

Transition towards natural livestock farming

Report on natural remedies used worldwide against ectoparasites in ruminants



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Introduction

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Glossary

Allopathic medicine: chemically synthesized medicine; also called conventional medicine

Alternative medicine: medicine which sets itself in opposition to allopathic/“conventional” medicine; practices that aim to achieve the healing effects of allopathic medicine, however, evidence of their efficacy may be lacking; also called complementary medicine

Avermectins: a group of drugs used to treat parasitic infections

Ectoparasites: parasites who live outside the host body such as flies, mosquitoes, fleas, mites, lice, etc...

Ectoparasiticide: antiparasitic against external parasites

Embryogenesis: the birth/production of an embryo (in this case parasitic ones)

Engorged: parasites attached to their host and full of the host’s blood

Ethnobotany: the scientific study of the traditional knowledge of plants and their medical uses

Homeopathy: often regarded as pseudoscience, these remedies are based on a series of dilutions based on the original product

Ivermectin: a drug used to treat (internal) parasitic infections, it belongs to the avermectin drug family

LC₅₀: An indication of the concentration (of a product) required for 50% mortality in a parasite population

Lousicidal: lethal effects in lice

Macrocyclic lactones: chemically synthesized products, or derivatives of the product of soil microorganisms. The macrocyclic lactones include milbemycin and ivermectin and are used in veterinary practices against internal and external parasitic infections

Natural Remedies: remedies which, in opposition to allopathic medicine, are not chemically synthesized; remedies which are made using only natural products and procedures

Ovicidal: lethal effects against eggs

Oviposition: birth and positioning of eggs (in this case parasitic ones)

Phytotherapy: therapy based on the use of plants (which usually have some medicinal properties)

Executive Summary

The use of synthetic ectoparasiticides have several negative consequences, as they have a detrimental effect on the insects in the environment - possibly even higher organisms such as vertebrates - leading to loss of biodiversity. Furthermore, the use thereof promotes insecticidal resistance, rendering the ectoparasiticides ineffective. Many stakeholders (including farmers) have voiced their desire for alternatives to ectoparasiticides, and are looking into natural remedies. However, there exists a knowledge gap in the Netherlands regarding scientific literature which is fuelled by a negative attitude and/or general scepticism.

Our aim is to provide an overview of natural remedies used worldwide against ectoparasites, and to provide a foundation for further research to aid the transition towards natural livestock farming.

Through our literature review, 325 natural remedies were identified, and ten of the most promising remedies were further described in detail. These collected entries were compiled into a database (see Appendix 2: Database of natural remedies against ectoparasites found worldwide). Further sections are developed on remedies for ectoparasites of cattle, goats, sheep and general 'indiscriminate' animals (of ruminant type). The outcomes from questionnaire responses and interviews provide the perception of natural remedies from different stakeholders in different countries.

Despite the low response rate of the questionnaire built for the project, when combining the information obtained from the interviews, valuable insights and perspectives were gained. During the literature review, mainly natural remedies against ticks were found (for prevention and treatment). Limitations of the interviews, questionnaire and literature review are discussed. Specific recommendations for Dutch farmers are not given, instead an overview of effective natural remedies is provided. This is due to the insufficient perspective into the Dutch situation; as such, it is not possible to assess how applicable these remedies are for Dutch farmers, in the limited amount of time reserved for this project. Lastly, future research which could address these limitations - as well as general opportunities in the transition towards natural livestock farming - are examined.

Problem Analysis

A major concern of current society is to have a transition into more environmentally friendly and sustainable farming. Over the years, the abundant use of chemicals and antibiotics in agriculture – while improving production performance on farming practice has caused both an increased resistance in target organisms and negative environmental impacts. More specifically, in the field of animal husbandry, and especially in ruminant livestock rearing, synthetic antiparasitics treat and prevent ectoparasites efficiently. Nevertheless, their extensive use has led to increased resistance/decreased susceptibility to the treatment mentioned. In addition, they are detrimental to the environment – their impacts on soil health, as well as local biodiversity, are extensive.

In addressing this issue in the Netherlands, there appears to be no practical - or sustainable - alternative solution to synthetic ectoparasitics. Nevertheless, there is an abundance of knowledge concerning natural remedies that are used as antiparasitics all over the world. The use of natural remedies is often a cultural belief based on ethnoveterinary medicine, pharmaceutical plant properties as well as cultural and 'traditional' knowledge. In many regions like China (Chinese medicine), Mediterranean, Indian (Ayurveda), African or Latin American countries, these practices are easier culturally accepted (Zhang, 2015). For example, in a Chinese research on the personal acceptance of ethical traditional medicine based on 1300 samples, 48.3% of respondents often choose traditional medicine while, only 8.4% remain sceptical. Amongst the respondents who believe in traditional medicine, 33% of them thought it was more effective than 'Western medicine' and 30.3% thought the side-effects are less pronounced; these are two main reasons for their preference, in conjunction with respondents' culture and history (Huang et al., 2018). There is often great scepticism in the adaptation of natural remedies to 'Western standards', especially in the Netherlands. According to our interviews with experts, there is a lack of scientific research in Western countries, which contributes to the gap of existing knowledge regarding natural remedies.

Today in the Netherlands, there are many ethical concerns - both about the environmental impact of antiparasitic use *and* the increased resistance of ectoparasites against them - from multiple stakeholders such as farmers, veterinarians, academics and consumers. First and foremost, farmers should have an alternative option to synthetic ectoparasiticides, due to their negative consequences on the environment, animal health - and production. Dutch veterinary education does not touch upon alternative for synthetic antiparasitics; many veterinarians are currently looking to gain more scientific knowledge in that field. Academics and researchers are looking for scientific proof as to the effectiveness of natural remedies against ectoparasites. Additionally, consumers are concerned about the environmental impact of the products on the market, their potential contamination with antiparasitic residues, and ethical implications regarding animal health and welfare.

The aforementioned arguments have fueled a need to learn from other countries' use of natural remedies, in order to eliminate the knowledge gap, and to give stakeholders scientifically proven alternatives to synthetic ectoparasitics. The main aspects of this knowledge gap can be described in the following research questions.

Main Research Question: What natural remedies are available to deter (or reduce) ectoparasite infection on ruminants?

Sub-research questions:

- **Q1:** What is the current situation in The Netherlands regarding antiparasitic use and its impact on the environment?
- **Q2:** What natural remedies are already implemented in the Dutch livestock farming?

- **Q3:** What is known worldwide about natural remedies and management methods against external parasites in ruminants?
- **Q4:** Can these antiparasitic remedies be implemented in the Dutch farming business? And in what way can these natural remedies be incorporated in Dutch natural livestock farming (management level, active or passive administration)?

Methods & Materials

Several methods were used to address the abovementioned research questions of the project. The main method used was a literature research/review, through online research engines like Google, Google Scholar, PubMed, Science Direct, and more; the search was based on key words related to the research questions. Furthermore, interviews were conducted with experts that had experience in the relevant topics to the project. Finally, there was an attempt to gain supplementary data and information in the limited time available with the use of an online questionnaire, that was formed specifically for that project in order to gain access to relevant stakeholders in other countries as well.

Literature review

The first step to this project was the literature review. It provided the essential information for the project report and played a crucial role in the interview preparations. The literature review was implemented based on the research questions and took place over a period of two and a half weeks. The current situation is largely summarized by Dutch literature. Regarding the natural remedy availability aspect, the information was collected from a myriad of countries across the globe.

Firstly, a literature review from scientific papers was conducted, to provide reliable insight into our project. Then, the information from various channels - such as scientific articles, specialized books, farming magazines and internet articles - was collected to explore the potential of natural remedies from different countries. Subsequently, the relevant information was filtered according to reliability, validity, and feasibility. This information is compiled into a table of natural remedies used worldwide (see Appendix 2: Database of natural remedies against ectoparasites found worldwide). Finally, the most relevant results of the literature reviews are summarized in the *Solutions* section, and general recommendations of natural remedy use are made.

Interviews

Interviews with stakeholders were organized over a period of three and a half weeks. In total, three academic experts, two farmer representatives, two veterinarians, and one producer of veterinary medicine were interviewed. For each interview, an outline was made as preparation, which was tailored according to the interviewees' background. Throughout the interviews, the experts shared their personal experience, attitudes, and knowledge about natural remedies. The literature review and report writing were based on the information obtained from the interviews. The outcome of the interviews and perspectives of the experts are anonymously summarized in the results.

Questionnaire design and analysis

In this project, a questionnaire was designed for data collection from different countries. The questionnaire was constructed with multiple choices and open questions based on the four research sub-questions.

A questionnaire was compiled with questions that touched upon demographic, professional background, experience with various ectoparasitic infestations, awareness and application of

natural remedies on treatment and prevention. The final questionnaire takes approximately 10-15 minutes to complete and was translated into five different languages (English, Dutch, Greek, French and Chinese). The final questionnaire is available in appendix.

The data collected via the questionnaire was adapted in further sections to demonstrate actual cases on awareness of natural remedy, attitudes, and natural remedy application in farming practices in different regions.

Report

The literature review, interviews and the assessment of the questionnaire are processed in this report. The current situation in the Netherlands - and across the world – regarding potential solutions are summarized in further sections. This report concludes with some scientifically proven recommendations and future opportunities regarding implementation of natural remedies against ectoparasites in Dutch animal husbandry, and exams any remaining uncertainties.

Problem description

Current situation in the Netherlands regarding antiparasitic use and impacts on the environment

For the purposes of our project, we focus on organic livestock keeping in the Netherlands. A reason for that is because of the additional rules regarding allopathic medicine. In organic livestock keeping, farmers are suggested and encouraged to use alternative medicine (amongst which are natural remedies, and homeopathic products). Additionally, in organic cattle, goat, and sheep farming, farmers are only allowed to use a maximum of three synthetic medicine treatments a year and only when a veterinarian prescribes it (Skal, N.D.a; Skal, N.D.b). No such limit exists for conventional livestock keeping, therefore, any suggestions or advice for organic farming could potentially be applied for conventional farming as well. The next sections outline the impacts of antiparasitics, and review the implications of the transition into natural livestock farming.

The impacts of antiparasitics

The negative consequences of using synthetic medicine in livestock farming are starting to become self-evident. Namely, the use of synthetic antiparasitics have devastating effects on the environment. The current control of external parasites relies on chemicals that act as neurotoxic agents; these chemicals damage the nervous system of the external parasites, with eventually a fatal outcome (Bártíková et al., 2016).

In the Netherlands, macrocyclic lactones (type of synthetic ectoparasiticides) are widely used against parasites on sheep and cattle. These substances are usually applied several times a year to serve as preventative measures (Lahr, 2016). Several studies have reported on the impacts of avermectin (a macrocyclic lactone) residues, most notably of ivermectin, doramectin and moxidectin, the parent substances of ivermectin (a drug in the avermectin family), can be detected in the cattle faeces even 58 days after administration. Higher administration levels resulted in higher residue concentrations in the faeces of cattle in the first few days after administration. After day five, the residue concentrations are in similar ranges to the lower dosages. However, the residue concentrations are dependent on the administration method (e.g., oral or via injections) (Steel & Wardhaugh, 2002).

The capability of avermectins to affect the development of several arthropod species are also often reported. Avermectins are proven to have (sub)lethal effects, including detrimental effects to the development of larvae and adults of Diptera and Coleoptera species. The use of synthetic medicines, such as organophosphates, were also found to negatively affect earthworms. The

cumulative impacts of synthetic antiparasitics on soil quality – and the different organisms living near or in the soil – will be further detailed in the next sections.

Soil

Macrocyclic lactones – but also synthetic pyrethroids and organophosphates used as ectoparasiticides – can be found as residues in faecal and urine samples, and end up in the soil, affecting ecosystems (Steel & Wardhaugh, 2002). When using an administration dose of 200 µg of macrocyclic lactones, peak residue concentrations in cattle faeces occur from the first day of administration to the sixth- or eighth-day post-administration, showing that environmental leaching takes place. Organophosphate excretion occurs mainly via the urine and was found in a study to have high mobility, as well as high adsorption and desorption rates in the soil. The impact of synthetic pyrethroids and organophosphates on soil fauna is largely dependent on various factors, such as the type of soil, pH and salt content (Lewis et al., 1993). All these factors determine the retention time of synthetic pyrethroids and organophosphates in the soil (Beynon, 2012). It has been shown that synthetic pyrethroids and organophosphates increase unwanted bacterial growth in the soil and decrease the abundance and diversity of predatory protozoa (Semple et al., 2000).

Earthworms

A study in earthworms shows that synthetic pyrethroids and organophosphates (found in the soil) are harmful to earthworms, which may, as an effect, alter the decomposition rate of organic matter (Beynon, 2012). However, many studies on the effects of ivermectin on earthworms show contradictory results (Steel & Wardhaugh, 2002) – although, many of these studies were subjected to criticism. Overall, no evidence was found concerning the direct effect of ivermectin residues on earthworms (Svendsen et al., 2005).

Earthworms are important organisms that play a large role in influencing the soil quality; the decreased viability of faecal matter-feeding organisms (due to avermectins) consecutively affects the abundance and physiological aspects of the earthworms – and in turn, soil quality. Due to the important role of earthworms in the farm-soil ecosystem, it is of the essence to conduct more research on the effects of the current use of parasiticides, in order to obtain *valid* conclusions (Peloci et al., 2014).

Coleoptera

Species of insects within the order of Coleoptera – notably, beetles – are often reported to be affected by avermectins, mainly in terms of negative impacts on reproductive capabilities. The magnitude of these effects seems to vary both among and within species.

Cattle treated with doramectin resulted in faecal residues with a significant detrimental effect on the viability of the dung beetle (*Dichotomius anaglypticus*). The survivability of the dung beetle was reduced when exposed to the residues in faecal matter, for up to 10 days after doramectin administration to the animal. In another dung beetle species (*Onthophagus gazella*), it was observed that the larval development was completely inhibited when the residue concentration in the faeces exceeded 64 parts-per-billion (ppb). Sub-lethal effects of eprinomectin (another avermectin) were also observed, mainly fecundity reduction in dung beetle species (Steel & Wardhaugh, 2002).

The toxic effects of milbemycins (another macrocyclic lactone) were found in the dung beetle species *Euoniticellus fulvus*. When used subcutaneously in cattle and sheep, they caused a reduced fertility in the animals. Fertility was reduced after exposure to these products in faecal matter of cattle and sheep - the cattle and sheep were treated subcutaneously with milbemycins. Several species within the order of Coleoptera faced increased mortality when exposed to faecal residues of these synthetic ectoparasiticides (Doherty et al., 1994).

Synthetic pyrethroids also have toxic effects on both adult as well as young dung beetles. The toxicity of synthetic pyrethroids and organophosphates varies between application methods - pour-on application of these substances in cattle seems to result in the largest toxicity on dung invertebrates. Beetles and flies feeding on faeces containing synthetic pyrethroid residues will experience increased mortality, by a rate of 10-30% (Beynon, 2012).

Diptera

The larvae of flies seem to be affected by the toxic properties of the synthetic pyrethroids at field concentrations. Synthetic pyrethroids were administered to cattle in some experiments with a certain dose and application frequency that was suggested for Tsetse control (Vale et al., 2004). Diptera species also had decreased viability and increased mortality when they were exposed to doramectin and eprinomectin (Floate et al., 2001; Steel & Wardhaugh, 2002). Furthermore, there was also a delay in reproductive development, reduced fecundity and increased larval mortality when exposed to milbemycin residues in faeces (Steel & Wardhaugh, 2002). These combined effects could have a negative impact on the Diptera population.

Vertebrates

As various vertebrate species feed on the coprophagous invertebrates, there is the possibility that they also experience negative effects from the ectoparasitocides. One can think of the toxic effects in the vertebrates, but also, the reduction in invertebrate 'prey' may lead to starvation of some vertebrate species. More research is needed to link the organophosphates and synthetic pyrethroids to vertebrate toxicity and reduction in population size (Beynon, 2012).

Transition towards natural remedies/alternative medicine

As was explained in the previous section, the use of synthetic parasiticides has many negative and cumulative consequences. Natural remedies present themselves as an ecologically friendly alternative to these synthetic antiparasitics.

The difference between 'regular' and alternative medicine are the clinical trials and additional research that 'regular' medicines must undergo before they are approved.

Both the regular and alternative medicine have to undergo specific procedures to be labelled as such. Additionally, for the regular medicines, this includes clinical trials and research on the active compounds. Nevertheless, the therapeutic effects of the active substances described in literature, regarding alternative medicine and how these active substances are derived from their raw materials and approved by the *College Ter Beoordeling van Geneesmiddelen*, Medicines Evaluation Board (CBG MEB, 2015).

Looking at credible sources into alternative medicine, it becomes clear that there is a problem of lack of research; the sparsity of research has led to few and outdated sources. In a study from 2004 by Kijlstra and colleagues, organic goat farms were examined; the study reported that 75% of the farmers expressed having used at least one alternative medicine to treat their animals. Since then, few recent and relevant developments have taken place. With this lack of research comes scepticism from various other parties such as farmers, veterinarians, academics and other users. For instance, some veterinarians worry about the validity and effectiveness of natural remedies and are hesitant to incorporate them into their practices.

Nevertheless, there seems to be a growing interest in natural remedies, promoted by organic farming. In 2015, 61% of the Dutch dairy cattle farmers reported using natural remedies as an alternative for antibiotics (Biojournaal, 2016). In 2014, this was 45% of the Dutch dairy cattle farmers, of which 10% have used herbal substances (Veeteelt, 2015). Different companies have realized that there is a demand for natural solutions and as such, have started formulating antiparasitic products.

Natural remedies available in the Netherlands

There is no single official guideline about the use of natural remedies or products for livestock in the Netherlands. However, there are some very informative resources; a) academic sources: such as the “*Stable Booklets*” by Maria Groot; b) information found about natural remedies in internet resources; and c) information regarding manufactured alternative products available on the Dutch market. In this section, some of the more common and easy-to-access natural remedies are discussed.

Remedies reported in academic resources

External parasites have had a linked relation with farmers over the years, affecting their animals’ health and production. That is why the farmers tried and used a lot of remedies in the past against them. For example, for deterring flies in the stables, several farmers reported using garlic, either as a powder mixed into the feed or by boiling garlic in the stables (Elbertsen, 2004). Other reported methods included shaving the animals, applying a soap-solution to the animals’ skin and even creating nesting spaces for swallows (Elbertsen, 2004).

The Fyto-v project was a two year long collaborative project instigated by the Dutch ministry of Agriculture, Nature and Food. This research project studied the use of phytotherapy on reducing and treating animal diseases. One specific product that is mentioned in the fyto-V report, “*Entroguard*”, is available in the Netherlands. The product is *mainly* used to obtain a healthy gut system; it can be applied to many animal species and multiple age levels of the animal. *Entroguard* consists mainly of garlic and cinnamon, which are known to be used in veterinary products against internal and external parasites (Kleijer-Ligtenberg, 2008). In the database of Fyto-v, two additional natural products were mentioned: “*Parasiten-Frei*” and “*Bremsen-Frei Plus*”. These products are manufactured and imported by Dr. Schaette; *Parasiten-Frei* is used against lice and flees in both small ruminants (goats) and cattle. The main active ingredients of *Parasiten-Frei* are natural pyrethrum extract and piperonylbutoxide. *Bremsen-Frei Plus* is used against flies, mosquitoes and hornets in small ruminants and cattle. The active ingredients of this product are geranium oil, lavender oil, propan-2-oil, eucalyptus oil, hertshoorn oil and glycerine. The data was collected from proprietary data (product information) (Fyto-V, N.D.a; Fyto-V, N.D.b).

According to the *Stable Booklets*, there are several general management methods that are applied to prevent ectoparasite infestation in ruminants. These general practices include allowing for nesting places for swallows, bats, good ventilation and keeping the stables clean and dry (Elbertsen, 2004; Groot, 2011; Groot, 2018). Parasitic wasps (i.e., wasps in the families of Ichneumonidae and Pteromalidae), are effective against flies associated with ruminants, as they are the natural enemy of these flies. One can apply this method by bringing the wasp pupae into the stable. The *Stable Book* regarding cattle includes several applications to prevent or treat lice, scabies, mites and flies.

Natural remedies against ectoparasites (in Dutch ruminant livestock) found in the previously mentioned academic sources are listed in the Table 1, below.

Table 1: List of natural remedies available against ectoparasites of ruminants in the Netherlands

Host	Remedies for different types of ectoparasites			
	Ticks	Flies	Mosquitoes	General
General (applied to several ruminants)		Oleum animale foetidum crudum: smell repels flies	Oleum animale foetidum crudum: smell repels mosquitos	

<p>Cattle (Elbertsen, 2004).</p>		<ul style="list-style-type: none"> - Electric fly swatters and stick tape traps - Putting garlic powder in feed mix <ul style="list-style-type: none"> - burning sticky fly traps - boiling garlic (scent deters flies) - branch of elderberry/<i>Sambucus nigra</i> in the stable - Spy: natural insecticide (By Novartis) 		<ul style="list-style-type: none"> - <i>Artemisia absinthium</i>: its etheric oils would have antiparasitic effects - <i>Juglans regia</i>: leaves are used for skin problems and against ectoparasites. - <i>Salvia officinalis</i>: contains tannins and etheric oils, which have antiparasitic effects.
<p>Goats (Groot, 2018)</p>		<ul style="list-style-type: none"> - Branch of elderberry/<i>Sambucus nigra</i> in the stable - Asilidae/ assassin fly; pupae are put into the stable 	<ul style="list-style-type: none"> - Branch of elderberry/<i>Sambucus nigra</i> in the stable 	
<p>Sheep (Groot, 2018)</p>	<ul style="list-style-type: none"> - Cold pressed neem oil with curcuma 	<ul style="list-style-type: none"> - Lavender oil - Eucalyptus citruodora - Geraniol - Neem oil - wild gale oil (<i>Myrica gale</i>) - citronella (from the lemon grass plant <i>Cymbopogon</i>) - Asilidae/ assassin fly (Groot, 2018) - Farm-O-San fly blocks; mineral blocks with garlic; the animals will have an unappealing smell for the flies 	<ul style="list-style-type: none"> - Mugwort (<i>Artemisia vulgaris</i>) 	<ul style="list-style-type: none"> - Citronella - Wild gale oil

The most important remedies that were mentioned above are products containing garlic. Garlic alters the odour of the animal, which repels flies. The use of natural enemies, assassin fly and parasitic wasps against flies were mentioned several times in the stable books. Also, etheric oils from various plant species were mentioned to have ectoparasite repellent properties.

Remedies reported in internet resources

Other sources (forums, websites, magazines, etc.) can also provide information about the use of natural remedies. However, the validity of this information is questionable - perhaps even controversial. The majority of these sources do not list references (let alone references to scientific articles), nor do they always provide their own experiences with it. Nonetheless, it may be worthwhile to look into them, since it gives an indication as to which natural remedies a farmer can use. Examples of natural remedies include essential oils having insect repellent properties, e.g., tea tree, eucalyptus and lavender (Eveleens, N.D.). Other commonly mentioned remedies are the application of *hertshoornolie* (*Oleum animale foetidum crudum*) and garlic as a feed supplement (Fokkersvereniging Ouessantschapen, N.D.; Müller, 2014). The website of Teken-vlooien states that neem oil and coconut oil repel ticks, fleas and other insects, specifying that it is the lauric acid in coconut oil that acts as an active ingredient (Teken-vlooien, N.D.).

The aforementioned examples give insight as to what information an average person encounters when looking for natural remedies. However, with these sources, the origins are unknown and may not be credible. These uncertainties can pose a risk if the 'advice' turns out to be harmful.

Manufactured alternative products

As previously mentioned, farmers seem to be quite interested in alternatives for synthetic products. Certain companies have noticed this demand and in return, are developing natural-based

alternatives for them. These products range from being 100% pure products to a mixture of several different products. Table 2, shown below, gives a few prominent examples of natural-based products that are advertised to work against ectoparasites. VITALstyle is a prominent company that offers natural-based products; however, after contacting them, they responded that they currently do not have plans for developing a product against ectoparasites.

Table 2: List of manufactured alternative products for ectoparasites available in the Netherlands

Product	Active ingredients	Claims	Company
Knoflookgranulaat	Garlic	When used in high doses mixed in the feed, it repels flies on horses	Hopp Health
Happy skin Zomereczeem Spray	Plant-based fatty acids and monoglycerides	Spray on sensitive areas of the horse and it repels mosquitoes	Green Valley
RumiBloc REPELLO	Essential oils, vitamins and minerals	Repels mosquitoes and flies by altering the odour of the skin of ruminants	Herbavita
Vliegenblok biologische	Not specified	Repels flies on horses	Prolako
Barricade schaap	Natural oils	Repels insects for up to six weeks on sheep	Holland Animal Care
Maden Weg	Natural oils	Prevents flies from laying eggs on the sheep and repels already present larvae	Holland Animal Care
Muscastop	Not specified	Repels flies for up to one week	Refona

Literature review and other outputs

In this section, an overview of the outputs is given. These are the literature review, questionnaire and interview. The overall summary of the literature review, in the form of a table, can be found in the Appendix 2: Database of natural remedies against ectoparasites found worldwide. Only the ten most mentioned natural remedies from the database are explained in further detail, as these have more information available. A few prevention and management practices are also discussed in this section. Furthermore, an overview of the results of the questionnaire will be given - however, no data analysis will be applied as the response was quite low. Lastly, a summary of the interviews with the stakeholders will be given.

Noteworthy prevention and management practices

Other than administration of natural remedies to or on the animal, there are also several treatments that can be applied in the environment, in order to prevent and/or treat external parasitic infestations. The labour intensity varies between these preventative and treatment management practices, but they may be easier to implement compared to methods that require individual application on individual animals. For example, when bringing new animals into the herd, it is useful to quarantine them first, in case they have ectoparasites that could easily cross-infect other animals (Arsia, N.D.). Similarly, it is advantageous to deep clean and disinfect the premises and transport vehicles before and after every transportation, to avoid potential ectoparasitic contamination (Arsia, N.D.). Other management practices that a farmer can implement include, for example, maintaining low animal loads, which can limit parasitic pressure and allow animals to develop immunity sufficiently (Lifeprairies, 2013). The farmer can also record the history of a plot and monitor for different ectoparasitic infestations, which allows for identification of risk factors (e.g., weather conditions, seasons, humidity, etc...) which contribute to ectoparasitic pressure

(Lifeprairies, 2013) When these factors are known, a farmer can adjust their strategy to their needs by, for example, applying antiparasitic treatments earlier, cleaning out the premises more often or even applying rotational grazing (ADMM, 2017; Lifeprairies 2013).

For more passive management practices that are less labour-intensive, it is possible to utilize natural predators against ectoparasites. These could, for example, be chickens kept around the animals, or use of parasitic wasps as indicated in the Stable booklets by Maria Groot. Chickens will forage and eat a variety of insects, including ticks (Wanzala et al., 2017). Feeding strategies are also easier to implement but could be difficult to monitor, depending on the intake of individual animals. Additionally, the adjusted feed nutrition could be beneficial for the animal's health and/or immune system, making them more resilient against ectoparasites. One remedy found in Canadian literature suggested feeding 28 grams of algae to young cattle each day, as both preventative and a method of treatment (OACC, 2009). An older study from Kenya reported that the addition of neem seed powder to goat feed can reduce tick attachment and increased tick mortality (ICIPE, 1999). An article found in Pakistani literature described the tactic of adding two to three doses of *Citrullus colocynthis* fruit (100g) to animal feed as a preventative method against ticks (Babar et al., 2012).

Regarding passive environmental practices, in Kenya, neem plants (*Azadirachta indica*) are grown around the stables to repel ticks (Wanzala et al., 2017). For prevention and treatment against fly larvae in France, basil essential oil can be sprayed (0.1% concentration) on humid bedding once a week (Bassoleil, 2019). Additionally, nomadic communities in Kenya create hanging bouquets from *Vitex doniana* and *Vitex fischeri* to drive away ticks from their livestock (Wanzala et al., 2012).

Most mentioned natural remedies worldwide

Neem (*Azadirachta indica*)

The application of neem (*Azadirachta indica*) as a solution to tick infestations is reported in many different studies. The mainly used form of application is neem seed oil, with neem seed powder also used in a specific case. Ndumu et al. (1999) found that neem seed oil can work against tick larvae (in an in vitro experiment) and that the effectiveness increases with a higher concentration solution. Other studies used similar methods, which monitor the mortality of ticks in neem seed oil, to identify the effectiveness of neem seed oil with in vitro tests. Abdel-Shafy & Zayed (2002) claimed that the application of neem seed extract can cause the failure of hatching eggs. Furthermore, two studies both found 70-100% mortality of ticks after treatment by neem seed extract at different concentrations (Kalakumar et al., 2000; Al-Rajhy et al., 2003).

During in vivo studies, a mixture of neem seed oil and eucalyptus oil was sprayed to the skin of cattle and goats daily, with 92.2% and 97.8% mortality identified after eight days' treatment as well as a reported decrease in the protein concentration in the body of ticks (Sivaramakrishnan et al., 1996). Another in vivo study fed neem seed powder to goats; a significant effect on reducing larvae attachment and increase tick mortality were reported (ICIPE, 1999). Additionally, fly repellent activity was found by a recent study (Kamatchi & Parvathi, 2020), which suggested that neem seed oil can prevent flies from approaching animals when it is sprayed on the horn or hooves of cattle and goats. Overall, *A. indica* use against ticks, as well as its fly repellent action potential, make it a plausible remedy.

Tobacco (*Nicotiana spp.*)

Tobacco plants, also known as *Nicotiana spp.*, are frequently used for their medicinal properties. *Nicotiana spp.* has been mentioned in many different articles - whilst most of these articles are reviews or surveys, two older experimental studies indicated that *N. tabacum* extracts were effective against ticks. A 10% crude extract resulted in 50% mortality after 36 hours, a 66%

inhibition of oviposition and 69.8% inhibition of embryogenesis in *Boophilus microplus* ticks (Mansingh & Williams, 1998).

Another study combined *Nicotiana tabacum* with 'Magadi soda' (soda ash) to create 'Kupetaba', which was then dissolved in water to create different dilutions of Kupetaba stock solution (Dipeolu & Ndungu, 1991). It was reported that the stock solution protected calves for up to 120 hours from ticks, compared to control calves. Furthermore, Kupetaba was effective against the different immature stages (nymph and larvae) of ticks and even a 50% dilution remained effective. In general, application of Kupetaba was found to interrupt ticks from completing feedings, inhibit oviposition of engorged ticks and result in 90.95% unhatched eggs (compared to 5.25% in control) (Dipeolu & Ndungu, 1991).

Several surveys and reviews report that the leaves of *Nicotiana spp.* are used preventative and as a treatment for several ectoparasites (including ticks, flies and lice) by farmers from Ethiopia, Turkey, Trinidad and Tobago, and more (Tesfaye et al., 2015; Yaşar et al., 2015; Wanzala et al., 2017). Additionally, people of the Paliyar tribe in India use it as fly repellents (Kamatchi & Parvathi, 2020). In general, the most common application was grinding the leaves, mixing it with water or potash and applying it on the animals as a treatment against ectoparasites (Tamiru et al., 2013; Tesfaye et al., 2015; Kabore et al., 2012; Wanzala et al., 2017). While the initial studies seem promising, one can argue that there are potential health hazards with the use of tobacco on livestock animals. It is unclear whether the active compound nicotine will have effects on the animals or consumers when they ingest the animal products. Further studies are required to guarantee the safety of use of tobacco as a natural remedy.

Camphor laurel (*Cinnamomum camphora*)

Camphor is an aromatic component obtained from the Camphor laurel (*Cinnamomum camphora*). The lousicidal and ovicidal efficacy of camphor essential oil were tested against *Haemotopinus tuberculatus* (buffalo lice). In vitro, a water solution mixture containing different percentages of Camphor oil was subjected to direct contact assays. In vivo, pour-on solutions with 1.4 ml camphor per kg body weight were applied on the buffalo subjects. Both in vitro, as well as in vivo tests, resulted in 100 % mortality of *H. tuberculatus* lice.

Ovicidal effects of camphor were also measured regarding the buffalo lice eggs. A solution with a 22% camphor concentration resulted in 88.2% reduction in buffalo lice egg hatchability (Khater, 2009). Camphor is also effective to an extent against *Bovicola ocellatus*, but only when the concentration of camphor is high enough. At only a concentration of 8.6% camphor, a mortality of 50 percent of *B. ocellatus* was observed ($LC_{50}=8.6$) (Talbert & Wall, 2012). Overall, camphor seems to be highly effective against lice infestations.

Wormwood (*Artemisia spp.*)

Three different papers were found on *Artemisia spp.* (also called wormwood). These papers discussed the acaricidal properties and effects of the species *Artemisia herba-alba*, *Artemisia absinthium* and *Artemisia monosperma*. An essential oil solution (with a concentration of 1mg/ml) of *A. herba-alba* was tested on *Ixodes ricinus* nymphs in a laboratory bioassay. *A. herba-alba* was found to have a strong repellence (84.2 %) against *I. ricinus* ticks in vitro (El-Seedi et al., 2017).

Another study on *A. herba-alba* revealed that its crude extracts have strong acaricidal effects on the tick species *Hyalomma dromedarii* (in the larval stage). The acaricidal efficacy is dependent on the solvent type and concentration of the *A. herba-alba* extract. The most striking results were: 1) *A. herba-alba* extract in ethyl acetate solvent: a concentration of 19.5 mg per 100 ml or higher resulted in a mortality of 91.03% and 2) *A. herba-alba* extract in diethyl ether solvent: a concentration of 155 mg per 100 ml led to a mortality of 92.99%. The LC_{50} was the lowest when ethyl acetate was used as a solvent. The concentration and solvent dependency also hold for *A.*

monosperma. Regarding *A. monosperma*, the lowest LC₅₀ occurred when hexane was used as a solvent. *A. monosperma* in the hexane solvent resulted in a high mortality (83.96%) at a concentration of 157 mg per 100 ml (with a LC₅₀ of 4.37) (Abdel-Shafy et al., 2007).

Another study revealed that *A. absinthium* essential oil appeared to be highly effective against spider mites. The LC₅₀ varied between the different extraction methods that were used to obtain the essential oil of *A. absinthium*. The extraction method of direct steam distillation resulted in the highest mortality among spider mites with a LC₅₀ of 0.04 mg per cm² (Chiasson et al., 2001). The mentioned *Artemisia* species appear to have strong acaricidal effects, but their efficacy is highly dependent on the extraction method, solvent type and extract concentration.

Whiteweed (*Ageratum houstonianum*)

From the genus *Ageratum* (whiteweed), *Ageratum houstonianum* was researched in relation to its acaricidal effects. The effectiveness of an *A. houstonianum* essential oil against *Rhipicephalus lunulatus* was tested both in vitro and in vivo. A concentration of 0.03 µl per gram resulted in 100% tick mortality (3 days post-treatment) in vitro and a 95.1% mortality (8 days post treatment) in vivo (Tedonkeng Pamo et al., 2005).

A different study tested the essential oil, which was obtained from the flowers of *A. houstonianum*. Filter papers were impregnated with the essential oil in different concentrations. The ticks (*R. lunulatus*) were placed on the filter papers with essential oil. This intervention treatment with essential oil was very effective against *R. lunulatus* (100% mortality within six days for all doses), with mortality rate being dependent on the time that passes after treatment, and the essential oil concentration in the applied solution (Pamo et al., 2004). *Ageratum houstonianum* seems to have strong acaricidal properties and the previous mentioned studies show very promising results.

Capsicum spp.

Capsicum species are most known for their fruit which have varying intensities of 'spiciness', which is caused by the presence of an active compound called capsaicin (Li et al., 2019). Natural capsaicinoids were found to have an insecticidal effect on adult aphids (Li et al., 2019). The use of *Capsicum* spp. is quite widespread. According to a survey conducted in Kenya, locals use the fruit, leaves and stems of *Capsicum frutescens* to create suspensions and hanging bouquets against ticks (Wanzala et al., 2012). In Brazil, locals claimed that the fruit and bark of *Capsicum frutescens*, when triturated in water, would work against ticks (Silva et al., 2014).

Ethanol extracts made from *Capsicum annum* resulted in 36.2% inhibition of oviposition and 23.3% inhibition of embryogenesis as shown in an in vitro test in ticks (Mansingh & Williams, 1998). Another study reported a 100% mortality rate within one minute in *Boophilus decoloratus* ticks treated with *Capsicum* extract in an in vitro assay (Regassa, 2000). In the aforementioned study, the extract was obtained by mixing commercial spice with butter fat, which can be a practical solution for farmers. *Capsicum annum* was also reported to be effective against mosquitoes. A study in mosquitoes reported 96-99% mortality in larvae treated with 0.024% *Capsicum annum* ethanolic extract, depending on the mosquito species (Madhumaty et al., 2007). Overall, *Capsicum* spp. shows potential as an ectoparasiticide, especially if the extract can be contained by mixing commercial spice with butter fat.

Aloe spp.

Literature about *Aloe* encompasses many different species, with *Aloe ferox* mentioned most commonly. In two surveys, farmers reported the use of *Aloe ferox* as a remedy against ticks and mites (Moyo & Masika, 2009; Sanhokwe et al., 2016). Two different application methods were mentioned, either crushing the leaves (and soaking them in water overnight) for topical application or mixing the juice of the leaves with drinking water (Moyo & Masika, 2009; Sanhokwe et al., 2016).

A 30% acetone extract of *A. ferox* showed an average repellency of 60.67% against *Rhipicephalus appendiculatus* (Mawela, 2008). As for different *Aloe* species, farmers from Ethiopia reported in an interview to use *Aloe megalancatha* against ectoparasites by cutting the leaves and applying the latex on the skin of animals (Tesfaye et al., 2015). The leaves of *Aloe broomii* can be crushed, mixed with paraffin oil and kitchen ash to create a paste to be applied on tick infested areas on animals (Wanzala et al., 2017). Additionally, the leaves of *A. broomii* can be boiled in water to create a cattle dip and disinfectant against ticks and the leaf juice can be used for topical applications (Wanzala et al., 2017). Extracts made from *Aloe marlothii* with methanol, acetone and dichloromethane showed to have significant repellent effects of 58.9%, 50.2% and 73%, respectively, against ticks (Mawela, 2008). The same study also reported that infusions (as soap, water and paraffin) made from *Aloe ferox* and *A. marlothii* did not result in significant tick-repellent activity, though the effects of *Aloe spp.* as treatments against ticks were not evaluated. Results from initial experiments with *Aloe spp.* seem to be encouraging, and provide a good foundation for further research.

Castor bean (*Ricinus communis*)

Castor bean, or *Ricinus communis*, has been reported several times in literature to be a natural remedy against ectoparasites. Livestock owners in Ethiopia use *R. communis* as a treatment against ectoparasites by grinding the leaves and applying it on the affected skin sites (Tesfaye et al., 2015). Additionally, the indigenous Paliyar tribe of India use *R. communis* for both prevention and treatment. Approximately 100 grams of mature seeds are crushed and mixed with curcuma powder into a paste, thereafter one tablespoon of the paste is applied to a cloth and tied to areas of tick infestations; it has an additional effect of being a fly repellent (Kamatchi & Parvathi, 2020). There are some indications that these customs are effective, with several studies investigating the effects of this traditionally used remedy.

An in vitro study reported that a 10% *R. communis* extract resulted in a 49% inhibition of oviposition, 51.5% inhibition of embryogenesis and 30% mortality after 36 hours in ticks (Mansingh & Williams, 1998). Another study investigated its repelling effects, and showed that a 30% *R. communis* extract made with dichloromethane had an average repelling effect of 87.5% for up to one hour (Mawela, 2008). There are indications that *Ricinus communis* are effective against ticks, though compared to other natural remedies, such as neem, research is still lacking.

Basil (*Ocimum spp.*)

Ocimum species are another potential natural remedy for ectoparasites. Two studies on *Ocimum micrantonum* were encountered during the literature review, and two on *Ocimum suave*. Mansingh & Williams (1998) found *O. micrantonum* crude extracts had a high acaricidal index (76), inhibited 56.1% of embryogenesis, 38.8% inhibition of oviposition but only 10% mortality after 36 hours. In further studies, *O. micrantonum* root extract was reported to have a high acaricidal activity of 87% against tick larvae in an in vitro experiment (Rosado-Aguilar et al., 2010).

O. suave oil was identified to have powerful mosquito repellent properties but it does not have significant insecticidal properties against flies or as a larvicide against mosquitoes (Chogo & Crank, 1981). A further study on *O. suave* (Mwangi et al., 1995) reported the *O. suave* oil could kill all tick larvae at more than 0.2% concentration. The effectiveness increased with higher concentrations; at 100% concentration, there was a 74.5% mortality in adult ticks. *Ocimum spp.* is a useful herb against ticks with reliable evidence, however, the recent studies are lacking.

Marigold (*Tagetes minuta*)

Tagetes minuta was reported to have acaricidal activity against ticks and fly-repellent properties. A survey among smallholder farmers in Kenya found boiled *T. minuta* was used as herbal medicine against ectoparasites applied as sprayed decoction (Njoroge & Bussmann, 2006). Another survey

(Wanzala et al., 2012) on nomadic communities in Kenya also mentioned the leaves and flower of *T. minuta* could be used against ticks by spraying their dust; other forms of *T. minuta* were an aqueous suspension and hanging bouquets.

In a further study, Andreotti et al. (2013) conducted both in vitro and in vivo experiments to identify the effectiveness of *T. minuta* essential oil. Their outcome showed that the 20% *T. minuta* essential oil was 99.98% more effective than the control group. The tick weight, egg weight, and larvae viability were all significantly reduced after treatment. Another study also reported finding a pungent oil of *T. minuta* that acts as a fly repellent (Bizimana & Schreckle, 1996). Overall, the application of *T. minuta* against ticks and fly prevention is relatively credible, however, further evidence is still needed.

Questionnaire analysis

(The entire questionnaire is available in Appendix 1: Questionnaire on external parasites of ruminants.)

In total, ten respondents filled in the questionnaire. Five of them were from China, four from Greece and one from the Netherlands. The questionnaire was mainly tailored to farmers and veterinarians. There are five farmers and three veterinarians involved in our survey, none of them from organic farms. The samples were discussed separately according to the origin of place. The Dutch veterinarian participated in the interview as well, thus, her perspectives are discussed in the interview section.

The two farmers and two veterinarians from Greece all work with sheep or goats. One of the farmers has a farm with cattle, sheep, and goats. The ectoparasite problem is recognized as a relatively significant issue on their farms because the ectoparasites can spread several diseases to distant areas and cause production losses. The ectoparasites with the highest incidence rate are ticks, mosquitoes and flies. The reported ectoparasite cases occurred throughout the year in Greece, due to the climate. Multi-surface disinfection with acaricides is the main solution for Greek farms. The four Greek respondents think the effectiveness of anti-parasitics is still significant compared with the past. According to them, the environmental impact of ectoparasite treatment is a crucial factor for farming production but the most important characteristic of an antiparasitic is the effectiveness of each antiparasitic treatment and prevention. All the respondents reported believing that natural remedies are useful, based on traditional knowledge - although none ever used natural remedies.

In the Chinese respondents, all three investigated farmers work for intensified dairy farms without pastures. According to these respondents, fly prevention is the most severe issue on their farms. Then the mosquitoes and ticks are viewed as minor problems. Other ectoparasites are absent in their farming production. The ectoparasite cases concentrate in summer. The application of synthetic anti-parasitics is still perceived as effective, and none of the respondents have used natural remedies - with two of them having never heard about the environmental impacts of synthetic anti-parasitics. The awareness of environmental sustainability is still lacking in Chinese intensive farming production. The attitude towards the use natural remedies as a solution to treat or prevent ectoparasites is relatively positive, although they do not know any natural remedy production in China.

The common application to treat and prevent ectoparasites in China is ivermectin injection, which is used in all the three respondent farms. Nevertheless, an ectoparasite prevention solution with essential oil and mineral oil spray bath is mentioned by two of the respondents, which is developed by a Chinese company (Ecosfarm Co.,Ltd, 2019). In the patent information from authority, it uses mineral oil or vegetable oil as the carrier; plant-based essential oil, traditional Chinese medicine extracted ingredients as active compound. The main active contents include diatomite mixture,

pyrethrin, chitosan, L-carvone, farnesol and methyl salicylate. The company declared that the prevention percentage for flies and ticks are 80% and 90%, respectively, based on the monitored data from 30 dairy farms. The two dairy farmer respondents used these natural remedies despite both claiming having never used them. It provides a feasible solution but also is an evidence that the awareness of natural remedies is lacking in China.

Interviews with the stakeholders

In general, the three academic experts have a positive inclination towards natural remedies, stating that there could be a role for them in animal husbandry. However, to tackle the problem with ectoparasites, one expert stated that the whole system should be considered, and natural remedies play only a small role in the overall picture. This would mean that in addition to natural remedies, multiple interventions should take place, such as monitoring of ectoparasite incidence and increasing resilience in the animals themselves.

All three academic experts mentioned the negative attitude towards alternative medicine in general - not just from academia, but from farmers and consumers as well. However, the perception of alternative medicine is slowly shifting, as the negative consequences of improper use of regular synthetic medicine are becoming known.

A recurrent theme among the interviewees was the gap in the knowledge regarding natural remedies existing in the Netherlands. This is partly due to the negative inclination towards it, but also because 'proper' research on natural remedies is quite rare. It is expensive and time-consuming to do so, which may not be very attractive for companies to invest in it.

Lastly, the academic experts shared their experiences with natural remedies. Planting walnut trees was mentioned, as its scent repels flies. One expert mentioned having holly available in stables as it provides protection against scabies mites. A variety of essential oils were also mentioned to work against ectoparasites, such as lavender, neem, eucalyptus and oregano. Regarding management practices, the suitability of natural remedies depends on the characteristics of Dutch farms. For example, it would be more feasible to mix an herb into the feed rather than individual topical application for the animals, in large scale farms.

Farmer representatives

In total, two farmer representatives were interviewed online: one from Greece, another from China.

The Greek farmer that was interviewed had over 25 years of experience and was a third-generation farmer from a family that used to have cattle. This farmer currently tends to a small herd with a size of about 100 sheep and serves as a secretary in an animal farmers' association in Attica, Athens. Our interview with her gave us an insight about the parasitic conditions in Greece. So far, most of the farmers are aware of the natural remedies, which are based on shared ancestral knowledge. Plants such as garlic, thyme, oregano, savory, lavender, and eucalyptus were considered to have properties against external parasites, nevertheless, farmers nowadays do not use them due to the lack of knowledge on their effectiveness. Instead, most of them use synthetic medicine, since effectiveness plays a crucial role for the farmers when choosing an antiparasitic; their choice is also relevant to their previous experience as well. Several individuals concerned about the use of synthetic medicine chose to use some of these herbs as a secondary, passive form of prevention against parasites by adding them in feed - the interviewed Greek farmer was one of them. Overall, the attitude of the farmers is positive when there is sufficient evidence about the natural remedies' effectiveness.

The Chinese farmer representative is a farm manager of two intensified dairy farms with 1500 heads of herd size. According to this farmer, there are no natural remedies used for ectoparasite prevention or treatment in China. He stated that herbal medicine is commonly used after calving

as a nutritional supplement, but the herbal products for ectoparasites are rarely seen. Nevertheless, he heard about plant-based essential oils being used for repellent ectoparasite in some dairy farms. The attitude to natural remedies from the farmer is neutral because of the effectiveness and cost. He reported that synthetic medicines still show a strong effectiveness with his cows. Additionally, his farms are landless so the impacts from parasitic residue to his farms' soil are limited. In addition, his budget for ectoparasite treatment and prevention is approximately 5 euro per cow per year. Currently, ectoparasitic resistance and environmental impacts of synthetic products are not urgent problems in his farms. Overall, the natural remedies do not have any advantages compared with synthetic parasiticide, in his opinion. However, the farmer is still looking forward as to the outcome of this project. In one of the interviews with experts, an expert mentioned Indian smallholders prevent ectoparasite by brushing their cows daily. Based on the information from the Chinese farmer representative, an automatic cow brush is available on his farms, and in some other farms in China. If essential oil is sprayed on this cow brush as a parasite repellent, it could be seen as a potential solution for passive prevention.

Veterinarians

In total, five veterinarians were contacted. The Dutch veterinarian shared their personal experiences and the current developments regarding the use of natural remedies against ectoparasites. The Dutch veterinarian representative has over thirty years of experience with livestock farming, including fieldwork abroad (e.g., Latin America). It was mentioned that there is a lot of reserve of veterinarians regarding the use of natural remedies against ectoparasites. According to the veterinarian, Dutch veterinary education is not aimed at the use of natural remedies, and with the lack of knowledge in the Netherlands, the mentality of veterinarians towards using natural remedies is rooted in scepticism. In her opinion, farmers and veterinarians need to work together and combine perspectives. In this way, the sceptic mentality of veterinarians will change towards a more positive and open view of natural remedies.

The Dutch veterinarian also spoke briefly about the necessity to switch the livestock farming towards the "old farming ways". However, the problems related to the "old ways" will occur again and the knowledge about this has been forgotten. Therefore, she expressed the importance of information that needs to be collected from other countries, as farmers in several foreign countries still use herbs and other natural remedies in livestock farming (with good results).

Four Greek veterinarians were contacted, two of them filled in the questionnaire, two of them were parasitologists, and three of them were academics. One of the parasitologist veterinarians, who also happened to be an academic, completely discarded the idea of natural remedies and did not want to fill in the questionnaire because her (negative) opinion on the subject was set. The second academic had a positive attitude about natural remedies; following our email contact with him, he remarked that during his studies, he did not acquire any knowledge of natural remedies, to his dismay. Considering that his specialization was different as both veterinarian and academic, he preferred not to fill in the questionnaire due to lack of knowledge in the specific topic, but he brought us in contact with the second parasitologist of the Greek veterinarians. She was very positive about participating, had relevant knowledge and agreed to fill in the questionnaire. Finally, a fourth veterinarian was approached - a recent graduate - in order to get an insight on the current knowledge taught in the Greek veterinary schools, and the view of a young professional. She also agreed to fill in the questionnaire, instead of an interview due to lack of time.

Producer of veterinary medicine

A sale manager who is employed by an international producer of veterinary medicine in China was interviewed. He has a MSc. degree and experience on dairy and beef cattle farming practices. The sale manager stated that Ivermectin and Abamectin are the two major injectable drugs, and

Amitraz is the common spray drug to treat ectoparasites. There was not any commonly accepted herbal medicine for ectoparasites in China.

With the intensification of dairy farms, most of dairy farms in China are operated as companies and family farms are rare. The owners of dairy farms may not be involved in the farming production but employ farm managers to manage the farming production. The farm manager, who implements the farming production, only focuses on the effectiveness of ectoparasiticides to get a high production performance. The environmental sustainability is ignored in the farms in which owners are absent. Many traditional Chinese medicines for animals remain in research experiments and are rarely used in practice; the pharmacological and pharmacokinetic mechanisms are not clearly identified. The side effects are still uncertain for application. The use of natural remedies may be environmentally friendly, but the effectiveness cannot be guaranteed. Therefore, the synthetic ectoparasiticides are commonly used in the intensified dairy farms.

Based on the interview with the producer, it can be inferred that the dairy farming in China is currently focused on the production performance. Thus, the Chinese farmers are not motivated to apply natural remedies to their animals without external stress from policies, although they have a higher acceptance on herbal medicine from their culture. In summary, the natural remedies could be relatively commonly used in the livestock systems which pay attention to environmental sustainability and lack synthetic medicine availability.

General recommendations per animal species

Over the past few weeks of project research, we have compiled a database with natural remedies from worldwide herbs that can be used against external parasites in ruminants. Based on our interviews, we concluded that in the Netherlands, the most common/important parasites to be considered are ticks, flies, mites, mosquitoes, lice and fleas. Specific recommendations for Dutch farmers are not given due to limited perspective of their context and time constraints of this project. Instead, an overview of effective natural remedies and general recommendations are provided.

We came upon 325 remedies in literature research that are used worldwide or are proven to be used against external parasites in cattle, goats, sheep, and ruminants, for a total of 98 references. The application of the remedies was usually 'active' (248) in the external part of the animal, with only a few of them being passive (11) and even fewer could be applied either actively or passively (7). The remedies' function was most of the times used as a 'treatment' (177), whereas 57 were used for preventative and repelling purposes. Furthermore, 36 of them had both functions. Moreover, there were 15 management/control prevention techniques. The form that the remedies were applied varied from essential oils, dilutions, baths, soaps, concoctions/decoctions/infusions, solutions, pastes, fresh or dried plant parts (e.g., leaves, bark, stems, etc..) and feed, to management practices such as rearing chickens, or cultivating parasite-repellent plants in pastures. The effectiveness was suggested for all 325 remedies but at different levels, depending on the experiment, in vitro or in vivo, the parasite, animal and environmental characteristics. The effectiveness could be either low described as potential, acaricidal properties shown, or very effective with percentages over 70% to 100%.

Most of the literature found was scientific articles (168) and journal articles on traditional veterinary practices (125), and a few of them were MSc theses, PhD dissertations, books, and annual reports. Most of them were either for indiscriminate ruminant animals (157) or cattle (66), and fewer were for goats and sheep. Concerning the reported target parasite, most of the entries referred to ticks (210), and small number of remedies for other parasites. The remedies found spanned 29 countries, and all continents.

Based on the above-mentioned information and database, the following recommendations can be suggested, per animal and parasite, as well for the 'indiscriminate' ruminant animal and parasite categories.

Cattle

Table 3: Most effective natural remedies found worldwide for cattle ectoparasites

Parasite concerned	Application (Management/ remedy)	Product	Comments	Reference
Flies; Lice	Preventative/ repellent or Treatment	Camphor, onion, peppermint & chamomile essential oils	In vitro study showed that oils effectively killed lice within 2 minutes and also decreased egg viability; in vitro study showed a repelling effect against flies for 6 days	Khater et al., 2009
Ticks	Treatment	Aganonerion polymorphum and Anethum graveolens	Acute acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994
Ticks	Treatment	Aganonerion polymorphum and Calotropis procera	Acute acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994
Ticks	Treatment	Azadiracta indica	100% undiluted neem seed oil had effect of 100% mortality on larvae after 48h, in vitro	Ndumu et al., 1999
Ticks	Treatment	Azadiracta indica	Neem oil had 60-75% acaricidal efficacy for buffaloes and cattle infested with ticks, in in vitro and in vivo trials	Kalakumar et al., 2000
Ticks	Treatment	Bursera simaruba	In vitro; stem bark 10% extracts had acaricidal effects (99.1±0.7%) mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	Caesalpinia gaumeri	In vitro; extracts had acaricidal effects (90.1±4.8 % mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	Calotropis procera and Pentapetes Phoenicia	Acute acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994
Ticks	Treatment	Capraria biflora	In vitro; extracts had acaricidal effects (86.6±9.9 % mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	Cassearia corymbosa	In vitro; stem bark extracts had acaricidal effects (99.5±0.5 % mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	Diospyros anisandra	In vitro; leaf and stem bark extracts had acaricidal effects (87.9±8.6 % & 98.8±1.0 % mortality in nymphs, respectively)	Rosado-Aguilar et al., 2010
Ticks	Treatment	Ectoparasiticide AV/EPP/14 (Cedrus deodara, Pongamia glabra, Azadirachta indica, Eucalyptus globulus and Acorus calamus)	Compound is sprayed on animals (1:4 dilution with tap water); 100% effective after 24h treatment; Reinfestation after 15 days eliminated with 2nd treatment	Ravindra et al., 2000
Ticks	Treatment	Havardia albicans	In vitro; leaf extracts had acaricidal effects (93.0±12.0 % mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	Ocimum micrantun	In vitro; root extracts had acaricidal effects (87.0±3.2 % mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	Petiveria alliacea	In vitro; leaf and stem extracts had acaricidal effects ((95.7±2.9 % & 99.2±0.5 % mortality nymphs, respectively)	Rosado-Aguilar et al., 2010

Ticks	Treatment	<i>Solanum erianthum</i>	In vitro; stems extracts had acaricidal effects (97.8±1.8 % mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	<i>Solanum tridynamum</i>	In vitro; stems extracts had acaricidal effects (98.0±1.7 % mortality in nymphs)	Rosado-Aguilar et al., 2010
Ticks	Treatment	<i>Stemona collinsae</i>	Both in vitro and in vivo study saw an increase in the mortality of nymphs and adults	Jansawan et al., 1993
Ticks	Treatment	<i>Stemona collinsae</i>	Whole plant extract (at 50% concentration) resulted in 100% mortality in seed ticks, and 93.33% mortality in engorged adult ticks, after 24hrs	Jansawan et al., 1993
Ticks	Treatment	<i>Tagetes minuta</i>	The essential oil showed 99.98% efficacy in comparison with the control group, at 20% concentration	Andreotti et al., 2013
Ticks	Treatment	<i>Azadiracta indica</i> (neem); <i>Eucalyptus</i> spp.; <i>Milletta pinnata</i> (pongamia)	Highest mortality of ticks with Neem oil + Eucalyptus oil mixture at 10% concentration; elevated mortality with Neem oil + Pongamia mixture also at 10% concentration	Sivaramakrishnan et al., 1996

For cattle, 66 reports were found, the majority of which were about ticks (44), flies (10), then lice (8), mites (6), and fleas (2). Furthermore, 25 indiscriminate antiparasitics were found for cattle (mainly cows with a few mentions of buffalo).

The Table 3 above shows some of the most effective remedies (according to the literature) that could be used against ticks, fleas and lice in cattle. Further information for all the parasites can be found in the total database table in the Appendix 2: Database of natural remedies against ectoparasites found worldwide.

Rosado-Aguilar et al. (2010) mentions that a 10% concentration of crude extract of different plants, including *Bursera simaruba*, *Caesalpinia gaumeri*, *Capraria biflora*, *Cassearia corymbosa*, *Diospyros anisandra*, *Havardia albicans*, *Ocimum micrantun*, *Petiveria alliacea*, *Solanum erianthum*, *Solanum tridynamum*, showed very high mortality rates for tick nymphs, between 86% and 99%, especially when applied in the nymphs and rechecked after 48 hours. These reported extracts could be beneficial to farmers due to their practical implementation.

Azadiracta indica (or neem seed oil) was also 100% percent effective against larva of ticks after 48 hours, when used in forms of dilution. Neem was highly favourable amongst the reports that were found, both for the effectiveness, application and accessibility. Kalakumar et al. (2000) stated in their experiments that neem oil use could have a 60-70% effectiveness in cattle and buffaloes against adult ticks; this was proven both in in vitro and in vivo studies. Furthermore, another promising remedy is *Stemona collinsae*, which, when applied in a 50% concentration of the whole plant extract, can cause a 100% mortality of tick seeds and a 99.33% in engorged adult ticks in 24 hours. In an in vivo test by Andreotti et al. (2013), it was shown that *Tagetes minuta* had a 99.98% effectiveness when applied to the skin of the animal uniformly, at a 20% concentration of the essential oil, and had effects against larvae, nymphs and adult ticks in a few days.

Another noteworthy suggestion against ticks could be the use of mixtures of antiparasitic remedies in the form of oils when diluted in different concentrations. The most effective through our literature research seem to be the use of a mixture of *Cedrus deodara*, *Pongamia glabra*, *Azadirachta indica*, *Eucalyptus globulus* and *Acorus calamus*. According to Ravindra et al. (2000), a compound of these remedies sprayed on the animals in a 1:4 dilution had a 100% effectiveness after 24 hours of the treatment application. Another mixture that was suggested for its high effectiveness against

external parasites is one from Sivaramakrishnan (1996); here, the mixture of oils was of neem and eucalyptus oil or neem and pongamia oil in 10% concentration.

Most of the remedies that seem to be most effective against external parasites and especially ticks were actively in the forms of essential oil dilutions used on the animal and had relatively fast effects (a few hours to days). Their effectiveness affected either the larva, nymph, or adult parasite. Several mechanisms also affected the embryogenesis, and oviposition of the parasites eggs as well as their mortality.

Regarding other external parasites and especially flies and lice, camphor, onion, peppermint and chamomile essential oils mixture seemed to be very effective in the experiments of Khater et al. (2009). The mixture seems to be fatal for lice in only two minutes after its application.

Cinnamomum camphora essential oil, an essential oil mixture of olive oil, ajowan, oregano, lemon-scented gum, Chinese cinnamon, clove, lavender, as well as algae (in passive use in the feed), diatomaceous earth, garlic, natural flax seed oil were also some remedies that were used against lice. The latter three can be used against mites; an essential oil mixture (aniseed, camphor, eucalyptus, pennyroyal mint, rosemary, sassafras) is also reported to work against mites. Furthermore, the preventative measures taken against flies included the use of catnip oil, diluted geraniol, *Sesbania aculeata*, ointments, dust, tobacco, and *Ricinus communis* (Castor bean), which were either sprayed in various forms on the animals or had repellent properties proven in experiments. Treatments or preventative measures (for cattle especially) against fleas we found included *Capsicum frutescens* in trituration of the fruit or the bark, or even the application of pork lard.

Finally, several remedies that are indiscriminate for parasites but had antiparasitic effects for cattle can be found in the database table in the Appendix 2: Database of natural remedies against ectoparasites found worldwide.

Goats

Table 4: Most effective natural remedies found worldwide for goats ectoparasites

Parasite concerned	Application (Management/ remedy)	Product	Comments	Reference
Ticks	Treatment	Azadiracta indica (neem); Eucalyptus spp.; Milletta pinnata (pongamia)	Highest mortality of ticks with Neem oil + Eucalyptus oil mixture at 10% concentration; elevated mortality with Neem oil + Pongamia mixture also at 10% concentration	Sivaramakrishnan et al., 1996
Ticks	Treatment	Azadirachta indica	Neem seed powder fed to the goats, resulting in a reduction of successful attachment of larvae; increased mortality of nymphs and adults; reduction in moulting of nymphs	ICIPE, 1999
Ticks	Treatment	Essential oil of Ageratum houstonianum	Soap foam contained essential oil of A. houstonianum; both in vitro and in vivo experiments showed high tick mortality	Tedonkeng Pamo et al., 2005

For goats, 13 reports were found, of which the majority were on ticks (7), mites (4), then flies (2). Two further antiparasitics were found for the 'indiscriminate' parasite category. Table 4, above, gives the most effective remedies found in the literature – all of which concerned ticks.

Two of the three relevant remedies found are essential oil-based; the first remedy is the application of a mixture of either Neem oil and Eucalyptus oil *or* Neem oil and Pongamia oil (at 10% concentration). These mixtures were reported to result in elevated mortality of ticks (when applied directly to the infested area). The second essential oil remedy implied the use of a soap foam containing the essential oil of *A. houstonianum*, which resulted in high tick mortality in both in vitro and in vivo experiments. This remedy would also need to be applied to the tick-infested area. The final remedy also included neem, although in the form of seed powder to be fed to the goats. This remedy was reported to reduce successful attachment of larvae (and therefore can also be seen as preventative) as well as increase mortality in nymphs and adults, and reduce nymph moulting.

Further remedies against various goat parasites can be found in the database in the Appendix 2: Database of natural remedies against ectoparasites found worldwide; these remedies do not, however, have the same level of reported efficacy as the three remedies outlined above.

Sheep

Table 5: Most effective natural remedies found worldwide for sheep ectoparasites

Parasite concerned	Application (Management/ remedy)	Product	Comments	Reference
Flies	Treatment	Lavender and camphor essential oils	In vitro testing showed that both lavender and camphor oils had larvicidal effects; lavender more effective than camphor at 32% concentration	Shalaby et al., 2016
Flies	Preventative/ repellent or Treatment	Tea tree oil (TTO)	In vitro test; strong repellent against flies and discouraged oviposition; eggs treated with 1% TTO did not hatch; larvae moved away from places treated with TTO	Callander & James, 2012
Flies	Treatment	Vetiver, cinnamon and lavender essential oils	In vitro study showed that oils affected negatively larval development and resulted in high mortality	Khater et al., 2018
Mites	Treatment	Neem oil	Mentions efficacy against various mites and ticks	Gupta & Vohra, 2020

For sheep, 14 reports were found, of which the majority concerned flies (10), then mites (3) - one report concerned fleas and ticks. The Table 5 above gives the relevant antiparasitic remedies found in the literature for sheep.

Of the four most effective (and relevant) remedies found against ectoparasites in sheep, three concern flies; all four remedies outlined in Table 5 rely on essential oils. The first remedy uses lavender and camphor essential oils as a treatment against flies; in vitro testing showed larvicidal effects for both of these oils, with lavender being 32% more effective than camphor oil. Tea tree oil (TTO) could be used either as a preventative/repellent *or* treatment method; in vitro tests showed its effectiveness in repelling flies as well as inhibiting egg hatching, with just 1% TTO. Vetiver, cinnamon and lavender essential oils could also be used as treatment against flies, with one in vitro study demonstrating their ability to negatively affect larval development and subsequent high mortality. Finally, neem oil could be used to treat against mites and ticks, with a certain degree of efficacy.

Other remedies of varying effectiveness can be found in the database, in the Appendix 2: Database of natural remedies against ectoparasites found worldwide.

Indiscriminate

Many of the remedies found were specific to parasites – and thus did not discriminate according to type of ruminant (cattle, goats or sheep); 235 remedies were found to belong to this category, among which the majority concerned ticks (166), flies (12), indiscriminate/general ectoparasites (12), mosquitoes (9), then mites (7) and finally lice (2). Within this general ‘indiscriminate’ ruminant category were remedies which could be applied to multiple parasites. These remedies were for mites and ticks (13), flies, lice and ticks (3), fleas and lice (3), lice and ticks (2), fleas and ticks (2), then flies and mosquitoes (1), lice, mites and ticks (1), flies, fleas, mosquitoes and ticks (10), and finally, flies, lice, mites and ticks (1).

Table 6 and Table 7 give the relevant remedies against ectoparasites in all ruminants (with the first of the two reporting on multi-application remedies - i.e., remedies that can be preventative or ‘treatments’, and the second, on solely ‘treatment’ remedies).

Table 6: Multi-application (and unknown) remedies found for ruminants (indiscriminate of animal type)

Parasite concerned	Application (Management/ remedy)	Product	Comments	Reference
Ticks		Artemisia herba-alba	Extracts made from aerial parts demonstrated larvaecidal activity (toxicity) in vitro	Abdel-Shafy et al., 2007
Ticks		Artemisia monosperma	Extracts made from aerial parts demonstrated larvaecidal (H. dromedarii) activity (toxicity) in vitro; essential oils to H. dromedarii and A. persicus	Abdel-Shafy et al., 2007
Fleas; Flies; Mosquitoes; Ticks	Preventative/ repellent	Vitex agnus castus	The seeds of the monk's pepper (CO ₂ extract) can be used in a spray and can repel external parasites for 6 hours or more	Mehlhorn et al., 2005
Ticks	Preventative/ repellent	Aloe marlothii	Leaf extract (applied topically) has repellent effect on ticks	Mawela, 2008
Ticks	Preventative/ repellent	Cleome hirta	Oil made from aerial parts of C. hirta is a tick repellent	Ndungu et al., 1999
Ticks	Preventative/ repellent	Clerodendrum glabrum	Leaf extract (applied topically) has repellent effect on ticks in bioassay	Mawela, 2008
Ticks	Preventative/ repellent	Conyza dioscoridis, Artemisia herba-alba & Calendula officinalis essential oils	In vitro assay and field trial, nymphs were repelled by the essential oil	El-Seedi et al., 2017
Ticks	Preventative/ repellent	Gynandropsis gynandra	Essential oil of G. gynandra demonstrated repellent qualities in bioassays	Lwande et al., 1999
Ticks	Preventative/ repellent	Jatropha curcas	Leaf extract (applied topically) had repellent effect on ticks in bioassay	Mawela, 2008
Ticks	Preventative/ repellent or Treatment	Melinis minutiflora	The whole plant is toxic/repellent to ticks	Fernández-Ruvalcaba et al., 2004
Ticks	Preventative/ repellent	Mesembryanthemum forsskale	Various extracts (made from aerial parts of M. forsskale) had toxic effects of tick larvae	Abdel-Shafy et al., 2007
Ticks	Preventative/ repellent or Treatment	Ocimum suave	Oil made from O. suave leaves works as a repellent and acaricide	Chogo & Crank, 1981
Ticks	Preventative/ repellent or Treatment	Reaumuria hirtella	Various extracts (made from aerial parts of R. hirtella) had toxic effects of tick larvae	Abdel-Shafy et al., 2007

Ticks	Preventative/ repellent or Treatment	Ricinus communis	Leaf extract (applied topically) had repellent effect on ticks in bioassay	Mawela, 2008
Ticks	Preventative/ repellent	Strychnos madagascariensi	Aqueous leaf extract (applied topically) had repellent effect on ticks in bioassay	Mawela, 2008
Ticks	Preventative/ repellent or Treatment	Tagetes minuta	Essential oil of T. minuta (from leaves, stems and fresh flowers) had tick repellent properties; moulting of engorged nymphs was also delayed	Nchu et al., 2012
Ticks	Preventative/ repellent	Tagetes minuta	Laboratory assays demonstrated tick- repellent properties of T. minuta oil	Wanzala, 2009

Through the literature there were many remedies that were considered to have preventative and repellent properties against different parasites. More specifically, 57 references belonged in the “Preventative/repellent” category, 36 more were in the “Preventative/repellent or Treatment” category, and 15 entries were under the category “Prevention/control/management”, for a total of 108 remedies. Once more, the most reported parasite with the most effective and relevant remedies were ticks.

A large number of the remedies reported above use essential oils. *Tagetes minuta*, *Ocimum suave*, *Gynandropsis gynandra*, *Cleome hirta* and a mixture of *Conyza dioscoridis*, *Artemisia herba-alba*, and *Calendula officinalis* essential oils were just some of the oils that can be applied externally to the ruminants and have preventative properties against ticks.

Amongst these effective natural remedies, one could also find plant extracts of *Artemisia monosperma*, *Clerodendrum glabrum*, *Jatropha curcas*, *Mesembryanthemum forsskale*, *Reaumuria hirtella*, *Strychnos madagascariensis* and *Ricinus communis*.

Vitex agnus castus, otherwise known as monk pepper, was reported to have repellent properties against other parasites besides ticks, including fleas, flies and mosquitoes (notably, that was the only reference on mosquitos). More preventative remedies can be found in the full database in the Appendix 2: Database of natural remedies against ectoparasites found worldwide.

Table 7: Treatment natural remedies for external parasites in ruminants (indiscriminate of animal type)

Parasite concerned	Application (Management /remedy)	Product	Comments	Reference
Ticks	Treatment	Aloe ferox	Leaf infusion, when applied topically to infested zone, has toxic effect to ticks	Mawela, 2008
Ticks	Treatment	Artemisia absinthium	Essential oils made from whole plant have acaricidal activity	Chiasson et al., 2001
Ticks	Treatment	Asclepias curassavica Azadirachta indica Blighia sapida Bontia daphnoides Capsicum annum Catharanthus roseus Cuscuta americana Cycloptis semicordata Ervatamia divaricate Erythrina corallodendron Gliricidia sepium Hibiscus rosa-sinensis Lantana involucrata Lippia alba Melicoccus bijugatus Mimosa pudica Momordica charantia Nerium oleander Nicotiana tabacum	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998 Williams, 1993

		Ocimum micranthum Oreopanax capitatus Petiveria alliacea Pimenta dioica Piper amalago Ricinus communis Salvia serotina Sida acuta Simarouba glauca Spigelia anthelmia Stachytarpheta jamaicensis		
Ticks	Treatment	Azadiracta indica	Neem seed oil caused significant reduction in larval feeding activity and reduction in moultability of nymphs	Al-Rajhy et al., 2003
Ticks	Treatment	Azadiracta indica	Neem seed plant extract resulted in increasing hatching rate (larvae are underdeveloped and dead); caused hatching failure; increased mortality rates	Abdel-Shafy & Zayed, 2002
Ticks	Treatment	Calotropis procera	Glycosidal extract of C. procera had effects similar to those of commercial acaricides	Al-Rajhy et al., 2003
Ticks	Treatment	Capsicum spp.	In vitro testing showed 100% mortality of ticks after direct application (after just one minute)	Regassa, 2000
Ticks	Treatment	Chamaecyparis nootkatensis	Crude extracts of ground duramen and leaves toxic to tick nymphs	Panella et al., 1997
Ticks	Treatment	Digitalis purpurea	Glycosidal extract of D. purpurea had effects similar to those of commercial acaricides	Al-Rajhy et al., 2003
Ticks	Treatment	Euphorbia aegyptiaca	Extract of E. aegyptiaca had strong toxic effects against H. dromedarii larvae	Abdel-Shafy et al., 2007
Ticks	Treatment	Euphorbia candelabrum	Extract induced mortality in all stages of tick development, including adults, in bioassays	ICIPE, 1998/1999
Ticks	Treatment	Euphorbia obovalifolia	In vitro trials showed tick mortality up to 100% (5 minutes after direct application); In vivo trials showed that latex of E. obovalifolia could reduce tick burden up to 80%	Regassa, 2000
Ticks	Treatment	Ficus brachypoda	In vitro testing showed 100% mortality of ticks after direct application (after just 10 minutes)	Regassa, 2000
Ticks	Treatment	Hyptis verticillata	Extract has chemosterilant (sterilizing) activities against the tick	Porter et al., 1995
Ticks	Treatment	Juniperus virginiana	Crude extracts of ground duramen and leaves showed great larvaecidal activity	Panella et al., 1997
Ticks	Treatment	Nicotiana tabacum	Mixture of dried N. tabacum leaves and "Magani soda" mineral had acaricidal effect against ticks at all stages; both in vitro and in vivo trials	Dipeolu & Ndungu, 1991
Ticks	Treatment	Peganum harmala	Various extracts (made from aerial parts of P. harmala) had toxic effects of tick larvae	Abdel-Shafy et al., 2007
Ticks	Treatment	Petiveria alliacea	Dibenzyltrisulfide, isolated from P. alliacea roots, had stronger acaricidal effects than three tested commercial acaricides, inhibited oviposition, and reduced successful egg hatching	Williams et al., 1997

Ticks	Treatment	Piqueria trinervia	Aqueous solutions made from piquerols A and B, compounds found in P. trinervia, had acaricidal effects on larvae; Piquerol A caused mortality in adult female ticks	Gonzales-de la Parra et al., 1991
Ticks	Treatment	Pongamia pinnata	Elevated mortality with Neem oil + Pongamia mixture also at 10% concentration	Sivaramakrishnan et al., 1996
Ticks	Treatment	Senna italica subsp. arachoides	Root extract had acaricidal effects on H. marginatum rufipes adults	Magano et al., 2008
Ticks	Treatment	Silybum marianum	Various extracts (made from aerial parts of S. marianum) had toxic effects of tick larvae	Abdel-Shafy et al., 2007
Ticks	Treatment	Tamarindus indicus	Crude extract of T. indicus (fruit extract aqueous solution) had acaricidal activity on engorged female ticks	Chungsamarnyart & Jansawan, 2001

The Table 7 above gives some natural remedies that were suggested as the most effective 'treatments' against ruminant external parasites (with no differentiation between ruminant animals). From the 243 entries in the 'Indiscriminate category', 115 belong in the "Treatment" sub-category. Most of the applications are done externally in this category, and once again, most of the entries refer to ticks.

Mansingh & Williams (1998) and Williams (1993) are two studies which report on numerous different plant extracts that have been found to have acaricidal effects against ticks. Some of the most researched remedies, reported on earlier in this report, including neem oil, tobacco, aloe and *Capsicum spp.* are also mentioned in this table. Furthermore, *Capsicum spp.*, *Euphorbia obovalifolia* and *Ficus brachypoda* were reported to have 100% mortality shortly after their application on ticks (Regassa, 2000).

Further treatments (for all ruminants alike) can be found for more parasites in the full database located in the Appendix 2: Database of natural remedies against ectoparasites found worldwide.

Discussion & Future Opportunities

Discussion of interviews and questionnaire

The interviews provided insights from different stakeholders. Academic experts, veterinarians, conventional farmers, synthetic medicine producers and one biodynamic farmer were interviewed. Unfortunately, there were no responses from organic farmers despite our efforts to contact them. The farmers who participated the interviews are from Greece and China. There was limited contact with Dutch organic farmers (thus no questionnaires were filled out by them); most of the information we gained on the perspectives of Dutch farmers were indirect, and via the academic experts.

The questionnaire was designed as a supplement to the interviews. However, the response rate was quite low. Due to time limitations, only a few people completed the questionnaire - although we distributed it to as many people as possible in different countries. Ultimately, 10 respondents filled the questionnaire. The data from the questionnaire cannot support any quantitative analysis, but still provided useful supplementary information. Thus, a delineation of the replies was done as descriptive analysis. Additionally, to gain a higher response rate, most questions were set as optional questions. It reduced difficulties in filling in the questionnaire and respondents could skip questions which they were not willing to respond to/share information about, but some crucial questions were also left as blanks. Overall, the questionnaire did not have the expected responses in terms of quantity, but it was an insightful addition to the project.

Discussion of literature review

The result of the literature review was an Excel database. During the literature analysis, several issues were encountered. Firstly, in order to make recommendations one has to keep the Dutch situation and context in mind, where information was lacking. Within the database, more than half of the resources were from tropical countries (such as Kenya, India and Ethiopia). Due to geographical restrictions, it may be possible that a very effective natural remedy may not be available in the Netherlands.

Ideally, a sizeable amount of information on natural remedies should come from in vivo experiments, as these are the best indicators for their ectoparasitocidal properties. So far, the database includes many scientific journal articles, many of which report on in vivo experiments. Some of these in vivo experiments are conducted on different species (e.g., rabbits and humans) but use ectoparasitic species that can also target ruminants. However, we assume that application and efficacy of remedies that repel or treat ectoparasites will not be excessively different across species. Thus, these sources could be useful for further research in livestock animals.

Several articles were based on in vitro experiments; they provided useful results and information about potential application methods. There were, however, some contrasting results found between and sometimes even *within* in vitro studies. For instance, Regassa (2000) reported a high acaricidal efficacy of *Capsicum* extract but could not replicate these results in vivo. A variety of reasons can lead to discrepancies between studies, such as differences in methodologies, different insect species, different application techniques and even regional differences in the natural remedies used.

Lastly, most of the natural remedies mentioned in literature focus on ticks (212 out of 325 results). As such, there is a lack of documentation on other species, including fleas, flies, mites, lice and mosquitoes. This great disparity could be due to the clinical relevance of ticks, since they are vectors for many different diseases. Furthermore, certain tick species prey on multiple hosts, which can include humans, emphasizing the clinical importance of ticks. Additionally, farmers contacted for the interview and questionnaire mentioned that the main problems they faced were due to ticks, which further explains research focusing on ticks.

Limitations

Throughout the literature review we undertook, it became clear that the issue of natural remedies against ectoparasites in ruminant livestock is marred with limitations which further complicates research into the project. One of the important issues that came up during literature review was the lack of scope, as well as lack of systems-oriented thinking. We found a variety of remedies against various ectoparasites in different ruminants – but the information found often lacked clarity regarding its specific application. Rare were the mentions of age, sex and breed of animals to whom the remedies can be applied. As such, it is difficult to say whether the remedies found are, in fact, applicable to the context of Dutch animal husbandry.

To obtain more detailed information about application measures and the mechanism of action regarding the ectoparasitocides, the available natural remedies of one specific host and parasite species (prevalent in the Netherlands) could be analysed. The mechanism of action can provide more intel with respect to the reason behind the effectiveness (or lack thereof) against an ectoparasite. This would also elucidate some discrepancies between studies, like those mentioned in the discussion regarding the *Capsicum* extracts.

Research done into the subject in natural remedies is often solely focused on the effectiveness of a particular product against a particular parasite – and does not look into potential toxicity of the product, the risk of run-off (e.g., when a product is sprayed on the animals) or even the hazards

that come with wrong application. The further impact of these products on organisms which live on/around the animals were not found in any of the literature review we conducted. This lack of systems thinking points to a larger problem in research; beyond the lack of research into impacts of these natural remedies in the larger (eco)system, there is a lack of research into the sources of the issue.

The lack of information about the toxicity in the scientific articles created questions about the possible direct and indirect toxic effects of the natural ectoparasiticides on farm animals and humans. Consequently, more research is needed to obtain a more complete overview of the advantages and disadvantages of natural ectoparasitics. In addition, the potential impact on animals in the surrounding ecosystem at place of application might be a suitable future research subject. The toxicity of the natural remedies might vary between the short and long term (substances can build up in the body and cause adverse effects later in life) and both need to be investigated.

At this point in time, there is a significant lack of monitoring of ectoparasites (of ruminants) in the Netherlands. As such, the relevance of the remedies found worldwide is perhaps not even applicable to the Dutch situation – but due to this lack of monitoring, it is difficult to say. The issue of parasite-borne diseases is directly linked to these (vector) parasites, but without monitoring, we cannot look efficiently and effectively into natural remedies for the diseases which these ectoparasites carry. The disjunction between each of these issues (lack of monitoring of ectoparasites and subsequent issues for animal and human health, intense focus on specific parasites, lack of research into impacts of natural remedies) means we lose the ability to engage in systems thinking - a disadvantage in such an interconnected subject.

Future research

During our literature review, we found research limitations, such as the lack of scientific literature regarding natural remedies against ectoparasites on goats and sheep. Additionally, the information on lice, fleas and mites was limited (or outdated) with regards to the related natural remedies. To nullify these limitations, future in vitro and in vivo research can be executed to find potential natural remedies against these parasites.

Some scientifically available information found in available literature about the ectoparasitic effects of essential oils showed that a few of these were only tested on human subjects (incl., Hazarika et al (2012)). Other scientific studies tested parasite species related to hosts outside of the scope of our project. For example, the study of Al-Rajhy et al. (2003) observed the acaricidal effects of neem oil on camel ticks. Follow up research could be performed to obtain knowledge about the effectiveness of these essential oils on ruminants.

In addition, as there is a lack of information from organic farmers in this research; for future studies it might be useful to look into the perspective of organic farmers on natural ectoparasiticides and implement their knowledge in future reports. One could scrutinize the Dutch organic farmer perspective, but also the view of organic farmers worldwide.

Future opportunities

Through the research that was done in the last weeks, several future opportunities - which could assist the transition to a more traditional and natural farming - were identified. One opportunity for future research concerns in vivo research into the maximum potential of all remedies identified. The potential opportunities might lie in the combination of multiple beneficial remedies to maximize the efficacy of each active compound, while reducing the risk of resistance.

In addition, the application of these remedies could be an opportunity for future innovation, since most of the effective remedies were applied externally on the animal. In many cases, the

application of natural remedies in countries like China can be easier to be implemented through specific spray mechanisms of the remedy either at the gates of the farm, in the feeding lane or in the barn. Other possible options could be innovating a new and easier application, with, for example, a brush that could evenly distribute the remedy in a liquid form. These tools could be more attractive, convenient, and accessible to use for Dutch farmers.

Another option in the realm of tool development could be the production of a tool that could monitor the incidence of ectoparasitic infestations in the Netherlands. As such, it would be easier to identify the most hazardous parameters to avoid infestation – and ultimately gain better perspectives for systems thinking. Currently, there is no such monitoring in place.

Finally, the largest problem identified during this project was the difficulties of access to scientific knowledge on natural remedies, despite its frequently reported use worldwide. A website, or potential future application where the farmer and other interested stakeholders will have easy access to substantiated practical scientific knowledge might be of future assistance. As such, it is essential to further develop research into natural remedies; future projects could continue the work started during this consultancy project.

Appendix 1: Questionnaire on external parasites of ruminants

Cover page:

We are a team of five MSc students at Wageningen University undertaking the Academic Consultancy Training (ACT) course. During this course, we are diving into a project on the transition towards natural livestock farming on behalf of the Platform Natuurlijke Veehouderij, and, in particular, looking at the natural remedies available against external parasites of ruminants.

The following questions will help us gather data on what natural remedies are available (worldwide) and in what contexts they are used.

Depending on your answers, the questionnaire will take between 10 and 15 minutes. You can answer it anonymously or not.

We would like to thank you in advance for your time and kind collaboration.

Note that the final question is "do you have any comments/questions for us", which is when you should submit the questionnaire. Please do not press the submit button before that

1. What is your country of origin? [Open question]

2. What is your profession? [Multiple choice]

(If you are currently retired, select [retired] and the profession(s) you performed before retirement.)

- Farmer
- Veterinarian
- Academic (lecturer/researcher/professor, etc...)
- Medicine producer or distributor
- Retired
- Other

3. How many years of experience in your field do you have? [Single choice]

- a. 0-2 years
- b. 3-5 years
- c. 6-10 years
- d. 11-25 years
- e. More than 25 years

4. Would you prefer to answer the questionnaire anonymously or not? [Yes or No]

- Anonymous
- I am fine with giving my name and contact details

5. Please give your name and email (or other contact details if you prefer) below. [Open question]

6. What kind of animals do you have on your farm/where does your expertise lie in? [Multiple choice]

- Cattle
- Sheep
- Goats
- None of the above
- Other

7. What is your farming practice? [Multiple choice]

- a. Conventional
- b. Organic
- c. Intensive
- d. Semi-intensive
- e. Traditional (e.g., agropastoralism)
- f. Other

8. What is your herd size? [Single choice]

(If you have cattle)

- a. 0-25
- b. 26-80
- c. 81-150
- d. 151-300
- e. 301-1000
- f. > 1000
- g. None/not applicable

9. What is your herd size? [Single choice]

(If you have sheep)

- 0-25
- 26-80
- 81-150
- 151-300
- 301-1000
- > 1000
- None/not applicable

10. What is your herd size? [Single choice]

(If you have goats)

- a. 0-25
- b. 26-80
- c. 81-150
- d. 151-300
- e. 301-1000
- f. > 1000
- g. None/not applicable

External parasite infestations on ruminants

All of the following questions relate to the external parasite infestations that occur on ruminants.

We make a distinction between prevention (prevent first contact of parasites on the animal) and treatment (combat the existing parasitic infestation on an animal). Please read the questions carefully in order to avoid confusion.

11. What are the most common external parasites you have encountered, and how many infestations* per animal per year (on average)? [Scale statement]

Infestation includes: first contact of parasite with the animals (e.g., one tick on a sheep), multiple parasites on an animal and an animal getting diseases as a result of parasites.

	0	1-5	6-10	More than 10
Ticks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mosquitoes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fleas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mites	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. Do you think external parasites are a problem? [Scale statement]

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

0= Not a problem at all

10= A significant problem

13. Please explain why. [Open question]

14. During which season do most of the external parasitic infestations take place? [Multiple choice]

- Spring
- Summer
- Autumn
- Winter
- Other

15. Which of the following locations have you seen as a point of infestation? [Multiple choice]

- Pasture (e.g. common area, pastoralism, mountainous area.)
- Pasture (Own pasture)
- Cross infection from new animals
- Indoors
- Other

16. How often are your animals outside? [Single choice]

- a. Always (all year round)
- b. Most of the time (\pm 9 months of the year)
- c. Half of the time (\pm half of the year)
- d. Sometimes (\pm 3 months of the year)
- e. Never

17. Who is the most likely to detect or diagnose the animals with external parasitic infestations? [Single choice]

- a. Farmers
- b. Veterinarians
- c. Experts
- d. I don't know
- e. Other

18. Which current practices do you know for the prevention of external parasites? [Multiple choice]

- a. Internal product administration
- b. External product administration
- c. Product administration in surroundings (stables, etc.)
- d. I don't know of any practices
- e. Other

19. For farmers or others who keep animals: do you take any preventative measures against external parasites? [Yes or No]

For those who do not keep animals (veterinarians, experts, etc.): do you suggest any preventative measures to farmers?

20. Can you clarify which preventative measures you are using against external parasites? [Open question]

E.g., internal product administration, external product administration (on the skin and fur) and environmental product administration (aerosols, etc.)

21. Have you ever learnt about natural remedies? [Multiple choice]

- No
- Yes, from university/higher education
- Yes, from unions
- Yes, from social media (television, internet, etc.)
- Yes, from scientific papers
- Yes, from my friends and/or family
- Other

22. Do you use any of the following products to treat infestations of external parasites? [Multiple choice] *(e.g. herbs, diatomaceous earth, essential oils, etc...)

- a. I know of chemical/synthetic medicine
- b. I know of natural remedies*
- c. I use chemical/synthetic medicine
- d. I use natural remedies*
- e. None
- f. Other

23. Do you base your treatment procedures against external parasites according to: [Multiple choice]

- a. Veterinarian suggestions?
- b. Previous incidents/personal experiences?
- c. Personal knowledge/beliefs?
- d. Advice of fellow farmers?
- e. Not applicable
- f. Other

24. Compared to the past, synthetic anti-parasitics nowadays are

[Please complete the sentence above]

- a. Very effective
- b. Somewhat effective
- c. Less effective

- d. No longer effective
- e. Not applicable

25. Do you know of any other options of prevention/treatment against external parasitic infestation besides synthetic medicine? [Open question]

26. What is your attitude towards natural antiparasitic remedy use? [Scale statement]

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

0 = No inclination (negative)

10 = Strong inclination (positive)

27. Please explain your above chosen attitude/option. [Open question]

28. What are your estimates of the costs using chemical (external) anti-parasitics per animal? [Open question]

If you do not use chemical antiparasitics, write 0 down below. Specify your currency.

29. What are your estimates of the costs using natural remedies against external parasites, per animal? [Open question]

If you do not use natural remedies, write 0 down below. Specify your currency.

30. Are you aware of the environmental impacts of chemical anti-parasitic usage? [Yes or No]

- a. Yes, I have heard of it/am aware of it
- b. No, I have not heard from it/am not aware of it

31. Does environmental impact play a crucial role on your decision in using anti-parasitics (whether you use natural treatments or chemical/synthetic treatments, or both)

[Yes or No]

- 1. Yes
- 2. No
- 3. Not applicable

32. Which characteristics of a treatment against external parasites do you think are most important? [Scale statement]

Rank them from 1 (less important) to 6 (more important). Please use the ranks only once.

	1	2	3	4	5	6
Cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Effectiveness against external parasites	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Environmental impact	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Non-toxicity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Availability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

33. If your colleague told you about their experiences (positive or negative) with natural remedies against external parasites, how likely would you be to follow their suggestions? [Scale statement]

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

0 = Not at all likely 10 = Extremely likely

34. Please rate the effectiveness of each of the following treatments against external parasites according to your beliefs/position/stance. [Scale statement]

	1 = Not effective	2	3 = Neutral	4	5 = Effective
Chemical/synthetic treatments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural remedies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other: (please specify below)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

35. If you chose other in the previous question: could you specify which other anti-parasitic (external) treatment you think is effective? [Open question]

36. Have you ever used natural remedies against external parasites before? [Yes or No]

- a. Yes
- b. No
- c. Not applicable

37. Which remedies have you used, how (application and form), and against which external parasites? [Open question]

38. Who sent you this questionnaire? [Open question]

(Write down their names)

39. Thank you for answering our questionnaire! [Open question]

If you have any additional comments/questions, please add them below.

Appendix 2: Database of natural remedies against ectoparasites found worldwide

Table 8: List of natural remedies found worldwide against ectoparasites of (ruminant) livestock

Animal	Parasite concerned	Context	Country of origin	Application (Management/ remedy)	Product	Active or passive	Comments	Reference	Reference type (literature review/testimonial)
Cattle	Fleas; Flies; Ticks	Against flies, ticks and fleas	Brazil		Capsicum frutescens		Fruit and bark are triturated in water	Silva et al., 2014	Journal article on traditional veterinary practices
Cattle	Fleas; Ticks	To treat ectoparasitic infestations (ticks, fleas)	Spain	Treatment	Pork lard	Active	The pork lard is applied directly to the infested zone	González & Vallejo, 2021	Journal article on traditional veterinary practices
Cattle	Flies	Against flies	India	Preventative/ repellent	Nicotiana tabacum (Tobacco)	Active	Plant juice is applied on the body to repel flies	Kamatchi & Parvathi, 2020	Journal article on traditional veterinary practices
Cattle	Flies	Against horn flies (Haematobia irritans)	USA	Preventative/ repellent or Treatment	C8910 acids	Active	Reduction in horse fly feeding (laboratory bioassay) and spatial repellancy was measured; after 48h, feeding percentage was at about 45%	Zhu et al., 2015	Scientific article
Cattle	Flies	Against flies in cattle and sheep	France	Preventative/ repellent	Diluted geraniol	Active	Alcohol; sprayed on backs of animals	ADMM, 2017	Report on Farmer testimonials by ADMM
Cattle	Flies	Against horn flies (Haematobia irritans)	USA	Preventative/ repellent or Treatment	Geraniol	Active	Reduction in horse fly feeding (laboratory bioassay) and spatial repellancy was measured; after 48h , feeding percentage was at about 45%	Zhu et al., 2015	Scientific article
Cattle	Flies	Against Tsetse flies	Nigeria	Preventative/ repellent	Sesbania aculeata, ointments, dust, tobacco	Active	Cattle are washed with the infusion before crossing tsetse fly belts	Ibrahim et al., 1983	Journal article on traditional veterinary practices
Cattle	Flies	To treat cutaneous myiasis	Spain	Treatment	Vinegar and cow's milk	Active	The mixture is poured on the cow to reduce swelling caused by the myiasis	González & Vallejo, 2021	Journal article on traditional veterinary practices
Cattle	Flies; Lice	Against lice (Haematopinus tuberculatus) and flies (Musca domestica, Stomoxys calcitrans, Haematobia irritans)	Egypt	Preventative/ repellent or Treatment	Camphor, onion, peppermint & chamomile essential oils	Active	In vitro study showed that oils effectively killed lice within 2 minutes and also decreased egg viability; in vitro study showed a repelling effect against flies for 6 days	Khater et al., 2009	Scientific article

		& Hippobosca equina) in water buffalo							
Cattle	Flies; Ticks	Against ticks and flies	India	Preventative/ repellent or Treatment	Ricinus communis (Castor bean)	Active	100 gram mature seeds crushed, mixed with curcuma powder; 1 table spoon of the paste applied to a cloth and tied to place of tick infestation, also works as fly repellent	Kamatchi & Parvathi, 2020	Journal article on traditional veterinary practices
Cattle	Indiscriminate	Against ectoparasites	Kenya	Preventative/ repellent	Caesalpinia volkensii	Active	Leaves are boiled in water; the decoction is then sprayed on the animal	Njoroge & Bussmann, 2006	Journal article on traditional veterinary practices
Cattle	Indiscriminate	Against ectoparasites	Kenya	Preventative/ repellent	Synadenium compactum	Active	Bark is soaked in water; the infusion is then sprayed on the animal	Njoroge & Bussmann, 2006	Journal article on traditional veterinary practices
Cattle	Indiscriminate	Against ectoparasites	Kenya	Preventative/ repellent	Tagetes minuta	Active	Leaves are boiled in water; the decoction is then sprayed on the animal	Njoroge & Bussmann, 2006	Journal article on traditional veterinary practices
Cattle	Indiscriminate	Against ectoparasites	Kenya	Preventative/ repellent	Tithonia diversifolia	Active	Galls on the leaf are boiled in water; the decoction is then sprayed on the animal	Njoroge & Bussmann, 2006	Journal article on traditional veterinary practices
Cattle	Indiscriminate	Against ectoparasites	Kenya	Preventative/ repellent	Warburgia ugandensis	Active	Leaves are boiled in water; the decoction is then sprayed on the animal	Njoroge & Bussmann, 2006	Journal article on traditional veterinary practices
Cattle	Lice	Against louse (Haematopinus tuberculatus) in buffalo	Egypt	Treatment	Cinnamomum camphora essential oil	Active	Both in vitro and in vivo studies indicated the potential of the oils for repellent effects.	Khater et al., 2009	Scientific article
Cattle	Lice	Against lice (general)	France	Treatment	Essential oil (olive oil, ajowan, oregano, lemon-scented gum, Chinese cinnamon, clove, lavender)	Active	Leaves are boiled in water; the decoction is then sprayed on the animal	ADMM, 2017	Report on Farmer testimonials by ADMM
Cattle	Lice; Mites; Ticks	Against lice, mites and ticks in young animals	Canada	Preventative/ repellent or Treatment	Algae	Passive	Feed one ounce (\pm 28g) per animal per day	OACC, 2009	Brochure by Organic Agriculture Centre of Canada
Cattle	Lice; Mites; Ticks	Against lice, mites and ticks	Canada	Treatment	Diatomaceous earth	Active	Application to the infested zone; pierces the exoskeleton of the parasites	OACC, 2009	Brochure by Organic Agriculture Centre of Canada
Cattle	Lice; Mites; Ticks	Against lice, mites and ticks	Canada	Treatment	Garlic	Active	Topical treatment or tincture in feed	OACC, 2009	Brochure by Organic Agriculture Centre of Canada

Cattle	Lice; Mites; Ticks	Against lice, mites and ticks	Canada	Treatment	Natural flax seed oil	Active	Application of thin layer on insects will asphyxiate them	OACC, 2009	Brochure by Organic Agriculture Centre of Canada
Cattle	Mites	Against scabies	Canada	Treatment	Essential oil (aniseed, camphor, eucalyptus, pennyroyal mint, rosemary, sassafras)	Active	Apply essential oil to infested zone and allow it to penetrate	OACC, 2009	Brochure by Organic Agriculture Centre of Canada
Cattle	Mites	Against scabies	Canada	Treatment	Garlic	Active	Apply tincture to infested zone	OACC, 2009	Brochure by Organic Agriculture Centre of Canada
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Aganonerion polymorphum and Anethum graveolens		Acute acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Aganonerion polymorphum and Calotropis gigantean		Delayed acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Aganonerion polymorphum and Calotropis procera		Acute acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Aganonerion polymorphum and Cryptostegia grandiflora		Delayed acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Aganonerion polymorphum and Ixora nigricans		Delayed acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against ticks	South Africa	Preventative/repellent or Treatment	Aloe ferox	Active	Leaves of the tree are crushed and soaked in water; this mixture is set overnight and drained the next day - the obtained liquid is sprayed on cattle	Moyo & Masika, 2009	Scientific article
Cattle	Ticks	Against ticks	Brazil		Anadenanthera colubrina		Maceration and soak	Silva et al., 2014	Journal article on traditional veterinary practices
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Annona muricata and Piper nigrum		Delayed acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against ticks (Amblyomma variegatum)	Nigeria	Treatment	Azadiracta indica	Active	100% undiluted neem seed oil had effect of 100% mortality on larvae after 48h, in vitro	Ndumu et al., 1999	Scientific article

Cattle	Ticks	Against ticks (Boophilus microplus, Hyalomma anatolicum anatolicum and Rhipicephalus haemaphysaloides) in cattle and buffaloes	India	Treatment	Azadiracta indica	Active	Neem oil had 60-75% acaricidal efficacy for buffaloes and cattle infested with ticks, in in vitro and in vivo trials	Kalakumar et al., 2000	Scientific article
Cattle	Ticks	Against ticks (Boophilus microplus)	Brazil	Treatment	Brachiaria brizantha	Active	The grass has larvaecidal effects (potentially lethal)	Barros & Evans, 1989	Scientific article
Cattle	Ticks	Against cattle tick, Rhipicephalus (Boophilus) microplus	Mexico	Treatment	Bursera simaruba	Active	In vitro; 10% stem bark extracts had acaricidal effects (99.1±0.7% mortality in nymphs)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against cattle tick, Rhipicephalus (Boophilus) microplus	Mexico	Treatment	Caesalpinia gaumeri	Active	In vitro; 10% extracts had acaricidal effects (90.1±4.8% mortality in nymphs)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Calotropis gigantean and Cryptostegia grandiflora		Delayed acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Calotropis gigantean and Pentapetes Phoenicia		Delayed acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against cattle tick (Rhipicephalus microplus)	Thailand	Treatment	Calotropis procera and Pentapetes Phoenicia		Acute acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against ticks	Pakistan	Preventative/ repellent or Treatment	Cannabis sativa	Active	Grind 2 kg leaves with 1 kg mineral salts, burn it in tandoor and divide into 14 equal parts; twice a week, administer per 28 grams	Sindhu et al., 2010	Journal article on traditional veterinary practices
Cattle	Ticks	Against cattle tick, Rhipicephalus (Boophilus) microplus	Mexico	Treatment	Capraria biflora	Active	In vitro; 10% extracts had acaricidal effects (86.6±9.9% mortality in nymphs)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against cattle tick, Rhipicephalus (Boophilus) microplus	Mexico	Treatment	Cassearia corymbosa	Active	In vitro; 10% stem bark extracts had acaricidal effects (99.5±0.5% mortality in nymphs)	Rosado-Aguilar et al., 2010	Scientific article

Cattle	Ticks	Against ticks on cows and calves	Ethiopia	Treatment	<i>Croton macrostachyus</i>	Active	Roots chopped and mixed with water; mixture is applied to infested site	Tesfaye et al., 2015	Journal article on traditional indigenous knowledge
Cattle	Ticks	Against cattle tick, <i>Rhipicephalus (Boophilus) microplus</i>	Mexico	Treatment	<i>Diospyros anisandra</i>	Active	In vitro; 10% leaf and stem bark extracts had acaricidal effects (87.9±8.6% and 98.8±1.0% mortality in nymphs, respectively)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against cattle ticks (<i>Haematopinus tuberculatus</i> , <i>Boophilus microplus</i> , <i>Hyalomma anatolicum anatolicum</i> , <i>Hyalomma marginatum isaaci</i> and <i>Hyalomma dromedarii</i>) in buffalo and cattle	India	Treatment	Ectoparasiticide AV/EPP/14 (<i>Cedrus deodara</i> , <i>Pongamia glabra</i> , <i>Azadirachta indica</i> , <i>Eucalyptus globulus</i> and <i>Acorus calamus</i>)	Active	Compound is sprayed on animals (1:4 dilution with tap water); 100% effective after 24h treatment; Reinfestation after 15 days eliminated with 2nd treatment	Ravindra et al., 2000	Scientific article
Cattle	Ticks	Against ticks (<i>Boophilus decoloratus</i>)	Ethiopia	Treatment	<i>Euphorbia obovalifolia</i>	Active	Latex applied to infested zone reduces tick burden	Regassa, 2000	Scientific article
Cattle	Ticks	Against ticks (<i>Boophilus decoloratus</i>)	Ethiopia	Treatment	<i>Ficus brachypoda</i>	Active	Latex applied to infested zone reduces tick burden	Regassa, 2000	Scientific article
Cattle	Ticks	Against cattle tick, <i>Rhipicephalus (Boophilus) microplus</i>	Mexico	Treatment	<i>Havardia albicans</i>	Active	In vitro; 10% leaf extracts had acaricidal effects (93.0±12.0% mortality in nymphs)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against ticks (<i>Boophilus microplus</i>)	Brazil	Treatment	<i>Lippia triplinevis</i>	Active	In vitro test; worked against larvae and engorged females.	de Assis Lage et al., 2013	Scientific article
Cattle	Ticks	Against cattle tick (<i>Rhipicephalus microplus</i>)	Thailand	Treatment	<i>Ixora nigricans</i> and <i>Anethum graveolens</i>		Delayed acaricidal activity of combined crude extracts	Chungsamarnyart et al., 1994	Scientific article
Cattle	Ticks	Against ticks (<i>Rhipicephalus appendicuatus</i>) in buffalo	India	Treatment	<i>Margaritaria discoidea</i>	Active	Hexane extract made from leaves and stems	Kaaya et al., 1995	Scientific article
Cattle	Ticks	Against ticks (<i>Boophilus decoloratus</i>)	Brazil	Treatment	<i>Melia azedarach</i>	Active	Extract of <i>Melia azedarach</i> dried fruits had larvaecidal effects in vitro	Borges et al., 2003	Scientific article
Cattle	Ticks	Against cattle tick, <i>Rhipicephalus</i>	Mexico	Treatment	<i>Ocimum micranthum</i>	Active	In vitro; 10% root extracts had acaricidal effects	Rosado-Aguilar et al., 2010	Scientific article

		(Boophilus) microplus					(87.0±3.2% mortality in nymphs)		
Cattle	Ticks	Against ticks (Rhipicephalus appendicuatus) in buffalo	Kenya	Treatment	Ocimum suave	Active	Both in vitro and in vivo test were applied, it is used by oil extracted from steam distillation.	Mwangi et al., 1995	Scientific article
Cattle	Ticks	Against cattle tick, Rhipicephalus (Boophilus) microplus	Mexico	Treatment	Petiveria alliacea	Active	In vitro; 10% leaf and stem extracts had acaricidal effects (95.7±2.9% and 99.2±0.5 % mortality in nymphs, respectively)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against ticks	South Africa	Preventative/ repellent or Treatment	Ptaeroxylon obliquum (Sneeze-wood)	Active	Leaves of the tree are crushed and soaked in water; this mixture is set overnight and drained the next day - the obtained liquid is sprayed on cattle	Moyo & Masika, 2009	Scientific article
Cattle	Ticks	Against cattle tick, Rhipicephalus (Boophilus) microplus	Mexico	Treatment	Solanum erianthum	Active	In vitro; 10% stem extracts had acaricidal effects (97.8±1.8% mortality in nymphs)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against cattle tick, Rhipicephalus (Boophilus) microplus	Mexico	Treatment	Solanum tridynamum	Active	In vitro; 10% stem extracts had acaricidal effects (98.0±1.7% mortality in nymphs)	Rosado-Aguilar et al., 2010	Scientific article
Cattle	Ticks	Against ticks (Boophilus microplus)	India	Treatment	Stemona collinsae	Active	Both in vitro and in vivo study saw an increase in the mortality of nymphs and adults	Jansawan et al., 1993	Scientific article
Cattle	Ticks	Against ticks (Boophilus microplus)	Thailand	Treatment	Stemona collinsae	Active	Whole plant extract (at 50% concentration) resulted in 100% mortality in seed ticks, and 93.33% mortality in engorged adult ticks, after 24hrs	Jansawan et al., 1993	Scientific article
Cattle	Ticks	Against ticks (Rhipicephalus microplus)	Brazil	Treatment	Tagetes minuta	Active	The essential oil showed 99.98% efficacy in comparison with the control group, at 20% concentration	Andreotti et al., 2013	Scientific article
Cattle	Ticks	Against ticks	South Africa	Treatment	Solanum incanum	Active	Identified by in vivo trial, 5 % Solanum incanum extract concentrate treatment has acaricidal effect	Madzimure et al., 2013	Scientific article
Cattle	Flies	Against horn flies (Haematobia irritans)	Texas	Preventative/ repellent or Treatment	Catnip oil	Active	Reduction in horse fly feeding (laboratory bioassay) and spatial repellancy was	Zhu et al., 2015	Scientific article

							measured; after 48h , feeding percentage was at about 50%		
Cattle; Goats	Flies	Against flies and maggots	India	Treatment	<i>Azadirachta indica</i> (Neem)	Active	50 gram oil paste made from seeds applied externally to feet of cows and goats	Kamatchi & Parvathi, 2020	Journal article on traditional veterinary practices
Cattle; Goats	Flies	Against flies	India	Preventative/repellent	<i>Momordica charantia</i> (Bitter melon)	Active	100 gram of fresh leaves crushed, mixed with water and filtered; sediment applied topically	Kamatchi & Parvathi, 2020	Journal article on traditional veterinary practices
Cattle; Goats	Ticks	Against ticks (<i>Boophilus microplus</i>)	Japan	Treatment	<i>Azadirachta indica</i> (neem); <i>Eucalyptus</i> spp.; <i>Milletta pinnata</i> (pongamia)	Active	Highest mortality of ticks with Neem oil + Eucalyptus oil mixture at 10% concentration; elevated mortality with Neem oil + Pongamia mixture also at 10% concentration	Sivaramakrishnan et al., 1996	Scientific article
Goats	Indiscriminate	General antiparasitic	France	Preventative/repellent	Chopped ash branches, dried garlic powder	Passive	Added to feed	ADMM, 2017	Report on Farmer testimonials by ADMM
Goats	Indiscriminate	General antiparasitic	France	Preventative/repellent	Oil (cod liver oil, essential oil oregano, essential oil clove)	Passive	Small quantity per goat; added in feed once in autumn and once in winter	ADMM, 2017	Report on Farmer testimonials by ADMM
Goats	Mites	To treat scabies/mange	Spain	Treatment	Pork lard (and sulphur)	Active	Various methods across different Spanish regions; generally, the lard and sulphur mixture is applied to the infested zone	González & Vallejo, 2021	Journal article on traditional veterinary practices
Goats	Mites; Ticks	Against parasites; works against helminths, too	South Africa	Preventative/repellent or Treatment	<i>Aloe ferox</i>	Active; Passive	Infusion; leaves crushed and applied to skin OR decoction is added to drinking water	Sanhokwe et al., 2016	Journal article on traditional veterinary practices
Goats	Mites; Ticks	Against parasites; works against helminths, too	South Africa	Preventative/repellent or Treatment	<i>Elephantorrhiza elephantina</i>	Active	Decoction; roots are ground then added to water before being sprayed on animal	Sanhokwe et al., 2016	Journal article on traditional veterinary practices
Goats	Ticks	Against parasites; works against helminths, too	South Africa	Preventative/repellent or Treatment	<i>Acokanthera oppositifolia</i>	Active	Decoction; leaves are ground and added to water, mixture is drenched on animal	Sanhokwe et al., 2016	Journal article on traditional veterinary practices
Goats	Ticks	Against ticks (<i>Rhipicephalus appendiculatus</i>)	Kenya	Treatment	<i>Azadirachta indica</i>	Passive	Neem seed powder fed to the goats, resulting in a reduction of successful attachment of larvae; increased mortality of	ICIPE, 1999	Annual scientific report

							nymphs and adults; reduction in moulting of nymphs		
Goats	Ticks	Against parasites; works against helminths, too	South Africa	Preventative/ repellent or Treatment	Bulbine latifolia	Active	Decoction; leaves are ground and added to water, mixture is drenched on animal	Sanhokwe et al., 2016	Journal article on traditional veterinary practices
Goats	Ticks	Against ticks (Rhipicephalus lunulatus)	Cameroon	Treatment	Essential oil of Ageratum houstonianum	Active	Soap foam contained essential oil of A. houstonianum; both in vitro and in vivo experiments showed high tick mortality	Tedonkeng Pamo et al., 2005	Scientific article
Goats; others	Mites	Against mites causing goat mange	India	Treatment	Karanj oil		Karanj extracts also work synergistically with pyrethrins and neem	Gupta & Vohra, 2020	Report/Compendium
Indiscriminate	Fleas; Flies; Mosquitoes; Ticks	Against flies, ticks, mosquitos and fleas	Germany	Preventative/ repellent	Vitex agnus castus	Active	The seeds of the monk's pepper (CO ₂ extract) can be used in a spray and can repel external parasites for 6 hours or more	Mehlhorn et al., 2005	Scientific article
Indiscriminate	Fleas; Lice	Against lice, fleas	Turkey	Treatment	Delphinium staphisagria	Active	Incense	Yaşar et al., 2015	Scientific article
Indiscriminate	Fleas; Lice	Against lice, fleas	Turkey	Treatment	Lupinus albus	Active	Infusion	Yaşar et al., 2015	Scientific article
Indiscriminate	Fleas; Lice	Against lice, fleas	Turkey	Treatment	Nicotiana tabacum	Active	Infusion	Yaşar et al., 2015	Scientific article
Indiscriminate	Fleas; Lice; Ticks	Against lice, fleas, ticks	Turkey	Treatment	Juniperus oxycedrus	Active	Use with tar	Yaşar et al., 2015	Scientific article
Indiscriminate	Fleas; Lice; Ticks	Against lice, fleas, ticks	Turkey	Treatment	Linum usitatissimum	Active	Dissolve in linseed oil	Yaşar et al., 2015	Scientific article
Indiscriminate	Flies	Repellent action	India	Preventative/ repellent	Ageratum conyzoides	Active	5% essential oil extracted from the plant can provide >2h protection	Hazarikaa et al., 2014	Scientific article
Indiscriminate	Flies	Against Tsetse flies	Kenya		Azaridachta indica	Active	Oil smeared on the body of the animals	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Flies	Aginst fly larvae	France	Preventative/ repellent or Treatment	Basil essential oil	Active	Essential oil; pulverization once per week on humid bedding	Bassoleil, 2019	Brochure by French Chamber of Agriculture

Indiscriminate	Flies	Against stable fly (Stomoxys calcitrans)	Asia	Preventative/ repellent	Calophyllum inophyllum (Tamanu nut oil)	Active	In vivo (on human hands): Tamanu oil, when used in combination with different essential oils, had a synergistic effect in repelling flies; some essential oils when used in combination with Tamanu oil had similar protection times compared to DEET	Hieu et al., 2010	Scientific article
Indiscriminate	Flies	Against Tsetse flies	Kenya		Cissus purpurea	Active	Animals are bathed in emulsion made from roots	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Flies	Against livestock biting flies	Venezuela	Preventative/ repellent	Cucurbita sp.	Active	Squash leaf juice wash used as repellent	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Flies	Against Tsetse flies	Kenya		Euphorbia balsamifera	Active	Latex smeared on the body of the animals	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Flies	Repellent action	India	Preventative/ repellent	Homalomena aromatica	Active	5% essential oil extracted from the plant can provide >2h protection	Hazarikaa et al., 2012	Scientific article
Indiscriminate	Flies	Against flies (general)	France	Preventative/ repellent or Treatment	Lemongrass essential oil or Lemon-scented gum essential oil	Active	Essential oil; necessary to repeat pulverizations	Bassoleil, 2019	Brochure by French Chamber of Agriculture
Indiscriminate	Flies	Against Tsetse flies	Kenya		Sesbania sesban	Active	Animals are bathed in emulsion made from leaves	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Flies	Against flies in general, also fleas	Australia	Preventative/ repellent or Treatment	Tanacetum vulgare	Active; Passive	Foliage and essential oil have been used to repel and kill fleas and flies.	Lim, 2012	Book
Indiscriminate	Flies	Repellent action	India	Preventative/ repellent	Vitex negundo	Active	5% essential oil extracted from the plant can provide >2h protection	Hazarikaa et al., 2013	Scientific article
Indiscriminate	Flies; Lice; Mites; Ticks	Against lice, ticks, itch mite and cutaneous myiasis	France	Preventative/ repellent or Treatment	Chrysanthemum solution	Active	Solution	Dubois-Frapsauce, 2018	Bulletin made by veterinarian
Indiscriminate	Flies; Lice; Ticks	Against ticks, lice, flies and other insects	Burkina Faso	Treatment	Azadirachta indica	Active	Crushed seeds are mixed in with potash; the preparation is applied 1-2/day for one week	Kabore et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Flies; Lice; Ticks	Against ticks, lice, flies and other insects	Burkina Faso	Treatment	Cassia nigricans	Active	Leaves and stems are steeped in water for 1-2 days; the mixture is sprayed on the animal on the infested area	Kabore et al., 2012	Journal article on traditional veterinary practices

Indiscriminate	Flies; Lice; Ticks	Against ticks, lice, flies and other insects	Burkina Faso	Treatment	Nicotiana tabacum	Active	Crushed leaves are mixed in with potash; the preparation is applied once or twice to the animal, on the infested area	Kabore et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Flies; Mosquitoes	Against flies, mosquitoes	India	Treatment	Neem oil	Active		Schmutterer, 1990	Scientific article
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Aloe megalacantha	Active	Latex within leaf is to be applied to the affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	China	Treatment	Chrysanthemum cinerariifolium	Active	Dissolve in essential oil then spray on skin	Wang et al., 2020	Scientific article
Indiscriminate	Indiscriminate	Against larva and pupae	India	Treatment	Citrus sinensis essential oil	Active	Against larva and pupae by contact toxicity and fumigation	Kumar et al., 2011	Scientific article
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Datura innoxia	Active	Leaves are ground with water and applied to affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Laggera tomentosa	Active	Leaves are ground and applied to the affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Preventative/ repellent or Treatment	Nicotiana glauca	Active	Leaves are ground with water and applied to affected site; animal must be cleaned from the product within the day	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Otostegla integrifolia	Active	Leaves are ground with water and applied to affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Phytolacca dodecandra leaves	Active	Leaves are ground with water and applied to affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Piliostigma thonningii leaves	Active	Leaves are pounded and applied to affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Premna oligotricha	Passive	Leaves are put in fires for fumigation	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	China	Treatment	Realgar	Active	Spray on the skin with essential oil solvent	Liu & Xu, 2014	Book on traditional veterinary practices
Indiscriminate	Indiscriminate	Against ectoparasites	Ethiopia	Treatment	Ricinus communis	Active	Leaves are ground and applied to the affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices

Indiscriminate	Lice	Against lice (general)	Ethiopia	Treatment	Calpurnia aurea; Sida rhombifolia	Active	Leaves of <i>C. aurea</i> , in combination (or not) with whole parts of <i>S. rhombifolia</i> are boiled and applied topically to the infested area (until it is recovered)	Tamiru et al., 2013	Journal article on traditional veterinary practices
Indiscriminate	Lice	Against lice (general)	Ethiopia	Treatment	Nicotiana tabacum	Active	Infusion (leaves in hot water) are applied topically to the infested area	Tamiru et al., 2013	Journal article on traditional veterinary practices
Indiscriminate	Lice; Mites; Ticks	Against ticks, lice, mites also mange and myiasis	Pakistan	Treatment	Brassica campestris	Active	The oil of the seeds are used to apply on wounds (myiasis and mange) or topically for lice and tick infestations	Farooq et al., 2008	Journal article on traditional veterinary practices
Indiscriminate	Lice; Ticks	Against ticks and lice	India		Acacia leucophloea	Active	Juice of <i>Acacia leucophloea</i> and <i>Pergularia daemia</i> can be applied on the body	Jagadeeswary et al., 2014	Journal article on traditional veterinary practices
Indiscriminate	Lice; Ticks	Against ticks and lice	India		Kigelia africana	Active	Leaves are ground, mixed with garlic and applied on body	Jagadeeswary et al., 2014	Journal article on traditional veterinary practices
Indiscriminate	Mites	Treat scabies	Turkey	Treatment	Allium sativum	Active	Spray after crushing	Yaşar et al., 2015	Scientific article
Indiscriminate	Mites	Against mites	China	Treatment	Hydnocarpus hainanensis	Active	Dissolve in ethanol	Wang et al., 2020	Scientific article
Indiscriminate	Mites	To treat scabies	China	Treatment	Natural Sulphur	Active	Spray on the skin by cream with 10-25% content. 10-30g cream for cattle per time; 0.3-1g cream for sheep or goat.	Liu & Xu, 2014	Book on traditional veterinary practices
Indiscriminate	Mites	Against mites and louse	China	Treatment	Stemona tuberosa	Active	Dissolve in ethanol	Wang et al., 2020	Scientific article
Indiscriminate	Mites	Against mites	China	Treatment	Syzygium aromaticum (Clove)	Active	Mixed with essential oil	Wang et al., 2020	Scientific article
Indiscriminate	Mites	Against mites	China	Treatment	Tangerine Peel	Active	Solution, spray on skin	Wang et al., 2020	Scientific article
Indiscriminate	Mites	Against mites	China	Treatment	Taraxacum (Dandelion)	Active	Dissolve in ethanol	Wang et al., 2020	Scientific article
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/control/management	Azadirachta indica		Leaves used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/control/management	Cedrela odorata		Leaves used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/control/management	Cordia curassavica		Leaves used	Wanzala, 2017	Journal article on traditional veterinary practices

Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Eclipta alba		Plant tops used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Mammea americana		Seeds used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Manilkara zapota		Seeds used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Momordica charantia		Vine used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Musa species		Stem juice used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Nicotiana tabacum		Leaves used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Petiveria alliacea		Leaves used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Pouteria sapota		Seeds used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Renealmia alpinia		Leaves used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mites; Ticks	Against ticks and mites	Trinidad; Tobago	Prevention/ control/ management	Scoparia dulcis		Leaves used	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Mosquitoes	Against larva	India	Preventative/ repellent	Annona squamosa			George & Vincent, 2005	Scientific article
Indiscriminate	Mosquitoes	Against larva	India	Preventative/ repellent	Capsicum annum			Madhumathy et al., 2007	Scientific article
Indiscriminate	Mosquitoes	Against mosquitoes	India	Preventative/ repellent	Cymbopogon citratus (Lemon grass)	Active		Sharma & Dhiman, 1993	Scientific article
Indiscriminate	Mosquitoes	Against mosquitoes	India	Preventative/ repellent	Cymbopogon nardus (Citronella)	Active		Ansari & Razdan, 1995	Scientific article
Indiscriminate	Mosquitoes	Against larva	India	Preventative/ repellent	Jasmine			Ghosh et al., 2008	Scientific article
Indiscriminate	Mosquitoes	Against larva	India	Preventative/ repellent	Jatropha curcas			Kovendan et al., 2011	Scientific article

Indiscriminate	Mosquitoes	Against mosquitoes (<i>Culex tritaeniorhynchus</i>)	India	Treatment	<i>Phyllanthus emblica</i>	Active	Methanol extract of the plant is used to against mosquitoes.	Zahir et al., 2010	Scientific article
Indiscriminate	Mosquitoes	Against larva	India	Preventative/repellent	<i>Pongamia glabra</i>			George & Vincent, 2005	Scientific article
Indiscriminate	Mosquitoes	Against larva	India	Preventative/repellent	<i>Solanum villosum</i>			Das & Chandra, 2012	Scientific article
Indiscriminate	Ticks	Against ticks	Turkey	Treatment	<i>Quercus sp.</i>	Active	Spray after incinerator	Yaşar et al., 2015	Scientific article
Indiscriminate	Ticks	Against ticks	Turkey	Treatment	<i>Salix alba</i>	Active	Infusion	Yaşar et al., 2015	Scientific article
Indiscriminate	Ticks	Against ticks	Uganda		<i>Acacia drepanolobium</i> (Whistling thorn)	Active	Roots are crushed and mixed with water to create a liquid extract; animals are washed or drenched with the extract	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (<i>Hyalomma anatolicum anatolicum</i> and <i>Boophilus microplus</i>)	India	Preventative/repellent or Treatment	<i>Annona squamosa</i> (Sitaphal) seed	Active	Alcoholic extract is made from the seeds of the sitaphal fruit and was evaluated on its ancaricidel aspects; it showed promising results	Ghosh et al., 2006	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda		<i>Acacia gerrardii</i> (Grey-haired acacia)		Leaves are crushed and mixed with water to create extract	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Againt ticks	Kenya		<i>Acacia nilotica</i>		Root and bark	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Againt ticks	Kenya		<i>Acacia sieberiana</i>		Root	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	For tick infestations	Kenya	Treatment	<i>Acalypha fruticosa</i>	Active	Leaf paste of <i>A. fruticosa</i> is smeared on the infested area	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/repellent	<i>Acalypha fruticosa</i>	Active	Observed as tick attractant (field and lab work)	Hassan et al., 1994	Scientific article
Indiscriminate	Ticks	Againt ticks	Kenya		<i>Acalypha racemosa</i>		Root, bark and stem are used to make a concoction	Wanzala et al., 2012	Journal article on traditional veterinary practices

Indiscriminate	Ticks	Against ticks	South Africa	Treatment	Acanthospermum hispidum (Bristly strabur)	Active	Grind dried aerial parts of plant into a powder and apply on wounds	Magwede et al., 2014	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Ixodes spp.)	USA	Preventative/repellent	Acorus calamus	Active	Both aqueous and alcohol (rhizome) extracts are repellent	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Rhipicephalus lunulatus)	Cameroon	Treatment	Ageratum houstonianum	Active	Essential oil (from flowers) are toxic to the ticks	Pamo et al., 2004	Scientific article
Indiscriminate	Ticks	Against ticks	Kenya; South Africa	Preventative/repellent or Treatment	Aloe broomii	Active; Passive	Leaf juice is fed to cattle (passive, preventative); or topical application on infested zone (active; treatment)	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	South Africa	Treatment	Aloe ferox	Active	Leaf infusion, when applied topically to infested zone, has toxic effect to ticks	Mawela, 2008	MSc. thesis
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	South Africa	Preventative/repellent	Aloe marlothii	Active	Leaf extract (applied topically) has repellent effect on ticks	Mawela, 2008	MSc. thesis
Indiscriminate	Ticks	Against ticks	China	Treatment	Alumen	Active	Spray on the skin	Liu & Xu, 2014	Book on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Colombia; USA	Preventative/repellent or Treatment	Andropogon gayanus		Whole plant has toxic/repellent effects on ticks	Thompson et al., 1978	Scientific article
Indiscriminate	Ticks	Against ticks	Colombia	Preventative/repellent or Treatment	Andropogon gayanus		Whole plant has toxic/repellent effects on ticks	Aycardi et al., 1984	Scientific article
Indiscriminate	Ticks	Against ticks	Mexico	Preventative/repellent or Treatment	Andropogon gayanus		Whole plant has toxic/repellent effects on ticks	Fernández-Ruvalcaba et al., 2004	Scientific article
Indiscriminate	Ticks	Against ticks	Canada	Treatment	Artemisia absinthium	Active	Essential oils made from whole plant have acaricidal activity	Chiasson et al., 2001	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma dromedarii)	Egypt		Artemisia herba-alba		Extracts made from aerial parts demonstrated larvaecidal activity (toxicity) in vitro	Abdel-Shafy et al., 2007	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma)	Egypt		Artemisia monosperma		Extracts made from aerial parts demonstrated larvaecidal (H. dromedarii)	Abdel-Shafy et al., 2007	Scientific article

		dromedarii and Argas persicus)					activity (toxicity) in vitro; essential oils to H. dromedarii and A. persicus		
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Artocarpus altilis	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998 Williams, 1993	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus)	Jamaica	Treatment	Asclepias curassavica	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Azadirachta indica	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998 Williams, 1993	Scientific article
Indiscriminate	Ticks	For tick infestations	Kenya	Preventative/repellent	Azadirachta indica (Neem)	Passive	Neem (a tick-repellent) is grown around animal housing	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Hyalomma dromedarii)	Saudi Arabia	Treatment	Azadirachta indica	Active	Neem seed oil caused significant reduction in larval feeding activity and reduction in moultability of nymphs	Al-Rajhy et al., 2003	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Blighia sapida	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Bontia daphnoides	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma dromedarii)	Saudi Arabia	Treatment	Calotropis procera	Active	Glycosidal extract of C. procera had effects similar to those of commercial acaricides	Al-Rajhy et al., 2003	Scientific article

Indiscriminate	Ticks	Against ticks (mainly)	Ethiopia	Treatment	Calpurnia decandra	Active	Leaves are ground with water and applied to affected site	Tesfaye et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Cannabis sativa	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Capsicum annum	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus decoloratus, engorged females)	Ethiopia	Treatment	Capsicum spp.	Active	In vitro testing showed 100% mortality of ticks after direct application (after just one minute)	Regassa, 2000	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Catharanthus roseus	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Cecropia peltata	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (immature Ixodes scapularis)	USA	Treatment	Chamaecyparis nootkatensis	Active	Crude extracts of ground duramen and leaves toxic to tick nymphs	Panella et al., 1997	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Citrus aurantium	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	Kenya	Preventative/repellent	Cleome hirta	Active	Oil made from aerial parts of C. hirta is a tick repellent	Ndungu et al., 1999	Scientific article

Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	South Africa	Preventative/ repellent	Clerodendrum glabrum	Active	Leaf extract (applied topically) has repellent effect on ticks in bioassay	Mawela, 2008	MSc. thesis
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	Kenya	Treatment	Commiphora erythraea	Active	Exudate gum has acaricidal activity against larvae	Maradufu, 1982	Scientific article
Indiscriminate	Ticks	For tick infestations	Kenya		Commiphora erythraea or Commiphora incisa			Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Commiphora holtziana	Active	Has commercial use as a tick repellent	Beentje, 1994	Book on vegetation of Kenya
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	Kenya	Treatment	Commiphora myrrh	Active	Exudate gum has acaricidal activity against larvae	Maradufu, 1982	Scientific article
Indiscriminate	Ticks	Against ticks (Ixodes ricinus; nymphs)	Egypt	Preventative/ repellent	Conyza dioscoridis, Artemisia herba-alba & Calendula officinalis essential oils	Active	In vitro assay and field trial, nymphs were repelled by the EO	El-Seedi et al., 2017	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Crotalaria retusa	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Cuscuta americana	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Cycloptis semicordata	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma dromedarii)	Saudi Arabia	Treatment	Digitalis purpurea	Active	Glycosidal extract of D. purpurea had effects similar to those of commercial acaricides	Al-Rajhy et al., 2003	Scientific article

Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Dioscorea polygonoides	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Ervatamia divaricate	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Erythrina corallodendron	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks	Iran	Treatment	Eucalyptus spp.	Active	In vitro trial, combine with essential oil.	Madreseh-Ghahfarokhi et al, 2019	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma dromedarii)	Egypt	Treatment	Euphorbia aegyptiaca	Active	Extract of E. aegyptiaca had strong toxic effects against H. dromedarii larvae	Abdel-Shafy et al., 2007	Scientific article
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	Kenya	Treatment	Euphorbia candelabrum	Active	Extract induced mortality in all stages of tick development, including adults, in bioassays	ICIPE, 1999	Annual scientific report
Indiscriminate	Ticks	Against ticks (Boophilus decoloratus, engorged females)	Ethiopia	Treatment	Ficus brachypoda	Active	In vitro testing showed 100% mortality of ticks after direct application (after just 10 minutes)	Regassa, 2000	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Gliricidia sepium	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	Kenya	Preventative/repellent	Gynandropsis gynandra	Active	Essential oil of G. gynandra demonstrated repellent qualities in bioassays	Lwande et al., 1999	Scientific article

Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus and Amblyomma variegatum)	Kenya	Preventative/ repellent or Treatment	Gynandropsis gynandra	Active; Passive	Both repellent (whole plant) and acaricidal (direct contact with the leaves) properties in larvae, nymphs and adults	Malonza et al., 1991	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma dromedarii)	Egypt	Treatment	Haplophyllum tuberculatum	Active	Essential oil of H. tuberculatum had larvaecidal effects	Abdel-Shafy et al., 2007	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Hibiscus rosa-sinensis	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus)	Jamaica	Treatment	Hyptis verticillata	Active	Extract has chemosterilant (sterilizing) activities against the tick	Porter et al., 1995	Scientific article
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	South Africa	Preventative/ repellent	Jatropha curcas	Active	Leaf extract (applied topically) has repellent effect on ticks in bioassay	Mawela, 2008	MSc. thesis
Indiscriminate	Ticks	Against ticks (immature Ixodes scapularis)	USA	Treatment	Juniperus virginiana	Active	Crude extracts of ground duramen and leaves showed great larvaecidal activity	Panella et al., 1997	Scientific article
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Macaranga kilimandscharica	Active	Stem and root are used to make a suspension; M. kilimandscharica possesses bioactive compounds	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Treatment	Macuna poggei	Active	Bark and root are used; M. poggei possesses bioactive compounds	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Margaritaria discoidea	Active	Whole plant can be used to make a suspension while	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Treatment	Markhamia lutea	Active	Leaf and stem are used	Wanzala et al., 2012	Journal article on traditional veterinary practices

Indiscriminate	Ticks	Against ticks	Kenya	Treatment	Maytenus arbutifolius	Active	Found to have bioactive and toxic compounds	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Treatment	Maytenus heterophylla	Active	Found to have bioactive and toxic compounds	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Treatment	Maytenus senegalensis	Active	Found to have bioactive and toxic compounds	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Brazil; Kenya; Pakistan	Preventative/repellent	Melia azedarach	Active	Any part of plant can be used by suspension, dusting, rubbing bolus or paste	Soares et al., 2010	Scientific article
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/repellent	Neoboutonia melleri	Active	Stem and root are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/repellent	Paullinia pinnata	Active	Root and root bark are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/repellent	Physalis peruviana	Active	Stem, leaf, fruit and root are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	For tick infestations	Kenya	Preventative/repellent	Raising chickens	Passive	Chickens (which predate upon ticks) are raised in/around animal housing	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	South Africa	Preventative/repellent or Treatment	Ricinus communis	Active	Leaf extract (applied topically) has repellent effect on ticks in bioassay	Mawela, 2008	MSc. thesis
Indiscriminate	Ticks	For tick infestations	Kenya	Treatment	Salt	Active	Animals are bathed in a salt solution (100g salt/L water)	Wanzala, 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/repellent	Sapium ellipticum	Active	Root and bark are used to make decoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/repellent	Senna didymobotrya	Active	Root, bark and leaf are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices

Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Senna siamea	Active	Stem, leaf and root are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Senna singueana	Active	Root, stem and leaf are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Sesbania macrantha	Active	Stem and leaf are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Sesbania sesban	Active	Stem and leaf are used to make suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Preventative/ repellent	Solanum incanum	Active	Root and fruit-juice are used as suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Iran	Treatment	Zingiber officinale (ginger)	Active	In vitro trial, combine with essential oil.	Madreseh-Ghahfarokhi et al, 2019	Scientific article
Indiscriminate	Ticks	Against ticks and insects	Burkina Faso	Treatment	Adenium obesum	Active	Whole plant is mixed with water and the preparation is applied to the animal	Kabore et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda		Adenium obesum (Desert rose)	Active	Crush root tuber, mix with water to create a solution; use it to wash the animal's body	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		Agave sisalana	Active	Leaves are dried and ground into flour, applied as dust; chop the leaves and stem to create solution, which can be applied to animal	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Brazil	Preventative/ repellent	Ageratum conyzoides essential oil	Active	In vivo (on a human fingertip): use leaves to create an ethanolic extract - applied on the skin it is effective as a tick repellent	Soares et al., 2010	Scientific article

Indiscriminate	Ticks	Against ticks (Hyalomma anatolicum excavatum)	Egypt	Treatment	Azadiracta indica	Active	Neem seed plant extract resulted in increasing hatching rate (larvae are underdeveloped and dead); caused hatching failure; increased mortality rates	Abdel-Shafy & Zayed, 2002	Scientific article
Indiscriminate	Ticks	Against ticks	Kenya		Azardachta indica		The stem, bark, fruit, leaves and roots can be used to make a suspension or paste and dusting it on the animal	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda		Boscia angustifolia	Active	Roots are crushed and mixed with water, the liquid extract is used to wash the body of animals	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		Bridelia micrantha	Active	The leaves, root and bark are used to make a suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		Capsicum frutescens		The fruit, leaves and stems can be used to make a suspension, for dusting, smoking and hanging it as a bouquet	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	South Africa	Treatment	Cassia abbreviata	Active	Grind the bark and mix with water, the solution can be applied on wounds	Magwede et al., 2014	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	South Africa	Treatment	Cassia sophera	Active	Grind the aerial parts into a pulp, squeeze the pulp sap onto wounds; dry powder materials are topically applied as a wound dresser	Magwede et al., 2014	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	South Africa	Treatment	Cassytha filiformis	Active	Grind the fresh plant into a pulp and apply on wounds	Magwede et al., 2014	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	South Africa	Treatment	Cissus quadrangularis	Active	Grind the fresh plant into a pulp and apply on wounds	Magwede et al., 2017	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Pakistan		Citrullus colosynthis	Passive	2-3 doses of 100 gram Citrullus fruit mixed in animal feed	Babar et al., 2012	Journal article on traditional veterinary practices

Indiscriminate	Ticks	Against ticks	Kenya		<i>Clutia mollis</i>		Barks and leaves are used to make a concoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Clutia richardiana</i>		Aerial parts are used to make a concoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda		<i>Commiphora africana</i>	Active	Crushed roots are mixed with water and the liquid extract is used to wash the body of animals	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda		<i>Cucumis aculeatus</i>	Active	Crushed fruits are mixed with water to make a solution used to wash the body of animals	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda	Treatment	<i>Cucurbita maxima</i>	Active	Pound fresh leaves, mix them with water and decanted. This can be used to spray on tick affected areas	Opiro et al., 2010	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda		<i>Dalbergia melanoxylon</i>	Active	Crushed roots and bark are mixed with water and the liquid extract can be used to drench the animals	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Uganda		<i>Desmidorchis acutangula</i>	Active	Stems and leaves are crushed together and liquid is used to wash the body of animals	Byaruhanga et al., 2015	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Dolichos kilimandscharicus</i>		The stems, leaves and roots are used to make a concoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Dovyalis macrocalyx</i>		The crushed leaves can be used to create a decoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Drypetes gerrardii</i>		The roots and leaves can be used to create a decoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Entada abyssinica</i>		The roots, bark, leaves and buds are used to make a suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Pakistan	Treatment	<i>Eruca sativa</i>	Active	Apply seed oil onto affected skin	Babar et al., 2012	Journal article on traditional veterinary practices

Indiscriminate	Ticks	Against ticks	Uganda	Treatment	<i>Erythrina abyssinica</i>	Active	Roots and stem bark are pounded into fine particles and mixed with water; the solution is then filtered and can be sprayed in affected areas	Opiro et al., 2010	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Euphorbia candelabrum</i>		The stems, leaves and sap are used to make a suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Euphorbia heterochroma</i>		The stems and sap are used to make a suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Boophilus decoloratus, engorged females)	Ethiopia	Treatment	<i>Euphorbia obovalifolia</i>	Active	In vitro trials showed tick mortality up to 100% (5 minutes after direct application); In vivo trials showed that latex of <i>E. obovalifolia</i> could reduce tick burden up to 80%	Regassa, 2000	Scientific article
Indiscriminate	Ticks	Against ticks	Kenya		<i>Flueggea virosa</i>		The entire plant is used to make a decoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Garcinia buchananii</i>		The roots, bark, twigs and fruit are used to make a suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Hymenocardia acida</i>		The leaves and bark are used to make a decoction	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya		<i>Lantana camara</i>		The whole plant can be used for pour on or for steaming	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	<i>Lantana involucrata</i>	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Preventative/repellent or Treatment	<i>Laurencia obtusa</i>	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Williams, 1991	Scientific article

Indiscriminate	Ticks	Against ticks	Ethiopia	Treatment	<i>Lepidium sativum</i>	Active	The crushed seeds of <i>L. sativum</i> are mixed with cattle faeces and applied to the cattle's skin	Regassa, 2000	Scientific article
Indiscriminate	Ticks	Against ticks (<i>Boophilus microplus</i> ; engorged adult females)	Jamaica	Treatment	<i>Liagora elongate</i>	Active	Crude ethanol extracts of the algae were applied topically to ticks and resulted in acaricidal (mortality, some inhibition of oviposition and embryogenesis) effects	Williams, 1991	Scientific article
Indiscriminate	Ticks	Against ticks (<i>Boophilus microplus</i> ; engorged adult females)	Jamaica	Preventative/repellent or Treatment	<i>Lippia alba</i>	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (<i>Rhipicephalus appendiculatus</i> and <i>Amblyomma variegatum</i>)	Kenya	Treatment	<i>Margaritaria discoidea</i>	Active	Oil hexane and (latex) extracts have acaricidal effects against ticks	Kaaya et al., 1995	Scientific article
Indiscriminate	Ticks	Against ticks (<i>Boophilus microplus</i> ; engorged adult females)	Jamaica	Preventative/repellent or Treatment	<i>Melicococcus bijugatus</i>	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (<i>Rhipicephalus appendiculatus</i> and <i>Boophilus microplus</i>)	Mexico	Preventative/repellent or Treatment	<i>Melinis minutiflora</i>	Active/Passive	The whole plant is toxic/repellent to ticks	Fernández-Ruvalcaba et al., 2004	Scientific article
Indiscriminate	Ticks	Against ticks (<i>Hyalomma dromedarii</i>)	Egypt	Preventative/repellent	<i>Mesembryanthemum forsskale</i>	Active	Various extracts (made from aerial parts of <i>M. forsskale</i>) had toxic effects of tick larvae	Abdel-Shafy et al., 2007	Scientific article
Indiscriminate	Ticks	Against ticks (<i>Boophilus microplus</i> ; engorged adult females)	Jamaica	Treatment	<i>Mimosa pudica</i>	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article

Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Momordica charantia	Active; Passive	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Preventative/ repellent or Treatment	Nerium oleander	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Nicotiana tabacum	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	Kenya	Treatment	Nicotiana tabacum	Active; Passive	Mixture of dried N. tabacum leaves and "Magani soda" mineral had acaricidal effect against ticks at all stages; both in vitro and in vivo trials	Dipeolu & Ndungu, 1991	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Ocimum micranthum	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against mosquitoes & flies	Kenya; Tanzania	Preventative/ repellent or Treatment	Ocimum suave	Active	Oil made from O. suave leaves works as a repellent and acaricide	Chogo & Crank, 1981	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Preventative/ repellent or Treatment	Oreopanax capitatus	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article

Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Padina vickerisiae	Active	Crude ethanol extracts of the algae were applied topically to ticks and resulted in acaricidal (mortality, some inhibition of oviposition and embryogenesis) effects	Williams, 1991	Scientific article
Indiscriminate	Ticks	Against ticks	Egypt	Treatment	Peganum harmala	Active	Various extracts (made from aerial parts of P. harmala) had toxic effects of tick larvae	Abdel-Shafy et al., 2007	Scientific article
Indiscriminate	Ticks	Against ticks	Colombia; USA	Preventative/repellent	Pennisetum clandestinum	Passive	Possible anti-tick properties; if cattle is placed on P. clandestinum pastures for 2-4 days, then sprayed after removal, tick populations are significantly reduced	Thompson et al., 1978	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Petiveria alliacea	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Petiveria alliacea	Active	Dibenzyltrisulfide, isolated from P. alliacea roots, had stronger acaricidal effects than three tested commercial acaricides, inhibited oviposition, and reduced successful egg hatching	Williams et al., 1997	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Pimenta dioica	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Preventative/repellent or Treatment	Piper amalago	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article

Indiscriminate	Ticks	Against ticks (Boophilus microplus)	Mexico	Treatment	Piqueria trinervia	Active	Aqueous solutions made from piquerols A and B, compounds found in P. trinervia, had acaricidal effects on larvae; Piquerol A caused mortality in adult female ticks	Gonzales-de la Parra et al., 1991	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus)	India	Treatment	Pongamia pinnata	Active	Elevated mortality with Neem oil + Pongamia mixture also at 10% concentration	Sivaramakrishnan et al., 1996	Scientific article
Indiscriminate	Ticks	Against ticks	Egypt	Preventative/ repellent or Treatment	Reaumuria hirtella	Active	Various extracts (made from aerial parts of R. hirtella) had toxic effects of tick larvae	Abdel-Shafy et al., 2007	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Ricinus communis	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Salvia serotina	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma marginatum rufipes)	South Africa	Treatment	Senna italica subsp. arachoides	Active	Root extract had acaricidal effects on H. marginatum rufipes adults	Magano et al., 2008	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Sida acuta	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks	Egypt	Treatment	Silybum marianum	Active	Various extracts (made from aerial parts of S. marianum) had toxic effects of tick larvae	Abdel-Shafy et al., 2007	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Simarouba glauca	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article

Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Spigelia anthelmia	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Stachytarpheta jamaicensis	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	South Africa	Preventative/repellent	Strychnos madagascariensis	Active	Aqueous leaf extract (applied topically) has repellent effect on ticks in bioassay	Mawela, 2008	MSc. thesis
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Styopodium lobalum	Active	Crude ethanol extracts of the algae were applied topically to ticks and resulted in acaricidal (mortality, some inhibition of oviposition and embryogenesis) effects	Williams, 1991	Scientific article
Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged adult females)	Jamaica	Treatment	Symphytum officinale	Active	Crude ethanol extracts of fresh leaves applied topically to ticks resulted in acaricidal (mortality, inhibition of oviposition and embryogenesis) effects	Mansingh & Williams, 1998	Scientific article
Indiscriminate	Ticks	Against ticks (Hyalomma rufipes)	South Africa	Preventative/repellent or Treatment	Tagetes minuta	Active	Essential oil of T. minuta (from leaves, stems and fresh flowers) had tick repellent properties; moulting of engorged nymphs was also delayed	Nchu et al., 2012	Scientific article
Indiscriminate	Ticks	Against ticks (Rhipicephalus appendiculatus)	Kenya	Preventative/repellent	Tagetes minuta	Active	Laboratory assays demonstrated tick-repellent properties of T. minuta oil	Wanzala, 2009	PhD thesis
Indiscriminate	Ticks	Against ticks	Kenya		Tamarindus indica		The bark, roots and leaves are used to make a suspension	Wanzala et al., 2012	Journal article on traditional veterinary practices

Indiscriminate	Ticks	Against ticks (Boophilus microplus; engorged female tick)	Thailand	Treatment	Tamarindus indicus	Active	Crude extract of T. indicus (fruit extract aqueous solution) had acaricidal activity on engorged female ticks	Chungsamarnyart & Jansawan, 2001	Scientific article
Indiscriminate	Ticks	Against ticks	Kenya	Prevention/control/management	Vitex doniana	Passive	The roots, bark, leaves and fruit are used to make a hanging bouquet - smoke from burning the bouquet repels ticks	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks	Kenya	Prevention/control/management	Vitex fischeri	Passive	The whole plant is used to make a bouquet; smoke from burning the bouquet repels ticks	Wanzala et al., 2012	Journal article on traditional veterinary practices
Indiscriminate	Ticks	Against ticks (Rhipicephalus haemophysaloides)	India	Preventative/repellent	Nicotiana tabacum (Tobacco)	Active	Tobacco plant leaves are used due to repellent properties	Ghosh et al., 2006	Journal article on traditional veterinary practices
Sheep	Fleas; Ticks	To treat ectoparasitic infestations (ticks, fleas)	Spain	Treatment	Pork lard	Active	The pork lard is applied directly to the infested zone	González & Vallejo, 2021	Journal article on traditional veterinary practices
Sheep	Flies	Against sheep ked	Ethiopia	Treatment	Calpurnia aurea	Active	Acqueous extract applied to infested zone	Gemeda et al., 2014	Scientific article
Sheep	Flies	Against sheep ked	Ethiopia	Treatment	Cymbopogon citratus	Active	Essential oil applied to the infested zone	Gemeda et al., 2014	Scientific article
Sheep	Flies	Against flies in cattle and sheep	France	Preventative/repellent	Diluted geraniol	Active	Alcohol; sprayed on backs of animals	ADMM, 2017	Report on Farmer testimonials by ADMM
Sheep	Flies	To treat cutaneous myiasis	Spain	Treatment	Dried donkey excrement	Active	The excrement is applied directly to the wounds	González & Vallejo, 2021	Journal article on traditional veterinary practices
Sheep	Flies	Against sheep ked	Ethiopia	Treatment	Eucalyptus globulus	Active	Essential oil applied to the infested zone	Gemeda et al., 2014	Scientific article
Sheep	Flies	Against sheep ked	Ethiopia	Treatment	Foeniculum vulgare	Active	Essential oil applied to the infested zone	Gemeda et al., 2014	Scientific article
Sheep	Flies	Against flies (Lucilia sericata)	Egypt	Treatment	Lavender and camphor essential oils	Active	In vitro testing showed that both lavender and camphor oils had larvicidal effects; lavender more effective than camphor at 32% concentration	Shalaby et al., 2016	Scientific article
Sheep	Flies	Against cutaneous myiasis in sheep	France	Preventative/repellent	Natural geraniol and lemon-scented gum	Active	Essential oil	Dubois-Frapsauce, 2018	Bulletin made by veterinarian

Sheep	Flies	Against flies (<i>Lucilia cuprina</i>); to treat myiasis	Australia	Preventative/repellent or Treatment	Tea tree oil (TTO)	Active	In vitro test; strong repellent against flies and discouraged oviposition; eggs treated with 1% TTO did not hatch; larvae moved away from places treated with TTO	Callander & James, 2012	Scientific article
Sheep	Flies	<i>Lucilia sericata</i> species	Egypt	Treatment	Vetiver, cinnamon and lavender essential oils	Active	In vitro study showed that oils affected negatively larval development and resulted in high mortality	Khater et al., 2018	Scientific article
Sheep	Mites	Against mites causing sarcoptic mange	India	Treatment	Neem oil		Mentions efficacy against various mites and ticks	Gupta & Vohra, 2020	Report/Compendium
Sheep	Mites	To treat scabies/mange	Spain	Treatment	Pork lard (and sulphur)	Active	Various methods across different Spanish regions; generally, the lard and sulphur mixture is applied to the infested zone	González & Vallejo, 2021	Journal article on traditional veterinary practices
Sheep	Mites	Against mites	China	Treatment	<i>Sophora flavescens</i>	Active	Body bath by solution	Wang et al., 2020	Scientific article

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