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STRATEGIES TO CONTROL TICK INFESTATION IN ANIMALS

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ABSTRACT

Ticks are haematophagous parasites infesting animals as well as human beings, responsible as a vector in transmitting economically important pathogens that include bacteria, virus and protozoa. The frequent use of acaricides, developed for the control of arthropods has lead to evolution of tick resistance to acaricides, therefore the need for new alternatives including ecological, biological control and semiochemicals have garnerned attention for the sustainable control of the tick infestation.

INTRODUCTION

Ticks (Acari: Ixodoidea) are ectoparasites that play a crucial role, in transmitting various disease-causing pathogens of significance to public health and veterinary medicine. The study of tick-borne diseases gained significant attention globally following the outbreak of Rocky Mountain spotted fever in the United States during the late 19th century. Hematophagous arthropods, such as ticks, act as vectors that transmit pathogens, collectively referred to as vector-borne pathogens which can be zoonotic or non-zoonotic. These vectors are capable of spreading bacteria, viruses, and parasites. Ticks feed on their vertebrate hosts for extended periods, during which they can suppress the host's immune system. Beyond serving as vectors for various pathogens, ticks can inflict considerable harm on their hosts through prolonged feeding. This may lead to exsanguination in cases of severe infestation, secondary infections at the bite site, tick paralysis if feeding occurs near the spinal cord, and allergic reactions to tick bites (Jongejan and Uilenberg, 2004). Vector-borne diseases (VBDs) account for over 17% of infections globally, leading to more than 700,000 deaths annually. Among arthropod vectors, mosquitoes and ticks are the most significant. Ticks are also known to harbour bacterial endosymbionts, such as Rickettsia-like, Francisella-like, and Coxiella-like organisms. (Nicholson et al., 2019). In case of livestock they transmit a number of significant diseases like Theilerosis and Babesiosis causing economic loss to animal husbandry sector (Dehuri et al., 2022).

The Ixodidae family, commonly known as “hard ticks,” comprises two main groups: Prostriasta (genus Ixodes) and Metastriata (genera, includes *Rhipicephalus Dermacentor, Hyalomma, Margaropus, Nosomma*,). Meanwhile, the Argasidae family, or “soft ticks,” is divided into Argasinae (genus *Argas*) and Ornithodorinae (genera *Ornithodoros* and *Otobius*,).

Ticks undergo four life stages: egg, six-legged larva, eight-legged nymph (without reproductive organs), and eight-legged adult (male or female). Their feeding behavior, or tropism, depends on species and developmental stage. Ticks can be monotropic, ditropic, or teleotropic, requiring one, two, or multiple hosts, respectively. These vectors feed on a wide range of terrestrial hosts, including wild animals (mammals, birds, reptiles, and amphibians), livestock, and pets, thereby transmitting tick-borne pathogens (Anderson and Magnarelli, 2008).

Control of ticks

Chemical control

The primary approach to decreasing tick populations involves the use of chemical insecticides in areas where ticks are likely to encounter hosts. Traditional insecticides, such as organophosphates, carbamates, and pyrethroids, are generally cost-effective, and applying them broadly can significantly lower tick numbers in specific areas. Among these, carbaryl and chlorpyrifos have been commonly used for tick control. However, their high toxicity to vertebrates has led to some products being banned by regulatory authorities or withdrawn by manufacturers. Less harmful options, including synthetic pyrethroids, have shown effectiveness at lower doses compared to organophosphates and carbamates, though typically for shorter periods. Nonetheless, all commercial insecticides pose risks to non-target invertebrates, such as pollinators and natural predators of pests. Additionally, repeated use of insecticides can promote resistance in tick populations. These limitations have spurred efforts to develop alternative tick control strategies.

Ecological control methods

Ecological control focuses on habitat management and host-related strategies. For instance, controlling ticks in habitats often involves altering vegetation by removing plants that provide shelter to ticks. Additionally, pasture management, which includes strategic resting periods and seasonal changes in grazing areas, has been implemented as a method to reduce tick populations and has shown effectiveness in minimizing their prevalence (George, 2000).

Biological control

Biological control methods employ natural agents such as predators, parasitoids, and pathogens to manage tick populations. Predators include species like rodents, birds, ants, spiders, lizards, and beetles. Parasitoids, such as Ixodiphagus wasps, lay eggs in engorged ticks; the larvae feed on the ticks and emerge to target other ticks. Other biological agents include nematodes, fungi that attack soil-dwelling tick stages and herbal preparations (Regassa 2000).

Oxpeckers: Birds such as *Buphagus africanus* (yellow-billed oxpecker) and *B. erythrorhynchus* (red-billed oxpecker) are notable for feeding on ectoparasites, primarily ticks.

Bacteria: Bacteria like Bacillus thuringiensis and B. cereus produce crystalline toxins during sporulation, disrupting the gut walls of insects.

Entomopathogenic Nematodes (EPNs): Families like Heterorhabditidae and Steinernematidae parasitize insects. Infective juveniles actively enter hosts through natural openings and release bacteria that kill the host within 24–72 hours.

Entomopathogenic fungi: Fungi like *Beauveria bassiana* and *Metarhizium anisopliae* are effective against ticks and insects by penetrating their cuticles. However, these fungi require high humidity, are sensitive to UV light, and may affect non-target arthropods.

Plant extracts: A formulation consisting of herbal ingredients like *Azadirachta indica* and *Vitex negundo* has been found to be effective in combatting tick infestation among dairy animals. Other plant extract preparations showing promising results include *Ficus* spp, *Calotropis procera*, *Allium sativum*, *Leucaena leucocephala*, Solanum incanum, Capsicum, *Cymbopogon* spp and *Piper tuberculatum*.

Genetic tick control

Cattle breeds such as Bos indicus demonstrate higher resistance to ticks compared to Bos taurus. Crossbreeding these breeds aims to produce animals that are both tick-resistant and efficient meat producers, particularly in tropical regions.

Vaccination

Recombinant vaccines introduced in the 1990s aim to minimize the use of chemical acaricides. These vaccines target specific tick antigens, either exposed or concealed, to stimulate the host's immune response and reduce tick infestations.

Tick antigens are generally classified as either exposed or concealed. Exposed antigens are those that naturally interact with the host immune system during tick infestations, enabling hosts immunized with these antigens to receive a boost from continuous tick exposure. In contrast, concealed antigens are hidden from the host immune system, necessitating repeated immunizations to maintain elevated antibody levels. However, concealed antigens present an advantage since ticks are less likely to have developed mechanisms to evade the host's immune response, unlike exposed antigens (de la Fuente et al., 2016) A significant challenge in developing anti-tick vaccines, similar to other anti-parasite vaccines, lies in identifying effective antigens. This difficulty is heightened when dealing with obligate intracellular parasites due to the overwhelming presence of proteins from the host or vector, which complicates the detection of pathogen-specific proteins (Abbas et al., 2023). For concealed antigens, key attributes include their accessibility to antibodies ingested during tick feeding and their essential role in the tick's physiological processes. Advances in tick genome analysis, supported by bioinformatics, RNA interference (RNAi), mutagenesis, immunomapping, transcriptomics, proteomics, expression library immunization (ELI), and related technologies, have paved the way for a faster, more systematic, and thorough approach to tick vaccine development ((Nuss et al., 2021).

Bm86 Antigen: This hidden antigen, derived from the tick gut, forms the basis of commercial vaccines like TickGARD Plus and Gavac Plus. When cattle are vaccinated, antibodies produced against Bm86 disrupt the tick's digestive system, leading to their death. Over time, this reduces tick populations on farms. However, regular re-vaccination is necessary to maintain immunity, as Bm86 is not naturally introduced during tick feeding. Recombinant Bm86 is mass-produced using genetically engineered bacteria.

Semiochemicals in tick control

Semiochemicals are chemical signals that influence tick behavior, such as finding food or mates. These compounds, secreted externally, include pheromones like 2,6-dichlorophenol, the first sex pheromone identified in ticks (Sonenshine 2004).

Various chemicals function as pheromones, ranging from highly volatile molecules like substituted phenols—such as methyl salicylate, o-nitrophenol, and 2,6-

dichlorophenol—to non-volatile cholesteryl esters, which act as contact pheromones. Many of the compounds influencing these behaviors include purines, substituted phenols, and cholesteryl esters, alongside other pheromonal substances like organic acids, hematin, and ecdysteroids (Carr and Roe, 2016).

Pheromones for aggregation, attachment, and mating are particularly useful for tick control. Novel devices combine these pheromones with acaricides to manage ticks effectively, either on vegetation or livestock.

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