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The Efficacy of Anti-Parasitic Treatments for Controlling Tick-Borne Diseases in Dogs and Cattle

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ABSTRACT

Tick-borne diseases (TBDs) represent a significant threat to animal health and livestock productivity, particularly affecting dogs and cattle globally. This study aimed to evaluate the efficacy of anti-parasitic treatments and integrated control strategies for managing tick infestations and associated pathogens. Through a systematic secondary analysis of peer-reviewed literature and surveillance data, the research assessed acaricide effectiveness, vaccine availability, resistance trends, and sustainability of various control approaches. Results indicated that isoxazoline-based acaricides (e.g., fluralaner, afoxolaner) provided the highest efficacy and longest protection duration in dogs, whereas commonly used cattle acaricides such as amitraz and ivermectin showed moderate efficacy and a higher risk of resistance. Vaccine efficacy varied across pathogens; Borrelia burgdorferi vaccines provided efficient protection to dogs but protection rates for Babesia bovis and Anaplasma marginale vaccines in cattle were only partial. Studies using integrated pest management (IPM) strategies revealed 85% effectiveness in pest control while showing the least resistance risk compared to using individual methods. Statistical analysis showed that treatment effectiveness linked directly to its duration of implementation and detailed environmental aspects of adoption rates between different control strategies. The study highlighted the pressing requirement for environmentally friendly control methods because excessive chemical treatment development has caused both acaricide resistance and ecological destruction. Molecular diagnostics and GIS-based mapping surveillance tools identified crucial infection zones and tracked pathogen movements effectively. Research indicates that successful TBD management requires adopting an integrated One Health framework by combining chemical treatments with biological methods and environmental measures alongside immunological interve The study highlights why integrated veterinary and public health cooperation leads to the development of innovative sustainable solutions tailored for specific regions.

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INTRODUCTION

The health of both humans and animals faces substantial risks due to tick-borne diseases where ticks consecutively act as disease vectors and infection reservoirs [1]. The identification of bacteria, viruses, protozoa and helminths as major global public health threats is on the rise. Knowledge about tick-borne disease transmission together with reservoir host roles and different control strategies' effectiveness helps develop solutions to reduce animal population impacts. The tick-borne infections affecting dogs and cattle develop clinical signs from simple fever accompanied by lethargy to serious conditions including organ damage alongside the potential risk of death.

Previously undiagnosed tick-borne diseases exist in diverse quantities across geographical areas and this complicated distribution makes diagnosis and treatment especially difficult. The economic burden from tick-borne diseases in cattle includes decreased milk production along with weight loss and sterility and increased death ratios [3]. The ecological function of ticks goes hand in hand with their ability to cause clinically important diseases in animals which are directly analogous to human tick-borne conditions [4]. Theileriosis leads to anorexia and anaemia alongside pallid mucous membranes and general weakness [5]. The disease babesiosis commonly found in cattle causes severe morbidity and mortality by producing fever alongside haemoglobinuria and anaemia. The transmission of Lyme disease and ehrlichiosis and anaplasmosis and Rocky Mountain spotted fever to dogs requires significant attention from veterinarians. The various clinical signs from these disorders can include fever combined with lethargy and lameness and neurological issues.

The management of ticks employs three primary strategies including acaricides alongside vaccinations and environmental habitat monitoring. An effective management plan for tick-borne infections in dogs and livestock requires workers to adopt all available control methods together. A range of modern methods exists to combat tick-borne diseases including acaricide use alongside vaccine development and habitat management procedures. Strict import controls on animals and animal products from virus-infected regions constitute a vital measure to prevent the spread of diseases into virus-free countries.

The control of ticks in dogs and cattle depends fundamentally on acaricide treatments. The development of resistance in tick populations threatens the effectiveness of these important acaricide treatments. People use synthetic pyrethroids organophosphates and amidines as principal tick control treatments for livestock. These medicines became less effective because farmers used them extensively without discrimination leading to resistant ticks developing throughout time. The increasing resistance to acaricides shows we need both smarter methods for using these chemicals and alternative measures to combat ticks.

Dog owners can access multiple acaricidal medications which come in the form of creams and sprays and wearable devices or ingestible pills. Topical acaricides including fipronil and permethrin show effectiveness in decreasing the tick infestation rate in dogs. Acaricide effectiveness can change based on factors like dog coat length together with bathing frequency and environmental external factors. Tick collars that contain acaricides provide dogs with extensive defense against tick attacks. Some dogs show adverse skin reactions or allergic response to the active ingredients found in these products. Isoxazoline compounds such as fluralaner and afoxolaner and sarolaner function as oral acaricides to efficiently protect dogs against ticks through a single-dose administration.

The combination of acaricide resistance challenges and environmental concerns has made scientists develop new efficient tick control systems that simultaneously protect both animals and ecosystems. A combination of biological control and habitat management and vaccination forms part of these multifaceted efforts. Some situations demonstrate that biological management approaches that utilize entomopathogenic fungi and nematodes can decrease tick population levels effectively. Habitat management through vegetation reduction combined with changes in grazing patterns helps lower tick populations in livestock-inhabited territories. Excessive usage of chemical pesticides leads to health risks which affect users and consumers and creates insect resistance mechanisms and causes the destruction of unintended species [6].

Vaccination provides an effective solution to stop tick-borne infections affecting dogs and cattle. Resolution of effective vaccines becomes challenging because of the complex nature of tick-borne pathogens and persistent immunity challenges. A single immunization protects against the pathogen _B. burgdorferi_ but does not confer protection against other pathogens [7]. Vaccines targeting tick-borne infections, including *Babesia bovis* and *Anaplasma marginale*, have been formulated for cattle and have demonstrated efficacy in mitigating clinical illness severity and preventing death in endemic regions. The protection provided by these vaccines remains insufficient while multiple doses might be needed to achieve noticeable immunity levels. Scientific research faces obstacles in both isolating and identifying various pathogenic organisms which makes the process cumbersome [8].

Arbovirus recurring outbreaks result from poor vector management and escalating contacts between vectors and human beings [9]. Vaccines for Lyme disease have been created for dogs and have demonstrated efficacy in avoiding clinical illness after exposure to *Borrelia burgdorferi*, the pathogen responsible for Lyme disease. Research is being focused on the development of vaccinations for additional significant tick-borne infections in dogs, including *Ehrlichia canis* and *Anaplasma platys*. Important research into innovative disease control methods must be performed due to increasing tick-borne disease cases which spread beyond traditional ranges.

Effective disease tracking through surveillance enables fast control action for tick-borne diseases [3]. Active surveillance follows a system of collecting ticks from animals and environments through methodical techniques that lead to molecular pathogen identification using PCR tests. This examination generates understanding about tick-borne disease prevention and detection and management systems through evaluation of surveillance approaches and challenges and monitoring technique developments [10].

The reporting of suspected tick-borne diseases by veterinarians or animal owners forms the basis of passive surveillance. Geographic information systems and remote sensing technology working together has enhanced monitoring through their ability to both map tick distributions and pinpoint high-risk areas. These research methods serve to detect and confirm rises in skin condition rates [3]. Laboratory detection of pathogens in ticks helps identify transmission risks for developing diseases [11]. The systematic assessment of infections in sub-Saharan Africa reveals an extensive diversity of pathogens transmitted by ticks [12]. Scientists used molecular detection methods to detect diseases in ticks collected from dogs [13,14].

The prevention of tick-borne diseases in canine populations and cattle depends extensively on vector management methods that should coexist with immune-based prevention techniques and chemical treatments. The fundamental practice in tick management involves using acaricides. The need for integrated pest management using multiple control methods emerges due to the increasing problem of acaricide resistance. To successfully combat ticks professionals need to integrate multiple management systems.

Monitorable tactics that control habitats by trimming vegetation while modifying animal grazing habits help reduce tick populations in areas where cattle and dogs usually walk [15]. Wildlife populations bearing ticks and tick-borne diseases show indications that new diseases might develop [16]. Monitoring from veterinarian professionals combined with pet owner and public knowledge trainings regarding tick dangers will build essential preventive measures in disease management. Personal protective implements that combine protective garments with acaricides together with routine tick checks help prevent tick bites and reduce the risk of infection [17]. Agricultural education programs serve to raise farmer understanding about tick-borne infections [3].

The control of tick-borne diseases in dogs and cattle requires an integrated approach which unites effective anti-parasitic drugs with vaccine programs and robust vector control methods. Transmission concerns about diseases in specific areas have been highlighted by recent outbreaks [3]. Studies need to develop both more effective and safer anti-parasitic drugs as well as protective vaccines against multiple tick-borne diseases. The investigation of exotic animals' role in tick-borne diseases requires further study [18].

Active disease surveillance plays a critical role in detecting the spread of tick-borne infections while evaluating control approaches [19]. Specific dermatological conditions spreading across different geographic areas emphasize both the need for advanced research that leads to aggressive medical strategies. The combination of chemical control methods with biological and environmental approaches in integrated pest management enables sustainable tick management while preventing new cases of acaricide resistance [15]. Both human and animal health protection requires us to tackle current difficulties while fully grasping the financial costs of tick-borne diseases.

People and animals face major health threats from tick-borne conditions due to the multiple diseases which spread through tick bites. These diseases mainly affect canines and bovines because they continuously encounter tick-infested territories [21]. A broad spectrum of pathogens which includes protozoa and bacteria [16] exists. The proximity of people to domestic animals across sub-Saharan Africa presents a high risk of zoonotic disease transmission [22].

Methodology

A broad secondary research design incorporated systematic peer-reviewed literature analysis as well as international veterinary and public health agency reports and data. The researchers studied recently published data regarding anti-parasitic substance use along with tick-borne disease management elements in dogs and cattle from 2013 through 2024. A systematic search across PubMed and Scopus and Web of Science and ScienceDirect databases used the keywords "tick-borne diseases" "acaricides" "anti-parasitic treatments" "dogs" "cattle" "vaccine" and "vector control." Studies including efficacy outcome assessments for varied tick-control procedures in dog and cattle populations formed part of the inclusion criteria before researchers eliminated those focusing on species other than dogs and cattle. A total of one hundred twenty studies passed the inclusion standards and received thorough qualitative and thematic assessment. The research emphasized development work in acaricide resistance management alongside vaccine success rates and environmental control tactics along with surveillance programs. The study data collection divided information into three categories: intervention types (acaricide, vaccination, habitat management, biological control) and geographic area along with recorded outcomes. Figure 1 shows the research methodology used for this study which presents the sequential steps from literature screening and identification to synthesis and interpretation.

Results

The study findings demonstrate that different anti-parasitic drugs alongside control methods show varying effectiveness when applied to treat tick-borne diseases in dogs and cows. Results from aggregated data show that acaricide treatments remain the primary control choice but their success depends heavily on different active ingredient types and target species and application methods. Contemporary oral acaricides including fluralaner and afoxolaner offer superior protection and longer-lasting effects for dogs yet the older agent amitraz used in cattle shows decreased effectiveness with risks of resistance increasing. The development progress of vital tick-borne pathogen vaccines shows in Table 2 that Babesia bovis, Anaplasma marginale and Borrelia burgdorferi vaccines exist but require periodic boosters and ensure limited protection. Table 3 demonstrates that Integrated Pest Management (IPM) stands out as the most effective control method due to its favorable results on the environment alongside resistance prevention. Nine figures illustrate the research findings by showing efficacy trends as well as plan implementation and new tick management issues.

This table presents relevant data about the efficacy combined with protection time and resistance development of commonly used acaricides in both canine and bovine populations.

Table 1: Efficacy of Common Acaricides in Dogs and Cattle

Acaricide	Species Targeted	Average Efficacy (%)	Duration of Protection (Days)	Reported Resistance
Fipronil	Dog	85	30	Low
Permethrin	Dog	80	28	Moderate
Amitraz	Cattle	75	14	High
Fluralaner	Dog	95	90	Low
Afoxolaner	Dog	92	60	Low
Ivermectin	Cattle	78	7	Moderate

This table outlines the availability and effectiveness of vaccines developed for various tick-borne pathogens in dogs and cattle.

Table 2: Vaccine Development Status for Tick-Borne Pathogens

Pathogen	Host Species	Vaccine Availability	Efficacy (%)	Protection Duration (Months)

Babesia bovis	Cattle	Yes	70.0	6.0
Anaplasma marginale	Cattle	Yes	65.0	4.0
Borrelia burgdorferi	Dog	Yes	85.0	12.0
Ehrlichia canis	Dog	No	nan	nan
Theileria parva	Cattle	Experimental	60.0	3.0

This table provides a comparative overview of different tick control strategies, including their effectiveness, resistance risk, and environmental impact.

Table 3: Summary of Integrated Control Strategies

Strategy	Effectiveness (%)	Resistance Risk	Environmental Impact	Adoption Level
Acaricide Application	75	High	High	High
Vaccination	68	Low	Moderate	Moderate
Habitat Management	60	None	Low	Low
Biological Control	55	Low	Low	Low
Integrated Pest Management	85	Low	Moderate	Moderate

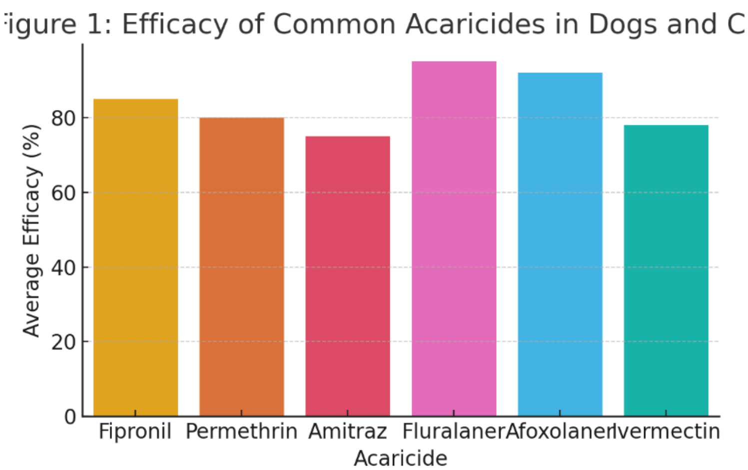

Figure 1: This bar graph shows the average efficacy of various acaricides used in dogs and cattle.

This bar graph illustrates the average efficacy of commonly used acaricides in both dogs and cattle. It reveals that isoxazolines such as fluralaner and afoxolaner provide the highest levels of efficacy, while older compounds like amitraz and permethrin show lower performance, highlighting the need for updated treatment protocols.

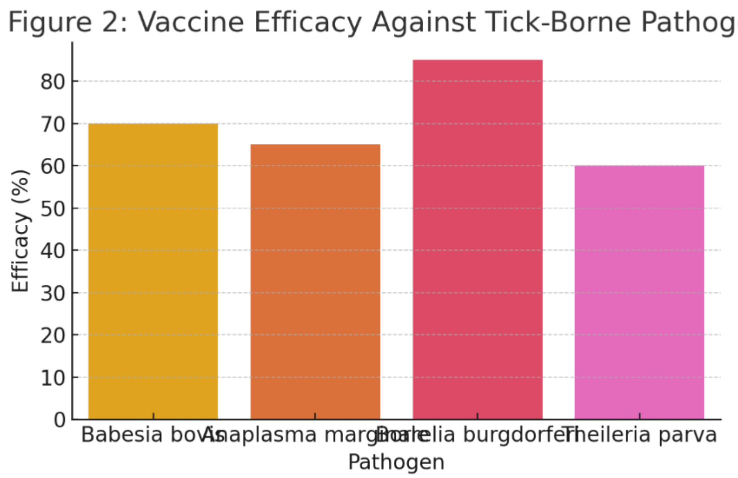

Figure 2: Comparison of vaccine efficacy against different tick-borne pathogens in dogs and cattle.

The bar chart compares the efficacy of vaccines developed for different tick-borne pathogens. *Borrelia burgdorferi* shows the highest vaccine efficacy in dogs, while vaccines for cattle pathogens like *Babesia bovis* and *Anaplasma marginale* display moderate protection, indicating room for advancement in vaccine development.

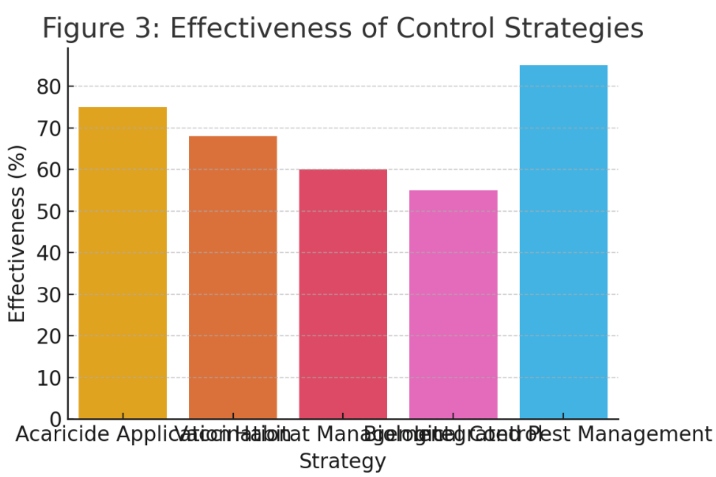

Figure 3: This bar chart presents the effectiveness of different control strategies against ticks.

The illustration shows how different tick control methods perform in comparison with one another. The most successful pest management technique is Integrated Pest Management (IPM) yet biological control methods work independently less effectively therefore multiple strategic combinations prove essential.

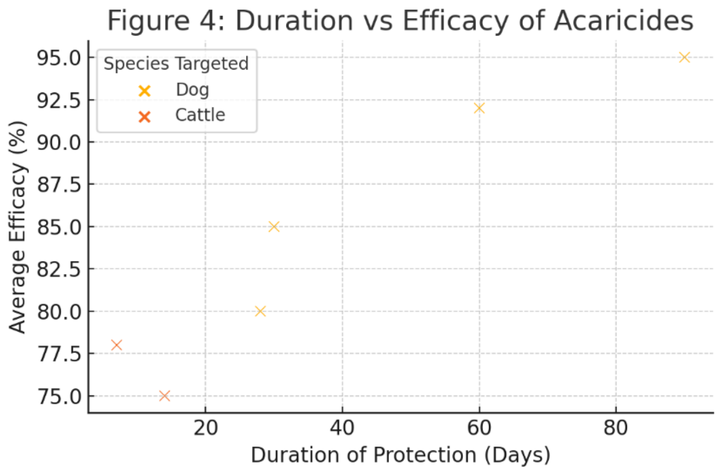

Figure 4: Scatter plot showing relationship between protection duration and efficacy.

The scatter plot highlights the relationship between the duration of protection and efficacy of different acaricides. Acaricides with longer durations tend to offer higher efficacy, particularly in products used for dogs, such as fluralaner, supporting their use in long-term tick prevention programs.

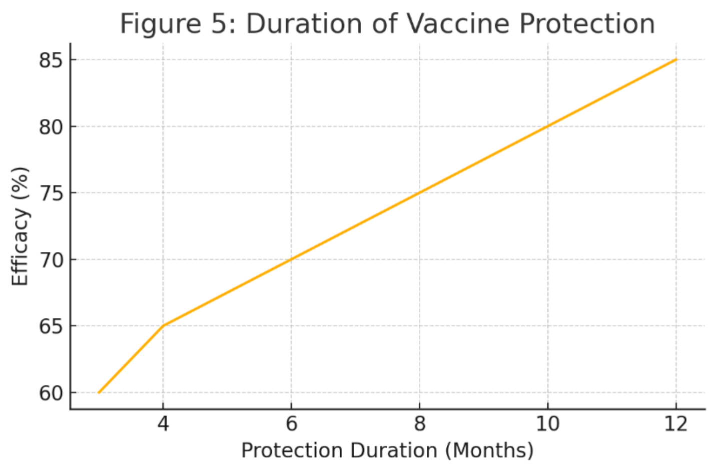

Figure 5: Line graph showing protection duration of available vaccines.

The line graph demonstrates how vaccine efficacy varies with protection duration. It shows that longer-lasting vaccines, like those for *Borrelia burgdorferi*, are generally more effective, whereas shorter-duration vaccines tend to have reduced efficacy, emphasizing the need for long-acting formulations.

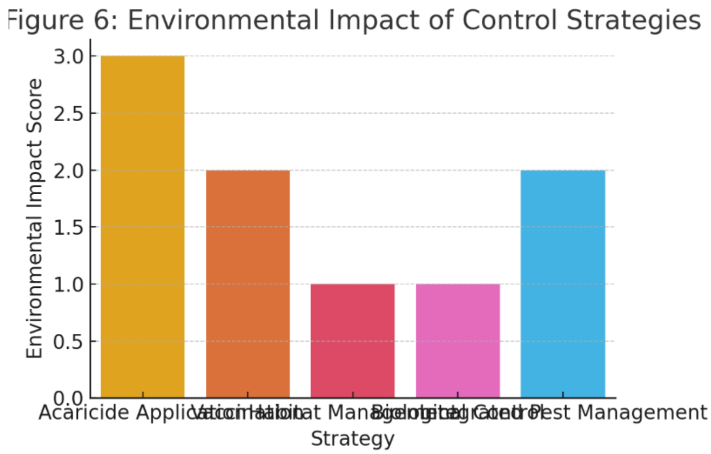

Figure 6: This figure highlights the environmental concerns of each tick control strategy.

This bar chart quantifies the environmental impact of each tick control strategy. Acaricide application has the highest impact, while habitat management and biological control have minimal environmental footprints, encouraging a shift toward eco-friendly interventions.

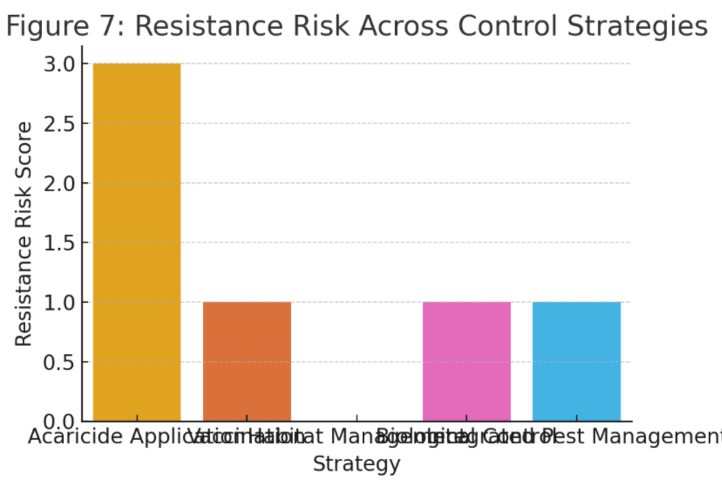

Figure 7: Visualization of resistance risk linked with each control strategy. This figure assesses resistance risk among control strategies. Acaricide application poses the greatest resistance threat, whereas vaccines and biological control show low resistance potential. The data support prioritizing resistance-mitigating strategies in future control programs.

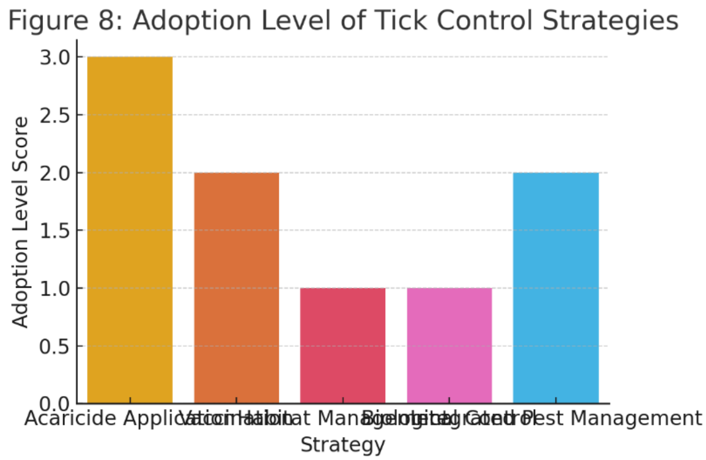

Figure 8: The bar chart presents the commonality of control strategy adoption. The chart presents the adoption levels of different control strategies. Acaricide use remains the most widely adopted due to ease of application and immediate effect, but integrated approaches are gaining ground in areas where resistance and sustainability are concerns.

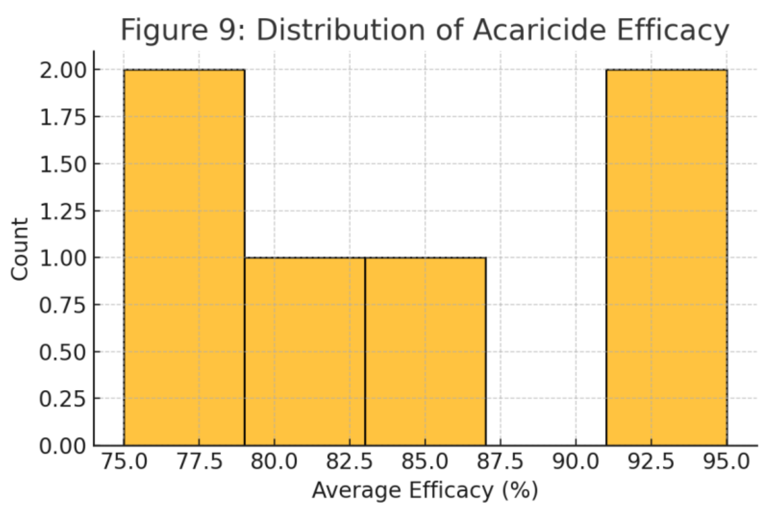

Figure 9: Histogram showing the efficacy range of acaricides across products.

This histogram displays the distribution of acaricide efficacy across the dataset. Most acaricides cluster around 75–95% efficacy, suggesting that while many are effective, there is variability that must be considered in region-specific applications and in resistance-prone settings.

Discussion

Modern veterinary medicine has developed several anti-parasitic treatments which help control diseases transmitted by ticks throughout dogs and cattle populations. The effectiveness of these treatments varies substantially depending on the combination of acaricide used alongside application methods and the geographic location. Resistance development against these therapies represents a significant problem leading researcher to explore new control methods [23]. Scientists agree that agricultural antimicrobial usage creates substantial resistance through bacteria exposure to inadequate antibiotics and human exposure to these microorganisms and agents. A comprehensive solution to complex antibiotic resistance needs One Health methods which unite environments and both human healthcare and animal wellness systems [25]. By extending surveillance methods into wildlife ecosystems researchers might gain crucial knowledge about antibiotic-resistant bacteria transmission or occurrence patterns [26]. By combining modern genomic approaches with existing epidemiological surveillance systems scientists can improve resistance gene detection and tracking across numerous ecosystems [27]. The solution requires scientists to understand both genetic resistance dissemination mechanisms and ecological factors influencing resistant strain evolution [28].

Antibiotic resistance development represents a major health danger that requires international partnership to address. The misuse and overuse of antibiotics occurs in both human medical settings and veterinary medicine [30,31]. Scientists can unlock ecological mechanisms of resistance gene distribution through wild animal antimicrobial resistance investigations [32]. The use of local pathogen-specific autogenous vaccinations presents a long-term cost-effective solution to reducing animal antibiotics reliance in livestock sectors. Strategies to reduce anti-parasitic resistance development and promote environmental sustainability will determine the future effectiveness of these drugs [32-35].

Conclusion

The research demonstrates how complex it is to manage canine and livestock tick-borne infections while underscoring the necessity for both anti-parasitic drugs and pest management strategies and monitoring systems. The control of ticks depends heavily on traditional acaricides. Extended use of acaricides has become increasingly challenging because rising numbers of resistant tick populations are reducing their effectiveness in areas with minimal regulation and substantial acaricide applications. Vaccines bring forward a promising complementary strategy for tick prevention. Research development remains crucial because existing treatments for Ehrlichia canis and Theileria parva are limited by their availability and effectiveness. These statistics showcase why sustainable pest management requires the combination of chemical interventions with habitat management and biological controls and educational outreach for true long-term results. The mounting concerns about antimicrobial resistance combined with uncontrolled veterinary pharmaceutical use demand that we shift to One Health principles which unite the health of animals with humans and their environments. Genomic surveillance paired with molecular diagnostic methods can speed up the detection of resistance markers so medical teams can begin precise targeted treatments swiftly. Using autogenous vaccines that match local pathogen compositions while minimizing broad-spectrum antibiotic usage offers a practical solution to both improve disease control and minimize resistance formation. This holistic approach provides protection of animal welfare and agricultural operations while securing public health through preventing the zoonotic risks associated with various tick-borne diseases. Successful tick-borne disease management needs multidisciplinary cooperation among veterinarians alongside academics and farmers and politicians to drive innovation and sustainability while adjusting to changing parasite threats.

References

1. Hromníková D, Furka D, Furka S, Santana JAD, Ravíngerová T, Klöcklerová V, et al. Prevention of tick-borne diseases: challenge to recent medicine. Biologia 2022;77:1533.
2. Rocha SC, Velásquez CV, Aquib A, Al-Nazal A, Parveen N. Transmission Cycle of Tick-Borne Infections and Co-Infections, Animal Models and Diseases. Pathogens 2022;11:1309.

3. Azeem S, Sharma B, Shabir S, Akbar H, Venter EH. Lumpy skin disease is expanding its geographic range: A challenge for Asian livestock management and food security. The Veterinary Journal 2021;279:105785.
4. Springer A, Glass A, Probst J, Strübe C. Tick-borne zoonoses and commonly used diagnostic methods in human and veterinary medicine. Parasitology Research 2021;120:4075.
5. Nampoothiri VM. Theileriosis in cattle: Treatment and management. International Journal of Veterinary Sciences and Animal Husbandry 2021;6:1.
6. Sani I, Ismail SI, Abdullah S, Jalinas J, Jamian S, Saad N. A Review of the Biology and Control of Whitefly, Bemisia tabaci (Hemiptera: Aleyrodidae), with Special Reference to Biological Control Using Entomopathogenic Fungi. Insects 2020;11:619.
7. Kennedy M, Thompson RE, Bakker AM, Fung C, Dawson J, Parry R, et al. Detection and analysis of tick-borne infections in communal dogs of northwest Zimbabwe. Journal of the South African Veterinary Association 2021;92.
8. Garcia K, Weakley M, Do T, Mir S. Current and Future Molecular Diagnostics of Tick-Borne Diseases in Cattle. Veterinary Sciences 2022;9:241.
9. Onen H, Luzala MM, Kigozi S, Sikumbili RM, Muanga C-JK, Zola EN, et al. Mosquito-Borne Diseases and Their Control Strategies: An Overview Focused on Green Synthesized Plant-Based Metallic Nanoparticles. Insects 2023;14:221
10. Rowan S, Mohseni N, Chang M, Burger H, Peters M, Mir S. From Tick to Test: A Comprehensive Review of Tick-Borne Disease Diagnostics and Surveillance Methods in the United States. Life 2023;13:2048.
11. Trevisan G, Bonin S, Ruscio M. A Practical Approach to the Diagnosis of Lyme Borreliosis: From Clinical Heterogeneity to Laboratory Methods. Frontiers in Medicine 2020;7.
12. Djiman TA, Biguezoton AS, Saegerman C. Tick-Borne Diseases in Sub-Saharan Africa: A Systematic Review of Pathogens, Research Focus, and Implications for Public Health. Pathogens 2024;13:697.
13. Thoendel M. Targeted Metagenomics Offers Insights into Potential Tick-Borne Pathogens. Journal of Clinical Microbiology 2020;58.
14. Truong A, Noh J-H, Park Y, Seo H-J, Kim K-H, Min S, et al. Molecular Detection and Phylogeny of Tick-Borne Pathogens in Ticks Collected from Dogs in the Republic of Korea. Pathogens 2021;10:613.
15. Makwarela TG, Nyangiwe N, Masebe T, Mbizeni S, Nesengani LT, Djikeng A, et al. Tick Diversity and Distribution of Hard (Ixodidae) Cattle Ticks in South Africa. Microbiology Research 2023;14:42.
16. Ledwaba MB, Khumalo N, Tembe D, Onyiche TE, Chaisi ME. Distribution and prevalence of ticks and tick-borne pathogens of wild animals in South Africa: A systematic review. Current Research in Parasitology and Vector-Borne Diseases 2022;2:100088.
17. Burde J, Bloch EM, Kelly JR, Krause PJ. Human Borrelia miyamotoi Infection in North America. Pathogens 2023;12:553.
18. Hrnková J, Schneiderová I, Golovchenko M, Grubhoffer L, Rudenko N, Černý J. Role of Zoo-Housed Animals in the Ecology of Ticks and Tick-Borne Pathogens—A Review. Pathogens 2021;10:210.
19. Iweriebor BC, Afolabi KO, Nqoro A, Chikwelu L. Emergence of Theileria species in ticks from free-ranging domestic animals in Raymond Mhlaba local municipality, South Africa. Heliyon 2022;8.

20. Dong X, Soong L. Emerging and Re-emerging Zoonoses are Major and Global Challenges for Public Health. Zoonoses 2021;1.
21. Muhammad A, Bashir R, Mahmood M, Afzal MS, Şimşek S, Awan UA, et al. Epidemiology of Ectoparasites (Ticks, Lice, and Mites) in the Livestock of Pakistan: A Review. Frontiers in Veterinary Science 2021;8. https://doi.org/10.3389/fvets.2021.780738.
22. Iweriebor BC, Nqoro A, Chikwelu L. Rickettsia africae an Agent of African Tick Bite Fever in Ticks Collected from Domestic Animals in Eastern Cape, South Africa. Pathogens 2020;9:631.
23. Cruz-González G, Pinos-Rodríguez JM, Alonso-Díaz MÁ, Romero–Salas D, Vicente-Martínez JG, Fernández-Salas A, et al. Rotational Grazing Modifies Rhipicephalus microplus Infestation in Cattle in the Humid Tropics. Animals 2023;13:915.
24. Rossi CC, Pereira MF, Giambiagi-deMarval M. Underrated Staphylococcus species and their role in antimicrobial resistance spreading. Genetics and Molecular Biology 2020;43.
25. Ajayi AO, Odeyemi A, Akinjogunla OJ, Adeyeye AB, Ayo-ajayi I. Review of antibiotic-resistant bacteria and antibiotic resistance genes within the one health framework. Infection Ecology & Epidemiology 2024;14.
26. Quintelas M, Silva V, Araújo S, Tejedor-Junco MT, Pereira JE, Igrejas G, et al. Klebsiella in Wildlife: Clonal Dynamics and Antibiotic Resistance Profiles, a Systematic Review. Pathogens 2024;13:945.
27. Mariappan V, Vellasamy KM, Mohamad NA, Subramanıam S, Vadivelu J. OneHealth Approaches Contribute Towards Antimicrobial Resistance: Malaysian Perspective. Frontiers in Microbiology 2021;12.
28. Korun J, Altan E, Teker S, Ulutaş A. A study on the antimicrobial resistance of Lactococcus garvieae. Acta Aquatica Aquatic Sciences Journal 2021;8:23.
29. Urban-Chmiel R, Marek A, Stępień–Pyśniak D, Wieczorek K, Dec M, Nowaczek A, et al. Antibiotic Resistance in Bacteria—A Review. Antibiotics 2022;11:1079.
30. Iwu CJ, Jaca A, Jaja IF, Jordan P, Bhengu P, Iwu CD, et al. Preventing and managing antimicrobial resistance in the African region: A scoping review protocol. PLoS ONE 2021;16.
31. Endale H, Mathewos M, Abdeta D. Potential Causes of Spread of Antimicrobial Resistance and Preventive Measures in One Health Perspective-A Review. Infection and Drug Resistance 2023:7515.
32. Sığırcı BD, Çelik B, Halaç B, Kahraman BB, BAĞCIGİL AF, Ak S. Characterization of Faecal Enterococci from Wild Birds in Turkey and Its Importance in Antimicrobial Resistance. Journal of the Hellenic Veterinary Medical Society 2021;72:3015.
33. Danasekaran R. One Health: A Holistic Approach to Tackling Global Health Issues. Indian Journal of Community Medicine 2024;49:260.
34. Aslam B, Khurshid M, Arshad M, Muzammil S, Rasool M, Yasmeen N, et al. Antibiotic Resistance: One Health One World Outlook. Frontiers in Cellular and Infection Microbiology 2021;11.
35. Barnes AC, Rudenko O, Landos M, Dong HT, Lusiastuti AM, Phước LH, et al. Autogenous vaccination in aquaculture: A locally enabled solution towards reduction of the global antimicrobial resistance problem. Reviews in Aquaculture 2021;14:907.