Chapter 11
Ethnoveterinary Plants and Practices for the Control of Ticks and Tick-Borne Diseases in South Africa

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Keywords Medicinal plants · Ethnoveterinary medicine · Ticks · South Africa

11.1 Economic Importance of Ticks

Livestock production in South Africa is a significant contributor to food security and clothing, and provides many social and economic attributes to the country. It is estimated that two-thirds of resource-poor rural households keep some type of livestock. Poor urban households, even in large cities, also own livestock (Meissner et al. 2013). While these farmers face many constraints in their farming activities, the most important limiting factor to the productivity of their animals is the prevalence of ticks and the diseases they carry. The latter is particularly important in the wet season as the warm climate of the tropics and sub-tropics enables many species of ticks to flourish, while the large populations of indigenous wild animals also provide a constant reservoir for ticks and infectious organisms (Jongejan & Uilenberg 2004).

Ticks are the most economically important ectoparasites of domestic animals and man (Mans et al. 2000). They are hematophagous arthropods ranked close to mosquitoes in their capacity to transmit important diseases (viral, bacterial, rickettsial and protozoal), which can be severely debilitating or fatal (Jongejan and Uilenberg 2004). Ixodids (hard ticks) such as *Amblyomma, Hyalomma* and

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Rhipicephalus species and argasids (soft ticks) such as *Argas persicus*, the most important poultry parasite, are among the most economically important parasites in the tropics and subtropics (Rajput et al. 2006). It is estimated that the global economic burden due to ticks and tick-borne diseases on animal health ranges from US$ 13.9 to 18.7 billion annually (De Castro et al. 1997). In Africa, tick-borne diseases kill nearly 1.1 million cattle annually with resultant economic losses of US$168 million (Minjauw and McLeod 2003).

11.2 Direct Economic Losses Due to Ticks

11.2.1 Biting Stress and Loss of Production

All feedings of ticks at each stage of the life cycle are parasitic. During the feeding process, ticks attach to the skin of their host with their mouthparts. Pruritus (itching) due to the release of histamine from mast cells and pain (caused by bradykinin release) at the numerous feeding sites on the host's skin results in general decrease in food intake (anorexia) of affected animals with resultant weight loss, poor growth and losses in milk production. Other effects include chronic blood loss (anaemia), which over time also contributes to weight loss and poor production from a number of contributing factors of which the main one is from the loss of nutrients to a significant number of ticks (Jonsson 2006).

11.2.2 Physical Damage

Despite their differing sizes, larval, nymphal and adult mouthparts of argasids and ixodids penetrate to a similar depth towards the base of the Malpighian layer of the skin and this may occur within 5 min of the arrival of the tick on the host, causing open wounds (Jones et al. 2015). The skin attempts to repair itself through an orchestrated cascade of biochemical events: haemostasis, inflammation, tissue proliferation and tissue remodelling. These events produce scars at several feeding sites that remain for years, long after the ticks have detached. When skins of these livestock are made into leather, these scars remain as blemishes that reduce the value of the leather.

11.2.3 Wound Infection

The process of tick feeding also results in secondary wound infections with opportunistic bacteria (such as *Staphylococcus aureus*) and fungi (such as *Aspergillus fumigatus)* on the skin. The wound site is also susceptible to infestation with larvae of parasitic flies causing myiasis – the infestation of the body of a live vertebrate animal by larvae of flies that grow inside the host while feeding on its tissue. The adult females of parasitic flies lay their eggs on the animal, and these hatch in approximately 8–24 h, depending on the environmental conditions. Once hatched, the larvae tunnel through wounds into the host's subcutaneous tissue. Painful, slow-developing ulcers or furuncle (boil) like sores occur. After about 24 h, bacterial infection is likely and, if left untreated, could lead to septicaemia (bacteria in the blood), which may be fatal (Mukandiwa et al. 2012). *Cordylobia anthropophaga* (tumbu fly) has been endemic in the subtropics of Africa for more than 135 years (Adisa and Mbanaso 2004).

11.2.4 Poisoning by Ticks

Tick paralysis, a major form of tick toxicosis in animals, is caused by the adult female tick during the period of rapid engorgement (days 5–7), although large numbers of larval or nymphal ticks may also cause paralysis. More than 60 species of ticks have been implicated so far to induce tick paralysis. The most noted and dangerous tick in this respect in South Africa is the Karoo paralysis tick (*Ixodes rubicundus*). The adult tick excretes a toxin that causes paralysis in sheep, goats and cattle. The paralysis commonly occurs from February and reaches a peak in April and May. Sudden drops in temperature caused by rain, cold winds and cloudy conditions seem to stimulate the activity of the adult ticks. Affected animals become paralysed and some may show signs of uncoordination and stumbling. Unless ticks are removed, the animal remains paralysed and dies within days (Durden and Mans 2016). The feeding of the cattle leg tick, *Rhipicephalus praetextatus,* also causes toxicosis in cattle in Africa, resulting in paralysis.

11.3 Indirect Economic Losses Due to Ticks

In addition to causing direct losses, ticks are vectors of numerous, economically important diseases of livestock and humans and as such are key targets for infection control.

11.3.1 Viral Diseases

11.3.1.1 African Swine Fever (ASF)

African swine fever virus, the causative agent of ASF, is the only member of the Asfarviridae family and the only virus with a double-stranded deoxyribonucleic acid genome transmitted by arthropods that replicates in the cytoplasm of infected cells (Rowlands et al. 2008). It is endemic to sub-Saharan Africa and exists in the wild through a cycle of infection between ticks and wild pigs, bush pigs and warthogs (Denis 2014).The ASF virus is transmitted in domestic pigs by the feeding of *Ornithodoros moubata* ticks.

In South Africa, reports of ASF date back to as early as 1926 when it was first recorded in the northern parts of the country, formerly known as Transvaal (Boshoff et al. 2007). In 1935, South Africa instituted and gazetted a designated ASF control area that mainly encompasses the Limpopo Province, the northern parts of North West and KwaZulu-Natal provinces and the northeastern parts of Mpumalanga Province (Fig. 11.1). The designation of the area was based on the presence of

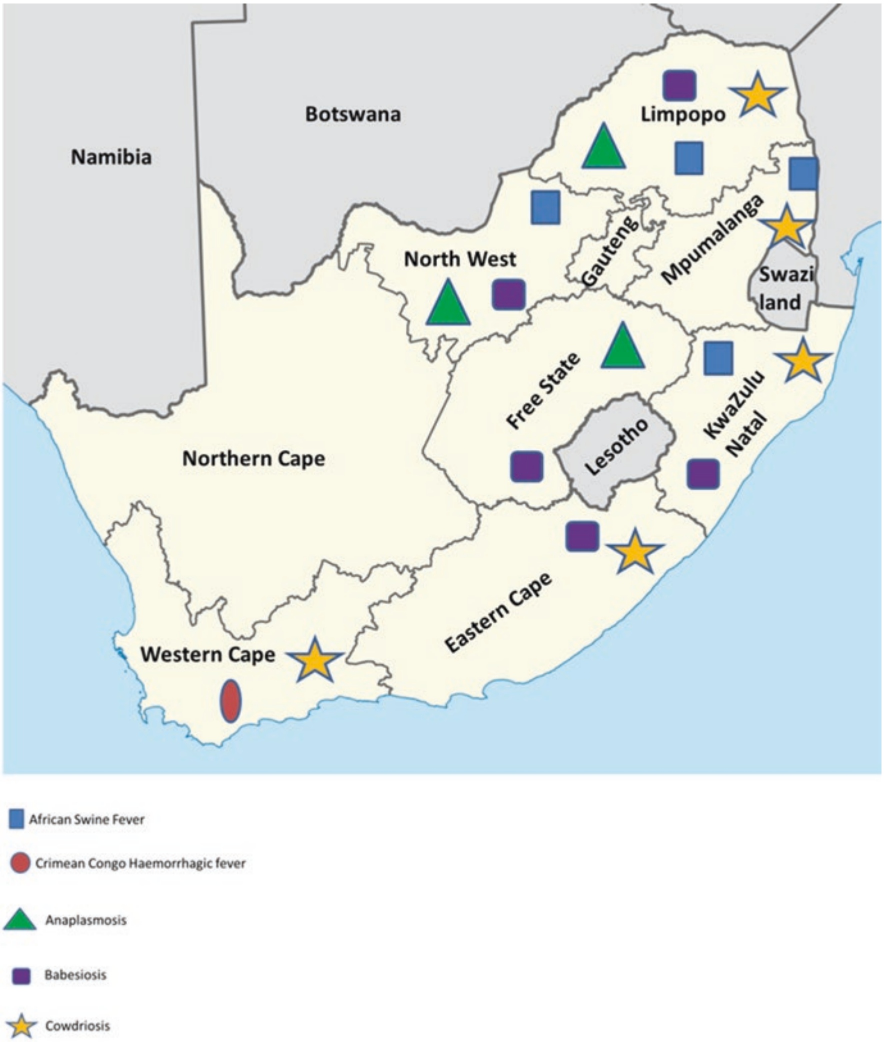

Fig. 11.1 Distribution of economically important tick-borne diseases in South Africa

epidemiologically significant factors (host, environmental and etiologic agent factors) and the presence of outbreaks. The last reported outbreak in Mpumalanga occurred in 1951. In 1996, an outbreak was reported just outside the control area in Bela-Bela, Limpopo Province (Penrith 2009). In 2012, confirmed cases of ASF were reported in Gauteng (Penrith 2013).

The acute form of the disease (transmitted by highly virulent strains) is highly contagious and causes high mortality in pigs. Pigs may develop a high fever, but show no other noticeable symptoms for the first few days. They then gradually lose their appetite and become depressed. In white-skinned pigs, the extremities turn bluish-purple and haemorrhages become apparent on the ears and abdomen. Groups of infected pigs lie huddled together, shivering, breathing abnormally and sometimes coughing. Within a few days post-infection, they enter a comatose state and die. In pregnant sows, spontaneous abortions occur and in milder infections, affected pigs lose weight and develop signs of pneumonia, skin ulcers and swollen joints (Howey et al. 2013).

11.3.1.2 Crimean-Congo Haemorrhagic Fever (CCHF)

Crimean-Congo haemorrhagic fever is caused by a virus of the Bunyaviridae family a medically important, endemic tick-borne pathogen in South Africa (Ince et al. 2014). The first outbreak of the disease was described in 1944 in the Crimean peninsula, Eastern Europe, in people bitten by ticks while harvesting crops and sleeping outdoors (Capua 1998). The virus is typically transmitted by the so-called "bont poot" ticks, *Hyalomma rufipes* and *H. truncatum.* The pathogen is geographically aligned to the distribution of the tick vector, and occurs in the more arid parts of South Africa, particularly on the inland plateau. *Hyalomma* ticks feed on a variety of domestic ruminants (sheep, goats and cattle) as well as wild herbivores, hares, hedgehogs and certain rodents. Although CCHF virus infection in animals is generally subclinical (ostriches are however susceptible), it generates viremia levels capable of supporting virus transmission to uninfected ticks (Ince et al. 2014). The disease is zoonotic and while clinical disease is rare in infected animals, it is severe in infected humans with a mortality rate of 10–50% (Fajs et al. 2014).

The CCHF virus, which was unrecognised in South Africa before 1981, now appears to be widespread in animal reservoirs throughout most parts of the country (Sharifi-Mood et al. 2014). Thus, there is a large susceptible population and the risk of infection exists for livestock workers, veterinarians and other people who live or work in rural environments (Sharifi-Mood et al. 2014). In a study, 17 cases of CCHF were reported and all of them were workers in ostrich slaughterhouses in the Oudtshoorn district, Western Cape, South Africa (Capua 1998) (Fig. 11.1).

Typically, 1–3 days following a tick bite or 5–6 days after exposure to infected materials, flu-like symptoms, haemorrhage progressing to respiratory distress, kidney failure and shock occur. Patients usually begin to show signs of recovery 9–10 days post-infection. However, 30% of cases result in death during the second week of illness (Bente et al. 2013).

11.3.2 Bacterial and Rickettsial Diseases

11.3.2.1 Borreliosis (Lyme Disease)

Borreliosis is transmitted to domestic animals and humans from a natural reservoir among small mammals and birds by *Ixodes* ticks. The incidence and geographical spread of borreliosis is increasing and current serological and clinical evidence indicates that borreliosis has a worldwide distribution in humans, domestic and wild mammals and birds. The disease is endemic in northern Europe and the United States of America (Strijdom and Berk 1996) and the causative agents identified are *Borrelia afzelli, Borrelia burgdorferi* sensu stricto and *Borrelia mayonii* respectively (Shapiro 2014). The incidence of borreliosis in South Africa is unknown. The country has a wide variety of tick species that include five tick genera in which spirochaetes have been found elsewhere in the world. Although ticks of the *Ixodes* family are uncommon in South Africa, *B. burgdorferi* is reported to have been isolated from mosquitoes (Adebajo et al. 1994).

11.3.2.2 Anaplasmosis (Tick-Borne Fever, Gall Sickness)

Anaplasmosis is a disease of ruminants caused by obligate, intraerythrocytic bacteria of the order Rickettsiales, family Anaplasmataceae and genus *Anaplasma.* This includes *Anaplasma phagocytophilum, Anaplasma marginale, Anaplasma centrale, Anaplasma equi*, *Anaplasma bovis*, *Anaplasma ovis* and *Anaplasma platys.* Bovine anaplasmosis has been endemic in South Africa (Fig. 11.1) and 99% of the total cattle population is at risk of acquiring *Anaplasma marginale* infection (Mutshembele et al. 2014). Five tick species have been shown experimentally to transmit *Anaplasma marginale* in South Africa, including *Rhipicephalus microplus*, *R. decoloratus*, *R. evertsi evertsi*, *R. simus*, and *Hyalomma marginatum rufipes* (de Waal 2000). Although the term "anaplasmosis" is often associated with animal infection, the disease also occurs in humans (Hartelt et al. 2004).

This disease is characterised by progressive anaemia due to extravascular destruction of infected and uninfected red blood cells. Animals with peracute infections die within a few hours of the onset of clinical signs. Acutely infected animals are anaemic and lose condition rapidly, milk production falls, and inappetence and loss of coordination are common signs. Breathlessness upon exertion occurs, and a rapid pulse is usually evident in the late stages. Pregnant cows may abort and surviving cattle convalesce over several weeks, during which time haematologic parameters gradually return to normal (Lew-Tabor and Valle 2015). The animals that recover from the disease become persistently infected and serve as a reservoir of infection for mechanical and biological transmission by ticks (Kocan et al. 2003).

11.3.2.3 Cowdriosis (Heartwater)

The disease was known in South Africa for nearly 90 years before the causative organism was identified in 1925 as a rickettsia, originally named *Rickettsia ruminantium* (Cowdry 1925). The name was later changed to *Cowdria ruminantium*, from which arose the term 'cowdriosis' (Moshkovski 1947). Molecular phylogenetic studies of the Rickettsiales in the 1990s uncovered the real evolutionary relationships within the order and the organism was reclassified as *Ehrlichia ruminantium* in the family Anaplasmataceae (Allsopp 2015). *Ehrlichia ruminantium*, an obligately intracellular organism, which is transmitted by *Amblyomma hebraeum* ticks, is endemic in South Africa (Stotlsz 2005) (Fig. 11.1). It infects cattle, sheep, goats and some wild ruminants, and the disease is frequently fatal (Plans and Plan 2016). It is estimated that mortality due to cowdriosis is more than twice that due to babesiosis and anaplasmosis combined (Plans and Plan 2016).

The common name of the disease, "heartwater", is derived from fluid that accumulates around the heart or in the lungs of infected animals. In peracute cases, animals may drop dead within a few hours of developing a fever, sometimes without any apparent clinical signs; others display dyspnea (laboured breathing) and/or paroxysmal convulsions. In the acute form, animals often show anorexia and depression along with congested and friable mucous membranes. Dyspnea slowly develops and nervous signs such as hyperesthesia, a high-stepping stiff gait, exaggerated blinking and chewing movements. Terminally, prostration with bouts of opisthotonus (pedaling and stiffening of the limbs) and convulsions are seen. In subacute cases, the signs are less marked and the involvement of the central nervous system is inconsistent (Plans and Plan 2016).

11.3.2.4 Ehrlichiosis (Tropical Canine Pancytopenia, Canine Rickettsiosis, Canine Hemorrhagic Fever, Canine Typhus, Tracker Dog Disease)

Ehrlichia canis is a rickettsial bacteria belonging to the family Ehrlichiaceae and is transmitted by *R. sanguineus.* It causes ehrlichiosis, a disease of dogs, although humans, goats and cats can also become infected after exposure to ticks (Loftis et al. 2008). The disease was first described in South Africa in 1938 (Geromichalou and Faixová 2017). Serological surveys have shown that dogs with antibodies reactive with *E. canis* by indirect immunofluorescence assays can be found in 42% of dogs in South Africa (Inokuma et al. 2005).

There are three stages of canine ehrlichiosis, each varying in severity. The acute stage, occurring several weeks post-infection and lasting for up to 1 month, can lead to fever and bone marrow suppression with resultant pancytopenia (lowered peripheral blood cell counts). The second stage (subclinical phase), has no apparent clinical signs and can last through the animal's life-time, during which the animal remains infected with the organism. Some are however able to successfully eliminate the disease during this time. In some however, the third and most serious stage of infection, the chronic phase, will commence. Pancytopenia, bleeding, lameness, neurological degeneration, ophthalmic disorders and kidney failure may result. Clinical signs of human ehrlichiosis include fever, headache, eye pain and gastrointestinal upset (Reeves et al. 2008).

11.3.3 Protozoal Diseases

11.3.3.1 Babesiosis (Redwater, Texas Cattle Fever, Piroplasmosis)

Babesiosis is the cause of serious economic losses in South Africa and involves most areas with an annual rainfall of more than 400 mm (De Vos 1979) (Fig. 11.1). The causative agent is *Babesia*, the second most common haemoparasite of mammals, after *Trypanosoma.* Ticks, especially *R. (B.) microplus, R. sanguineus, R. (B.) decoloratus* and *I. scapularis* transmit several *Babesia* species to cattle (*Babesia bovis, Babesia bigemina*); horses (*Babesia equi, Babesia caballi);* dogs (*Babesia canis*); cats (*Babesia felis, Babesia cati*) and humans (*Babesia microti, Babesia duncani*, *Babesia divergens, Babesia venatorum*) (Gray et al. 2010).

Clinical signs in domestic animals include fever, anorexia, haemolytic anaemia, muscle pain, vomiting, weight loss, enlarged liver, icterus (yellowing of the mucous membrane); general organ failure and death may ensue (Shaw and Day 2005).

11.3.3.2 Theilerioses

This refers to a group of diseases caused by *Theileria* in domestic and wild animals in tick-infested areas. East Coast fever, an acute disease of cattle, is caused by *Theileria parva* and transmitted by the tick, *R. appendiculatus.* It is a serious problem in east and southern Africa. The African buffalo (*Syncerus caffer*) is an important reservoir of the pathogen, although infection is asymptomatic. The disease is characterised by fever, which occurs 7–10 days post-infection and panlymphadenopathy (generalised swelling of the lymph nodes). Anorexia develops and the animal rapidly loses condition, lacrimation (abnormal secretion of tears) and nasal discharge may occur. Terminally, dyspnea is common, and death usually occurs 18–24 days post-infection (Katzer et al. 2010).

Theileria annulata, the causative agent of tropical theileriosis, transmitted by *Hyalomma* ticks, is widely distributed in north Africa, the Mediterranean coastal area, the Middle East, India and Asia. It can cause mortality of up to 90%, but strains vary in their pathogenicity. The kinetics of infection and the main clinical findings are like those of *Theileria parva*, but anaemia is often a feature of the disease (Sayin et al. 2003).

Theileria lestoquardi (previously known as *Theileria hirci*) causes a disease in sheep and goats like that produced in cattle by *Theileria annulata*, with which it is closely related. *Theileria equi* in horses causes equine piroplasmosis and *Theileria* *lewenshuni* and *Theileria uilenbergi*, transmitted by *Haemaphysalis* ticks, have been identified as the causative agents of a severe disease in sheep in China (Englund and Pringle2004).

11.4 Tick Control

Tick control programmes are largely based on the use of commercially available chemicals such as the arsenicals, organochlorines, phenylpyrazoles, organophosphates, carbamates, formamidines, pyrethroids, macrocyclic lactones and more recently, the spinosyns, insect growth regulators and isoxazolines on/in the animals or in the environment (Gassel et al. 2014; Adenubi et al. 2018). Several active ingredients with acaricidal and/or tick repellent effects are commercially available for use on companion animals, livestock and humans. These are prescribed in different formulations, including tablets, sprays, soaps, shampoos, powders, impregnated collars, dip solutions, pour-on and spot-on applications. The global parasiticide market was valued at US$ 6509 million in 2013. This is expected to reach US$8918 million by 2019, growing at a rate of 5.4% (www.marketsandmarkets.com). In 2013, Africa accounted for 2.7% of the global parasiticide market, which was valued at US$173.8 million. Of this, ectoparasiticides accounted for 60.1% (US$96.2 million) and this is expected to reach US$137.9 million, growing at a rate of 6.3% by 2019 (www.marketsandmarkets.com).

Commercial acaricides are expensive and not easily accessible to rural farmers. In addition, toxicity due to overdosing, resistance due to underdosing and misuse as well as food and environmental contamination has been reported (Panella et al. 2005). This has led to the search for safe and environmentally-friendly alternatives and a number of unconventional tick control approaches have been advocated (Mondal et al. 2013). These measures are directed towards averting production losses, dropping tick numbers to minimal levels, decreasing chemical residue risks and reducing the dependence on chemicals (Ghosh et al. 2007). Such methods include pasture spelling (Manjunathachar et al. 2014), vaccination (de la Feunte and Kocan 2014), biological control (Nana et al. 2015; Nana et al. 2016), genetic manipulation (Kocan et al. 2003) and the use of ethnoveterinary practices with herbal remedies at the core of therapy (Adenubi et al. 2016, 2018).

11.5 Ethnoveterinary Medicine

Rural and semi-urban farmers have limited access to veterinary care, information about animal diseases, therapeutic veterinary medicines and vaccines and therefore have to rely heavily on ethnoveterinary medicine in most cases. Ethnoveterinary medicine refers to the holistic, interdisciplinary study of indigenous knowledge and its associated skills, practices, beliefs, practitioners and social structures pertaining to the healthcare and husbandry of food, work and other income-producing animals.

The goal is to increase human wellbeing via increased benefits from stock-raising (Martin et al. 2001; Van der Merwe et al. 2001). While the use of ethnoveterinary medicine is common practice in rural farming areas, it is often questioned for its inherent safety and efficacy by the Western world as the use has developed through trial and error and only rarely via deliberate experimentation for the development of modern pharmaceuticals (Katerere and Naidoo 2010). Hence, ethnoveterinary medicine has been viewed as less systematic, less formalised and at times even questioned for its validity. Nonetheless, there is a growing acceptance that ethnoveterinary medicine has therapeutic value and needs further evaluation not only to justify its use, but also as a potential source of newer medications to combat multi-resistant pests and disease organisms (Lans et al. 2007a, b).

Ethnoveterinary medicine plays an important role in the animal health care system in South Africa (Mathias-Mundy and McCorkle 1995). Rural and semi-urban farmers have indigenous practices to treat ticks and tick-borne diseases using medicinal plant species, manipulative techniques, herd management and socio-cultural procedures. These practices are perceived as simple, cost-effective, environment friendly, contextually appropriate and culture-based (Kolawole et al. 2007). The modality involved in the production of herbal medicines varies according to the active ingredients to be extracted, the route of administration and the medical intent (prophylaxis or therapeutics). Livestock owners and herders prepare infusions, decoctions, powders, drops, fumes, pastes and ointments from medicinal plants, animal, mineral and other natural substances. These could be administered topically, as drenches, suppositories, or through smoke and vapours intra-nasally.

There are several threats undermining the relevance of ethnoveterinary medicine in contemporary African societies. These include ecological and technological changes, access to modern health facilities, anthropogenic and natural factors that threaten the existence of many plant species of veterinary importance (Yineger et al. 2008). Because the mode of transfer and documentation of indigenous veterinary knowledge has been, and is still, oral and apprenticeship specific, partial or total loss of accumulated medical heritage is likely (Yineger et al. 2008). Rapid socio-economic and outward rural migrations and paucity of research on ethnoveterinary uses of medicinal plants in treating livestock diseases further undermines its relevance (Maphosa and Masika 2010). We provide information from selected studies that include ethnoveterinary plants and practices, used in traditional veterinary medicine in South Africa for tick infestation as repellents or acaricides. We believe that this may be useful to researchers working on plants as potential tick control agents.

11.5.1 Traditional Tick Control Methods in South Africa

Masika et al. (1997), Luseba and Van der Merwe (2006) and Moyo and Masika (2009) reported several alternative tick control methods such as chickens pecking on livestock, topical application of used engine oil, manual removal by cutting and pulling the ticks, Jeyes fluid and the use of medicinal plants.

Domestic chickens remove ticks from recumbent livestock in the morning hours as well as ingesting engorged adult ticks that have dropped off to the ground. There have been proposals that chickens be incorporated into integrated tick control programmes for livestock in rural villages in South Africa, on the condition that chicken-friendly acaricides are used (Moyo and Masika 2009). However, the use of chickens cannot be a major control method because their consumption rate is minimal, and some farmers do not have enough chickens to feed on ticks.

Used engine oil is said to be effective in controlling cattle ticks (Masika et al. 1997), however its safety to animals and meat consumers has not been assessed. Toxic components in used engine oil, such as lead, chromium, copper and zinc, can contaminate some plants and the environment (Delistraty and Stone 2007). The components may also become concentrated in animal by-products consumed by humans and may be toxic to them. Many rural farmers depend on government pensions and cannot afford to buy conventional acaricides. They resort to using used engine oil to control ticks on their cattle. However, the use of engine oil is not a practice that should be promoted.

Jeyes fluid is a commercial product, used as a household disinfectant. It contains mainly tar acids – 13% m/m carbolic acid – and sodium hydroxide (1%). The use of Jeyes fluid as an acaricide probably dates back to the use of carbolic dip for tick control more than 50 years ago (Moyo and Masika 2009). Jeyes fluid is a corrosive product that has the potential to cause adverse effects on the skin and eyes. With prolonged and repeated skin contact, it may result in irritation, skin dermatitis, blisters and burns (Moyo and Masika 2009). The safety of Jeyes fluid to animals and the environment, together with its residual effect to consumers, is not known and therefore caution needs to be taken when using it or its use needs to be discouraged.

Manual removal of ticks is widely practiced in smallholder farming systems in South Africa. Masika et al. (1997) reported that 10% of livestock owners in the central region of the Eastern Cape Province of South Africa either cut ticks off with blades, scissors or pulled them from their animals. Manual removal of ticks could be an alternative to complement the main tick control method. However, it is laborious and pulling off the ticks damages the animal tissues, especially for ticks with long mouth parts.

11.5.2 Use of Medicinal Plants

South Africa boasts a unique and diverse botanical heritage with over 30,000 plant species of which about 3000 are used therapeutically (Steenkamp and Smith 2006). In addition to this unique botanical heritage, South Africa has a cultural diversity with traditional healing being integral to each ethnic group. Farmers use different parts of some medicinal plants against livestock ticks and tick-borne diseases (Table 11.1).

Table 11.1. Plant species used for tick control in South Africa

Plant family	Plant species	Common name (English)	Vernacular names	Plant part used and preparation	Distribution	Results of reported acaricidal/ tick repellent assays	References
Asphodelaceae	*Aloe ferox* Mill.	Bitter aloe	Bitteraalwyn (Afrikaans)	Fresh leaves are crushed, soaked in water overnight, strained and the mixture sprayed on cattle	Western Cape Eastern Cape southern KwaZulu-Natal, south-eastern part of the Free State	The crude extracts showed weak activity to *R. appendiculatus* species	Mawela (2008)[a]
		Red aloe	Inlaba (IsiZulu) Ikhala (IsiXhosa)				Moyo et al. (2009)[b]
Asteraceae	*Helichrysum* species	Everlasting	Kooigoed (Afrikaans) Imphepho (IsiXhosa, IsiZulu)	The plant burnt to ash and the smoke repels ticks. The ash is also placed in the incubators of incubating hens	Limpopo	NR	Mwale and Masika (2009)[b]
					Mpumalanga KwaZulu-Natal Free State Eastern Cape Western Cape		
Asteraceae	*Tagetes minuta* L.	Khaki bush Khaki weed African marigold	Unukayo (IsiXhosa)	Fresh leaves are crushed, soaked in water overnight, strained and the mixture sprayed on cattle	Eastern Cape	*Hyalomma rufipes* adults exhibited a significant dose-repellent response to the essential oil of *T. minuta*. The oil also significantly delayed moulting of 60% of nymphs after 25 days	Moyo et al. (2009)[b]

							Nchu et al. (2012)[a]
Rutaceae	*Ptaeroxylon obliquum* (Thunb.) Radik.	Sneezewood	Nieshout (Afrikaans)	Fresh leaves are crushed, soaked in water overnight, strained and the mixture sprayed on cattle	Eastern Cape	400 mg/ml repelled ticks (100%) for 40 min post-treatment	Moyo et al. (2009)[b]
			umThathi (IsiXhosa)				Moyo and Masika (2013)[a]
Verbenaceae	*Lippia javanica* (Burm.f.) Spreng	Fever tea Lemon bush	Inzinzinibz (IsiXhosa)	The whole plant is burnt to ash and the smoke repels ticks	Eastern Cape	The aqueous leaf extracts of *L. javanica* was effective at controlling cattle ticks at 10% and 20% w/v	Madzimure et al. (2011)[a]
			Umsuzwane	Ticks are sprayed with crushed leaves mixed with water or twigs are used as bedding in fowl runs	Kwazulu-Natal	Acetone extract of *L. javanica* afforded a sustained repellent activity over time (90%)	York et al. (2011)[c]
			Umswasi (IsiZulu)				Maroyi (2017)[b]

NR none reported
[a]Reference for reported acaricidal/tick repellent studies
[b]Reference for ethnoveterinary usage
[c]Reference for vernacular names/distribution

11.6 Conclusions

The South African middle-class population has increased dramatically in the last 10 years with concomitant growth in demand for livestock foods (Meissner et al. 2013). Livestock farming thus plays an enormous role in providing sustenance to these people as well as poor communities and stabilising the economies of towns in non-metropolitan areas. It becomes imperative that pests such as ticks, which have major impacts on animal health, be effectively controlled.

The efficacy of ethnoveterinary plants and practices for preventing and treating ticks and tick-borne diseases and range management strategies identified in this study needs to be fully investigated and potentially integrated into veterinary extension services. It is important that livestock farmers share ideas on traditional knowledge with veterinarians to optimise productive capacity of herds and enhance sustainable rural livelihoods.

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