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Research Article

Epidemiological and Therapeutics Studies on Tick Species of Small Ruminants in Hargelle District, Afder Zone, Somali Region, Ethiopia

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ABSTRACT

Background: Tick infestations are the major causes of skin diseases and economically important parasitic diseases which hampers small ruminant production. The present study was conducted with aim of estimating prevalence of tick infestation, identifying common tick species and comparing acaricidal efficacy of commonly used acaricides in small ruminants in Hargele district of Somali region, Ethiopia.

Methods: A cross sectional and controlled field trial were carried out from July 2016 to May 2017 to study the epidemiology of tick infestation and evaluating the comparative efficacy of the three commonly utilized acaricides (diazinon, amitraz and ivermectin).

Result: The overall prevalence rate of tick infestation in small ruminants was 83.2% and species and body condition showed significant difference in the prevalence rate ($p<0.05$). In this study, *Rhipicephalus* was the most abundant (61.3%) and the most widely distributed genus whereas, *Hayaloma* was the least prevalent (17.1%) tick genus. *R. pulchellus* was the most abundant species followed by *R. evertsievertsi*, and *R. (B.) decoloratus*. Ivermectin-amitraz combination showed significant superiority ($p<0.05$) in relation to reducing mean tick count as compared to ivermectin alone and ivermectin-diazinon combination. Ivermectin-amitraz combination was able to eliminate almost all ticks from the body of infested goats 3-day post treatment with 100% efficacy.

Conclusion: The study revealed the high prevalence of tick infestation causing serious problem in small ruminant production in the study area. Therefore, attention should be given to the control of tick infestation in the region using effective therapeutic regimes and prevention strategies.

Keywords: Acaricides; Comparative efficacy; *Rhipicephalus*; Small ruminants; Tick infestation

INTRODUCTION

Small ruminants are the most important sources of income for the agricultural communities and are one of the main earners for foreign currency through skin and meat export. In addition, these are among the most important sources of animal proteins, accounts for 35% of meat and 14% of milk for local consumptions and constitute 92% of the value of semi-processed skin export trade [1]. However, their contribution to food production, rural cash income, and manure for soil fertility and export income are far below the expected potential [2]. This may be due to several factors, such as shortage of feed, genetic selection, housing and ectoparasitism [3].

Ectoparasitism cause considerable economic losses to farmers due to loss of animals' productivity, mortality and skin diseases [4,5]. Ticks and tickborne diseases cause considerable losses to the livestock economy and rank third among the major parasitic problems in Ethiopia after trypanosomes and endo-parasitism. The most common tick-borne diseases are *Anaplasmosis*, *Babesiosis*, *Theileriosis* and Heart water disease. Besides these, ticks also cause non-specific symptoms like dermatitis, toxicosis and paralysis [6].

Ticks belong to the phylum Arthropod, class Arachnid, and order Acari. The families of ticks parasitizing livestock are categorized into two: *Ixodidae* (hard ticks) and *Argasidae* (soft ticks) [7]. Ticks that are considered most important to animals' health in Africa comprise of about seven genera and sixteen species [8]. In Ethiopia, there are 47 species of ticks found on livestock, most of them have

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importance as vector and disease-causing agents, have damaging effect on skin and hide production [9,10]. The main genera of ticks found in Ethiopia are *Ambylomma* (40%), *Boophilus* (21%) and *Heamaphysalis* (0.5%), *Hyalomma* (1.5%) and *Rhipicephalus* (37%) [11,12].

Studies and reports from different parts of the Ethiopia showed that skin quality deterioration is very evident mainly due to ectoparasites [12,13]. Ticks, lice, keds, and mange mites are the major ectoparasites of small ruminants in Ethiopia [14]. The occurrence and spread of skin diseases has been shown to correlate with host factors, poor management, climatic factors, feed scarcity and inadequate veterinary services [15].The leather industry is one of the growing economic sectors in the country, but has lost revenue due to decline in quality and fall in export price [16]. According to reports from tanneries, hide and skin problem due to external parasites causes 35% of sheep and 56% of goat skins to be rejected in Ethiopia [17].

To overcome the economic and health problems posed by ectoparasite invasion in livestock, there is need to put appropriate control strategies in place. The application of chemicals is still the most effective method of ectoparasite control. In Ethiopia, over the past decades ectoparasites are mainly controlled by using variety of acaricides; including organochlorines, organophosphates, carbamates, amidines or synthetic pyrethroids [18,19].However, with the most widespread, under or over concentration and frequent use of organochlorines and organophosphate compounds, ectoparasites are likely to develop resistance in Ethiopia [18,19].

Therefore, studies on tick dynamics [20] with the efficacy status of acaricides against the most abundant and important ectoparasites in particular areas are necessary to carry out efficient ectoparasite control and burden reduction [21].In contrast to this huge economic loss caused by ticks, most of the pastoralists in the Somali region neglect ticks as animal health problem, most of them have little knowledge about effect of tick on their small ruminants and none of them know diseases transmitted to domestic animals by ticks [14]. Therefore, research should find ways of identifying and validating the effective therapeutic regimes and adopt an appropriate ectoparasite control strategy to safeguard the livelihood of livestock keeping society. Despite these facts, there is very little systematic research on population dynamics and appropriate control strategies of ticks under pastoral setting in Ethiopia. Moreover, there has not been a specific study conducted on status of tick infestation on small ruminants and comparative acaricidal efficacy test on commonly used acaricides in the study area. In line with this fact, the present work aimed at assessing status of tick infestation in small ruminants, identification of common tick species and comparative field efficacy trial of three commonly used acaricides and adopting effective tick control in Hargelle district, Afder Zone of Somali Regional State, Ethiopia through participatory approach.

MATERIALS AND METHODS

Period and study area description

The study was conducted from July 2016 to May 2017 in Bargelekebele of Hargele district in Afder Zone of Ethiopian Somali Regional State. Afder (Somali:Afdheer) is one of the eleven Zones of the Somali Region of Ethiopia. Afder is bordered on the southwest by the GanaleDorya River which separates it from Liben, on the west by the Oromia Region, on the north by Nogob Zone, on the northeast by Shabele Zone, and on south by the Provisional Administrative Line with Somalia. The administrative center of Afder is Hargele other towns in Afder include West Imey, and Cherti. The Afder Zone has estimated livestock population of 722,709 goats, 1,152,509 sheep, 16,471 cattle, 140,454 camels and 4,398 equines [22].

Study animals

Small ruminants (sheep and goat) of different age categories of both sexes that are kept under traditional extensive management system were included in the study. For the epidemiological study,"a total of 384 small ruminants (222 goats and 162 sheep) were randomly selected from the area and examined for the presence of ticks". Before clinical examination, the age, sex and body condition of each selected animal were recorded. The age of animals was categorized as young (0-2 years), adult (<2-4 years) and old (above 4 years of old) as per method described by Gatenby [23]. Age determination was made using owner's information and by dentition. Body condition scores were determined following the procedures documented by Steele [24] and ESGPIP [25] for sampled animals as poor, medium, and good classes following 1 up to 5 grading system.

Sample size determination

The desired sample size to assess the status of tick infestation in small ruminants was calculated by considering 95% confidence level, 5% desired absolute precision and as there is no previous research work conducted in the study area, 50% expected prevalence was adopted to determine the sample size using the formula given by Thrusfield [26]. Accordingly, a total of 384 small ruminants (222 goats and 162 sheep were selected and included in the study. A total of 20 goatsin 4 groups and each group belonging to same herd were used for comparative field efficacy experimental trials.

$$N = \frac{1.96^2 \times \sigma_{exp}\left(1-\sigma_{exp}\right)}{d^2}$$

Where: n=required sample size; Pexp=expected prevalence; d=desired absolute precision=0.05

Study design

The investigation employed a combination of epidemiological (cross-sectional and questionnaire survey) and experimental (controlled field trial) study designs. The study was carried out for 11 months from July 2016 to May 2017 using a cross sectional and controlled field experimental study design [26] to assess the prevalence of tick infestation, identify the common tick species and evaluation of comparative efficacy of the three commonly utilized acaricides (diazinon, amitraz and ivermectin)in Hargele district.

Questionnaire survey

Semi-structured interview using questionnaires was used as primary sources to collect data from respondents concerning tick infestation problems of small ruminants in their locality. By using the participatory survey, perception of herdsmen on tick invasion, seasonal occurrence and strategies of ectoparasite control was assessed. For this purpose, checklists were prepared for an in-depth interview of the livestock raisers to explore their traditional perception and knowledge on ectoparasite infestation, period of observation of ectoparasite on their livestock and common types of ectoparasites.

Tick collection and identification

The selected small ruminants were examined thoroughly from head to tail including legs for the presence of ticks on the body of the animals. The adult visible female and male ticks were collected from head (eye, ear), scrotum, around the anus, tail, leg and preserved in universal bottles containing 70% alcohol for further identification. The collected ticks from each bottle were placed onto petri-dishes and examined under stereomicroscope to identify to the species level with main identification features which included color, size and shape of mouth parts, scutum, anal groove, festoon, shape of base of capituli, coaxa I and presence of eye punctuation according to Welker et al. and Okello-Onen et al. [8,27].

Acaricidal efficacy study and participatory intervention

Based on the output from the participatory survey, personal observation in the field and recommendation from literature, a pilot experimental trial (in the field) using three commonly utilized acaricides (diazinon, amitraz and ivermectin) was done on field population of ticks. The choice of these acaricides was based on their commercial availability and patronage by livestock keepers in the area and recommendation from literature. The field efficacy trial was conducted in goat herds naturally and predominantly infested with Rhipecephaluspulchellus and Rhipecephalusevertsievertsi ticks under field condition. In addition, other tick species identified with minor number include Rhipecephalus (*Boophilus*) decloratus and H. truncatum. Application of chemicals was as follows:

Herd I (Group 1): Ivermectin (injection) alone

Herd II (Group 2): Ivermectin (injection)+diazinon (spray)

Herd III (Group 3): Ivermectin (injection)+amitarz (spray)

Herd IV (Group 4): Infested untreated (control group)

Thus, a total of 20 goats in 4 groups and each group belonging to same herdwith a mean number of >10 tick counts on different body sites were used for the trials (Figure 1).The acaricides were applied with more emphasis on tick infested regions of the body. The acaricides' concentration was based on the manufacturer's recommendation for hand spray (1:1000 for diazinon, 1:625 for amitraz) and injection (0.2 mg/kg of body weight). To monitor the number of ticks that attach and drop from animals, sketches was used to 1oughly locate the positions of ticks on animals.

Figure 1: Controlled field experimental efficacy trial scenes in the study area.

The tickicidal effects of the acaricides and dynamics of ticks on the animals was observed every other day and final results was recorded on Day 3, 5 and 7 post exposures. Antiparasitic efficacy of each treatment regimen was calculated using the following equation [28].

$$AE=[B-T/B]/B*100$$

Where AE is the antiparasitic efficacy, B is the mean number of surviving ticks in the control, and T is the mean number of surviving ticks in treatment. Finally, based on the outcome from each experiment, the right intervention regimen was decided which was scaled up at district level to reduce burden of ticks in sheep and goat flock in the area.

Data analysis

Data obtained was entered and stored in Microsoft Excel word sheet. Data was organized, edited and analyzed using Statistical Package for Social Sciences (SPSS) Version 20. Simple descriptive statistical analysis was used to analyze prevalence and distribution of tick species. Chi-square test was applied to compare the infestation rate with regard to body condition score, species, sex and age groups. Results generated from the investigation of field trial were expressed using descriptive statistics (mean ± standard error of mean, percentage and graphs). One-way analysis of variance (ANOVA) and the student t-test was employed for inter-group and intra-group difference analysis. Results were deemed statistically significant if $p \leq 0.05$ at 95% confidence levels.

RESULTS

Questionnaire survey result

All of the respondents (100%) know about tick and believe that tick infestation as major health problem of small ruminants. Among the participant pastoralists, 84% of them didn't practice treatment of tick infested animals while 70% of them believe that rainy season favors tick infestation. In addition, all the pastoralists indicated that there is no veterinary service in the study sites (Table 1). All PRG members reported that tick infestation is the major health problems of small ruminants in their locality.

Question content	Alternatives	Respondents	Total (%)
Ectoparasite infestation problem	Yes	50	100
	No	0	0
Common ectoparasites in your locality	Ticks	48	96
	Mange mites	2	4
	Flea	0	0
Know about tick	Yes	50	100
	No	0	0
Know the season for Tick infestation out break	Yes	43	86
	No	7	14
Season of tick infestation outbreak	Rainy season	35	70
	Early rainy season	8	16
	Dry season	3	6
	Throughout the year	4	8
Know the effect of ticks on the animals	Yes	45	90
	No	5	10
Practice treatment of infested animals	Yes	8	16
	No	42	84
Veterinary service in the locality	Yes	0	0
	No	50	100

Table 1: Questionnaire data representing the question items and respondent's response.

Tick infestation and risk factors

Out of the total 384 examined small ruminants, 322 (194 Caprine and 128 Ovine) were infested with ticks. The prevalence of tick infestation in goats and sheep were 87.4% and 79%, respectively and the overall prevalence in both species was 83.2%. The difference in the prevalence of tick infestation between species and body condition of animals was statistically significant ($p<0.05$). The prevalence rate was higher in goats (87.4%) than in sheep (79%) and higher in poor (81.5%) and medium body condition (88.8%) than good body condition of small ruminants (77.6%). The prevalence was found to be statistically insignificant within sex and age groups ($p>0.05$) (Table 2).

Variable		No of examined	No of infested (%)	X^2	p-value
Species	Caprine	222	194 (87.4%)	4.852	0.028
	Ovine	162	128 (79%)		
Sex	Male	166	139 (83.7%)	0.0031	0.956
	Female	218	183 (83.9%)		
Age	Young	95	75 (78.9%)	2.384	0.304
	Adult	199	169 (84.9%)		
	Old	90	78 (86.7%)		
BSC	Poor	81	66 (81.5%)	7.04	0.003
	Medium	187	166 (88.8%)		
	Good	116	90 (77.6%)		

Table 2: Prevalence of tick infestation based on age, body condition score (BCS), species and sex.

Tick burden and species identification

A total of 1657 adult ticks were collected from small ruminants in the study sites. Four different tick species were identified from three genera including *Boophilus* subgenus of *Rhipicephalus* during the study period: two *Rhipicephalus* species, one *Hyalomma* and *Rhipicephalus* (*Boophilus*) *decloratus*. *Rhipicephalus* (61.3%) was the most abundant and widely distributed genus in the study area whereas *Hayaloma* (17.1%) was the least prevalent tick genus in the study area (Table 3).*R. pulchellus*, was the most abundantly encountered species with high burden followed by *R. evertsievertsi*, and *R. (B.) decoloratus*. *H. truncatum* was the minor species observed in infested small ruminants in the study area (Table 4).

Genus of ticks	Total Number of ticks	% of total ticks
Rhipicephalus	1016	61.30%
Rhipicephalus (Bophilus)	359	21.60%
Hyalomma	282	17.10%

Table 3: Overall prevalence of total tick burden at genera level.

Tick Species	Total Number of ticks	%
R. Pulchellus	621	37.5
R. evertsievertsi	395	23.8
R. (B). Decoloratus	359	21.6
H. Truncatum	282	17

Table 4: Relative Prevalence of tick species in the study area.

Invivoacaricidal efficacy trials

The acaricidal efficacy assessment on live goats revealed significant superiority ($p<0.05$) of combination of Ivermectin and amitraz in relation to reducing mean tick count as compared to Ivermectin alone and Ivermectin and diazinon combination during the seven days observation period (Table 5). Ivermectin-Amitraz combination eliminated almost all ticks from the body of infested goats 72 h post treatment with 100% efficacy. Whereas the maximum antiparasitic efficacy brought about by Ivermectin alone, Ivermectin-diazinon combination was 93.75% and 96% respectively after 72 h of application. The efficacy of Ivermectin and Ivermectin-Amitraz combination was increased gradually until Day 7 post treatment but complete cessation of ticks was not achieved at the end of the experiment. When compared to the negative controls, all the drugs caused a significant reduction ($p<0.05$) in mean tick count. Average tick density in the infested untreated goats was nearly the same throughout the experiment.

Mean number of ticks (mean±SEM)/AE (%)				
Treatment	Pre-treatment	Post Treatment		
		Day 3	Day 5	Day7
Ivermectin only	19.4 ± 0.927	15.6 ± 1.03^{b,c}(93.75)	11.4 ± 0.75^{b,c}(95.4)	4.2 ± 0.37^{b,c}(98.3)
Ivermectin and Diazinon	13.8 ± 1.28	9.4 ± 0.8^{a,c}(96)	4.6 ± 0.25^{a,c}(98.1)	3.2 ± 0.74^{a,c}(98.7)
Ivermectin and Amitraz	13.6 ± 0.93	0 ± 0 (100)^{a,b,c}	0 ± 0 (100)^{a,b,c}	0 ± 0 (100)^{a,b,c}
Negative Control	17.6 ± 2.5	17.2 ± 2.31(0)	16 ± 2.39 (0)	15.8 ± 2.33 (0)

Note: Values are mean ± SEM; n=5; SEM: Standard Error of Mean; AE: Antiparasitic Efficacy; All superscripts indicate significance at $p<0.05$ (a compared to Ivermectin group, b compared to Ivermectin and diazinon group; c Negative Control).

Table 5: The efficacy dynamics of acaricides in relation to the day of examination.

Intervention

Mass acaricidal applications on small ruminants infested with tick infestation and their housing in the study area was done extensively using the most effective acaricides which is a combination of ivermectin and amitraz as shown in (Figure 2). One community animal health worker was trained during the study period on the preparation, dose and application of the acaricides. In addition, the research team donated effective acaricides and equipment's to the Bargelekebele representative to be used for future by the trained community animal health worker in the treatment of infested small ruminants.

Figure 2: Mass acaricide application on tick infested small ruminants and their houses using the most effective acaricide.

DISCUSSION

The questionnaire survey results revealed that the all respondents know or had information about the ticks and 100% of the interviewed participants believe that there is a tick infestation problem inthe

small ruminants in their locality. According to the majority of the respondent's analysis, tick infestation outbreak occurs during the rainy season. This is supported by Vatsya et al. [29] who reported rainfall (humidity) seemed to be an important macroclimatic factor influencing seasonal variation in tick infestation. Comparable findings were recorded in Jimma Zone [30] and in Borena pastoral area [31]. In addition, 16% of the respondents indicated they practice treatment of infested animals. In addition, all (100%) of the participants reported lack of veterinary service and tick control program in the district.

The present study revealed that tick infestation is still widespread and most significant external parasites of small ruminants in the study area. In this study a total of 1657 visible adult ticks were collected from infested sheep and goat. High prevalence rate of tick infestation was observed in Hargele district. This might be due to lack of veterinary service, control program in the area and agro-ecological condition of area is favorable for the existence of ticks. Comparable higher prevalence of tick infestation at 79.7% and 88% in small ruminants were also reported by Keder et al. [14] and Abunna et al. [32] in Fafan Zone, Somali Region respectively. Poor management and poor level of awareness of sheep and goat owners regarding the effect of ticks are believed to have contributed to widespread occurrence of infestations. Even though, pastoralists aware tick infestations as a problem in small ruminant production, awareness on prevention and control of ticks in has been not well understood by the community in the area.

However, the prevalence of tick infestation in the current study in sheep (79%) and goats (84.7%) was higher than the previously reported in eastern part of Amhara region, Northeast Ethiopia by [33] who had reported the prevalence of 18.6% in goats and 31.8% in sheep. The current study also disagrees with the studies conducted in Western Shoa Zone, Central Ethiopia by Zeryehun et al. [34] who had reported lower prevalence of ticks in sheep (22.5%) and goats (6.3%).The differences in these prevalence's might be due to the geographical difference, breed difference of the study animals and season of the study period.

In the present study, among the hypothesized risk factors associated with tick infestation, only species and body condition groups had significant association ($p<0.05$). Tick burden were significantly ($p<0.05$) higher in animals with poor and medium body condition than the good body condition. This may be due to the fact that poorly conditioned animals have low resistance to tick infestation and lack enough body capacity to build resistance whereas animals with good body condition showed reasonable combat to the infestation according to [35]. On the other way, tick infestation might be the cause for poor body condition instead of vice versa. There was no considerable difference ($p>0.05$) in the prevalence of ticks among different age groups and sex of animals. This is not in line with the previous research reports of Abdisa et al. [36] and Keder et al. [14] who reported statistically significant difference in the prevalence of tick infestation between different age groups.

In this study *Rhipicephalus* (61.3%) was the most abundant and widely distributed genus in the study area whereas *Hayaloma* (17.1%) was the least prevalent tick genus in the study area. R.pulchellus, was the most abundantly encountered species with high burden followed by R.evertsievertsi, and *R. (B.) decoloratus*. *H. truncatum* was the minor species observed in infested small ruminants in the study area. This is in agreement with the report of Keder et al. [14] who indicated *Rhipicephalus* (42.3%) was the most abundant and widely distributed genus in Fafan Zone.

Invivo field acaricidal efficacy trials indicated a significant superiority ($p<0.05$) of ivermectin-amitraz combination in relation to reducing mean tick count as compared to ivermectin alone and ivermectin-diazinon combination during the observation period. It was able to eliminate almost all ticks from the body of infested goats 3-day post application with 100% efficacy. This might be related to the decrease in the susceptibility of the tick to Ivermectin and diazinon. This finding is in line with report of Turkson et al. [37] who reported that field strain of some tick species is resistant to organophosphates like diazinon. Emergence of resistant ticks against organophosphate acaricides was also reported by Tessema et al. [38].

CONCLUSION

The finding of the present study indicates high prevalence and burden of ticks in Hargele district with overall prevalence of 83.2% and ticks are common and important ectoparasites of small ruminants causing health problems and reduction in production in the area. This study also provides data on the efficacy of three different commonly used acaricides against tick infestation on small ruminants, revealing a maximum efficacy (100%) at 3 days after treatment with ivermectin-amitraz combination and 98.3% and 98.7% at 7 days after treatment byivermectin alone and ivermectin-diazinon combination respectively. These findings will help to promote an effective control of tick infestations on animals, based on proper usage of the most effective acaricides combinations and on appropriate rotation scheme in order to avoid developing of chemo-resistance. Thus, it can be concluded that the high burden of tick infestation coupled with lack of veterinary service and awareness on the prevention and impact of ticks by the pastoralist, tick infestation is causing serious problem in small ruminant production in the area. Further investigation should be conducted on the frequency, distribution and seasonality of ticks and diseases these transmit in order to design efficient and cost-effective control measures. Therefore, it is recommended that attention should be given to the prevention and control of tick infestation in region using effective therapeutic regimes and other prevention strategies.

CONSENT TO PUBLISH

Not applicable.

AUTHORS' CONTRIBUTIONS

YGH: Conception of study, data collection, data analysis and interpretation, revising the manuscript and final approval of the version for publication. ANA: Design of the study, data collection and correction of the manuscript. AAA: Data collection and final editing and correcting of the manuscript. BAF: Design of study, writing and final editing and correcting of the manuscript.

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