

Ethnoveterinary Medicine for Livestock Ectoparasites: A Systematic Review of Plant-Based Treatments

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ABSTRACT

Farmers in many regions treat ticks, mites and lice on their animals with plants, and a large literature reports that extracts, oils and crude preparations kill or repel these parasites. This narrative review asks how much of that literature can be relied on when a farmer or veterinary adviser must decide whether to use a plant-based treatment. It draws on published work on livestock ectoparasites and acaricide resistance, on ethnoveterinary documentation, on the chemistry and stability of botanical products, and on the design and reporting of animal and laboratory studies, and it reports no new data. Three problems recur. Plant identity and preparation are often poorly specified, so that a result cannot be repeated or compared. Controls are frequently weak or absent, and laboratory assays on isolated parasites seldom predict what happens on a living animal exposed to weather, grooming and reinfestation. Safety, including toxicity to the host, irritation, and residues in milk and meat, is the least studied part of the chain. The review concludes that several plant products are credible leads, that none can yet be recommended on the strength of the evidence assembled here, and it sets out the minimum a study should report before a traditional treatment is promoted as a substitute for registered products.

Keywords: Ethnoveterinary medicine; Ectoparasites; Ticks; Botanical acaricides; Plant extracts; Residues; Narrative review

Citation: Strickland, Gualtieri and Barros [2024]. Ethnoveterinary Medicine for Livestock Ectoparasites: A Systematic Review of Plant-Based Treatments. DOI: [10.62649/v12.i01.2024.pp19-28](https://doi.org/10.62649/v12.i01.2024.pp19-28)

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Article Information: Received: August 7, 2023 Accepted: December 4, 2023 Published: March 22, 2024

Article Class: Narrative Review

1. Introduction

Anyone who has handled cattle, goats or poultry in a warm climate knows how persistent ectoparasites can be. Ticks feed on blood, damage hides and carry the organisms behind some of the most important diseases of livestock [1, 2]. Mites cause mange in ruminants, and the poultry red mite can settle into housing so thoroughly that it becomes a problem of the building as much as of

the birds [3]. The losses these parasites cause are real, though they are difficult to measure, and published estimates depend heavily on the production system and the method used [4, 5].

For decades the answer has been chemical. Successive classes of acaricides and insecticides have been applied as dips, sprays, pour-ons and injectables [6], and parasites have answered with resistance in many places [7, 8]. Where products

are costly, hard to obtain or no longer work well, farmers fall back on what is at hand. They crush leaves, boil bark, blend oils with fat, burn plant material in sheds, and wash animals with infusions that their grandparents used. Documenting and testing such practice is the business of ethnoveterinary research [9, 10].

The difficulty is that a plant is not a single, standard substance. Which species was it, which part, picked when, prepared how, applied at what strength and to which parasite? A report that cannot answer these questions cannot be repeated, and a result that cannot be repeated cannot guide a farmer. Add to this the common weakness of controls, the distance between a laboratory dish and a living animal in a field, and the thin evidence on toxicity and residues, and the picture is less encouraging than the number of positive abstracts suggests. The aim is a fair account of what is known and what is merely repeated.

This article is a narrative review. Although its title uses the word systematic, it was not prepared as a systematic review, and Section 3 explains exactly what was and was not done. We set out what is known about the parasites and the problem of resistance, how traditional knowledge is recorded, what plant products can plausibly do, and where the evidence falls short. We deliberately report no new data and quote no efficacy figures from individual studies that we could not check against the primary papers.

2. Literature Review

2.1 Livestock Ectoparasites and Their Burden

Ticks are the best studied group. They harm animals directly, by feeding, by damaging skin and hides, and by causing stress, and indirectly by transmitting pathogens [1, 2]. In cattle, infestation with the tropical cattle tick has measurable effects on productivity, and the size of those effects differs between breed types [4]. Economic assessments that add up the costs of parasites in a national herd are useful for showing the order of magnitude of the problem, though they rest on assumptions that a smallholder would not recognise [5].

Mites, lice, flies and fleas are less glamorous but no less troublesome. Wall has argued that changes in climate, animal movement and farming practice will alter which ectoparasites matter and where [11], and the spread of the poultry red mite through intensive and backyard flocks is an example of a parasite whose importance has grown with the way birds are kept [3]. For the

farmer, the species matters less than the practical result: itching animals, lost condition, damaged hides, and lower production.

Control has leaned on chemistry for a long time. The history of ectoparasiticides is a succession of compounds, each valuable when new and each eventually undermined by resistance or by concern about residues [6]. That history is the background to the present interest in plants, which is partly scientific curiosity, partly economic necessity, and partly a hope that natural products will prove gentler on animals and the environment. Whether that hope is justified is one of the questions this review returns to.

2.2 Resistance and the Search for Alternatives

Resistance to acaricides is well documented in cattle ticks, and it arises where products are used repeatedly and often at less than ideal doses or intervals [7, 12]. Strategies to manage it include rotation, targeted treatment, better diagnosis, and integration with non-chemical measures, none of which is simple for a farmer who lacks a laboratory [8]. Resistance is therefore both a biological process and a social one, shaped by access to advice, cost and habit.

It is in this setting that plant-based treatments are promoted. Reviews of botanical acaricides list a long catalogue of plants reported to kill, repel or disrupt the development of ticks and other arthropods [13, 14, 15]. The catalogue is real, and some entries are probably worth following up. But a catalogue of positive reports is not the same as a body of evidence, and the shorter the route from a leaflet to a farmer, the more important that distinction becomes.

2.3 Ethnoveterinary Knowledge and How It Is Recorded

Ethnoveterinary studies record what communities say they use, for which animals and which complaints. Surveys of livestock keepers in a single region can produce long lists of plants used for ruminants, poultry and rabbits, with ticks, lice and mange among the conditions treated [9, 10]. These records are valuable as cultural documentation and as a source of hypotheses. They are not, by themselves, evidence that the treatments work.

The distinction matters because widespread use and genuine efficacy are different things. Critical accounts of ethnopharmacological fieldwork point out that agreement among informants, the number of citations of a plant, and the persistence of a practice do not substitute for testing, and that voucher specimens and correct botanical names

are often missing from the record [16, 17]. The same pattern has been described for plants used against gastrointestinal worms in livestock, where traditional use is common and the experimental evidence is mixed and often hard to interpret [18]. Knowledge held by a community deserves to be recorded accurately, and tested honestly.

2.4 What Plants Contain and What They Might Do

Plants defend themselves with a wide range of secondary metabolites, and some of these affect arthropods. Essential oils, rich in terpenoids and phenylpropanoids, have received particular attention as insect control agents [19, 20], and reviews of the mechanisms behind insecticidal metabolites describe actions on nervous system targets as well as effects on growth, feeding and development [21]. Natural products in general have long been a source of leads for both medicines and crop protection chemicals [22, 23].

Several familiar agents are of plant origin. The nicotine of tobacco, the pyrethrins of certain flowers and the limonoids of the neem tree have all been used against insects, and the synthetic pyrethroids were modelled on a plant compound [6, 24]. The same history carries a warning: some of these materials are hazardous to animals and people as well as to parasites, which is a reminder that a plant origin says nothing about safety [24].

A distinction between killing and repelling is useful. Many essential oils repel arthropods rather than killing them, and repellency tends to last for a short time because the active compounds are volatile [25, 26]. For a tick that attaches and feeds for days, a repellent that fades within hours may offer little; for a biting fly, it may be useful. What a report claims to measure, and over what period, has to match what a farmer needs the treatment to do.

2.5 Preparations in Practice

Farmers rarely apply a pure compound. They apply a crushed leaf, a decoction, a macerate in water or oil, an ash, or a smoke. Each is a different mixture. The solvent used for extraction decides which compounds are taken from the plant [27], and a laboratory extract made with an organic solvent is not what a farmer makes in a pot. Essential oils, for their part, are chemically complex and unstable, changing with storage, heat and light [28]. Table 1 lists the main sources of variation that make two reports on the same plant hard to compare.

Table 1. Sources of variation in plant-based treatments and what each does to a report.

Source of variation	How it arises	Consequence
Plant identity	One local name covers several species; no voucher specimen [16, 36]	Cannot tell which plant was tested
Part and season	Leaf, bark, seed or root; harvest time and site differ [20, 28]	Chemistry differs between batches
Preparation	Fresh crush, decoction, solvent extract, oil or ash [27]	Different compounds reach the animal
Dose and vehicle	Handfuls or a bowl recorded; solvent or emulsifier used [37]	Concentration unknown; vehicle may act alone
Application	Spray, dip, rub, poultice or smoke; frequency varies	Contact time and coverage unrecorded
Parasite and stage	Species, life stage and resistance history differ [7, 13]	Susceptibility not comparable

Note: Qualitative summary drawn from the cited methodological and ethnopharmacological literature.

Preparation also has practical consequences. A fresh crush is cheap but bulky, and its strength depends on the day it was picked. An oil blend sticks to hair and may last longer but can irritate skin. A water extract is easy to make and prone to spoil. Whether such a treatment is feasible on a smallholding depends on these details at least as much as on the plant.

2.6 Safety, Residues and Regulation

The word natural invites an assumption of safety, and the toxicology literature does not support it. Essential oils show a range of biological effects, including cytotoxic and irritant ones, at concentrations that depend on the compound and the tissue [20]. Reviews of essential oils as biopesticides list low persistence, variable composition, cost and the lack of regulatory data among the main constraints on their use [29]. Botanical insecticides remain a small part of the pest control market, partly because of the cost of meeting registration requirements [24, 30].

For livestock a further question arises: what remains in milk, meat or eggs. Residues of veterinary drugs in food from animals are a recognised public health concern, and withdrawal periods exist because of it [31]. A plant preparation applied to a dairy animal or a laying hen may leave residues, and almost no one has measured them. This gap does not mean the products are dangerous. It means nobody can currently say, which is a different and less comfortable position.

3. Materials and Methods

3.1 Scope and Question

The review asks a single question in several parts: what evidence supports the use of plant-based preparations against ticks, mites, lice and related ectoparasites of livestock, and how reliable is that evidence for deciding what a farmer or adviser should do? The question was divided into the points a convincing study would have to address: how the plant and preparation were identified and described, which parasite and stage were treated, how the comparison was built, whether the setting resembled a working farm, and what was said about safety and residues. None of this is exotic, but each step is easy to skip when a result looks promising.

3.2 Literature Assembly

The review draws on peer-reviewed work in five areas: the biology and cost of livestock ectoparasites; acaricide resistance and its management; ethnoveterinary and ethnopharmacological documentation; the chemistry, stability and toxicology of botanical products; and the methodology of animal and laboratory studies and of evidence synthesis. Sources were chosen for relevance, standing in the field and clarity of method. Studies of insects of agricultural or medical importance are used for what they teach about chemistry, stability and safety, not as evidence of effects on livestock.

We did not run a formal systematic search and we do not claim one. There was no registered protocol, no defined databases or date limits, no duplicate screening and no scored risk of bias, which are the features that distinguish a systematic review [32, 33]. This is a narrative synthesis of the kind described in typologies of review methods [34], and narrative reviews have their own value when the aim is to interpret a heterogeneous literature [35]. The practical consequence is that the article is a better guide to what a good study should contain than to the exact size of any reported effect, and it avoids quoting figures from individual studies.

3.3 Appraisal Framework

To judge how far a report can be trusted, we used a short set of questions. Is the plant identified by its botanical name and, ideally, a voucher specimen [16, 36]? Is the preparation described well enough to be repeated, including solvent, part, dose and vehicle [27, 37]? Is there an appropriate comparison, with untreated and reference groups and a unit of analysis that matches the design [38, 39]? Does the setting

resemble the conditions in which the treatment would be used? And are safety and residues addressed? Reporting standards for animal research provide a useful yardstick for the third question [40].

4. Results

4.1 What Recurs in the Literature

Reviews of botanical acaricides describe plants from many families, with members of the neem family, the daisy family, the mint family, the myrtle family and the grasses appearing repeatedly, and they are weighted towards ticks rather than mites or lice [13, 14, 15]. Most of the entries are extracts or essential oils tested in the laboratory. Reports of whole-animal trials are fewer, and those that exist vary widely in design. The overall picture is of a large exploratory literature and a small confirmatory one.

This shape is common in natural products research. A great many materials are screened cheaply, a few look active, and fewer still are followed through to formulation, field testing and safety work [22, 30]. There is nothing wrong with screening. The trouble begins when a screening result is presented, in an abstract or on a leaflet, as if it were a recommendation. A liquid that kills a tick in a dish has cleared the first hurdle and very little more. Figure 1 sketches the chain that sits between a traditional use and a defensible recommendation, and marks the links that are most often missing.

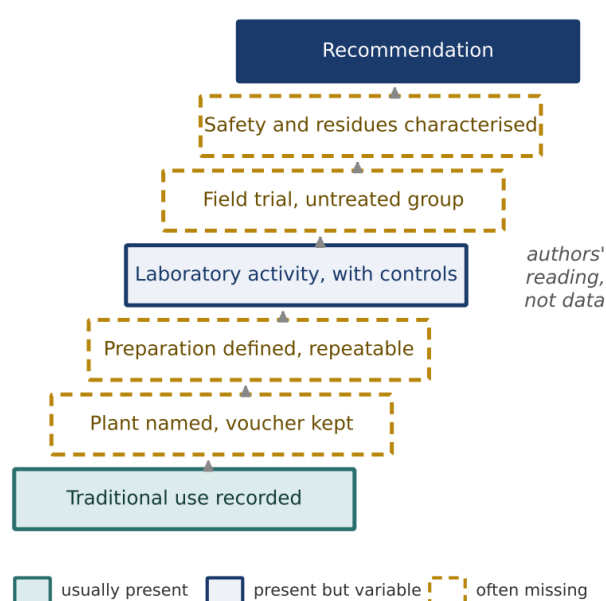


Figure 1. From traditional use to a recommendation: the chain of evidence and where it usually breaks (schematic, not data).

4.2 Laboratory Results and the Gap to the Field

Laboratory assays are the backbone of the evidence. They typically expose chosen life stages, often engorged females or larvae, to a plant extract or oil on paper or by immersion, with mortality, egg laying or hatching as outcomes [13]. Done well, such assays can rank materials and show a concentration-response relation. Done poorly, they confuse the effect of a solvent or emulsifier with the effect of the plant, and they report a single concentration with no reference product [37].

The step from dish to animal is large. On a living host the preparation meets hair, sweat, sunlight and rain; the animal rubs and licks; ticks feed for days; and new parasites arrive from pasture the moment treated ones die [4]. Volatile compounds fade quickly [25, 28]. A treatment may kill ticks in a dish and protect an animal for an afternoon at best. Table 2 sets the two settings side by side.

Table 2. Laboratory assays compared with conditions on a working farm.

Feature	Laboratory assay	Working farm
Parasite	Chosen stage, often engorged females or larvae [13]	Mixed stages; reinfestation from pasture [4]
Exposure	Controlled contact on paper or by immersion	Hair coat, sun, rain, rubbing and licking
Dose	Fixed concentration in a known vehicle [37]	Uneven application and wash-off
Persistence	Short observation window	Weeks of protection needed; volatile compounds fade [25, 28]
Comparator	Solvent and reference product in the same run	Untreated group often missing [39, 40]
Outcome	Mortality, egg laying, hatching	Counts, welfare, production, disease risk [4, 5]
Host	Absent	Skin reaction, intake, residues [20, 31]

Note: General contrasts; individual studies may depart from them in either direction.

Even where a field trial exists, the chance of misreading it is high. Natural infestation fluctuates with season and weather, so a fall in counts after treatment may reflect nothing more than the time of year. Without an untreated comparison group managed alongside, there is no way to tell. This is the commonest reason a promising dish result turns into an uninterpretable field report.

4.3 Heterogeneity of Plants and Preparations

The heterogeneity described in Table 1 is not a technical nuisance; it is the central obstacle to

synthesis. Vernacular names are shared by unrelated plants, and the same plant is known by different names in different places, so that a survey entry cannot be matched to a laboratory study without a voucher [16, 36]. Within a correctly named species the chemistry of the product varies with part, harvest and storage [20, 28], and with the extraction method [27].

The consequence is that two studies reporting the same plant may be testing different chemical mixtures against parasites of different susceptibility [7, 13]. Pooling their results would be meaningless, and a narrative reader should be wary of treating agreement or disagreement between them as informative. Figure 2 gives a qualitative reading of how common preparation types fare against practical questions; it is our judgement and not a measurement.

	Easy to standardise	Easy to test in laboratory	Common on farms	Safety data available
Fresh crushed plant	Low	Low	High	Low
Water decoction	Low	Medium	High	Low
Solvent extract	Medium	High	Low	Low
Essential oil	Medium	High	Low	Medium
Ash or smoke	Low	Low	Medium	Low

Qualitative reading by the authors, not data

Figure 2. Qualitative reading of preparation types against practical questions (authors' judgement, not data).

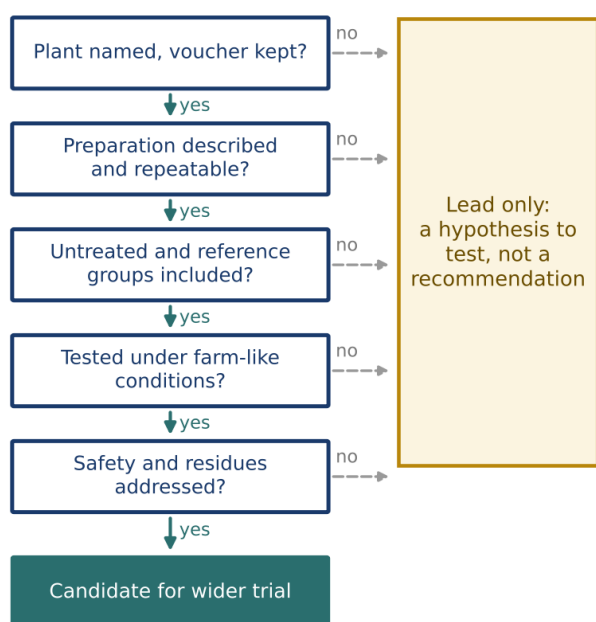
The pattern in Figure 2 explains a feature of the literature that puzzles newcomers: the preparations that are easiest to standardise and test, such as solvent extracts and essential oils, are often not what farmers use, and the preparations that farmers use are often hard to standardise. Bridging the two means testing the farmer's own recipe as it is made, as well as the laboratory extract, and reporting both.

4.4 Controls, Design and Reproducibility

The quality of controls is the next weakness. A credible study needs an untreated or vehicle-only group and, ideally, a reference product, with animals or pens allocated at random and outcomes assessed without knowledge of treatment [39, 40]. Many reports in this field lack one or more of these elements. Others treat each tick or each animal as an independent replicate when they share a dish, a pen or a pasture, which exaggerates precision

[38]. Small groups make results unstable and overstate effects when they reach significance [41].

These problems are not unique to ethnoveterinary work. Surveys of researchers show that failure to reproduce published results is widely experienced across the sciences [42]. They matter here because the case for many plant-based treatments rests almost entirely on this kind of study. Reporting estimates with intervals rather than only whether a result crossed a threshold would help a reader judge how large and how certain an effect is [43]. Figure 3 turns the appraisal questions into a simple decision path. The point is not that a study is poor, only that its result travels less far than its abstract suggests.



Schematic of appraisal logic, not data

Figure 3. Decision tree for judging a report of a plant-based treatment (schematic, not data).

Publication practice adds a further distortion. A screening study that finds activity is easier to place in a journal than one that finds nothing, and selective reporting of outcomes is among the factors researchers themselves name when asked why results fail to reproduce [41, 42]. The practical effect is that the visible catalogue of active plants probably overstates how many truly work, and the plants that were tested and found wanting rarely appear at all. A reader should keep that in mind before counting entries in a review table as votes in favour.

Taken at face value, such a path eliminates many reports, and it should. That is not harshness for its own sake. A farmer who adopts a poorly tested treatment and sees animals still infested may delay

effective control, and in the meantime resistant parasites and disease may spread. The cost of a false positive falls on the person with the least capacity to absorb it.

4.5 Safety and Residues

Safety is the least developed part of the evidence. Studies of efficacy seldom record skin reactions, behavioural change or intake in treated animals, and almost none address residues in milk, meat or eggs [20, 31]. The questions a report should answer are summarised in Table 3. Several of them concern people, since farm workers prepare and apply these materials by hand, often without protection [29].

Table 3. Safety and residue questions a plant-based treatment should answer.

Question	Why it matters	A report should state
Is the plant toxic to the host?	Natural origin is not a guarantee of safety [20, 24]	Species, part and signs observed
Skin and eye reaction	Oils and extracts can irritate, especially on young or damaged skin [20, 29]	Reactions looked for and recorded
Residues in milk and meat	Withdrawal times are unknown for plant preparations [31]	Whether milk and meat were tested or withheld
Handler exposure	Preparation and application are done by hand [29]	Protective practice
Environmental effects	Used dip or spray liquid reaches soil and water [19, 30]	How waste liquid was disposed of
Regulatory status	Rules for botanical products differ by country [24, 30]	Legal status where the work was done

Note: Questions follow the toxicological and regulatory literature cited; they are not attributed to any single study.

Environmental questions are also open. Used dip or spray liquid ends up in soil and water, and botanical products are not automatically benign to non-target organisms [19, 30]. The reasonable position is that plant-based treatments should be held to the same questions as any other product, in proportion to the way they are used, and that the burden of demonstration should not be waived because the origin is familiar. Where a product is intended for animals producing milk, meat or eggs for human food, the residue question is not optional.

5. Discussion

5.1 Interpretation and Practical Reading

The main finding of this review is a qualified one. Plant-based materials plausibly have activity

against livestock ectoparasites, and the chemistry offers credible mechanisms [19, 21]. But the literature as it stands cannot tell a farmer which preparation to use, at what strength, how often, or with what expected result in the field. The steps that would answer those questions, repeatable preparations, proper controls, field testing, and safety and residue work, are the ones least often reported.

A second reading concerns how to treat traditional knowledge. Dismissing it would be wrong, since it generates hypotheses that laboratory screening alone would not. Taking it at face value would be equally wrong, since use and efficacy are not the same thing [17]. The respectful course is to test it properly, with the communities involved, and to report the negative results as carefully as the positive ones. Knowledge held by a community deserves to be recorded accurately, and tested honestly.

Third, the practical risk is asymmetric. If a plant-based treatment works and a farmer does not use it, a convenient option is lost. If it does not work and is used in place of an effective product, animals suffer and resistance in the parasite population can continue unchecked [7, 8]. That asymmetry argues for presenting these treatments as options under evaluation, not as established replacements.

Three findings would change this reading. A well-controlled field trial with a repeatable, fully described preparation and a clear and persistent reduction in parasite burden relative to an untreated group would turn a lead into an evidence-based option. Residue data showing that milk and meat are unaffected under realistic use would remove a major barrier. And evidence of harm to treated animals or handlers would move safety to the front of any advice [20, 31]. These points apply with equal force to any new product, whether it comes from a plant or a factory.

5.2 Limitations

This is a narrative review and shares the limits of that form. The selection of sources reflects judgement, no formal search or scored appraisal was done, and the review does not quote numerical results from individual efficacy studies, because these could not be checked against the primary reports for this article. A reader who needs an effect size for a particular plant should consult the original study directly, applying the appraisal questions above, or wait for a formal systematic review of the kind that reporting standards describe [32, 33].

The review also leans on work from other fields and other animals. Evidence on insect control chemistry, essential-oil stability and toxicology comes largely from agricultural and food science [19, 28], and studies of worm control in livestock inform the discussion of traditional use [18]. These are imperfect proxies for ectoparasites on living livestock. We have used them to frame hypotheses, and the conclusions should be read in that light. Reviews of this kind are more useful when they say where the evidence stops than when they smooth it over.

5.3 What a Convincing Study Would Contain

A study that could settle the matter for a given plant would begin by identifying the plant by its botanical name with a deposited voucher specimen, and by describing the part used, the place and season of collection, and the preparation in enough detail to be repeated [27, 36]. It would test the preparation in the form farmers use as well as a standardised extract, with a solvent or vehicle control and a reference product in the same run [37].

The field phase would use an untreated comparison group managed under the same conditions, allocate animals or pens at random, and treat the unit that shares exposure as the unit of analysis [38, 39]. It would follow animals long enough to see re-infestation, record counts, welfare and production, and report estimates with their uncertainty [43]. It would also record skin reactions and intake, test or withhold milk and meat, and describe how used liquid was disposed of.

5.4 Directions for Future Work

Three needs stand out. First, a formal systematic review of field and whole-animal studies, with a transparent search, defined outcomes and a risk-of-bias assessment adapted to veterinary studies [32, 39]. Second, a small number of well-designed field trials of the most promising preparations, in the settings where they are used, with community involvement. Third, safety and residue work, which is currently the largest gap and the one most likely to decide whether a product can be recommended for dairy and food-producing animals [29, 31].

5.5 Practical Reading for Advisers and Smallholders

For an adviser, the sensible position is neither to dismiss plant-based treatments nor to promise results. A household that wishes to try one can do so as a small recorded trial: a group of animals treated and a comparable group left alone in the

same shed or pasture, with parasite counts and skin condition noted the same way for both. Records of the plant, the part, the preparation and the number of applications are as important as the counts, since without them a result cannot be repeated by the next farmer.

Such a trial is not a substitute for formal research and should not be reported as one. It can still tell a household whether a practice is workable, whether it is worth the labour, and whether any change is large enough to notice against the ordinary variation between animals and seasons. Animals showing heavy infestation or signs of tick-borne disease need effective, registered treatment, and a trial of a plant preparation should never delay it [2, 12].

Records kept by farmers can add to this over time. If households that try a plant-based treatment write down the plant, the part, the preparation, the number of applications and the counts on treated and untreated animals, advisers could eventually read many small accounts side by side. A common format makes later comparison possible [40].

6. Conclusion

Plants are a plausible source of help against livestock ectoparasites, and the traditions that use them deserve serious study. The evidence, as we can responsibly summarise it, does not yet allow a plant-based treatment to be recommended as a replacement for a registered product. The obstacles are specific: plants and preparations that are not defined well enough to repeat, controls that are weak or missing, a wide gap between laboratory assays and the field, and very little information on toxicity and residues. Claims of cure should be treated with caution until they meet those standards.

For the practitioner, the message is practical rather than discouraging. A plant-based treatment can be tried as a recorded, controlled trial on a small scale, never in place of effective treatment for a sick animal, and with attention to the safety of animals and handlers. For the researcher, the opportunity is a short list of promising preparations tested carefully enough, in the right setting, to turn a long tradition into knowledge that a smallholder can rely on.

7. Acknowledgements

The authors thank colleagues who commented on earlier drafts of this review.

8. Funding

This work received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

9. Conflict of Interest

The authors declare no conflict of interest.

10. Author Contributions

K.S. conceived the review and wrote the sections on ectoparasite control and safety. G.G. wrote the sections on plant chemistry and preparations. I.B. wrote the sections on study design, evidence appraisal and public health. All authors revised the manuscript and approved the final version.

11. Ethics Statement

This is a review of published literature. No animals were used and no ethical approval was required.

12. Data Availability

No new data were generated. All sources are cited in the reference list.

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