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Efficacy of *Derris acuminata Bentham* for Tick Control in Diary Cattle

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Abstract

Tick causes great economic loss to the dairy industry through poor body condition and reduced milk yield. Using chemical acaricides, a standard method for controlling ticks in dairy cattle leads to resistance development and environmental degradation. Therefore, this study assessed Derris's (*Derris acuminata* Bentham's) effect on tick control as an alternative to chemical acaricide in cattle. The study was conducted in Khatoed Block, Gasa district, Bhutan. A total of 60 dairy cattle (31 Jersey crosses and 29 Brown Swiss crosses) were randomly sampled from 9 households for the study. The powdered roots of derris were used as treatments at concentrations of 7.5%—treatment 1, 10%—treatment 2, 12.5% —treatment 3, and control with 15 animals each through 0, 2, 4, and 6 weeks. Overall, the mean number of ticks was 50% or more in dairy cattle assigned to control than the treatments (p<.05) during the entire study period. Therefore, we recommend derri*s* as an eco-friendly alternative to chemical acaricide to control ticks in cattle.

Keywords: Acaricides, Cattle, Rotenone, Sustainable, Tick

Introduction

Tick is one of the oldest groups of arthropods and has existed for millions of years with very few changes in body structure (Fuente *et al.,* 2007). They are responsible for economic losses through the direct effect of blood-sucking and as vectors of pathogens and toxins (Eskezia & Desta, 2016). For example, about 30% of dairy production in India is affected annually due to tick bites and tick-borne diseases (Muhammad *et al.*, 2008). Moreover, animals infested with ticks showed reduced feed intake, affected the host metabolism, caused stress, and caused a reduction in live weight gain and anaemia, especially in young animals (Mondal *et al*., 2012).

There are a few methods for controlling ticks in dairy cattle. Many external acaricides are used to control ticks in cattle because they are readily available and convenient to apply, including dipping or spraying (Nyahangare, 2019). In Bhutan, many acaricides, such as deltamethrin and fluemethrin, are supplied to farmers free of cost by the Bhutanese government. This leads to excessive use, harming the environment and human health (De Meneghi *et al*., 2016) and cost to the government exchequer. Alternatively, plant extracts, such as zanthoxylum (Yangzom *et al*., 2023), derris, tobacco, neem, and ryania, which have insecticidal properties, have been reported effective

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against ticks (Yoon, 2009). In particular, the rotenone extract from the root of derris species has been used to control ticks in cattle (Mawela, 2008). These plant extracts have been shown to reduce tick feeding and viability (Habeeb, 2010), which would be cheaper and more cost-effective to control tick infestation. Despite the considerable promise of alternative acaricide, using derris to control cattle ticks is rare, and studies in Bhutan are limited. Hence, we studied the effect of derris (*Derris acuminata* Bentham) in controlling cattle ticks.

Materials and Method

Study area

The study was carried out in Khatoed block, Gasa district. Khatoed is the smallest, with an area of 326 sq. km and 60 households (Gasa Dzongkhag Statistics, 2020)—many farmers rear livestock to gain additional income. According to Livestock Statistics (2020), this block has 230 cattle (56 Brown Swiss breeds, 66 local cattle, and 114 Jersey crossbreeds). According to the seroprevalence survey by Pem *et al*. (2021), ticks are prevalent in Gasa, but studies are limited.

Selection of households and animals

The household rearing above five numbers of Jersey cross or Brown Swiss cross cattle were randomly selected for the experiment and were classified based on similar management practices to control for bias resulting from different management practices. 60 cattle were selected randomly (39 females and 21 males), irrespective of age, using a lucky draw method. The local breed was excluded from the experiment to minimise the bias because they are known to be resistant to tick bites compared with improved breeds (Vajana *et al*., 2018). All dairy cattle were reared under free grazing management practices.

Collection of derris root and preparation of the root powder

For the experiment, 30 kg of fresh derris root was collected from Tsirang Dzongkhag, Bhutan. The roots were washed in tap water, chopped into 1-1.5 cm in length and oven-dried at 40°C for 72 hours (Zubairi *et al*., 2014). The dried root was crushed into powder using a grinding machine, and the powder was stored in a zip-lock poly-ethylene bag to protect against oxidation (Yoon, 2009).

In-vitro assessment

One hundred ticks, including adults and young, were collected from the cattle for the in -vitro assessment. The in-vitro assessment was done at the Dzongkhag Veterinary Hospital laboratory, Gasa, to determine the preparation's inhibitory concentration and dose rate for the field trial. About 250 ml tap water was added in a petri dish (90 mm diameter) containing the measured weight of dried root powder to make different concentrations: Treatment 1— (5%: 83.5 g of derris), Treatment 2— (10%: 166.7g of derris), Treatment 3— (15%: 250 g derris). Ten live ticks were placed in each petri dish and were examined every 2 hrs intervals for 72 hrs to assess the effect of different derris concentrations on tick mortality. The ticks were examined for any movement at a temperature of 38 °C for 20 minutes to confirm that they were dead.

Field experimental design

A completely randomised design (CRD) was used to assess the effect of different concentrations of derris on ticks. The trial animal was randomly allotted to four groups with 15 animals each. The in-vitro dose rate assessment showed that a 10% derris concentration (formed an ideal paste to apply) is more effective than the 5% and 15% concentrations. Therefore, during the final trial, 10% ± 2.5% was taken, making derris powder solution concentration of T0 (no derris), T1: 7.5% (mean of 5% and 10%), T2: 10% and T3: 12.5% (mean of 10% and 15%) as guided by in-vitro dose rate assessment. To ensure that the prepared derris paste was neither dry nor diluted, 10% ± 2.5% was used because 10% serves as

an excellent paste for application on cattle.

Application and tick count

Using a clean cloth, the solution was applied directly to the udder, scrotal area, and axilla (tick's predilection site). The solution was applied on 0, 7, 14, 21, and 28 days of the experiment at 0800 hours. Ticks were counted manually from the animal's predilection site before applying powder solution, every 72 hours, and the 7th day after the application. The same procedure was followed for 35 days.

Data analysis

Data was recorded in Microsoft Excel and was exported to International Business Machines- Statistical Package for Social Sciences version 26 for further analysis. The data were described using mean and standard deviation. The one-way analysis of variance (ANOVA) was used to compare the means of tick counts among the different treatments. Bonferroni *post* hoc test was used to compare the differences in means if the result was significant ($p<.05$). Similarly, a comparison of the effect of initial tick counts on the final tick count on cattle was done using a dependent *t*-test. One-way repeated measures ANOVA was used to compare the effect of derris in tick control in dairy cattle as the treatment progressed to its final week.

Results and Discussion

In-vitro results

The in-vitro assessment was carried out to determine the final dose rate of the derris powder. In the 10% derris concentration, mortality was 100% within 36 hours, followed by 5% and 15% solution in 60 hours (Table 1).

Table 1. Frequency of death of ticks after in-vitro assessment within 72 hrs (count)

Treatments	Time of death (hrs)							
	0	**12**	**24**	**36**	**48**	**60**	**72**	**Total**
5%	10	3	3	2	1	1	0	10
10%	10	5	3	2	0	0	0	10
15%	10	3	2	2	2	1	0	10

Effect of initial tick counts to the final tick count on cattle

Our result shows that the initial tick count was not significantly different from the final tick count on dairy cattle ($p>.05$). Gadzirayi *et al*. (2009) reported that the number of final ticks present in the host is associated with the initial tick due to adaption advantages, resistant development, and reproduction potential. However, all the animals in this study were kept under the same management, and there were equal chances of picking up the tick during the grazing period. Moreover, the infested tick could have been killed due to the effect of rotenone present in derris, where the rotenone compound is listed as an anthelmintic, molluscicide, and insecticide (Kalume *et al*., 2012).

Effect of derris on tick control

After the completion of treatment on week six (Table 2), the lowest tick counts were found in animal groups treated with T2 (3.47 ± 2.70), followed by T1 (7.27 ± 5.96), treatment 3 (8.47 ± 5.96) and T0 (32.47 ± 5.09). This may be because treatment 2 formed an ideal paste to apply on animals (neither dry nor watery). If the derris solution is dry (in treatment 3), the derris pastes probably fell from the animal's body when applied to the cattle, which might be less effective in controlling ticks. In contrast, if the derris solu-

tion is watery (in T1), the derris concentration would have minimal effect on ticks with ineffective adhesion of derris paste on the animal's body. The result of this study was similar to the observation of Folashade & Omoregie (2013) who have recorded a higher level of effectiveness of derris root powder on tick control in sheep. This is because the rotenone compounds in this plant result in brain disorders resulting in tremor, stiffness, default in walking, balance, and coordination, rapid cell death, respiratory disorder, and cardiac failure that leads to the ultimate death of the insects (Giordano *et al.*, 2012). In addition, the root and stem of the derris plant have been used in insecticidal preparation for pest control in agriculture as its extract is easily degradable with short residual effects that do not harm the consumer (Sirichamorn *et al.,* 2012).

Table 2. Effect of derris on tick counts among the treatments at different time intervals (mean ± SD)

Treatment	Weeks			
	0	2	4	6
T0	6.87 ± 4.14^{a}	16.27 ± 7.06^{a}	24.13 ± 10.99^{a}	32.47 ± 5.09^{a}
T1	11.00 ± 8.75^{a}	8.73 ± 4.23^{b}	9.47 ± 5.24^{b}	7.27 ± 5.96^{b}
T2	9.40 ± 4.95^{a}	8.07 ± 4.06^{b}	9.40 ± 5.44^{b}	3.47 ± 2.70^{b}
T3	12.07 ± 6.25^{a}	9.27 ± 5.06^{b}	10.87 ± 4.85^{b}	8.47 ± 5.96^{b}

Means with different superscripts along columns differ significantly ($p < .05$). T0 (no derris), T1: 7.5% (mean of 5% and 10%), T2: 10% and T3: 12.5% (mean of 10% and 15%).

The difference in tick counts every 72 hours was not significant ($p > .05$). These findings suggest that regular application of derris extract every three days may be necessary to maintain its effectiveness in reducing tick counts. Similarly, it was reported that the effectiveness of derris extract lasted three days after application (Wiwattanapatapee *et al.,* 2009). Therefore, considering the consistent effectiveness of derris extract in reducing tick counts for three days, it is recommended to incorporate regular application of derris extract as part of a comprehensive tick control strategy for cattle.

Conclusion

We found that derris can control ticks in dairy cattle; in particular, the 10% derris concentration was found to be more effective in controlling ticks. Therefore, derris can be an alternative solution to replace the chemical acaricides for tick control in cattle.

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