Global Veterinaria 16 (3): 238-246, 2016
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2016.16.03.102101

Prevalence and Species Composition of Ticks Infesting Cattle In and Around Bishoftu Town, Oromia Region, Ethiopia

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Abstract: A cross section study was conducted from October 2013 to March 2014 in and around Bishoftu town with the objectives of determining the prevalence of bovine tick species within groups of age, sex, breed and body condition scores under different management systems and to assess the effects of different tick species on the packed cell volume. Out of the 384 cattle examined, 270 (70.31%) were found to be infested by one or more tick species. About 1066 ticks were collected and the collected tick were identified to genera and species level, four genera; namely *Ambylomma, Rhipicephalus (Boophilus)* and *Hyalomma* and five species were identified of, which *Ambylomma variegatum* was the most abundant tick species comprising of 43.6 % of the total collection and the least abundant tick species was *Hyalomma marginatum rufipes* (4.7%). The association of the prevalence of tick infestation with different risk factors was assessed to be statistically significant between sex, body condition, breed of cattle and management. However, it was statistically insignificant between the age group of animals. Male animals were statistically significantly infested more than females, which was 79.09% and 58.53%, respectively. Local breed were statistically significantly infested more than crossbreed, which were 82.75% and 31.91%, respectively. Medium and poor body condition animals were statistically significantly infested ticks than good body conditioned cattle, which were 76.70%, 74.24% and 17.94%, respectively. There was no statistically significant variation between the age groups, however, adult age group was more infested than the young age group, which was 74.56% and 58.1%. Cattle kept under extensive production system were highly infested than in those kept under semi-intensive production system with statistically significant difference. There was no significant difference between tick infestation and anemia but tick-infested cattle have lower mean packed cell volume (PCV) than the non-ticks infested cattle, which was 27.90% and 29.43%, respectively. Therefore further research should be undertaken to study the exact effect of ticks on the packed cell volume (PCV) and effective tick control programs should be formulated and implemented based on the patterns and factors of ticks responsible for their distribution.

Key words: *Amblyomma* · Anemia · *Hyalomma* · Packed Cell Volume · *Rhipicephalus*

INTRODUCTION

Ethiopia is blessed with a large population of livestock in Africa and is estimated to have about 53.99 million cattle, 24.06 million goats, 25.5 million sheep, 1.91 million horses, 6.75 million donkeys, 0.35 million mules, 0.92 million camels and 50.38 million poultry [1]. However, poor health and productivity of animal due to disease has considerably become the major obstacle to the potential of livestock industry [2]. Nowadays parasitism represents a major obstacle to development and utilization of animal resource [3].

Ectoparasites are organisms that spend all or part of their life cycles on the external of another organism, the host and in the process extract nutriment from it for survival. They could live on, puncture, burrow or attach onto the surface of their host causing discomfort, annoyance, weight loss, loss of condition, reduction in milk production and irritation of the skin, which subsequently leads to ulceration and secondary infections. These result negative effect on animal welfare, animal husbandry and general quality of production [4].

Ticks are interesting largely because of their considerable medical and veterinary importance [5].

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They have attracted a great deal of scientific attention due to their role as vectors of numerous pathogens [6]. They belong to the phylum Arthropoda, class Arachnida, order Acari. Totally over 896 valid tick species (702 Ixodid, 193 Argasid and 1 Nuttalliella tick) have been recorded from all climatic zones throughout the world [7]. Seven of these genera contain species of veterinary and medical importance. These are *Ambylomma*, *Dermacentor*, *Haemaphysalis*, *Hyalomma*, *Ixodes* and *Rhipicephalus* [5].

Ticks are cosmopolitan in distribution, but occur principally in tropical and subtropical regions [8]. Ethiopia being a tropical country provides optimal climatic conditions for growth and multiplication of ticks. Several tick species of the genera *Ambylomma*, *Haemaphysalis*, *Hyalomma* and *Rhipicephalus* have been identified in Ethiopian [9]. Tick surveys have been carried out in different regions by different researchers [10-14]. More than 60 species of ticks infesting both domestic and wild animals have been recorded [9] and 33 of these are known to be most common and are important parasites of livestock [10].

Tick borne diseases transmitted by the major tick species in Ethiopia are Anaplasmosis, Babesiosis, Ehrlichiosis and Theileriosis [12, 15]. Due to economic and veterinary importance of ticks, their control and the transmission of tick borne diseases remain a challenge for the cattle industry in tropical and subtropical areas of the world [16].

The pathogens transmitted by ticks can cause high morbidity and mortality in livestock some of the most important tick transmit diseases are bacteria (*Rickettsia*, *Ehrlichia*, *Borrelia*) and protists (*Babesia* and *Theileria*) [17]. These diseases generally affect the blood and lymphatic system and cause fever, anemia, jaundice, anorexia, weight loss, milk drop, malaise, swelling of lymph node, dyspnoea, diarrhea, nervous disorders and even death these factors also contribute to losses in milk production, calving interval and weaning performance [18].

The distribution limits of ticks are determined by a complex interaction of factors such as climate, host density, host susceptibility and grazing habits [19]. Therefore, the objectives of this study were to determine the prevalence of bovine tick species within groups of age, sex, breed and body condition scores under different management systems in and around Bishoftu town and to assess the effects of different tick species on the packed cell volume.

MATERIALS AND METHODS

Study Area: The study was conducted in and around Bishoftu town. Bishoftu is located in Central Oromia regional state, at a distance of 47 km of the South Eastern part of Addis Ababa. It is the main city of Ada'a district, situated on two international trade routes, which are connected by Franco-Ethiopia Djibouti Railway and Addis-Moyale Nairobi, Intercontinental Asphalted Road Transport Route [20]. Bishoftu lies between 9° N latitude and 39° E longitude and an altitude of 1860 meter above sea level. It gets an annual rainfall of 871 mm of which 80% is received during long rainy season starting from June to September and the remaining in short rainy season extending from March to May and the dry season from October to February. The mean annual maximum and minimum temperature are 26 and 14°, respectively with a minimum relative humidity of 63.8% [21].

Study Population: The study animals were all age groups of cattle that were randomly selected from small holders farms in and around Bishoftu.

Study Design: A cross sectional study was conducted to identify species of ticks and to determine the prevalence of ticks within a group of breeds, ages, body condition scores and sex and effect of tick species on packed cell volume. The age of cattle were grouped as young (1 to 3 years) and adults (> 3 years).

Sample Size Determination: The desired sample size was determined by assuming 50% expected prevalence of tick infestation at 95% confidence interval and 5% absolute precision. Therefore, the relevant formula for the desired sample size was based on Thrustfield [22] would be:

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

where n= required sample size p_{exp}=expected prevalence d=desired absolute precision

By substituting these values in the formula, the sample size taken was n = 384.

Collection and Preservation of Samples: After restraining cattle, visible adult ticks were carefully removed from the host for identification and count using steel forceps [23] following standard tick collection techniques [24]. Counting of ticks was done on one side of the animal [25].

Half body tick collection method on the alternative side was made. The collected ticks were placed in to universal bottle containing 70% ethanol [26]. Ticks were collected from different body parts of cattle such as head, neck and dewlap, posterior back and rump, ventral body part and the upper part of the tail were kept separately in to separate well labelled (date, sex, breed, body condition, management system, age, site of collection, predilection site) sample bottles and transported to Addis Abeba University College of Veterinary Medicine parasitology laboratory.

Tick Identification: Tick identification was performed based on identification keys adopted by Walker *et al*. [25].

Packed Cell Volume (PCV) Determination

Sample Collection and Laboratory Procedure: Parallel with tick collection procedures, PCV of all studied animals was determined. Blood samples were obtained by puncturing of the marginal ear vein with a lancet, collected directly into a capillary tube and filled to 3/4th of its length; the tube has been treated with heparin. The capillary tubes were placed in microhaematocrit centrifuge with sealed end outer most load the tube symmetrically to ensure good balance. After screwing the rotary cover and closing the centrifuge lid, the specimens were allowed to centrifuge at 12, 000 rpm for five minutes. Tubes were then placed in haematocrit reader and expressed the reading as a percentage of packed red cells to the total volume of whole blood and the animal with values of PCV less than 24% were considered anemic [27].

Data Analysis: All data were collected and statistical analyses were conducted using SPSS statistical software version 20.0 and Logistic regression using STATA 12 statistical computer software. The laboratory data were coded and the association of risk factors with the occurrence of the diseases was assessed using Chi-square. In all cases, 95% confidence intervals and P <0.05 was set for significance [22].

RESULTS

The Overall Prevalence of Ticks: A total of 1066 ticks were collected from different body part of tick-infested cattle. From examined cattle 270 (70.31%) were infested by tick. From the collected tick, four genera were identified, such as *Ambylomma, Rhipicephalus* and *Hyalomma*. Five species of ticks were identified, *Ambylomma variegatum* were the most abundant tick species comprising of 43.6 % of the total collection. *Rhipicephalus evertsi-evertsi,* which was 15.4% and the second most abundant tick species of the whole collection. The third widely distribute tick species was *Rhipicephalus* (*Boophilus) decolaratus*, which was accounted for 11.7% of the total collection and the fourth was *Ambylomma cohaerence* 5.4% and the fifth least abundant tick was *Hyalomma marginatum rufipes* (4.7%) (Table 1).

From the 384 cattle, examined 270 (70.31%) were positive for ticks. Adult cattle were more affected than young age cattle with the prevalence of 74.56% and 58.1*%* in adult and young age cattle, respectively. However, there was no statistically significance variation (P>0.05) between age groups. There was statistically significance variation (P< 0.05) between males and females with the infestation of tick, which was 79.09% and 58.53%, respectively. Local breed cattle were significantly (P < 0.05) infested by tick than crossbreed, which was 82.75% and 31.91%, respectively. Medium and poor body condition animals were statistically significantly (P < 0.05) infested by tick than good body condition, which were 76.70%, 74.24% and 17.94%, respectively. The cattle managed under extensive system were significantly (P< 0.05) infested by tick than the semi intensive which was 77.94% and 51.78%, respectively (Table 2).

Ticks Infestation Based on Sex: Out of the total 220 males examined 221 (79.09%) were positive for ticks of different genera, which were *Ambylomma* 57.3%, *Rhipicephalus* 38% and *Hayalomma* 5% while the total females examined were 164 and 96 (58.53%) were positive for different genera, of ticks of *Ambylomma* 37.8%, *Rhipicephalus* 26% and *Hayalomma* 5.0%. There was statistically significant difference (P < 0.05) in infestation by the genera of *Ambaylomma* and *Rhipicephalus* between sex groups. The males were infested with *Ambaylomma* more than female where the females were infested by *Rhipicephalus* more than males (Table 3).

Prevalence of Ticks in Relation to Management System: Out of the total examined cattle, 227 from extensive and 112 were from semi intensive management system. From these examined animals, there were the variations of the prevalence of different tick genera from management to management. There was statistically significant difference (P < 0.05) among genera of *Ambylomma* and *Rhipicephalus.* The genera of *Ambylomma* and *Rhipicephalus* were highly prevalent in extensive (Table 4).

Table 1: Distribution of tick species of cattle in and around Bishoftu town

Species of tick	Distribution of tick species
Ambylomma variegatum	43.6%
Rhipicephalus evertsi-evertsi	15.4%
Rhipicephalus (Boophilus) decolaratus,	11.7%
Ambylomma cohaerence	5.4%
Hyalomma marginatum rufipes	4.7%

Table 2: Association of risk factors with tick prevalence by multivariate logistic regression

				95 % Confidence Interval		
Variable	No sampled	OR	P-value	Lower Bound	Upper Bound	Proportion of tick infestation in relation to different risk factors
Age						
Young	101	-	-	-	-	n=59 (58.1%)
Adult	283	1.351297	0.328	.7396312	2.468803	n=211 (74.56%)
Sex						
Males	220	-	-	-	-	n=174 (79.09%)
Females	164	.4018376	0.002	.2232518	.7232795	n=96 (58.53%)
Breed						
Local	290	.1666327	0.000	.0692305	.4010726	n=240 (82.75%)
Cross	94	-	-	-	-	n=30 (31.91%)
Body condition						
Good	39	.0491448	0.000	.0158489	.1523895	n=7 (17.94%)
Medium	279	.7782727	0.500	.3756625	1.612374	n=214 (76.70%)
Poor	66	-	-	-	-	n=49 (74.24%)
Management						
Extensive	272	-	-	-	-	n=212 (77.94%)
Semi-intensive	112	3.289655	0.000	2.059079	5.255665	n=58 (51.78%)

Bottom Rule: OR=odds ratio, CI=confidence interval

Table 3: Prevalence of tick genera infestation in relation to sex of studied cattle

Ticks	Sex of animals	Examined	Positive	Prevalence	χ^2	P- value
Ambylomma	Males	220	126	57.3%	14.250	.034
	Females	164	62	37.8%		
	Total	384	188	49.0%		
Rhipicephalus	Males	220	84	38%	31.9	.000
	Females	164	43	26%		
	Total	384	127	33%		
Hayalomma	Males	220	11	5 %	.113	.737
	Females	164	7	5.0%		
	Total	384		70.31%		

Table 4: Prevalence of tick genera infestation in relation to management system

Ticks	Management	Examined	Positive	Prevalence	χ^2	P- value
Ambylomma	Extensive	272	157	57.72%	146.182	0.046
	Semi- intensive	112	31	27.67%		
Rhipicephalus	Extensive	272	82	30%	4.72	0.03
	Semi- intensive	112	22	19.6%		
Hayalomma	Extensive	272	11	4.0%	0.864	0.353
	Semi- intensive	112	7	6.2%		

Table 5: Prevalence of tick genera infestation in relation to body condition

Ticks	Body condition	Examined	Positive	Prevalence	χ^2	P- value
Ambylomma	Good	39	1	2.6%	40.830	.013
	Medium	279	158	56.6%		
	Poor	66	29	56.6%		
Rhipicephalus	Good	39	1	2.6%	-	-
	Medium	279	81	29%		
	Poor	66	22	33.3%		
Hayalomma	Good	39	1	2.6%	6.328	.042
	Medium	279	10	3.6%		
	Poor	66	7	10.6%		

Table 6: Prevalence of tick genera infestation in relation to age groups

Ticks	Age	Examined	Positive	Prevalence	χ^2	P- value
Ambylomma	Adult	283	154	54.4%	12.830	.023
	young	101	34	33.7%		
Rhipicephalus	Adult	283	81	28.6%	1.3	.26
	young	101	23	22.8%		
Hayalomma	Adult	283	15	5.3%	.905	.342
	young	101	3	3.0%		

Table 7: Anemic status with association of risk factors with tick prevalence by multivariate logistic regression

				95 % Confidence Interval		
Variable	No Sampled	OR	P value	Lower Bound	Upper Bound	Proportion of anemia status in relation to tick infestation
Age						
Young	101	-	-	-	-	n= 59(21)35.6%
Adult	283	.580461	0.052	.335634	1.003877	n=211(50) 23.7%
Sex						
Males	220	-	-	-	-	n=174(7) 4.02%
Females	164	1.17841	0.546	.6919975	2.006722	n=96 (35) 36.46%
Breed						
Local	290	-	-	-	-	n=240(27) 11.25%
Cross	94	1.6425	0.310	.6299914	4.282272	n=30 (11) 36.66%
Body condition						
Good	39	.17829	0.019	.0423901	.7498371	n=7 (0) 0%
Medium	279	-	-	-	-	n=214(28) 13.08%
Poor	66	-	-	-	-	n=49(7) 14.3%
Management						
Extensive	272	1.47449	0.383	.616568	3.526146	n=212 (27) 12.73%
Semi-intensive	112	-	-	-	-	n=58 (1) 1.72%

Prevalence of Tick Based on Body Condition Scores: There was statistically significant difference ($P < 0.05$) in tick infestation among body condition scores among the genera *Hayalomm* and *Ambylomma.* Poor and medium body conditions were significantly ($P < 0.05$) infested than good body condition (Table 5).

Prevalence of Ticks in Relation to Age: From 384 examined cattle, there were 101 young age groups and 283 adult age groups. Out of these examined cattle, 59 (58.1%) young ages and 211 (74.56%) adult ages animals were infested by different genera of ticks. There was significant variation ($P < 0.05$) between *Ambylomma* and age groups with high prevalence in the adult age group, while *Rhipicephalus* and *Hayalomma* were insignificantly ($P > 0.05$) infested in both age groups (Table 6).

Anemia Status in Relation to Tick Infestation: From the total cattle infested by tick 71 (26.3%) were anemic and 199 (73.3%) cattle were non-anemic with statistically non-significant difference between tick infestation and anemia ($P > 0.05$). From 59 young age group infested by ticks 21(35.6%) of them were anemic while 50 (23.7%) of the adult age group were anemic with statistically non-significant variation between age groups and anemic animals. Out of 96 female animals (35) 36.46% were

anaemic and of the total 174 male animals (7) 4.02%, were anaemic, respectively with no significant difference (P >0.05). Poor and medium body conditioned animals were highly anemic than good body conditioned and there was significant variation between body condition scores and anemic animals due to ticks infestation (P <0.05). There was no significant difference between anemia due to tick infestation and breed, crossbreed animals were more anemic than local breeds (P >0.05). Cattle managed under extensive management system were more anemic than semi-intensive management system but with no significant variation (P>0.05) (Table 7).

DISCUSSION

In Ethiopia the distribution of the most tick species, vary greatly from one area to other area. The present study showed that 70.31% of tick prevalence. Overall, 1066 ticks were collected from the two breeds (local and cross) of cattle under different management system. The most abundant tick species in and around Bishoftu town were found to be *A. variegatum* (43.6%). This result is in line with reports of Belew and Mekonnen [3] in Holeta district (45.49%), Tessema and Gashaw [28] in Asela town (48.2%) who described *A. varigatum* as the first most abundant tick species in their study areas. *Ambylomma variegatum* is the most common tick species infesting cattle and horse and it was widely distributed cattle ticks in Ethiopia [2, 10, 29, 30, 31, 32-36] and heavy infestation of *A. variegatum* was recorded in Shoa province and part of Wollega province [9]. This result disagreed with the findings of Bossena and Abdu (2012) in and around Asosa town (15%), Meaza *et al.* [37] in Bahir Dar (47.93%), Shiferaw and Onu [38] in west of Ethiopia (4.7%) and Sileshi *et al.* [39] who described that *Rhipicephalus (Boophilus) decolaratus*is the commonest and most wide spread tick in Ethiopia, collected in all administrative regions except in the Afar region. The reason why this tick species were found in very high number was probably due to the geographical location of the area and due to its being relatively active throughout the year.

Rhipicephalus evertsi-evertsi was found to be the second most abundant tick species in this study (15.4%). The result of this study is in line with Bossena and Abdu [40] in and around Asosa town (15.6%), Nibret *et al.* [41] in Chilga District (18.22%) and Tessema and Gashaw [28] in Asella (22%). This tick species shows no apparent preference for particular altitude, rainfall zones or seasons and native distribution of *R. evertsi–evertsi* in Ethiopia seems to be connected with middle height dry savannas and steppes in association with Zebra and ruminant [10].

Rhipicephalus (Boophilus) decolaratus was confirmed to be the third abundant tick species (11.7%) in this study. The result of the present study is in agreement with research works of Shiferaw and Onu (2013) (8.0%) in west Ethiopia, Tessema and Gashaw [28] in Asela (15.4%), Belew and Mekonnen [3] (18.0%) in Holeta. This tick species is abundant in wetter highlands and sub highlands receiving more rainfall [10] *Ambylomma cohaerence* was the fourth abundant tick species in the study area (5.4%). This result is in accordance with the report of Belew and Mekonnen [3] in Holeta, (5.02%) where the climate is humid much of the year.

Hyalomma marginatum rufipes was the least abundant tick collected with 4.7% of the total counts. This result was similar with the finding of Tessema and Gashaw [28] in Asela (2.5%), Belew and Mekonnen[3] in Holeta (1.86%). *H. marginatum rufipes* has been found in low population densities throughout Ethiopia between 500-3500m.a.s.l. except in some areas (Western Ethiopia), which have a wet climate most of the year [10] Warm moderately dry lowlands receiving minimum annual rainfall is its preferred habitat [42].

The proportion of tick infestation was higher in adult (74.56%) cattle as compared to young cattle (58.1%). However, there was no statistically significant association (P > 0.05) and the higher proportion may be due to outdoor management and long distance movement of adult cattle to search for food and water compared to younger cattle, so the chance of exposure is higher. This finding was also in agreement with the finding of Yakhchali and Hasanzadehzarza [43], who reported tick infestation were higher in adults (60.8%) than in youngest (20%) in Oshnavich. Feseha [44], Meaza *et al*. [37] and Tessema and Gashaw [28] also stated that a higher proportion in adults cattle than youngest.

There was also statistically significant association (P <0.05) in the infestation rate between sex groups, where higher infestation was recorded in males (79.09%) compared to females (58.53%). This variation may be associated with female animals, which were kept properly in the house with good management system for dairy purpose whereas male animals grazing on field all day may be exposed to tick infestation.

Medium and poor body condition animals were statistically significantly (P < 0.05) infested by ticks than good body condition animals, which were 76.70%, 74.24% and 17.94%, respectively. This might be due to poor and

medium body conditioned animals have reduced resistance and exposed to most kind of diseases when grazing on the field.

Study revealed that the presence of tick infestation in local breed was very high with a prevalence of 82.75% while in Cross breeds 31.91 %. There was statistically significant variation (P<0.05) in tick infestation in different cattle breeds might be attributed to differences in management systems and lack of emphasis to control ticks infestation on local breeds. The current finding is in line with the reports by Meaza *et al*. [37] in Bahir Dar, Kassa andYalew [45] in Haramaya district of east Ethiopia, Belew and Mekonnen[3] in Holota and Tessema and Gashaw[28] in Asela stated as the prevalence of tick infestation was found higher in local breed cattle than cross breed ones.

Ticks infestation was showed statistically significant difference (P< 0.05) in cattle kept under extensive production system with prevalence of 77.94 % while the prevalence of ticks on cattle kept under semi-intensive farming system was 51.78%. This difference in prevalence could be due to regular washing of barns and animals, regular treatments of animals with acaricides in semi-intensive production system reduce the susceptibility of tick infestations which is not practiced in extensive production system. This result was in agreement with Meaza *et al*. [37] in BahirDar and Belew and Mekonnen [3].

From the total cattle ticks infested 71(26.3%) were anemic whereas 199 (73.3%) cattle were non-anemic with statistically non-significant difference between tick infestation and anemia (P >0.05). The resulting low PCV value in tick infested cattle indicated that ticks involve in reducing the PCV. Other diseases considered to reduce the PCV values of the animals include haemoparasites, gastrointestinal parasite and nutritional imbalances (minerals deficiencies). The mean PCV of the crossbreed was greater than the mean PCV of the local breed, which were 28.57% and 27.37%, respectively. This might be due to differences in management systems, supplementary feeding to cross breeds, control measures taken against ticks and other diseases on crossbreed. In this study, there was no statistically significant difference between age, sex, breed, body condition and management system and anemia due to tick infestation. The tick infestation in adult age group became less anemic than the young age group; this might be due to high susceptibility of the young age to different diseases. The tick-infested females became more anemic than the males, this could be due to females were subjected to continuous production stress, such as pregnancy and lactation, which might lower their PCV and compromise their immunity.

CONCLUSION

The present study showed that high prevalence of Ixodid tick species in and around Bishoftu town. The important tick species investigated in this research were *Ambylomma variegatum*, *Rhipicephalus evertsi-evertsi*, *Rhipicephalus (Boophilus) decoloratus, Ambylomma cohaerence* and *Hyalomma marginatum rufipes*. In this study *Ambylomma variegatum* was the most abundant and widely distributed tick species and *Hyalomma marginatum rufipes* was the least prevalent. The PCV of tick-infested animals were lower than the non-tick infested animals but it was difficult to say that the exact cause of the lower PCV of the cattle were ticks, so further study should be undertaken to know the effect of ticks on the PCV. Effective tick control programs should be formulated and implemented based on the patterns and factors of ticks responsible for their distribution.

ACKNOWLEDGEMENTS

Addis Ababa University College of Veterinary Medicine and Agriculture is highly appreciated for provision of materials and facilities required to conduct this study.

REFERENCES

1. CSA, 2010. Central statistics Authority: Report on livestock and livestock characteristics. Vol-2; Addis Ababa, Ethiopia.
2. Mekonnen, B., I. Hussen and B. Bedane, 2001. The distribution of Ixodid ticks (Acari: Ixodidae) in central Ethiopia, Onderstepoort Journal of Veterinary Research, 68: 243-251.
3. Belew, T. and A. Mekonnen, 2011. Distribution of Ixodidae ticks on cattle in and around Holeta Town, Ethiopia. Global Veterinarian, 7(6): 527-531.
4. Colebrook, E. and R. Wall, 2004. Ectoparasites of livestock in Europe and the Mediterranean region. Vet. Parasitol., 120: 251-274.
5. Jongejan, F. and G. Uilenberg, 2004.The global importance of ticks. Parasitol., 129: 3-14.
6. Kaufman, W.R., 2010. Ticks: Physiology aspects with implications for pathogen transmission Ticks and Tick-borne Diseases, 1: 11-22.

7. Guglielmone, A.A., R.G. Robbins, D.A Apanaskevich, T.N. Petney, Estrada A. Pena, I.G. Horak, R. Shoa and S.C. Barker, 2010. The Argasidae, Ixodidae and Nuttalliellidae (Acari: Ixodida) of the world: a list of valid species names Zootaxa, 2528: 1-28.
8. Soulsby, E.J.L., 1982. *Helminths, arthropods and protozoa of domesticated animals* 7th ed. Bailliere Tindall, London, pp: 809.
9. Morel, P., 1980. Study on Ethiopian ticks (*Acaridae: Ixodidae*). 1st.Ed. Republic of France, Ministry of Foreign affairs, French Vet. Mission, Addis Ababa, Ethiopia, pp: 15-183.
10. Pegram, R., H. Hogstral and H. Wassef, 1981. Ticks (Acari: Ixodoidea) of Ethiopia. I. Distribution, ecology and host relationship of species infesting livestock. Bull. Of Intomol. Res., 71: 339-359.
11. De Castro, J.J., 1994. Tick survey, Ethiopia: a survey of tick species in western Ethiopia, including previous findings and recommendations for further tick surveys in Ethiopia.UNDP/ FAO. Rome, pp: 79.
12. Solomon, G., 1994. The off- host population dynamics of ticks at Abernossa ranch. EV Aproceedings, 8: 36-40.
13. Yilma, J.M., W.S. Daniel and P.H. Dorchies, 1995. Survey of ticks infesting domestic ruminants in south Wollo region of Ethiopia. Revue. Med. Vet., 146: 213-220.
14. Seyoum, Z., 2001. Study of ticks and tick-borne diseases on zebu cattle at Girana Valley in North Wollo zone. EVA Proceedings, 16: 129-143.
15. Mekonnen, S., 2000.Efficacy of fiumethrin 1% pour-on against ticks on cattle under field conditions in Ethiopia. Onderstepoort J. Vet. Res., 67: 235-237.
16. Lodos, J., O. Boue and J.A. De La Fuente, 2004. Model to simulate the effect of vaccination against Boophilus ticks on cattle.Vet. Parasitol., 87(4): 315-326.
17. Nijhof, A.M., C. Bodaan, M. Postigo, H. Nieuwenhuijs, M. Opsteegh, L. Franssen, F. Jebbink and F Jongejan, 2007. Ticks and associated pathogens collected from domestic animals in the Netherlands. Parasitol. Rese., 105(6): 1577-1587.
18. Jonsson, N.N., 2006. The productivity effects of cattle tick (Boophilusmicroplus) infestation on Cattle, with particular reference to Bosindicus cattle and their crosses. Vet. Parasitol., 2: 1-101.
19. Minjauw, B. and J.J. De Castro, 2000. Host resistance to ticks and tick-borne diseases: Its role in integrated control. *Breeding for Diseases Resistance in Farm Animals.* CAB International, pp: 153-169.
20. Central Agricultural Census Commission (CACC), 2013. Statistical reports on livestock farm implement.
21. NMSA, 2013: National Meteorology Service Agency Addis Ababa, Ethiopia.
22. Thrusfield, M., 2005.Veterinary Epidemiology. 3rdEdn Blackwell Science Ltd., Edinburgh UK, pp: 626.
23. Richard, L.B., 2001. Ticks (Arachinida): The practical veterinarian, veterinary parasitology, USA, Butterworth-Heinemann, pp: 7-9.
24. Ndhlovu, D.N., P.V. Makaya and B.E. Penzhorn, 2009. Tick infestation and udder and teat damage in selected cattle herds of Matabeleland South, Zimbabwe. Onderstepoort Journal of Veterinary Research, 76: 235-248.
25. Walker, A.R., A. Bouattour, J.L. Camicas, A. Estrada-Pena, I.G. Horak, Latif, A.A.R.G. Pegram and P.M. Preston, 2003. Ticks of domestic animals in Africa: a guide to identification of species, Bioscience Report, pp: 1-221.
26. Rahmeto, A., F.A. Thedrous, A. Mesele and B. Jemere, 2010. Survey of tick (Acari: Ixodidae) infesting cattle in two districts of Somali Regional State, Ethiopia. Veterinary World, 3(12): 539-543.
27. VandenBossche, P., W. Shumba and P. Makhambera, 2000. The distribution and epidemiology of bovine trypanosomosis in Malawi. Vet.Parasitol., 88: 163-176.
28. Tessema, T. and A. Gashaw, 2010. Prevalence of ticks on local and crossbreed cattle in and around Asela Town, South East, Ethiopia, Amber Animal Health Department, East Gojam, Ethiopia Vet. J., 14(2): 79-89.
29. Bekele, T., 2002. Studies on seasonal dynamics of ticks of Ogaden cattle and individual variation in resistance to ticks in eastern Ethiopia, Journal of Veterinary Medicine B, 49: 285-288.
30. Zeleke, M. and T. Bekele, 2004.Species of ticks on camels and their seasonal population dynamics in eastern Ethiopia, Tropical Animal Health and Production, 36: 225-231.
31. Mekonnen, S., R.G. Pegram, S. Gebre, A. Mekonnen, Y. Jobre and S. Zewde, 2007. A synthesis of ixodid (Acari: Ixodidae) and argasid (Acari: Argasidae) ticks in Ethiopia and their possible roles in disease transmission, Ethiopian Veterinary J., 11(2): 1-17.
32. Yacob, H.T., H. Ataklty and B. Kumsa, 2008a. Major ectoparasites of cattle in and around Mekelle, northern Ethiopia, Entomological Res., 38: 162-30.
33. Yacob, H.T., B. Nesanet and A. Dinka, 2008b. Prevalence of major skin diseases in cattle, sheep and goats at Adama Veterinary Clinic, Oromia regional state, Ethiopia, Revue de MedecineVeterinaire, 159(8-9): 455-461.

34. Abera, M., T. Mohammaed, R. Abebe, K. Aragaw and J. Bekele, 2010. Survey of ixodid ticks in domestic ruminants in Bedelle district, south western Ethiopia, Tropical Animal Health and Production, 42: 1677-1683.
35. Chanie, M., T. Negash and A. Sirak, 2010. Ectoparasites are the major causes of various types of skin lesions in small ruminants in Ethiopia, Tropical Animal Health and Production, 42: 1103-1109.
36. Abebayehu, T. and M. Kibrom, 2010. Study on ectoparasitic defects of processed skins at Sheba tannery, Tigray, northern Ethiopia, Tropical Animal Health and Production, 42: 1719-1722.
37. Meaza, G., M. Abdu and K. Yisehak, 2013. Determination of the Prevalence of Ixodid Ticks of Cattle Breeds, Their Predilection Sites of Variation and Tick Burden Between Different Risk Factors in Bahir Dar, Ethiopia, Global Veterinaria, 13(4): 520-529, 2014 ISSN 1992-6197 DOI: 10.5829/idosi.gv. 2014.13.04.8634.
38. Shiferaw, T.Z. and S.H. Onu, 2013. Prevalence of ectoparasite infestations of cattle in Bench Maji zone, southwest Ethiopia, Vet World, 6(6): 291-294, doi:10.5455/vetworld.2013.291-294
39. Sileshi, M., R.G. Pegram, G. Solomon, M. Abebe, J. Yilma and Z. Sileshi, 2007. A synthesisof review of *Ixodid*s (*Acari: Ixodidae*) and *Arga*s (*Acari: Argasidae*) ticks in Ethiopia and their possible role in diseases transmission. Ethiopia Vet. J., 2: 1-22.
40. Bossena, F. and M. Abdu, 2012. Survey on the distribution of tick species in and around Assosa Town, Ethiopia, Res. J. Vet. Scei., 5(2): 32-41. 2012ISSN1819-1908.
41. Nibret, M., B. Basaznew and F. T ewodros, 2012. Hard Ticks (Ixodidae): Species Composition, Seasonal Dynamics and Body Site Distribution on Cattle in Chilga District, Northwest Ethiopia, Asian J. A. Sci., 4(5): 341-345
42. De Castro, J.J., 1997. Sustainable tick and tick-borne disease control in livestock improvement in developing countries. Vet. Parasitol., 71: 77-97.
43. Yakhchali, M. and H.S. Hasanzadehzarza, 2004. Study on some ecological aspects and prevalence of different species of hard ticks (Acarina: Ixodidae) on cattle, buffalo and sheep in Oshnavieh suburb. Pajouhesh-va-Sazandegi in Anim. Fish. Sci., 63: 30-35.
44. Feseha, B., 1997. Species composition and distribution of *Ixodid* ticks in Eastern Harerghiea, Ethiopia. Agri. Sci., 16: 37-51.
45. Kassa, S.A. and A. Yalew, 2012. Identification of Ixodide ticks of cattle in and around Hararamaya district, Eastern Ethiopia. Scientific Journal of Crop Science, 1: 1.