Acta Parasitologica Globalis 11 (3): 126-132 2020
ISSN 2079-2018

DOI: 10.5829/idosi.apg.2020.126.132

# A Study on Ticks (Ixodidae) Infesting Cattle in Hawassa, Shashemene and Arsi Negele Districts, Ethiopia

*Minychel Terefe Alamneh*

Livestock and fishery development office, Hawassa zuria wereda,
Sidama regional state, Hawassa, Ethiopia

**Abstract:** A cross-sectional study was conducted to identify the common ixodid ticks and their abundance on cattle in Hawassa, Shashemene and Arsi Negele districts. During the period of 2019 october to 2020 april, a total of 4554 adult ticks were collected from 410 local and Holstein Friesian cross breed cattle. Out of the total tick count, 2516 were males and 2038 were females. Nine species of ticks that belong to three genera (*Amblyomma, Hyalomma* and *Rhipicephalus*) were identified in the three districts covered by the study with significant variation ($p < 0.05$) between the districts. Considering the relative abundance of each tick species *A. lepidum* (55%) was the most abundant tick species identified in Hawassa district followed by *Hy. truncatum* (15.3%) while *Rh.e.evertsi* was the least abundant (0.9%). In the Shashemene district, the most abundant tick species identified was *A. varigatum* (39%) followed by *Rhipicephalus* (formerly *Boophilus*) *decoloratus* (23.3%) whereas, *Rh. pravus* (0.3%) was the least abundant tick species identified. In Arsi Negele district, *A. varigatum* (57.2%) was the most abundant tick species identified followed by *Hy. rufipes* (19%) while *Rh. e. evertsi* (0.2%) was the least abundant tick. The overall mean tick burden was the highest in local breed animals on breed base, the extensive management system in a management system basis, poor body condition in light of body condition and wet season on the bases of the season. The mean tick burden was found to be independent of sex and age of animals ($p > 0.05$). An overall male to female ratio of 1.2:1 was also determined showing the dominance of males based on sex. The limited scope of awareness regarding the impact of ticks and the absence of tick control strategy in the area are the most important factors accountable to the widespread existence of different tick species in the area. For that reason, formulating and implementing effective tick control programs, based on distribution factors of ticks and factors responsible for their destruction, creating awareness to the society regarding the impact of ticks and appropriate pasture management in communal grazing area would be imperative to minimize the effect of ticks and ultimately to improve the living standards of the society.

**Key words:** Abundance · Arsi-Negele · Cattle · Hawassa · Ixodid Ticks

## INTRODUCTION

Ticks are obligate, blood-feeding ectoparasites of vertebrates, particularly mammals and birds [1, 2] which belonging to the class Arachnida, Order Acari. Once they attach to the host for a blood meal, ticks can result in diverse effects leading to significant losses due to blood loss, tick worry, damage to hides and introduction of toxins [3]. Moreover, ticks are responsible for the transmission of tick-borne pathogens of various types and secondary attacks from other parasites [4].

There are at least 850 tick species in two major families, namely the Ixodidae or 'hard' ticks (so-called by their hard dorsal shield) and the Argasidae or 'soft' ticks (due to their flexible leathery cuticle). The family Ixodidae comprises approximately 80% of all tick species, including the species of greatest economic importance. However, Argasid ticks also play a significant role as vectors of diseases, especially in poultry [5].

Ixodidae is a family of hard ticks with a hard dorsal shield. There are three active stages in the life cycle of a hard tick; larvae, nymphs and adult ticks. Each instar

**Corresponding Author:** Minychel Terefe, Livestock and Fishery Development Office, Hawassa Zuria Wereda, Sidama Regional State, Hawassa, Ethiopia.

takes a blood meal only once and long periods are spent on vegetation between blood meals. Most ticks require three different hosts to complete one full cycle. These three-host ticks detach on completion of feeding, drop from the host, molt and wait for another host. However, in some tick species, the engorged larvae remain on the host, where they molt rapidly to become nymphs, continue to feed and then drop as engorged nymphs. These two host ticks include *Rhipicephalus evertsi* and some *Hyalomma* species. In one host ticks, the nymphs also remain on the same host and continue to feed as adults. *Boophilus* species are typical of one host ticks. After the female drops from the host, she seeks a sheltered place for oviposition where she lays a single batch of several thousand eggs and then dies [6].

It has been estimated that 80% of the world's cattle are infested by ticks [7] and the production of over 1000 million cattle and a similar number of sheep around the world is affected [4]. Also, ticks are a major hindrance to improving animal production in the tropical and subtropical regions of the world [1]. Ticks that are considered to be most important to the health of domestic animals in Africa comprise of 40 species [8].

In Ethiopia, several species of ticks belonging to the genus *Amblyomma*, *Rhipicephalus* including the former genus *Boophilus*, *Hyalomma* and *Haemaphysalis* have been reported [2, 9, 10]. Tick and tick-borne diseases cause considerable losses to the livestock economy of Ethiopia, ranking third among the major parasitic diseases, after trypanosomosis and endoparasitism. The country's environmental condition and vegetation are highly conducive for ticks and tick-borne disease perpetuation [11].

However, the relative distribution of the different genera and species of ticks vary depending on environmental and management factors that determine their relative abundance from one place to another [2]. Hence, up-to-date data regarding Ixodid ticks infesting cattle in Hawassa, Shashemene and Arsi Negele districts are currently lacking. Therefore, the objectives of this study were to provide up-to-date information regarding ticks infesting cattle in Hawassa, Shashemene and Arsi Negele districts and to contribute information for use in the development of a suitable tick control strategy by policymakers and implementing bodies.

## MATERIALS AND METHODS

**Study Area:** The study was conducted in Hawassa, Shashamane and Arsi Negele districts. Hawassa is located between 7°06´North latitude and 38°48´ East longitudes and is situated at an elevation of 1697 meters above sea level. The farming system practiced in the district is a mixed crop-livestock type. The vegetation coverage comprises natural pastures (Herbaceous vegetation Composed mainly of grass and forbs) and browses (trees, shrubs and leaves) [12, 13].

Shashemene is a town in the West Arsi zone, Oromia region, Ethiopia. The town is located about 250km from the capital of Ethiopia, Addis Ababa. It has a latitude of 7°12' North and longitude of 38 °36' East. The farming system practiced in the district is like that of Hawassa (mixed crop-livestock type). The vegetation coverage comprises natural pastures (herbaceous vegetation composed mainly of grass and forbs) and browses (trees, shrubs and leaves) [14].

Arsi Negele was found in southeastern Ethiopia, in the Mirab Arsi Zone of the Oromia region on the paved high way north of Shashemene. This town has a longitude and latitude of 7°21'N and 38°42'E and an elevation of 2043 meters above sea level [15]. The farming system practiced in the district is mixed crop-livestock type. The vegetation coverage comprises natural pastures (herbaceous vegetation Composed mainly of grass and forbs) and browses (trees, shrubs and leaves).

**Study Population:** The study animals include all breeds of cattle in the study areas. The study was conducted regardless of age, sex and their body condition (it included all age groups, both male and female animals and all animals with different body condition score).

**Study Design:** The type of study employed was a cross-sectional investigation using cattle in the selected areas. Observations were carried out on study animals selected randomly from the study population regardless of age, sex, body condition score and breed.

**Sample Size and Sampling Technique:** The total number of cattle required for the study was calculated based on the formula given by Thrusfield [16] for a simple random sampling method. By rule of thumb where there is no information for an area, it is possible to take 50% prevalence. In this study, 50% expected prevalence with a 5% desired level of precision and a 95% confidence level was used to calculate the sample size using the following formula.

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

where,
n = sample size
$P_{exp}$ = expected prevalence (50%)
d = desired level of precision (5%)

Therefore, the sample size calculated for the study according to the given formula was 384 cattle. However, 410 cattle were selected from the three districts by a systematic random sampling technique.

The study herds were selected purposively based on the accessibility and the owner's willingness to cooperate for the study. Cattle herds were visited and sampled early in the morning before released to the field and thereafter samples were taken to Hawassa University Veterinary Parasitology Laboratory. Out of three study areas, some villages were randomly selected from each.

**Tick Collection and Identification:** Once the selected cattle were restrained, ticks were removed from the half body retaining their good condition for identification [17]. Ticks collected from different body region were placed separately by body region in different labeled universal bottles containing 70% ethanol [8] and transported to the Parasitology Laboratory of the Faculty of Veterinary Medicine, Hawassa University for identification at species level using stereomicroscope following the standard identification procedures described by Walker *et al*. [8]. The body regions examined for the collection were head, dewlap, brisket, belly and back, udder/ scrotum, anal/ genital region, leg and tail [18]. The number of ticks collected was doubled to determine the approximate tick burden per animal [19].

**Data Analysis and Management:** The data was properly coded and entered into the Microsoft Excel-2010 spreadsheet. It was filtered for invalid entry and then transferred to STATA software for statistical analysis. Descriptive statistics like mean and percentages were calculated to display the status of ticks relative to some considered variables. Categorical data were analyzed using Pearson's chi-square test (Fisher's exact). The difference in mean tick burden between districts, season, breed, sex, age and body condition score of animals was analyzed using one-way ANOVA depending on the number of categories of a variable. In all calculations, the confidence level was set at 95% and statistical significance at a p-value of less than 0.05.

## RESULTS

A total of 4554 ticks were collected from cattle in the three districts during the study period. Out of this, 1558 ticks were from cattle in Hawassa, 1294 ticks were from cattle in Shashemene and the rest 1702 ticks were from Arsi Negele. The ticks collected belong to four different genera i.e. *Amblyomma, Hyalomma* and *Rhipicephalus* (Table 1).

Cattle in the three districts were infested with nine identical species of ticks with different levels of infestation. Statistical analysis revealed that a significant difference ($p < 0.05$) in the abundance of most tick species between the three districts except for *A. gemma* ($p = 0.086$), *Rh. pravus* ($p = 0.188$) and *Rh. e. evertsi* ($p = 0.343$). Considering the relative abundance of each tick species, *A. lepidum* (55%) was the most abundant tick species identified in Hawassa district followed by *Hy. truncatum* (15.3%) while *Rh.e.evertsi* was the least abundant(0.9%). In the Shashemene district, the most abundant tick species identified was *A.variegatum* (39%) followed by *Rh. decoloratus* (23.3%) while *Rh. pravus* (0.3%) was the least abundant tick species identified. In Arsi Negele district *A. variegatum* (57.2%) was the most abundant tick species identified followed by *Hy. rufipes* (19%) while *Rh. e. evertsi* (0.2%) was the least abundant tick species identified (Table 2).

The results of the statistical analysis of the association between mean tick burden and different risk factors using ANOVA are given in Table 3. Accordingly, the season of tick collection, sex of the animal, body condition of the animal, breed of the animal and the management system practiced revealed significantly

Table 1: The relative abundance of four genera of ticks identified from cattle in study areas

| Genus of ticks | Hawassa | Shashemene | Arsi -Negele | Total | Relative abundance (%) |
|---|---|---|---|---|---|
| *Amblyomma* | 1126 | 778 | 1192 | 3096 | 68 |
| *Hyalomma* | 250 | 108 | 358 | 716 | 15.7 |
| *Rhipicephalus* | 182 | 408 | 152 | 742 | 16.3 |
| Total | 1558 | 1294 | 1702 | 4554 | 100 |

Table 2: Differences in the relative abundance of tick species among the three districts.

| | Relative abundance (%) in each district | | | Test for difference | |
|---|---|---|---|---|---|
| Tick species | Hawassa | Shashemene | Arsi Negele | $x^2$ | P-value |
| *A. varigatum* | 15.8 | 39 | 57.2 | 14.7356 | 0.001 |
| *A. lepium* | 55 | 8.3 | 8 | 60.6413 | <0.001 |
| *A. gemma* | 1.7 | 13.1 | 4.8 | 4.9163 | 0.086 |
| *Hy. rufipes* | 0.8 | 6.3 | 19 | 34.2188 | <0.001 |
| *Hy. truncatum* | 15.3 | 2 | 2.1 | 31.7006 | 0.001 |
| *R.(B.) decoloratus* | 2.8 | 23.3 | 7.5 | 12.7636 | 0.002 |
| *Rh. lunulatus* | 8 | 6.2 | 0.5 | 16.2794 | <0.001 |
| *Rh. pravus* | 0 | 0.3 | 0.7 | 3.3401 | 0.188 |
| *Rh. e. evertsi* | 0.9 | 1.7 | 0.2 | 2.1422 | 0.343 |
| Total | 100 | 100 | 100 | | |

Table 3: Analysis of mean tick burden in cattle

| Variable | | N | Mean burden | Std. dev | *x*2 | P-value |
|---|---|---|---|---|---|---|
| District | Hawassa | 135 | 21.3 | 13.2 | 0.62 | 0.273 |
| | Shashemene | 134 | 19.8 | 12.3 | | |
| | Arsi Negele | 141 | 22.4 | 14.9 | | |
| Season | Dry months | 215 | 16.2 | 8.4 | 13.12 | <0.0011 |
| | Wet months | 195 | 23.3 | 14.7 | | |
| Breed of animal | Local | 139 | 26.8 | 13.6 | 91.7 | <0.001 |
| | HF cross | 79 | 11.5 | 5.7 | | |
| Sex of animal | Male | 212 | 23.9 | 15 | 7.33 | 0.018 |
| | Female | 198 | 19 | 11.9 | | |
| Age of animal | Young | 120 | 16.2 | 10.3 | 23.19 | 0.057 |
| | Adult | 237 | 20.4 | 12.7 | | |
| | Old | 53 | 33.8 | 14.5 | | |
| BCS of animal | Poor | 73 | 36.7 | 13.1 | 99.26 | <0.001 |
| | Medium | 128 | 19.9 | 10 | | |
| | Good | 209 | 13.3 | 7.2 | | |
| Mgt. system | Extensive | 183 | 30.4 | 12.9 | 98.81 | <0.001 |
| | Semi intensive | 164 | 16.6 | 7.2 | | |
| | Intensive | 63 | 10.4 | 4.2 | | |

Table 4: Count of ticks displayed by species and sex

| | Count by sex | | |
|---|---|---|---|
| Tick species | Male (M) | Female (F) | M: F ratio |
| *A. varigatum* | 964 | 756 | 1.3:1 |
| *A. lepidum* | 622 | 476 | 1.3:1 |
| *A. gemma* | 142 | 138 | 1.03:1 |
| *Hy.rufipes* | 228 | 188 | 1.2:1 |
| *Hy.truncatum* | 178 | 122 | 1.5:1 |
| *R.(B.) decoloratus* | 210 | 264 | 0.8:1 |
| *Rh. lunulatus* | 148 | 64 | 2.3:1 |
| *Rh.pravus* | 6 | 10 | 0.6:1 |
| *Rh.e.evertsi* | 20 | 20 | 1:1 |
| Total | 2516 | 2038 | 1.2:1 |

higher mean tick burden in the wet season, in male animals, in animals with poor body condition score, local breeds and extensive management system respectively ($p< 0.05$) While district and age of the animal did not show any effect at all ($p>0.05$). This implies that the mean tick burden was found to be independent of sex and age of the animals. Sex determination and count finding showed that of the total ticks collected, 2516 were males while the rest 2038 were females with an overall male to female ratio of 1.2 to 1 (Table 4).

## DISCUSSION

The current study revealed that the major genera of ticks infesting cattle in Hawassa, Shashemene and Arsi Negele districts belonged to *Amblyomma*, *Hyalomma* and *Rhipicephalus* in order of predominance. A closely similar result with greater frequency of *Amblyomma* species was reported by Teki and Addis [20] in cattle in and around Holeta town, Ethiopia. In this study, nine identical species of ticks were identified in cattle of the three districts with different levels of infestation. A report of similar composition for the majority of these species was reported by Teki and Addis [20].

The presence of similar tick species in the districts may be due to unrestricted cattle movement, which is a common phenomenon in the areas. However, *A. lepidum* (55%) was the most abundant species of tick in Hawassa followed by *Hy. truncatum* (15.3%). The *A.variegatum* is the most widely distributed cattle tick in Ethiopia and the reason could be further explained by the fact that *A.lepidum* occurs in arid and semi-arid areas [21]. On the other hand, *A. variegatum* was the most abundant tick species in Shashemene and Arsi Negele districts. This study was again in agreement with that of Teki and Addis [20]. The reason for this abundance could also be further explained by the fact that *A.variegatum* is the most widely distributed cattle tick in Ethiopia [22].

Statistical analysis revealed that a significant difference ($p < 0.05$) in the abundance of most tick species between the three districts except for *A. gemma* ($p = 0.086$), *Rh. pravus* ($p = 0.188$) and *Rh. e. evertsi* ($p = 0.343$). Considering the relative abundance of each tick species *A. lepidum* (55%) was the most abundant tick species identified in Hawassa district followed by Hy. *truncatum* (15.3%) while *Rh.e.evertsi* was the least abundant (0.9%). In the Shashemene district, the most abundant tick species identified was *A.variegatum* (39%) followed by *Rh. decoloratus* (23.3%) while *Rh. pravus* (0.3%) was the least abundant tick species identified. In Arsi Negele district, *A. variegatum* (57.2%) was the most abundant tick species identified followed by *Hy. rufipes* (19%) while *Rh. e. evertsi* (0.2%) was the least abundant tick species identified. Such a difference in the relative abundance of tick species might be attributed to the ecological variation between the districts. The most important environmental factors influencing the occurrence of ticks in biotype include temperature and relative humidity [3, 23].

In the current study, the overall mean tick burden was higher in wet months than in dry months. This variation may be associated with the wet season is favorable for the multiplication and abundance of ticks [3]. This study also revealed that the mean tick burden was higher in male animals than female animals. This variation may be associated with female animals which were kept properly in the house with a good management system for dairy purpose whereas, male animals grazing on the field all day may be more exposed to tick infestation. This result agrees with the study reported by Yussen [24]. However, the result disagrees with the finding of higher infestation in females by Desalegn *et al*. [25]. This difference may be due to the difference in the management system practiced.

The current study also revealed the mean tick burden assessed between local and cross breeds where higher records were found in local breeds than HF cross breeds which might be because of their difference in the management system, lack of supplementary feeding to local cattle breeds, lack of control measures against tick on local cattle and taking more care to HF crossbreeds. In the current study, there was a significant association of mean tick burden between two breeds of animals ($p= 0.000$). These results were in agreement with the study reported by Teki and Addis [20].

Mean tick burden was higher in poor body conditioned animals as compared to medium body conditioned and good body conditioned animals. This was because poor body condition scored animals have reduced resistance to tick infestation and lack of enough body potential to build resistance. So, they might be exposed to any kind of disease when grazing on the field. This finding agrees with the study reported by Desalegn *et al*. [25].

The mean tick burden was also higher in animals which were managed extensively than intensive. This might be because animals managed intensively have close observation by the owner and if the owner detected a tick, they may remove through their hands or spray with chemicals, but animals managed extensively are exposed to tick infestation due to poor management by the owner and they simply move anywhere for grazing and harbor tick easily. With most of the tick species identified, males outnumbered females; this was most probably because fully engorged female ticks drop off to the ground to lay eggs while males tend to remain on the host up to several months later to continue feeding and mating with other females on the host before dropping. Host grooming easily removes semi engorged females as compared to males [26]. The finding agrees with the study reported by Desalegn *et al*. [25]. The females of *Rh. decoloratus* and *Rh. pravus* outnumbered males in this study probably due to the small size of the male which could not be seen. This result agrees with the study reported by Desalegn *et al*. [25].

## CONCLUSION AND RECOMMENDATIONS

In light of the current findings, it is possible to conclude that cattle in Hawassa, Shashemene and Arsi Negele are infested by different species of ticks despite the varying degrees of abundance which may be due vegetation coverage, management system practiced and

climatic and host factors. The limited scope of awareness regarding the impact of ticks and the absence of tick control strategy in the area are the most important factors accountable to the widespread existence of different tick species in the area. Therefore, based on the above conclusion the following recommendations are forwarded: An effective tick control program should be formulated and implemented based on the distribution factor of ticks and factors responsible for their destruction. Awareness should be created to the society regarding the impact of ticks. Appropriate pasture management in the communal grazing area should have to be given consideration.

## REFERENCES


1. Urquhart, G., J. Armour, J. Duncan, A. Dunn and F. Jennings, 1996. Veterinary Parasitology, 2nd edition. Black Well Science Ltd, pp: 307.
2. Mulugeta, A., Y. Beredu and A. Biruk, 2019. Ixodidae ticks of bovine; prevalence and major species identification in soddo zuria districts of wolaita zone, Ethiopia. Appro poult Dairy & Vet. Sci., 6(2). Apdv.000632.
3. Morel, P., 1989. Manual of Tropical Veterinary Parasitology, Tick-borne Diseases of Livestock in Africa. CAB International, UK, pp: 1-116.
4. Estrada-Pena, A., 2001. Forecasting habitat suitability for ticks and prevention of tick-borne diseases. Veterinary Parasitology, 98: 111-138.
5. Shivani, C., S. Jainder and K. Harpreet, 2014. Investigations on some hard ticks (Acari: Ixodidae) infesting domestic buffalo and cattle from Haryana, India. Journal of Entomology and Zoology, 2(4): 99-104.
6. Jongejan, F. and G. Uilenberg, 2004. The global importance ticks. Parasitology, 129: S1-S12.
7. Minjauw, B. and A. McLeod, 2003. Tick-borne diseases and poverty. The impact of ticks and tick-borne diseases on the livelihood of small- scale and marginal livestock owners in India and eastern and southern Africa. The research report, DFID Animal Health Programme, Center of Tropical Veterinary Medicine, University of Edinburgh, UK, pp: 1-116.
8. Walker, A., A. Bouattour, J. Camicas, A. Estrada Pena, I. Hora, A. Latif, R. Pegram and P. Preston, 2003. Ticks of domestic animals in Africa: a guide to the identification of species. Bioscience report, pp: 1-22.
9. Sileshi, M., L. Pegram, G. Solomon, M. Abebe, J. Yilma and Z. Sileshi, 2007. A synthesis review of Ixodid (Acari: Ixodidae) and Argasid (Acari: Argasidae) ticks in Ethiopia and their possible roles in disease transmission. Ethiopian Veterinary Journal, 11(2): 1-24.
10. Arega, A., A. Biruk and A. Mihiretu, 2018. Study on Major Cattle Ectoparasites in and Around Adama, Central Ethiopia. Journal of Natural Sciences Research, 8(13).
11. Rahmeto, A., F. Thedrous, A. Mesele and B. Jemere, 2010. Survey of ticks (Acari: Ixodidae) infesting cattle in two districts of Somali Regional State, Ethiopia. Vet. World, 3(12): 539-543.
12. Central Statistical Authority, (CSA), 2003. Livestock Population of Ethiopia.Central Statistical Authority, Addis Ababa, Ethiopia.
13. Asmare, K., 2004. Epidemiology of Brucellosis and its seroprevalence in cattle in Animal Health Professionals in Sidama zone, southern Ethiopia, [M.S. thesis], Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.
14. Central Statistical Agency [CSA-Ethiopia] and ICF International,2012. Ethiopia Demographic and Health Survey 2011. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Agency and ICF International.
15. Mapszoom, 2015. http// Mapszoom.com/ coordinates.php? (Assessed date Oct 26, 2018).
16. Thrusfield, M., 1995. Veterinary epidemiology, 2nd edition. Edinburgh, Blackwell science limited, pp: 182-198.
17. Young, A., C. Groocock and D. Kariuki, 1988. Integrated control of ticks and tick-borne diseases of cattle in Africa. Parasitology, 96: 403-432.
18. Keiser, M., R. Sutherst and A. Bourne, 1982. Relationship between ticks and zebu cattle in Southern Uganda. Tropical Animal Health Production, 14: 63-74.
19. Salih, D., I. Julla, S. Hassan, E.L. Hussen and F. Jongejan, 2008. A preliminary survey of ticks (Acari: Ixodidae) on cattle in Central Equatorial State, Southern Sudan. Onderstepoort. Journal of Veterinary Research, 75: 47-53.
20. Teki, B. and A. Addis, 2011. Distribution of Ixodid Ticks on Cattle in and around Holeta Town, Ethiopia. Global Veterinaria, 7(6): 527-531.

21. Horak, I., W. Stoltz's and H. Heyne, 2003. The short course in the identification of southern and northeast African ticks. Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, South Africa, pp: 110.
22. Morel, P., 1980. Tick distribution and vegetation. Study on Ethiopian ticks (Acaridae, Ixodidae), pp: 259-266.
23. Latif, A.A. and A.R. Walker, 2004. An Introduction to the Biology and Control of Ticks in Africa. ICTTD-2 Project, pp: 1-29.
24. Yussen, Y., 2009. A preliminary survey of cattle Tick species and burden in and around Bako town. DVM Thesis School of Veterinary medicine Jimma University, Jimma, Ethiopia.
25. Desalegn, T., A. Fikru and S. Kasaye, 2015. Survey of Tick Infestation in Domestic Ruminants of Haramaya District, Eastern Hararghe and Ethiopia. Journal of Bacteriology and Parasitology, 6: 246.
26. Solomon, G., G.P. Kaaya, F. Gebreab, T. Gemetchu and G. Tilahun, 1998. Ticks and tick-borne parasites associated with indigenous cattle in Did-tuyura ranch, Southern Ethiopia. Ins Sci Applic., 18: 19-28.