Chapter 55

Botanicals as an Alternate for Tick Infestation in Livestock

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ABSTRACT

In Pakistan, agriculture is the primary livelihood for many people, with livestock rearing being a key component. However, ticks, as ectoparasites, pose significant threats to these animals, potentially leading to severe health issues or even death. In underdeveloped regions like Pakistan, where proper knowledge and resources are scarce, the economic impact of tick infestations is substantial. Farmers commonly rely on acaricides to manage tick populations, but these chemical agents are not only costly but also contribute to environmental contamination, toxicity, and the development of tick resistance over time. Given these challenges, medicinal plants are emerging as a promising alternative to synthetic acaricides. Species such as *Calotropis procera, Ocimum basilicum, Allium sativum, Allium cepa, Cannabis sativa, Aegle marmelos, Carapa guianensis, Citrus maxima*, and *Withania somnifera* have demonstrated varying degrees of effectiveness in controlling tick populations and reducing the impact of tick-borne diseases.

Keywords
Ticks Infestation, Acaricides, Ectoparasite, Zoonotic, Economic Impact, Epidemic

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INTRODUCTION

Pakistan is an agricultural country predominantly, accounting for 21% of GDP. Pakistan's population lives in villages, works in fields, and depends on livestock over 70% (Mather and Abdullah, 2015). Animals such as goats, camels, cows, and buffalos are raised professionally, and 30-35 million people make a living from it. Farmers in tropical and subtropical regions have higher losses due to animal parasite disease epidemics (Batool et al., 2019). Ticks, as blood-sucking ectoparasites, pose significant harm to livestock and often cause widespread infestations. (Admassu et al., 2015). These ectoparasites, which feed on blood, affect mammals, birds and reptiles (Ali et al., 2016). Ticks feed on their hosts' blood, resulting in weight loss, decreased meat and milk production, and skin damage (Khan et al., 2022). Ticks provide a substantial health risk to animals because they can spread disease, cause miscarriage, and even death (Durrani and Kamal, 2008; Zulfiqar et al., 2012). Ticks are zoonotic, which means they can spread diseases between animals and humans (Karim et al., 2017).

Life Cycle of Ticks

Ticks live in four stages: eggs, larvae (six legs), nymphs (eight legs), and adults (eight legs) (Blouin et al., 2021). Ticks are classified into three categories according to their life cycle (Figure 1): single host, two-host, and three-host ticks (Fletcher, 2003). Throughout their post-embryonic life, one-host ticks stay on just one host; adult ticks finally detach from their host. In order to complete their life cycle, two-host ticks need two hosts: after feeding, the larvae on one host mature into nymphs, which then separate to become adults looking for another host. Ticks with three hosts go through a process whereby the larvae molt into nymphs and depart from the host to feed; one particular host is needed for each developmental stage (Ali et al., 2013). Ticks use not only their eyes, but also a sensitive hair-like peripheral structure on their legs, body, and mouth to aid in their host-seeking activities. Ticks contain olfactory sensors that allow them to locate hosts and communicate with one another (Leonovich, 2013; Carr and Salgado, 2019). Ticks also react swiftly to ammonia and carbon dioxide, indicating the presence of a host (Auffray et al., 2022).

Tick-borne Diseases

Ticks leads to many diseases as shown in (Table 1)

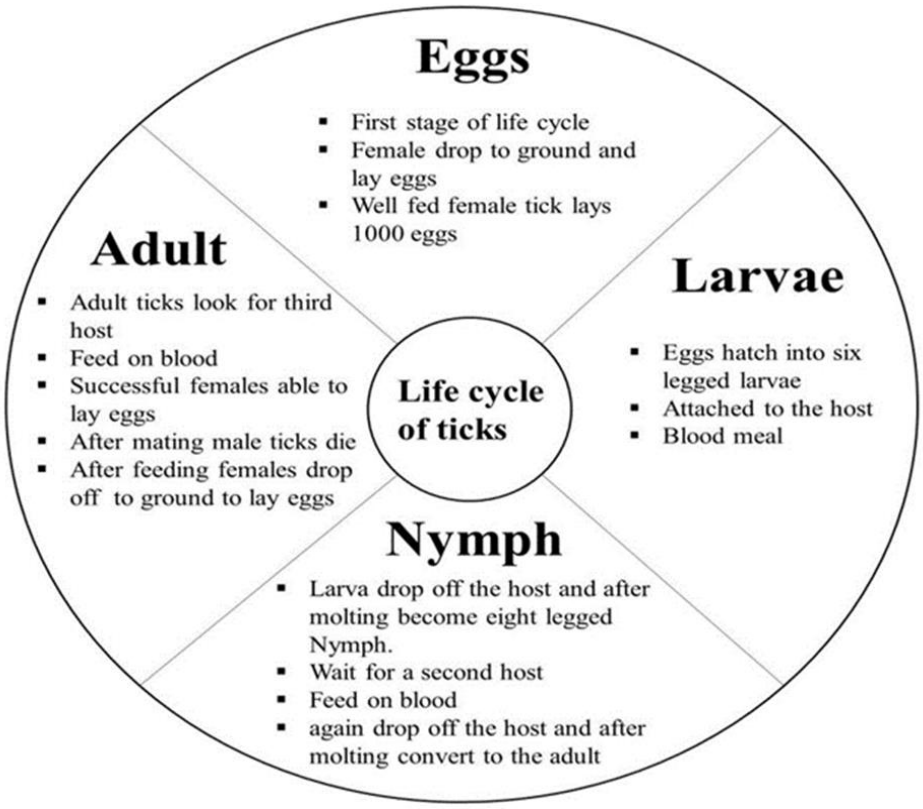

Fig. 1: Complete life cycle of tick

Table 1: Common tick borne diseases their causative agent, symptoms and mode of transmission

Sr #	Disease name	Causative agent	Mode of transmission	Symptoms	References
1	Lyme disease	*Borrelia mayonii*	*Borrelia burgdoferi*	Skin rash, fever, joint pain	https://www.cdc.gov/lyme/index.html.
2	Rocky Mountain spotted fever	*Rickettsia rickettsia*	*Dermacentor variabilis, D.andersoni, Rhipicephals sanguineus*	Headache, rash, nausea, muscle pain, vomiting abdominal pain fever	https://www.cdc.gov/rmsf/index.html.
3	Babesiosis	*Babesia microti*	Infected *Ixodes scapularis*	Sweating, chills, muscle aches, fever, hemolytic anemia , fatigue	https://www.cdc.gov/parasites/babesiosis/index.html.
4	Anaplasmosis	*Anaplasma Phagocytophilum*	*Ixodes scapularis* and *I. pacificus*	Nausea, loss of appetite, diarrhea, severe headache, fever, muscle aches	https://www.cdc.gov/anaplasmosis/index.html.
5	Ehrlichiosis	*Ehrlichia chaffeensis, E.ewingii E.muris,*	*Amblyomma americanum* and *Ixodes scapularis*	Headache, chills, upset stomach, fever, nausea, rash, muscle aches	https://www.cdc.gov/ehrlichiosis/index.html.

Application of Acaricides for Tick Control and Identification

The chemicals used to kill ticks are known as acaricides. Some of the poisons used against ticks over the last two decades include macrocyclic lactones, organophosphates, and pyrethroids (Abbas et al., 2014). Each acaricide behaves differently. Some distinct kinds of acaricides are listed below:

a) **Metabolic Acaricides**

Through attacking tick metabolic processes, metabolic acaricides eliminate the ectoparasites.These acaricides inhibit or reduce the function of enzymes required for cellular respiration in a variety of metabolic pathways. For example, 3-BrPA can inhibit the activity of hexokinase, a glycolytic enzyme, by up to 50%. Similarly, metabolic acaricides can change the response time of glycolysis and gluconeogenesis enzymes. They can also harm the mitochondrial respiratory chain, killing ticks (Braz et al., 2019).

b) Neurotoxic Acaricides

Neurotoxic acaricides are those that cause electrical or chemical reactions in tick neurological systems (Hart, 1986). Neurotoxic acaricides target tick neurological systems, causing paralysis and death (Cerqueira et al., 2022). These acaricides cause paralysis and increased nervous system activity by blocking the sodium ion channel (Wismer and Means, 2018). Pyrethrins, permethrin and pyrethroids are all neurotoxic acaricides (Abbas et al., 2014).

c) **Repellent Acaricides**

Repellent acaricides usually do not kill ticks, but instead prevent them from feeding, hatching, and molting on the host. Most repellent acaricides emit a characteristic odor that impairs ticks' olfactory senses, making it difficult for them to recognize or cling to their hosts. Certain medications have been shown to repel ticks (Kayaa, 2000).

Effects of Acaricides

The usage of these acaricides has various disadvantages, including contaminating our environment and attacking non-targeted organisms, which is harmful to human and animal health (Monteiro et al., 2018; Nath et al., 2018). Most tick species are resistant to many medications (Abbas et al., 2014). Many farmers in Pakistan claim that certain vital herbs are excellent at tick control (Zaman et al., 2012). Ticks are external parasites that can harm animals and people, either directly or indirectly. Tick-borne diseases have become a leading cause of economic losses in the global livestock industry, with nearly 10% of all ticks capable of transmitting diseases as vectors (Jongejan, Uilenberg, 2004). Ticks are a serious impediment to the development of the livestock business because ticks have a severe impact on milk and meat output, and Ticks consume the blood of the animal, causing weight loss. They also make animals prone to viral, bacterial and fungal, infections (Ahmed et al., 2007). Acaricides are chemicals used to control ticks, however there are numerous issues associated with their use.

a) Expansion of Resistance

A significant drawback with employing acaricides is that over time, ticks become resistant to the chemicals, making them ineffective for control purposes an example of this is observed in *Rhipicephalus* (Boophilus) *microplus*, a tick species infesting cattle, where resistance against acaricides has been documented (Davey et al., 2006).

b) Chemical Costs

Despite their high cost, these pesticides are not widely accessible and might be difficult for farmers to afford them, especially those countries that are developing (Dipeolu et al., 1992).

c) Environmental Contamination

There is also the problem of environmental toxicity brought by chemical acaricides because their residues contaminate the environment (Mulenga et al., 2000; Wellington et al., 2017).

Toxicity to Humans and Animals

The substance which is used for combating the acarines affects, in turn, animals and people. Any wrong handling during treatment or application of these chemicals also have toxic implications for both (Madzimure et al., 2011).

Meat and Milk Contamination

Persistence in the carcase and offal, acaricidal chemical residues may contaminate the meat and milk of the animal. People may face a lot of health problems by consuming contaminate meat and milk products infected with bacteria. As it has been noted earlier, the process of synthesizing new acaricides is challenging and demanding (Nath et al., 2018). Thus, it becomes imperative to come up with some method and strategies that are efficient as well as innovative against these ticks. People have been using plants for treatment of various diseases; but in today's world of modernization, it is mandatory to isolate these biologically active compounds to produce good drugs (Abubakar and Haque, 2020). Due to many adverse effects of acaricidal medications, it is imperative that an alternative approach for controlling ticks is sought. It is because, therefore, the opportunity of using plant extracts as an optimal approach to eliminating ticks and mites as well is equally significant as it is efficient not to mention eco-friendly.

The Importance of Medicinal Plants

In a historical evaluation of medicinal plants, the article pointed out that, traditional information that has been passed over the use of the knowledge of these plants has been through generations of observations and experiences of their efficiency in treating various diseases. Allopathic and Ayurvedic treatments as well as traditional practices have been used plant parts to cure diseases affecting the lungs, toxicity, skin diseases, stomach disorders and neurological disorders (Muthu et al., 2006; Rana et al., 2021). Traditional medicines especially those that use herbs have been considered as treatment remedies for various illnesses with the possibility to eradicate diseases like COVID-19.

However, previous studies carried out by (Polat et al., 2013) towards the documentation of traditional uses of medicinal plants in Solhan; Bingol- Turkey and Malatya- Turkey. Another research done in Nigeria is by (Bhat et al., 1985)

who undertook a survey on traditional use of plants in Nigeria and ascertained that 24 species of plants were used for medical purposes in different regions of Nigeria. A similar knowledge was studied in a little more detail in the Indian Himalayan area of Chhota Bhangal western himalaya by uniyal et al 2006 and on the part of terai and central development region of Nepal among the tribal population by Joshi and Edington 1990.

Calotropis procera

The plant studied is *Calotropis procera* (figure 2) or more commonly known as aak which belongs to family Apocynaceae (Kaur et al., 2021). *Calotropis procera* is a deciduous plant which is somewhat woody, adolescent and has a high germinating growth rate in the semiarid and dry regions of the world without having regular accesses to fertilizer or irrigation water (Kaur, Verma, Nagori, and Chadha, 2021). These xerophytes can grow to be of 6m in length and prevalent in East Africa as well as Asia according to Witt, Beale, and Van Wilgen, 2018. These plants have opposite as well as alternate leaves rulings on the stems. They mostly have bronze colored dusted white sepals which are purple at the tip and have white petals which form at the terminal or axillary positions (Abeysinghe and Scharaschkin, 2022).

Fig. 2: *Calotropis procera*

Ocimum basilicum

Sweet basil is an annual herb that usually reaches a height of about two feet. It is formally known as *Ocimum basilicum* and belongs to the *Lamiaceae* family (figure 3). it is commonly found in Tropical, subtropical, and arid regions (Rubab et al., 2017 ; Egata, 2021) It is grown exclusively in Pakistan's Punjab province. This herbaceous plant throws off a powerful scent and grows branches on both sides (Rubab et al., 2017). The abundance of phenolic acid, phenolics, flavonoids, many polyphenols, and significant essential oils in the plant confers therapeutic significance. Leaves have been used traditionally to treat asthma, fever, and cough. Additionally, it has been shown to be beneficial for menstrual cycle abnormalities (Shahrajabian et al., 2020). Oil of this plant has been found very effective against muscle cramps, cold and brain fag (Naz et al., 2015) also given as a first aid for snake bite and insect sting (Adam et al., 2019; Nguyen et al., 2022). Using plants as a treatment for digestive issues, diarrhea, and dyspepsia is thought to be effective (Nazir et al., 2021; Kumar et al., 2022). The main medicinal use for this plant emerges from its anti-inflammatory and anti-cancerous properties. In addition to this, it is known as an anti-stress substance (Shahrajabian et al., 2020).

Allium sativum

Allium sativum (figure 4) commonly known as Garlic or Lehsan, belong to family *Amaryllidaceae,* has been efficaciously used for tick management (Jagadeeswary et al., 2014). Farmers in Canada, Brazil, India and Pakistan have successfully managed tick populations by using Garlic .Potential therapeutic applications with naturally occurring compounds in this herb with include, allyl methyl thiosulfnate, diallyl thiosulfnate (allicin), alliin, ajoene, diallyl disulphide, methyl allyl thiosulfnate ,diallyl trisulfde and ,deoxyalliin (Aboelhadid et al., 2013). Allicin is believed to be the most effective of these substances in reducing tick infestations (Martins et al., 2016). At a dose of 40 mg/mL on ticks, this plant demonstrated a highly deadly effect on eggs lying down, egg hatching, and overall larval death. After 96 hours following treatment, a 45% solution containing both herbal extracts substantially reduced the amount of ticks in cattle (Nasreen et al., 2020). When treated at particular dosages, garlic essential oils generated substantial mortality (90-100%) in 10-day-old *R. microplus* tick larvae (Madzimure- Nyahangare et al., 2011).

Fig. 3: *Ocimum basilicum*

Fig. 4: *Allium sativum*

Allium cepa

Allium cepa (Figure 5) is a single cotyledon bulbous plant that is harvested twice a year and is the most widely farmed among allium species. Sulphur compounds in A. cepa are responsible for its distinct taste, odor, eye irritation, and therapeutic effects (Brewster 2008). The onion (*Allium cepa*) belongs to the *Amaryllidaceae* family and is one of the most frequently farmed plants in the genus *Allium* (Koneru et al., 2016). *Allium cepa's* phytochemical screening revealed the presence of alkaloids, cardiac glycosides, flavonoids tarpenes, and resins (Gazuwa et al. 2013). *Allium cepa* has thiosulphonate and quercetin which has curative benefits (Kumar et al. 2010). A significant result was obtained that *Allium* cepa possess activity against Boophilus annulatus. The study showed that the best in vitro extract of *A. cepa* was ethanol extract of this plant (Sarwar, 2017. At acaricidal activity of methanol and aqueous extracts from the red cultivar of *Allium cepa* on female L. *Rhipicephalus* (*Boophilus*) annulatus ticks that were fully fed and engorged were tested in a study. Aqueous extract at 400 mg/ml in the red cultivar *Allium cepa L.* resulted in a tick mortality rate of 66. 66% at the same time frame that the mortality rate by cypermethrin was less at 25%. The percent inhibition of oviposition that is 80% resulting from the aqueous extract of red cultivar *Allium cepa L* was higher than that of cypermethrin.

Cannabis sativa

Marijuana or hemp or ganja belong to the Cannabaceae family of plants, and has been used in the past to repel insects (Johnson et al., 2019). This results probably from the terpenes, ketones, and ester chemical compounds present in the leaf glands rendering the variety to possess a foul smell that can scare away insects (Bonini et al. 2018). Raw cannabis leaves contains as much as 75per cent volatile compounds like; limonene and pinenes, the last a known insecticides (Elzinga et al. 2015). Methyl ketones isolated from *C. sativa* helps in reducing crop pest (Andre et al. 2016). It is as a result

very likely that the combined activity of these compounds could make *C. sativa* important in controlling livestock arthropod pests. Research conducted have shown that the oils which are extracted from the industrial hemp possess important anti-tick attributes (Nasreen et al., 2020). In this study cannabis which belongs to *Cannabis sativa* (figure 6) was tested on *Rhipicephalus microplus* for its efficiency using the following methods; adult immersion and larval packet methods. It had a very high lethality score to egg laying, egg hatching and overall larval deaths at a concentration of 40 mg/mL. A 45% solution of herbal extracts caused a reduction of at least 50% ticks on the body of cattle 96 hours after treatment. The study indicates that *C. sativa* should be investigated further as a supplement or substitute for synthetic acaricides due to its the ability to manage *R. microplus* ticks (Nasreen et al., 2020).

Fig. 5: Allium cepa

Fig. 6: *Cannabis sativa*

Aegle marmelos

Aegle marmelos (Fig. 7) commonly called bilwa or bael is one of the most essential medicinal plants in the ayurveda. The only species in the Aegle genus and a part of the *Rutaceae* family, it is known in English as the 'stone apple' Aevergreen, slow growing, thorny and erect subtropical tree is native to India, Thailand ,Burma, Ceylon and Indochina (Palatty et al., 2013). In this plant, the main phytochemical group found are; steroids, aeglemarmelosine, alkaloids and coumarins. Feared species of tick such as *H. bispinosa* and R. (B.) micro plus belong to this category. In another study done for 24 hours, the study showed that 100% mortality of *H. bispinosa* caused by acaricide and 100% mortality of R. (B.) microplus by larvicide (Elango et al 2011).

Carapa guianensis Aubl.

Carapa guianensis (Fig. 8) of the *Meliaceae* family and commonly known as andiroba tree. Its origin of the name is from the indigenous language, tupi-guarani, of Brazil and it means 'bitter taste' (Parveen et al., 2021)). Local people of northern Brazil, have incorporated *L. leucocephala* in their traditional remedies as an antirheumatic, antithermic, antibacterial, anti-inflammatory, and repellent for insects using the oil derived from the seeds (Roma et al., 2013). This substance also prevents egg laying behavior in the female *Boophilus microplus* and *Anacentor nitens* ticks and at the same time functions as acaricides (Farias et al., 2007). This paper established that Andiroba seed oil treatment impacts on the oocytes morphological and physiological characteristics hence reducing the reproductive potential of female *Rhipicephalus sanguineus* ticks. Several of these changes advantage the survival of tick embryos; thus, the protein, polysaccharide, and lipid content of these cells reduces considerably.

Fig. 7: *Aegle marmelos*

Fig. 8: *Carapa guianensis Aubl.*

Citrus maxima Burm

Citrus maxima burm (Fig. 9) is also known as Shaddock, Papanus, Pummelo, and Chakotra is a perennial shrub belongs to the family *Rutaceae*. This fruit is consumed in the raw form throughout the length and breadth of India (Louzada et al., 2021). Different parts of this plant have been shown to possess medicinal properties by several researches done across the world. The chemical composition of this plant fruit consists of phenol, saponin, alkaloid, tannin and terpenoids (Chanthaphon et al., 2008).

Fig. 9: *Citrus maxima Burm.*

Fig. 10: *Withania somnifera Dunal*

Withania somnifera Dunal

Withania somnifera Donal (figure 10) is a member of *Solanaceae* Family. It is one of the most extensively utilized medicinal crops in India's late Kharif season, farmed commercially on dry ground. Other common names for this plant are Winter Cherry, Punir, Asgandh and Ashwagandha. For centuries .The underground stems and orange-to-red fruit of this plant have been used for medicinal purposes (Srivastava et al., 2018). Steroids, alkaloids, salts, flavonoids *R. (B.) microplus* are the chemical constituents. Leaves part of plant used for tick control. 50% egg hatching inhibition of *R. (B.) microplus* occurs within in 15 days (Monika et al., 2014).

Tamarindus indica L.

The tamarind tree, also called as *Tamarindus indica,* (figure 11) is a dicotyledonous plant belonging to the *Leguminosae* family, which is part of the *Caesalpiniaceae* family. Tamarind trees are distinguished by their tree-like morphology, including evergreen leaves with sturdy, malleable branches and remarkable wind resistance (El-Siddig et al., 2006). *Tamarindus indica,* a long-lived evergreen hardwood tree found in several nations and regions such as Asia (including India), Africa (tropical region), and Egypt, is also used for medicinal purposes (Aly et al., 2022) The tamarind tree contains high levels of proteins, carbohydrates, fiber, lipids, and vitamins such as thiamine, niacin, riboflavin, β-carotene and ascorbic acid. There were additional minerals such as potassium and calcium, as well as phytochemicals. This plant showed 99% acaricidal activity and cause mortality of *R. (B.) microplus* within 7 days as survey conducted in Thailand (De Caluwé et al., 2010).

Fig. 11: *Tamarindus indica L.*

Conclusion

Ticks, as blood-sucking ectoparasites, present a major threat to livestock in Pakistan, particularly in rural regions where agriculture and animal husbandry are vital for livelihoods. These parasites not only cause significant economic losses by reducing meat and milk production but also pose serious health risks to both animals and humans by transmitting zoonotic diseases. The widespread use of synthetic acaricides to manage tick infestations has led to several challenges, including the development of resistance in tick populations, environmental pollution, and toxicity, further complicating the issue.Given these drawbacks, there is growing interest in alternative, more sustainable methods for tick control. The use of medicinal plants has emerged as a promising approach within integrated pest management strategies, offering an effective and environmentally friendly alternative to synthetic acaricides. These natural solutions help reduce dependence on chemical treatments while providing a viable option for controlling tick populations.

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