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Evaluation of a Nano-Herbal Acaricide to Mitigate Acaricidal Resistance in Dairy Cattle under Field Conditions in Tamil Nadu, India

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Abstract

Tick infestation is one of the major constraints affecting dairy productivity in tropical regions. Continuous use of synthetic acaricides has resulted in resistance among tick populations, necessitating the development of eco-friendly alternatives. The present field study evaluated the efficacy of TANUVAS-VIC Tix Killer, a nano-herbal acaricide, in comparison with a polyherbal spray and farmers' conventional practice for controlling ticks in dairy cattle. The trial was conducted from September to December 2025 in Thalinji village of Karur District. Results showed a significant reduction in tick load within 28 days when treated with the nano-herbal formulation. Milk yield increased from 8.0 to 8.3 L/animal/day in animals treated with Tix Killer. Re-infestation was lowest (5%) in the nano-herbal treatment compared to the polyherbal spray (10%) and farmers' practice (20%). Economic analysis indicated a higher benefit-cost ratio (1.57) for the nano-herbal treatment. The study suggests that nano-herbal acaricides can be an effective and sustainable approach for managing tick infestation and improving dairy productivity.

Keywords: Dairy cattle, Tick infestation, Herbal acaricide, Milk production, Nano-herbal formulation

1. Introduction

Ticks are among the most important ecto-parasites affecting livestock worldwide and are responsible for significant economic losses due to reduced productivity, transmission of tick-borne diseases, and increased treatment costs. These parasites reduce feed intake, cause blood loss, and transmit haemoprotozoan diseases such as babesiosis and anaplasmosis in cattle (Benavides *et al.*, 2001) ^[1]. Chemical acaricides are widely used for tick control; however, their indiscriminate use has led to acaricidal resistance, environmental contamination, and residues in milk and meat products. Hence, there is growing interest in plant-based acaricides as sustainable alternatives. Herbal extracts such as neem (*Azadirachta indica*) and notchi (*Vitex negundo*) have been reported to possess acaricidal and repellent properties against cattle ticks (Thaware *et al.*, 2023) ^[8]. Plant-derived acaricides are eco-friendly and may reduce dependence on synthetic chemicals while effectively controlling tick populations. The present study aimed to evaluate the field performance of TANUVAS-VIC Tix Killer, a nano-herbal external application developed by Tamil Nadu Veterinary and Animal Sciences University, in comparison with a polyherbal spray formulation promoted by National Innovation Foundation - India and farmers' traditional practices.

2. Materials and Methods

2.1 Study Area

The study was conducted from September to December 2023 in Thalinji located in Thogamalai Block of Karur District. The region is predominantly rain-fed, and livestock farming plays a major role in rural livelihoods. Dairy cattle are reared mainly for milk production and regular calf production.

2.2 Problem Identification

Field surveys indicated a high prevalence of tick infestation in dairy cattle. Repeated use of conventional acaricides resulted in poor efficacy due to resistance. Farmers commonly used chemical acaricides, which provided only temporary relief.

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2.3 Technologies Evaluated

Treatment	Description	Source
T1	Nano-herbal acaricide (Tix Killer) external application	TANUVAS (2022)
T2	Polyherbal spray prepared from neem and notchi leaves	NIF-DST (2019)
T3	Farmers' practice -Chemical application	Local practice

2.4 Critical Inputs Provided

Input	Quantity	Cost (₹)
Nano herbal (Tix Killer)	1 unit	400
Polyherbal spray	1 unit	200

2.5 Parameters Observed

The following parameters were recorded:

- Milk yield (litre/animal/day)
- Tick load (>4 mm diameter ticks)
- Re-infestation percentage
- Benefit-Cost Ratio (BCR)

Tick counts were recorded on Day 0, 7, 14, 21, and 28.

3. Results

3.1 Effect on Milk Yield and Tick Load

Treatment	Milk Yield (L/day) Before	After (30 days)	Tick count Day 0	Day 7	Day 14	Day 21	Day 28	Reinfection%	BCR
Tix Killer	8.0	8.3	40	28	19	10	5	5	1.57
Polyherbal spray	7.6	7.65	40	33	28	15	10	10	1.55
Farmers practice	6.0	6.2	40	37	33	25	15	20	1.20

The Nano-herbal acaricide significantly reduced tick load within 28 days compared to the polyherbal spray and farmers' practice.

3.2 Economic Analysis

Treatment	Gross Cost (₹/animal/month)	Gross Income (₹/animal/month)	Net Return (₹)	BCR
Tix Killer	2900	7470	4570	1.57
Polyherbal spray	2700	6885	4185	1.55
Farmers practice	2500	5580	3080	1.20

4. Discussion

The present study demonstrated that nano-herbal acaricides can effectively control tick infestation in dairy cattle. The reduction in tick population observed in this study agrees with earlier reports that plant-based extracts such as neem and *Vitex negundo* possess acaricidal activity against ticks (Singh *et al.*, 2014) [3]. Tick infestation leads to reduced milk yield, loss of appetite, and transmission of tick-borne diseases in cattle (Sadhu *et al.*, 2024) [4]. Herbal formulations provide an environmentally safe alternative to synthetic acaricides and reduce the risk of chemical residues (George *et al.*, 2004) [2]. The improvement in milk yield and economic returns observed in this study suggests that nano-herbal formulations may be a viable solution for managing acaricidal resistance in dairy farms. The superior efficacy of the nano-herbal formulation observed in the present study may be attributed to improved penetration and prolonged

residual activity of nano-sized particles on the skin surface. Nano-formulations enhance bioavailability and stability of active phytochemicals, thereby improving acaricidal efficiency even at lower concentrations (Kumar *et al.*, 2020) [7]. Similar findings were reported by Patil *et al.* (2021) [10], who observed significant reduction in tick burden in cattle treated with herbal nano-emulsions.

The gradual reduction in tick count from Day 7 to Day 28 indicates sustained acaricidal action of the nano-herbal formulation. Lower re-infestation percentages observed in the Tix Killer-treated group suggest possible repellent effects of herbal constituents such as azadirachtin and essential oils present in medicinal plants. Neem-based compounds are known to interfere with feeding, molting, and reproductive cycles of ticks (Benavides *et al.*, 2001) [1]. Improvement in milk yield recorded in treated animals could be associated with reduced stress and blood loss following tick control. Tick infestation adversely affects animal comfort and feed utilization efficiency, ultimately lowering milk production (Jonsson, 2006) [9]. Effective tick management therefore contributes directly to enhanced productivity and farm profitability.

The higher benefit-cost ratio obtained in the nano-herbal treatment indicates its economic feasibility under field conditions. Farmers also reported ease of application and absence of adverse skin reactions in treated animals. Adoption of herbal acaricides may therefore support sustainable dairy farming by minimizing dependence on synthetic chemicals and delaying development of acaricidal resistance. However, the present study was conducted under field conditions with limited sample size and duration. Further studies involving larger populations, seasonal variations, and molecular assessment of acaricidal resistance are required to validate long-term efficacy of nano-herbal formulations.

5. Conclusion

The field evaluation showed that TANUVAS-VIC Tix Killer, a nano-herbal acaricide, effectively reduced tick infestation and improved milk yield in dairy cattle. The treatment resulted in lower re-infestation rates and higher economic returns compared with polyherbal spray and farmers' conventional practice. The technology can therefore be recommended as an eco-friendly and economically viable strategy for tick control in dairy farms.

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