

## Cross-Sectional Study

# Prevalence of Major Parasitic Agents Involved in Camel Skin Diseases in Babile District, Eastern Ethiopia

Tesfalegn Bassa, DVM; Ufaysa Gensa, DVM\*

Department of Animal Science, College of Agriculture and Natural Resource, Werabe University, P. O. Box 46, Ethiopia

## \*Corresponding author

Ufaysa Gensa, DVM

Department of Animal Science, College of Agriculture and Natural Resource, Werabe University, P. O. Box 46, Ethiopia; Phone: +251937261313/+251928981994;

E-mail: ufaysage@gmail.com

## Article information

Received: November 3<sup>rd</sup>, 2023; Revised: December 20<sup>th</sup>, 2023; Accepted: December 22<sup>nd</sup>, 2023; Published: December 29<sup>th</sup>, 2023

## Cite this article

Bassa T, Gensa U. Prevalence of major parasitic agents involved in camel skin diseases in Babile District, Eastern Ethiopia. *Vet Med Open J.* 2023; 8(2): 74-79. doi: [10.17140/VMOJ-8-180](https://doi.org/10.17140/VMOJ-8-180)

## ABSTRACT

## Aim

A cross-sectional study was conducted from October 2017 up to April 2018 in Babile district, Eastern Hararghe zone, Oromiya regional state of Ethiopia.

## Objective

To determine the prevalence of major parasitic agents involved in camel skin diseases and their risk factors.

## Method

A cross-sectional study design was implemented to determine the prevalence of major parasitic pathogens, particularly mange mites and ticks affecting camel skin, and associated risk factors. The target animals for the study were dromedary camels reared under pastoral and agro-pastoral production systems in Babile district of Oromia Regional State of Ethiopia. The sample size for the study was estimated by taking an expected prevalence of 50%, an accepted error of 5%, and a confidence level of 95%. A chi-square test was used to evaluate the differences in the occurrence of parasites among categorical variables (age, sex, herd size, and season). A  $p$ -value  $\leq 0.05$  was considered statistically significant.

## Results

Out of 768 camels examined, 122 (15.9%) and 113 (14.7%) were found to be infested with ticks of various species and *Sarcoptes* species, respectively. Nine hundred twenty-nine (929) adult tick species, including 329 (35.4%) males and 600 (64.59%) females, were collected from selected camels. The tick species identified in the present study were *Rhipicephalus pulchellus* (29.7%), *Amblyomma gemma* (4.84%), *Hyalomma dromedarii* (13.56%), *Boophilus decoloratus* (2.58%), *Amblyomma variegatum* (23.04%), *Amblyomma coherens* (8.61%), *Rhipicephalus evertsi* (9.15%), *Rhipicephalus pravus* (2.37%), *Rhipicephalus sanguineus* (4.2%), *Rhipicephalus appendiculatus* (1.08%) and *Hyalomma marginatum* (0.86%). The mean tick burden observed was 1.2 ticks per camel. *Sarcoptes* species was the only mite observed during this study. The tick infestation rate varied significantly ( $p < 0.05$ ) between seasons (dry and wet), between sex groups, and between herd sizes of camels. However, there was no statistically significant difference ( $p > 0.05$ ) in the prevalence of tick infestation between the age groups. Mange mite infestation varied significantly between age groups (young and adults).

## Conclusion

Finally, the tick and mange mite infestations were highly prevalent in the indigenous dromedary camels in the Babile district. Therefore, special attention should be given to the programmed tick and mite control campaign in the area.

## Keywords

Babile; Camel; Mange mite; Prevalence; Ticks.

## INTRODUCTION

Camel diseases, which are widespread in all agro-ecological zones in Ethiopia, cause major economic and social losses to the pastoralist and agro-pastoralist populations. Particularly, the impacts of parasitic and infectious diseases are devastating in pastoral and

remote areas, where the lives of the communities entirely depend on their camels. In addition, the provision of veterinary services becomes very difficult in these areas due to poor infrastructure, limited resources, and the mobility of the population.<sup>1</sup> Trypanosomiasis, camel pox, contagious skin necrosis, pneumonia, mange mites, tick infestations, and internal parasites are among the major health

problems previously reported in camels in pastoral areas.<sup>2,3</sup> The most important tick species reported to infest camels in eastern Ethiopia include *Rhipicephalus pulchellus*, *Amblyomma gemma*, *Hyalomma dromedarii*,<sup>4,5</sup> *Amblyomma variegatum*, *Boophilus decoloratus* and some others with very low proportions.<sup>5</sup>

There are two families of ticks: the Argasidae (soft ticks) and the Ixodidae (hard ticks). Ixodidae are characterized by having a rigid chitinous scutum that covers the entire dorsal surface of the adult male.<sup>6</sup> Ticks are among the agents leading to blood loss, damage to the skin, and being involved in transmitting various disease-causing agents.<sup>7</sup> In addition, lesions formed by the tick's mouthparts may attract flies and can lead to secondary bacterial infections. Infested camels often show signs of irritation and exhibit pruritus. There is a concern that camel ticks can serve as vectors of disease pathogens in livestock. For instance, *Amblyomma lepidum* or *A. gemma* may transmit *Cowdria ruminantium* (heartwater) to cattle. Moreover, it is reported that *H. dromedarii* is the vector of *Theileria camelensis*.<sup>8</sup>

Mange mite infestation was one of the most commonly encountered camel diseases in Borana, with prevalence rates ranging from 37.8% to 54.9% at different seasons.<sup>9</sup> *Sarcoptes scabiei* var. *cameli* is one of the most commonly encountered mites, and the infection is characterized by severe clinical manifestations.<sup>9</sup> *Sarcoptes scabiei* belongs to the burrowing mites and is thought to have a number of subspecies or variants.<sup>6</sup>

New hosts are infected by contact, presumably from larvae, which are commonly present on the skin surface.<sup>6</sup> Fomites also play an important part in the transmission of mites. Sarcoptic mites can survive outside their host for several days and remain infective<sup>10</sup> if the microclimate is sufficiently moist and cool. During the dry season in the tropics, the mites most likely do not survive long off the host. However, in crowded wet places such as waterholes, indirect transmission may occur, most probably during the cool and moist part of the night and early morning hours.<sup>8</sup>

All camels, regardless of sex and age, may be affected by *S. scabiei*.<sup>11</sup> Regarding body conditions, it is reported that animals in poor condition are more susceptible to infection. However, reported Nayel et al<sup>11</sup> that animals in very good condition can also become infected. The reports on the seasonality of the disease are conflicting. Some reported a quiescent phase in winter, while others found a higher incidence in winter.<sup>12,13</sup> Moreover, Higgins<sup>14</sup> found a higher prevalence in Saudi Arabia during the hot summer months. To our knowledge, prevalence investigations of major camel skin parasites were limited in the Babille district of Oromia, Ethiopia. The present investigation aims to determine the prevalence of common parasitic agents involved in the skin diseases of dromedary camels and the risk factors associated with their occurrence.

## MATERIALS AND METHODS

### Study Area and Climate Description

The study was conducted in the Babille district in the eastern Hararghe zone of Oromia Regional State, Ethiopia. It is located 31

km away from the town of Harar and about 557 km east of Addis Ababa, the capital city of Ethiopia. It lies between 8°, 9°9', 23°N latitude and 42°, 15'-42°, 53' E longitude and is characterized by a semi-arid and arid climate with an average annual rainfall of 410-800 mm and an annual temperature range of 24-28 °C. Babille district shares its borders with Gursum from the north, Fedis from the west, Harari National Regional State from the north-west, and Somalia National Regional State in the east, south, and west. The livestock population of the district is 55935 bovines, 22920 caprines, and 12350 ovines. In Babille district, there is an estimated total camel population of 12,000 and 300 camel owners in 21 rural Kebeles. The area is semi-arid lowland and receives low and erratic rains that occur in highly seasonal patterns. The area is characterized by very sparse vegetation growth composed of bushes, trees, shrubs, and grasses.<sup>15</sup>

### Study Animal Population

The target animals for the study were dromedary camels reared under pastoral and agro-pastoral production systems in Babille district of Oromia Regional State of Ethiopia. The informants used female camels for milk production, and male camels are used as pack animals. The camel breed living in the study district was an indigenous-type Shinille camel with grey and brown hair. The major feed resources for camels in the study district are browsing trees or bushes, but sometimes grasses. Besides, the communal use of pastures and seasonal migrations of herds and households are important features. The dromedary camels were selected for this study because of their large presence in the area. The ages of camels were classified based on their puberty profiles as young ( $\leq 3$ -years) and adults ( $> 3$ -years). The camel herd size was classified into small herd sizes ( $< 20$ ), medium (20-40), and large herd sizes (above 40) according to Feyera et al<sup>16</sup>. Season classification was based on the meteorology of Babille district, with the long dry season (from October to February) and the small rainy season (from March to April).

### Study Design

A cross-sectional study was implemented from October 2017 up to April 2018 in Babille district, Eastern Hararghe zone, Oromiya regional state of Ethiopia, in order to determine the prevalence of parasitic pathogens, particularly mange mites and ticks affecting camel skin, and associated risk factors (sex, age, season, and herd size).

### Sampling Techniques and Sample Size Determination

Villages were first selected based on camel population and accessibility. Accordingly, Bishan-Babille, Iffa, Tula, Barkale, Errer-Guda, Ifa Dini, Abdi-buchi, and Dakata were included in the study. Then camel flocks or caravans were selected using a simple random sampling method. Similarly, individual animals within the flock were selected using a simple random sampling method. Animals, irrespective of their sex, age, clinical condition, and husbandry condition, were included in the study. The camels included in this study were not dewormed before the sampling.

As there is no comprehensive study on the prevalence of common skin diseases of camels in the specified areas, the sample size for the study was estimated by taking an expected prevalence of 50%, an accepted error of 5%, and a confidence level of 95%, according to the formula given by Thrusfield.<sup>17</sup> Therefore, 384 camels were included.

$$n = \frac{1.96^2 \times P_{exp} (1 - P_{exp})}{d^2}$$

Where n=required sample size, d=desired absolute precision, P<sub>exp</sub>=expected prevalence.

However, to obtain a more representative sample for the two seasons and to increase precision, a double sample size of 768 camels was randomly selected for this study.

### Specimen Collection and Transportation

In the case where mange mite is suspected, drops of glycerin were added to the edge of skin lesions to moisten the area. Scab materials were obtained from the edge of the lesion, and a blunt scalpel blade was used to scrape until blood was just drawn. The scrapings and the scalpel blade were submitted to adherent material. The specimens were submitted to the Haramaya University College of Veterinary Medicine's (HU-CVM) Parasitology Laboratory. First, the whole body of the animal was examined to search for ticks and identify if it was infested. Then a half-body of the animal was used to collect the tick for counting the burden. Ticks in different anatomical sites of the body region were collected carefully and gently with a horizontal pull to the body surface of the camel by hand. The collected adult ticks were preserved in universal bottles containing 70% ethyl alcohol. Then it was labeled appropriately, transported to the HU-CVM Parasitology Laboratory, and identified using a stereomicroscope.

### Laboratory Examination

**Identification of parasites:** For the identification of mites, the col-

lected samples were examined under a microscope, and species identification was performed according to the morphological keys given.<sup>18</sup> The samples were treated with a 10% potassium hydroxide solution and examined under a light microscope. The collected ticks were identified to species level using a stereomicroscope using the standards recommended by Walker et al<sup>7</sup>.

### Data Management and Analysis

All collected data were entered into a Microsoft Excel sheet and analyzed using statistical package for the social sciences (SPSS) version 20. The occurrence of the diseases based on clinical and laboratory analysis was determined using frequency distribution. A chi-square was performed to evaluate the differences in the occurrence of parasites among categorical variables (age, sex, herd size, and season). A p-value ≤0.05 was considered statistically significant.

## RESULTS

### Prevalence of Tick Infestation

From the 63 herds examined, about 54 (85.7%) camel herds were found to have at least one animal infested with ticks. Out of 768 camels examined, 122 (15.9%) were infested with ticks. The occurrence of ticks on animals was significantly varied (p<0.05) among seasons, herd size, and sex categories of animals (Table 1). The study showed the presence of 4 tick genera (*Rhipicephalus*, *Amblyomma*, *Hyalomma*, and *Boophilus*) with a total number of 929 adult ixodid ticks (Table 2). Among the tick species, *R. pulchellus* was identified as the most common tick species on camels, with a distribution of 276 (29.7%). The second and third most common tick species affecting camels in the study area were *Amblyomma variegatum* and *Hyalomma dromedarii*, with distribution percentages of 23.04% (214) and 13.56% (126), respectively. Among the ticks, 600 (64.6%) were females, while 329 (35.4%) identified as males (Table 2). Moreover, the tick burden in the study area was recorded at 1.2 (929/768).

Variables	Categories	No. of Animals Examined	No. of Animals Infested (%)	χ <sup>2</sup>	p-value
Season	Long dry	375	46 (12.3)	7.2	0.007
	Small rainy	393	76 (19.3)		
	Total	768	122 (15.9)		
Herd size	Small (<20)	432	81 (18.8)	6.1	0.01
	Medium (20-40)	336	41 (12.2)		
	Total	768	122 (15.9)		
Sex	Male	246	50 (20.3)	5.3	0.02
	Female	522	72 (13.8)		
	Total	768	122 (15.9)		
Age	≤3 years	273	40 (14.7)	0.5	0.4
	>3 years	495	82 (16.6)		
	Total	768	122 (15.9)		

**Table 2. Distribution and Sex Categories of Adult Tick Species**

Tick Genera	Tick Species	Number (%) of		Total (%) Distribution	Female to Male Ratio	Prevalence (%) (n=768)
		Female	Male			
Rhipicephalus	<i>R. pulchellus</i>	188 (20.2)	88 (9.5)	276 (29.7)	2.13	51 (6.6)
	<i>R. pravus</i>	13 (1.40)	9 (0.9)	22( 2.4)	1.44	7 (0.9)
	<i>R. evertsievertsi</i>	62 (6.67)	23 (2.5)	85 (9.2)	2.69	21 (2.7)
	<i>R. sanguineus</i>	31 (3.34)	8 (0.9)	39(4.2)	3.875	11 (1.4)
	<i>R. appendiculatus</i>	8(0.86)	2 (0.22)	10(1.1)	4	5 (0.6)
Amblyoma	<i>A. gemma</i>	23 (2.48)	22 (2.4)	45 (4.8)	1.04	21 (2.7)
	<i>A. variegatum</i>	117 (12.6)	97 (10.4)	214 (23.04)	1.21	57 (7.4)
	<i>A. coherence</i>	53 (5.71)	27 (2.91)	80(8.6)	1.96	19 (2.4)
Hyalomma	<i>H. dromedarii</i>	82 (8.83)	44 (4.7)	126(13.6)	1.86	25 (3.2)
	<i>H. marginatum</i>	4 (0.43)	4 (0.4)	8(0.9)	1	3 (0.3)
Boophilus	<i>B. decoloratus</i>	19 (2.05)	5 (0.5)	24(2.9)	3.8	6 (0.7)
	Total	600 (64.6)	329 (35.4)	929	1.82	

n=number of animals examined

### Prevalence of Mange Infestation

The present study showed that about 49 (77.8%) herds of camels were infested with mange mites. Out of 768 animals examined, 113 (14.7%) were infected by mange mites. *Sarcoptes* species was the only mange mite identified in the study area. The prevalence of mange mite infestation was significantly higher ( $p \leq 0.05$ ) in adult animals than the younger ones (Table 3). However, no statistically significant association ( $p > 0.05$ ) was seen among the sex, season, and herd size categories.

**Table 1. Prevalence of Mange Infestation Based on Risk Factors**

Variables	Categories	No. of Examined	No. of Infested (%)	$\chi^2$	p-value
Season	Long dry	375	50(13.3)	1.1	0.3
	Small rainy	393	63(16.0)		
Herd size	Small (<20)	432	63(14.6)	0.01	0.9
	Medium (20-40)	336	50(14.9)		
Sex	Male	246	41(16.7)	1.1	0.3
	Female	522	72(13.8)		
Age	$\leq 3$ years	273	26(9.5)	9.1	0.003
	>3 years	495	87(17.6)		
Total		768	113 (14.7)		

### DISCUSSION

In the present study, the overall prevalence of tick infestation (15.9%) is far lower than previous reports by Megersa et al<sup>9</sup> (97.7%), Taddese et al<sup>19</sup> (94.00%), and Isse et al<sup>20</sup> (97%) in the country. This could be due to the season of data collection, the access to veterinary services for camel owners, and the identified tick developmental stages. Particularly, this could be due to increased awareness of the impact of tick infestations and the use of varied drugs to control ticks and other external parasite infestations. The

current study showed that the most abundant tick species identified were *R. pulchellus*, with a distribution of 29.7%, followed by *Amblyomma variegatum* (23.04%) and *Hyalomma dromedarii* (13.7%). This is comparable with the previous report by Megersa et al<sup>9</sup>, who stated that *R. pulchellus* represented the main tick species infesting camels (69.6%).

In the present study, out of the total 929 adult ticks collected, females account for 600 (64.6%). This finding is in agreement with Kiffner et al<sup>21</sup>, who reported that female ticks were more prevalent than male ticks. It is disagreed with Megersa et al<sup>9</sup> and Wasihun et al<sup>22</sup> that the outnumbering of male ticks is due to the fact that female ticks, once fully engorged, drop off the host to oviposit while males remain for several months and continue feeding and mating with other females. However, in the present study, the relatively high number of female ticks could be due to the fact that male ticks are smaller than females because fully engorged adult female ticks are easily visible until dropped off from hosts or male ticks will die after mating with female ticks immediately, and biologically, it may also be due to hatching more female tick larvae than male tick larvae because during mating fertilization is a chance.

The study showed a significant increase ( $p < 0.05$ ) in tick prevalence during the small rainy season (19.3%) compared to the long dry season (12.3%) among the examined camels. This result is in agreement with the report of Nady et al<sup>23</sup> who reported an increased tick infestation during the rainy season compared to the dry months due to increased humidity. It is also indicated that the highest moisture is favorable for tick growth at all different developmental stages, and the skin is easily penetrated for sucking blood.<sup>9</sup>

The current study revealed that there was a statistically significant difference ( $p < 0.05$ ) in the prevalence of ticks among sex categories, with male camels tending to have higher rates (20.3%) than female camels (13.8%). This result is in agreement



with the report of Megersa et al.<sup>9</sup> This is because female camels are being daily restrained for milking, and during this time, the milkers might remove ticks by hand, which could lead to a gradual reduction in the average tick load. On the contrary, some reported that male animals are mainly used for transportation, and hence they are under close supervision by their owners for tick infestation, whereas female animals mostly dwell around grazing areas (shrubs) that create easy access for ticks.<sup>19</sup> Generally, there is no biological explanation for the sex-related susceptibility of camels to tick infestation.

Moreover, the study revealed that animals managed in small herd sizes were more infested by ticks than those in medium herd sizes ( $p < 0.05$ ). This could be due to the good attention given by owners to large herd sizes rather than small herd sizes of animals, because they consider themselves more economically advantageous, proud, and respected in society by having large herd sizes of animals.

In the current study, the prevalence of mange mite infestation was 14.7%, which is lower than the report of Megersa et al<sup>9</sup> who reported 25.9%. However, it was comparable with the report of Awol et al,<sup>24</sup> with 16.7% prevalence. This is because of the community's awareness of diseased camels at Babile Veterinary Clinics and the presence of effective drugs to treat them. The study showed a statistically significant difference ( $p < 0.05$ ) among age categories, with a higher prevalence in adult camels (17.6%) than in younger (9.5%). This is due to the fact that young animals acquire natural immunity obtained by feeding the colostrum of the dam, while adult animals lose immunity progressively due to the loss of energy of female animals during pregnancy, parturition, providing colostrum feed for the calf, and giving milk to owners, while male camels lose energy by transporting and carrying large loads.

### CONCLUSION AND RECOMMENDATIONS

In conclusion, out of 768 camels examined, 122 (15.9%) and 113 (14.7%) were found to be infested with ticks of various species and Sarcoptes species, respectively. The predominant tick species encountered in the present study were *R. pulchellus*, *A. variegatum*, and *H. dromedarii*. Factors like season, herd size, and sex were significantly associated with the prevalence of camel ticks in the study area. Sarcoptes species were also found to be important external parasites of camels in Babile district. Age is a factor affecting the infestation of camel mange mites in this study area. Further research work on the seasonal pattern, biology, and vector role of ticks should be carried out in Babile district. Immediate professional intervention is necessary to control ectoparasites, specifically *Sarcoptes scabiei* var. *cameli*, due to their zoonotic significance and the impact of infestation on camel production and productivity in the study area.

According to the above conclusion, the following recommendations are forwarded:

- The tick control program should be encouraged in the study area, with an increasing frequency of application in wet months.
- All stakeholders should pay special attention to the control and

prevention of external parasitic agents involved in the camel skin disease.

- An awareness campaign should be created for camel owners regarding the prevention of external parasitic infestations, regardless of their herd size.
- Further research should be carried out on the economic loss due to tick and mite infestations in this district.

### DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, Ufaysa Gensa, upon reasonable request.

### DECLARATIONS

This study was approved by the Ethical and Research Review Board of Haromaya University, Ethiopia, and a formal letter of contact was made with the selected zonal and district governmental bodies. Before starting the research, the camel owners consent was achieved by explaining the study objective through brief group discussions with the camel owners.

### CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

### REFERENCES

1. Zewdie S. Animal Health Services Delivery in Ethiopia. Paper presented at: 18<sup>th</sup> Annual Conference of the Ethiopian Veterinary Association (EVA); June 9-10, 2004; Addis Ababa, Ethiopia.
2. Demeke G. *Prevalence of Camel Trypanosomes and Factors Associated with the Disease Occurrence in Liben District, Borana Zone of Oromia region, Ethiopia* [master's thesis]. Debre Zeit, Ethiopia: Addis Ababa University; 1998.
3. Pegram RG, Hoogstrel H, Wassef HY. Ticks (Acarida: Ixodida) of Ethiopia distribution ecology and host relationship of species infecting livestock. *Bull. Entomol. Res.* 1981; 71: 309-359.
4. Dinka A, Eyerusalem B, Yacob HT. A study on major ectoparasites of camel in and around Dire-Dawa, Eastern Ethiopia. *Revue Méd. Vét.* 2010; 161(11): 498-501.
5. Zeleke M, Bekele T. Species of Tick on camels and their seasonal population dynamics in Eastern Ethiopia. *Trop. Anim. Health Prod.* 2004; 36: 225-231. doi: 10.1023/b:trop.0000016830.30194.2a
6. Urquhart GM, Armour J, Duncan JL, Dunn AM, Jennings FW. *Veterinary Parasitology*, 2<sup>nd</sup> ed. Oxford, England: Blackwell Science Ltd; 1996: 191-193.
7. Walker, A.R., Bouattour A, Camicas JL, et al. *Ticks of Domestic Animals in Africa: A Guide to Identification of Species*. Edinburgh, Scotland: Bioscience Reports Publishers; 2003: 1-221.
8. Wernery U, Kaaden OR. *Infectious Diseases in Camelids*. 2<sup>nd</sup> ed. Ber-

lin, Germany; Blackwell Science: 2002; 313-330.

9. Megersa BD, Bekele J, Adane B, Sheferaw D. Ticks and mange mites infesting camels of Boran pastoral areas and the associated risk factors Southern Ethiopia. *J. Vet. Med. Anim. Health.* 2012; 4(5): 71-77. doi: [10.5897/JVMAH12.029](https://doi.org/10.5897/JVMAH12.029)

10. Arlian LG. Biology, host relations and epidemiology of *Sarcoptes scabiei*. *Ann. Rev. Entomol.* 1989; 34: 139-161. doi: [10.1146/annurev.en.34.010189.001035](https://doi.org/10.1146/annurev.en.34.010189.001035)

11. Nayel NM, Abu-Samra MT. Sarcoptic mange in the one-humped camel (*Camelus dromedarius*). A clinico-pathological and epizootiological study of the disease and its treatment. *Journal of Arid Environments.* 1986. 10: 199-211. doi: [10.1016/S0140-1963\(18\)31240-0](https://doi.org/10.1016/S0140-1963(18)31240-0)

12. Lodha KR. Studies on sarcoptic mange in camels (*Camelus dromedarius*). *Vet Rec.* 1966; 79: 41-43. doi: [10.1136/vr.79.2.41](https://doi.org/10.1136/vr.79.2.41)

13. Rathore MS, Lodha KR. Observation on sarcoptic mange in camels (*Camelus dromedarius*). *Indian Vet. J.* 1973; 50: 1083-1088.

14. Higgins AJ. Sarcoptic mange in the Arabian camel. *World Review of Animal Production.* 1984; 49: 2-5.

15. Babile District Development of Livestock Resources and Fishery (BDDLRF). A technical report. 2018.

16. Feyera T, Admasu P, Abdilahi Z, Mammed B. Epidemiological and therapeutic studies of camel mange in Fafan zone, Eastern Ethiopia. *Parasit Vectors.* 2015; 8: 612. doi: [10.1186/s13071-015-1228-0](https://doi.org/10.1186/s13071-015-1228-0)

17. Thrusfield MV. *Veterinary Epidemiology.* 3<sup>rd</sup> ed. Edinburgh, UK: Black Well Science Ltd; 2005: 229-250.

18. Wall R, Shearer D. *Veterinary Entomology.* 1<sup>st</sup> ed. FL, USA: Chapman and Hall; 1997: 1-438.

19. Taddese A, Mustefa M. A study on camels ticks in and around Dire Dawa, Eastern Ethiopia. *Acta Parasitologica Globalis.* 2013; 4(2): 64-70. doi: [10.5829/idosi.apg.2013.4.2.64173](https://doi.org/10.5829/idosi.apg.2013.4.2.64173)

20. Isse F, Saed A, Ali M. Hard tick distribution of camels in and around Galkaio District, Somalia. *Glob J Med Res.* 2017; 17(1): 2249-4618.

21. Kiffner C, Lödige C, Alings M, Vor T, Rühle F. Attachment site selection of ticks on roe deer, *Capreolus capreolus*. *Exp Appl Acarol.* 2011; 53: 79-94. doi: [10.1007/s10493-010-9378-4](https://doi.org/10.1007/s10493-010-9378-4)

22. Wasihun P, Doda D. Study on prevalence and identification of ticks in Humbo district, Southern Nations, Nationalities, and People's Region (SNNPR), Ethiopia. *J. Vet. Med. Anim. Health.* 2013; 5(3): 73-80. doi: [10.5897/JVMAH12.040](https://doi.org/10.5897/JVMAH12.040)

23. Asmaa NM, ElBably MA, Shokier KA. Studies on prevalence, risk indicators and control options for tick infestation in ruminants. *Beni-Suef University Journal of Basic and Applied Sciences.* 2014; 3: 68-73. doi: [10.1016/j.bjbas.2014.02.009](https://doi.org/10.1016/j.bjbas.2014.02.009)

24. Awol N, Kiros S, Tsegaye Y, Ali M, Hadush B. Study on mange mite of camel in Raya-Azebo district, northern Ethiopia. *Vet Res Forum.* 2014; 5(1): 61-64.