Plant Sci.* 2012, 6, 113–119.

56. McCorkle, C.M.; Mathias-Mundy, E. Ethnoveterinary Medicine in Africa. *Afr. J. Int. Afr. Inst.* 1992, 62, 59–93. [CrossRef]

57. Nchu, F.; Nana, P.; Msalya, G.; Magano, S.R. Ethnoveterinary practices for control of ticks in Africa. In *Ethnoveterinary Medicine: Present and Future Concepts*; McGaw, L.J., Abdalla, M.A., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 99–122. [CrossRef]

58. Van Wyk, B.E. A family-level floristic inventory and analysis of medicinal plants used in Traditional African Medicine. *J. Ethnopharmacol.* 2020, 249, 112351. [CrossRef] [PubMed]

59. Chakale, M.V.; Mwanza, M.; Aremu, A.O. Ethnoveterinary knowledge and biological evaluation of plants used for mitigating cattle diseases: A critical insight into the trends and patterns in South Africa. *Front. Vet. Sci.* 2021, 8, 891. [CrossRef] [PubMed]

60. Eloff, J.N.; McGaw, L.J. Application of plant extracts and products in veterinary infections. In *New Strategies Combating Bacterial Infection*; Ahmad, I., Aqil, F., Eds.; Wiley-VCH Verlag GmbH & Co. KGaA: Weinheim, Germany, 2009; pp. 205–228. [CrossRef]

61. Abdalla, M.A.; McGaw, L.J. Introduction. In *Ethnoveterinary Medicine: Present and Future Concepts*; McGaw, L.J., Abdalla, M.A., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 1–3. [CrossRef]

62. Eloff, J.N.; McGaw, L.J. Plant extracts used to manage bacterial, fungal, and parasitic infections in Southern Africa. In *Modern Phytomedicine: Turning Medicinal Plants into Drugs*; Ahmad, I., Aqil, F., Owais, M., Eds.; Wiley-VCH Verlag GmbH & Co. KGaA: Weinheim, Germany, 2006; pp. 97–121. [CrossRef]

63. Eloff, J.N. Avoiding pitfalls in determining antimicrobial activity of plant extracts and publishing the results. *BMC Complementary Altern. Med.* 2019, 19, 106. [CrossRef] [PubMed]

64. Van Vuuren, S.; Holl, D. Antimicrobial natural product research: A review from a South African perspective for the years 2009–2016. *J. Ethnopharmacol.* 2017, 208, 236–252. [CrossRef]

65. Heinrich, M.; Appendino, G.; Efferth, T.; Fürst, R.; Izzo, A.A.; Kayser, O.; Pezzuto, J.M.; Viljoen, A. Best practice in research—Overcoming common challenges in phytopharmacological research. *J. Ethnopharmacol.* 2020, 246, 112230. [CrossRef] [PubMed]

66. Elisha, I.L.; Dzoyem, J.-P.; Botha, F.S.; Eloff, J.N. The efficacy and safety of nine South African medicinal plants in controlling *Bacillus anthracis* Sterne vaccine strain. *BMC Complementary Altern. Med.* 2016, 16, 5. [CrossRef] [PubMed]

67. Dzoyem, J.P.; McGaw, L.J.; Eloff, J.N. The antibacterial activity, antioxidant activity and selectivity index of leaf extracts of thirteen South African medicinal plants used in ethnoveterinary medicine. *S. Afr. J. Bot.* 2014, 83, 129–134. [CrossRef] [PubMed]

68. Adamu, M.; Naidoo, V.; Eloff, J.N. The antibacterial activity, antioxidant activity and selectivity index of leaf extracts of thirteen South African tree species used in ethnoveterinary medicine to treat helminth infections. *BMC Vet. Res.* 2014, 10, 52. [CrossRef] [PubMed]

69. Aremu, A.O.; Fawole, O.A.; Chukwuemekwu, J.C.; Light, M.E.; Finnie, J.F.; Van Staden, J. In vitro antimicrobial, anthelmintic and cyclooxygenase-inhibitory activities and phytochemical analysis of *Leucosidea sericea*. *J. Ethnopharmacol.* 2010, 131, 22–27. [CrossRef] [PubMed]

70. McGaw, L.J.; Van der Merve, D.; Eloff, J.N. In vitro anthelmintic, antibacterial and cytotoxic effects of extracts from plants used in South African ethnoveterinary medicine. *Vet. J.* 2007, 173, 366–372. [CrossRef]

71. Aremu, A.O.; Ndhlala, A.R.; Fawole, O.A.; Light, M.E.; Finnie, J.F.; Van Staden, J. In vitro pharmacological evaluation and phenolic content of ten South African medicinal plants used as anthelmintics. *S. Afr. J. Bot.* 2010, 76, 558–566. [CrossRef]

72. Masika, P.J.; Afolayan, A.J. Antimicrobial activity of some plants used for the treatment of livestock disease in the Eastern Cape, South Africa. *J. Ethnopharmacol.* 2002, 83, 129–134. [CrossRef]

73. Luseba, D.; Elgorashi, E.; Ntloedibe, D.; Van Staden, J. Antibacterial, anti-inflammatory and mutagenic effects of some medicinal plants used in South Africa for the treatment of wounds and retained placenta in livestock. *S. Afr. J. Bot.* 2007, 73, 378–383. [CrossRef]

74. Aremu, A.O.; Finnie, J.F.; Van Staden, J. Potential of South African medicinal plants used as anthelmintics—Their efficacy, safety concerns and reappraisal of current screening methods. *S. Afr. J. Bot.* 2012, 82, 134–150. [CrossRef]

75. Fouche, G.; Sakong, B.M.; Adenubi, O.T.; Pauw, E.; Leboho, T.; Wellington, K.W.; Eloff, J.N. Anthelmintic activity of acetone extracts from South African plants used on egg hatching of *Haemonchus contortus*. *Onderstepoort J. Vet. Res.* 2016, 83, a1164. [CrossRef]

76. Adamu, M.; Naidoo, V.; Eloff, J.N. Efficacy and toxicity of thirteen plant leaf acetone extracts used in ethnoveterinary medicine in South Africa on egg hatching and larval development of *Haemonchus contortus*. *BMC Vet. Res.* 2013, 9, 38. [CrossRef]

77. Githiori, J.B.; Athanasiadou, S.; Thamsborg, S.M. Use of plants in novel approaches for control of gastrointestinal helminths in livestock with emphasis on small ruminants. *Vet. Parasitol.* 2006, 139, 308–320. [CrossRef]

78. Bürglin, T.R.; Lobos, E.; Blaxter, M.L. *Caenorhabditis elegans* as a model for parasitic nematodes. *Int. J. Parasitol.* 1998, 28, 395–411. [CrossRef]

79. Geary, T.G.; Thompson, D.P.; Klein, R.D. Mechanism-based screening: Discovery of the next generation of anthelmintics depends upon more basic research. *Int. J. Parasitol.* 1999, 29, 105–112. [CrossRef]
80. McGaw, L.J.; Rabe, T.; Sparg, S.G.; Jäger, A.K.; Eloff, J.N.; Van Staden, J. An investigation on the biological activity of Combretum species. *J. Ethnopharmacol.* **2001**, *75*, 45–50. [CrossRef]
81. Shai, L.J.; Bizimenyera, E.S.; Bagla, V.; McGaw, L.J.; Eloff, J.N. *Curtisia dentata* (Cornaceae) leaf extracts and isolated compounds inhibit motility of parasitic and free-living nematodes. *Onderstepoort J. Vet. Res.* **2009**, *76*, 249–256. [CrossRef]
82. Gülçin, I. Antioxidant activity of food constituents: An overview. *Arch. Toxicol.* **2012**, *86*, 345–391. [CrossRef]
83. Granato, D.; Shahidi, F.; Wrolstad, R.; Kilimartin, P.; Melton, L.D.; Hidalgo, F.J.; Miyashita, K.; Camp, J.v.; Alasalvar, C.; Ismail, A.B.; et al. Antioxidant activity, total phenolics and flavonoids contents: Should we ban in vitro screening methods? *Food Chem.* **2018**, *264*, 471–475. [CrossRef]
84. Houghton, P.J.; Howes, M.J.; Lee, C.C.; Steventon, G. Uses and abuses of in vitro tests in ethnopharmacology: Visualizing an elephant. *J. Ethnopharmacol.* **2007**, *110*, 391–400. [CrossRef]
85. Dzoyem, J.P.; Eloff, J.N. Anti-inflammatory, anticholinesterase and antioxidant activity of leaf extracts of twelve plants used traditionally to alleviate pain and inflammation in South Africa. *J. Ethnopharmacol.* **2015**, *160*, 194–201. [CrossRef] [PubMed]
86. Sserunkuma, P.; McGaw, L.J.; Nsahlai, I.V.; Van Staden, J. Selected southern African medicinal plants with low cytotoxicity and good activity against bovine mastitis pathogens. *S. Afr. J. Bot.* **2017**, *111*, 242–247. [CrossRef]
87. Altemimi, A.; Lakhssassi, N.; Baharlouei, A.; Watson, D.G.; Lightfoot, D.A. Phytochemicals: Extraction, isolation, and identification of bioactive compounds from plant extracts. *Plants* **2017**, *6*, 42. [CrossRef] [PubMed]
88. Galvez, M.; Martin-Cordero, C.; Ayuso, M.J. Pharmacological activities of iridoids biosynthesized by route II. In *Studies in Natural Products Chemistry*; Attaur, R., Ed.; Elsevier: Amsterdam, The Netherlands, 2005; Volume 32.
89. Brielmann, H.L.; Setzer, W.N.; Kaufman, P.B.; Kirakosyan, A.; Cseke, L.J. Phytochemicals: The chemical components of plants. In *Natural Products from Plants*, 2nd ed.; Cseke, L.J., Kirakosyan, A., Kaufman, P.B., Warber, S.L., Duke, J.A., Brielmann, H.L., Eds.; Taylor and Francis Group: Boca Raton, FL, USA, 2006; pp. 1–49.
90. Olaokun, O.O.; Mkolo, N.M.; Mogale, M.A.; King, P.H. Phytochemical screening, antioxidant, anti-inflammatory and glucose utilization activities of three South African plants used traditionally to treat diseases. *Biol. Med.* **2017**, *9*, 1000412. [CrossRef]
91. Hajam, Y.A.; Rai, S.; Kumar, R.; Bashir, M.; Malik, J.A. Phenolic compounds from medicinal herbs: Their role in animal health and diseases—A new approach for sustainable welfare and development. In *Plant Phenolics in Sustainable Agriculture*; Lone, R., Shuab, R., Kamili, A.N., Eds.; Springer: Singapore, 2020; Volume 1, pp. 221–239. [CrossRef]