Ectoparasites of small ruminants in and around Kombolcha, northeastern Ethiopia

Mohammed Seid, Tesfaheywet Zeryehun, Jelalu Kemal and Berhanu Tilahun*

College of Veterinary Medicine, Haramaya University, P.O. Box 138, Dire Dawa, Ethiopia

**Corresponding author email: jelaluk@gmail.com*

Abstract

Infestation of small ruminants by ectoparasites such as ticks, mites, lice and fleas could lead to considerable economic loss due to morbidity, mortality and skin rejection. A cross-sectional study was carried out to estimate the prevalence of ectoparasites of small ruminants and to identify different ectoparasite fauna in and around Kombolcha, northeastern Ethiopia. Semi-structured questionnaire was used to generate preliminary data. The study also employed clinical examination and laboratory identification of different ectoparasites into genera and species level. A total of 350 small ruminants (147 sheep and 203 goats) were sampled and examined for prevalence of ectoparasites. The result of the questionnaire survey indicated that sheep and goats were the main species of animals raised by the farmers. The overall prevalence of ectoparasites were 25.7% (90/350), in which 25.9% (38/147) and 25.6% (52/203) prevalence were recorded in sheep and goats, respectively. The proportion of ectoparasites include: lice (11.7%), ticks (7.4%), mites (4.0%) and fleas (2.6%) in descending order. *A. variegatum, R. evertsi, S. caprae, D. caprae, L. africanus, D. caprae, S. ovis* and *C. canis* were identified at species level. There was no statistically significant association ($p>0.05$) between the prevalence of ectoparasites and the species, sex, age and body condition except *Rhipicephalus decoloratus* which was significantly higher in sheep with poor body condition. The study revealed ectoparasites to be one of the main constraints to small ruminant production in the area and hence warrants further strategic intervention.

Keywords: Ectoparasite; Goat; Infestation; Kombolcha; Prevalence; Sheep

Introduction

Ethiopia is believed to have the largest livestock population in Africa which has been contributing a considerable portion to the economy (CSA, 2017). It is well known that livestock products and byproducts in the form of meat, milk, honey, eggs, cheese and butter supply the needed animal protein that contributes to the improvement of the nutritional status of the people. Livestock sector also plays an important role in providing export commodities, such as meat, live animals, hides, and skins (Abunna *et al*., 2009).

Small ruminants are among the important sources of animal protein. It has been estimated that there are more than 30.7 million sheep and 30.2 million goats in Ethiopia (CSA, 2017). They provide 35% of meat and 14% of milk consumption (Ashenafi *et al.,* 2013). However, their contribution to food production and income generation is far below the expected potential. The reduced contribution would be due to the combined effects of several factors among which ectoparasitism is the utmost (Kumsa *et al.,* 2012). Ectoparasites such as ticks, mites, lice, and fleas affect a large population of sheep and goats in the country (Kumsa *et al.,* 2012; Beyecha *et al.,* 2014). They are one of the major hindrances to the productivity of small ruminants (Fthenakis *et al.,* 2001). In addition, studies from different parts of Ethiopia showed that skin quality deterioration is very evident mainly due to ectoparasite (Sertse, 2004; Hailu *et al.,* 2008a; Ashenafi *et al.,* 2013). Ectoparasites are reported to cause a wide range of health problems such as mechanical tissue damage, irritation, inflammation, hypersensitivity, abscesses, weight loss, and anemia. The occurrence and spread of these problems had been shown to correlate with host factors, poor management, climatic factors, feed scarcity and inadequate veterinary services (Solomon *et al.,* 2003).

For the last three years Amhara Regional State practiced ectoparasite control program in livestock using acaricides (MoARD, 2005; Kleemann, 2008). Despite implementation of the control programs in the region, ectoparasite infestation is still problematic in the region including other northern parts of Ethiopia. For example, Jarso *et al* (2014) reported 2.7% and 5.7% mange prevalence in sheep and goats respectively in Kombolcha. Furthermore, Mulugeta *et al* (2010) found 58% in goats and 55.5% prevalence of ectoparasites in sheep in Tigray Regional State after the implementation of the same control program. Therefore, the objectives of the present study were to estimate the current prevalence of ectoparasite infestation in small ruminants, to identify major

risk factors associated with the occurrence of ectoparasites and to identify the main ectoparasite species in small ruminants in the area.

Materials and methods

Study area and study animals

The study was conducted in and around Kombolcha, Amhara Regional State, Ethiopia. The area is found 377 km northeast of Addis Ababa with an altitude ranging from 1500-1840 meters above sea level. The topography of the area is generally marked by the presence of a number of mountains, plateaus, hilly and sloppy areas. The area has a bimodal rainfall with a three-year annual average of 1038 mm. The area has an average temperature of 18°C and a relative humidity that ranges from 23.9% to 79%. The production system of the area is mixed crop-livestock managed under extensive system. Small ruminants in the areas are indigenous breeds which comprise an estimated population of 58,182 goat and 26,957 sheep (ARARI, 2008).

Study design and sample size determination

A cross-sectional study was conducted from November 2016 to April 2017 to estimate the prevalence of ectoparasites in small ruminants. The sample size required was determined taking in to account the 26.7% expected prevalence (Jarso *et al.,* 2014), into consideration and using the formula given in Thrusfield (2005) as follows:

$$N = \frac{1.96^2 \text{ x Pexp (1-Pexp)}}{D^2}$$

Where: n=required sample size; P_{exp}=expected prevalence; d=desired absolute precision, 95% confidence interval and 5% precision. Accordingly, the calculated sample size was n=301. But to increase the precision 350 apparently healthy sheep and goats (147 sheep and 203 goats) were sampled randomly, to estimate the prevalence of ectoparasite on small ruminants. A greater number of goats were sampled because of their predominance in the area.

The explanatory variables considered were species, age, and sex and body condition. Animals were grouped in to poor and good body condition as described by Steele (1996). The small ruminants were also classified as young (less than

two years) and adults (greater than or equal to two years) according to the classification method used by Gatenby (1991).

Study methodology

Detection of ectoparasites and skin lesions was made through visual inspection and palpation of the skin. Collection of ectoparasites and their classification were performed based on methods described by Soulsby (1992). Ectoparasites such as ticks, lice and fleas that were encountered either on the skin surface or attached to hair were collected manually from their attachment site. Collected samples were preserved in 10% formalin or 70% ethanol. Skin scrapings from the suspected cases of mange mites were immersed in 10% KOH to detach mites from scabs and crusts. Then samples were submitted to Kombolcha Regional Animal Health Diagnostic and Investigation Center, Parasitology Laboratory and Entomology Section for genus and species identification using stereomicroscopy (Walker *et al.*, 2003).

Questionnaire survey

A semi-structured questionnaire was prepared and 70 livestock owners or members of the household were interviewed to obtain general information on the importance of raising sheep and goat, the production system, their awareness on ectoparasites that affect small ruminants, relation between seasonal variation and ectoparasite infestation, and treatment approach to alleviate ectoparasite infestation. For this purpose, animal owners from 10 Peasant Associations (PAs) were selected as representatives of 21 PAs and 7 individuals were asked in each PA.

Data management and analysis

All the data analysis was conducted by the Statistical Package for Social Science (SPSS) software version 20. Descriptive statistics such as percentages and frequency distribution were used to describe the nature and the characteristics of the data. The association of different risk factors with the prevalence of ectoparasites was computed by Chi-square (χ^2) test. In all the analysis, comparisons having a *p*-value less than 0.05 ($p<0.05$) were considered as statistically significant.

Results

The result of the questionnaire survey indicated that sheep and goats were the main species of animals owned by the farmers in the study area. The main objectives of keeping small ruminants were for income generation and use of their dung as fertilizer. About 96% (67/70) of the respondents explained that they were aware of the threats posed by ectoparasite in sheep and goats. In addition, 83% (58/70) of the respondents have practiced modern care treatment against ectoparasite of small ruminants. However, 17% (12/70) respondents used traditional treatment such as washing with soap, application of animal feces and burning on the festoon area of the ticks while the tick is on the skin of the animal.

The main skin diseases of small ruminants mentioned by respondents were lice, tick, mange mite and fleas, and small ruminants were the highly affected species of animals. Concerning the seasonality of most ectoparasite infestation, 64% (45/70) of the respondents agreed that the infestation load is highly aggravated after a long rainy season. Eighty-five percent (60/70) of the respondents also replied that direct contact of small ruminants at communal grazing and barn areas is the main transmission area of ectoparasites.

The present study showed that 25.7% (90/350) were infested with one or more ectoparasites. Of the total ectoparasites identified, 2.6% (fleas), 4.0% (mites), 7.4% (ticks) and 11.7% (lice) were recorded. The prevalence of ectoparasites in sheep and goats were 25.8% and 25.6%, respectively. Prevalence of ticks (8.2%) and mites (4.1%) in sheep was higher than goats, while prevalence of lice (11.8%) and fleas (2.9%) in goats was relatively higher than in sheep, lice (11.6%) and flea (2.0%). However, there was no statistically significant variation ($p > 0.05$) in the prevalence of ectoparasites between the two species of animals (Table 1).

Table 1. Overall prevalence (%) of ectoparasite within the small ruminants

Ectoparasite	Sheep (n=147)		Goats (n=203)		Total (n=350)		X^2 (p-value)
	No infested	Prevalence (%)	No infested	Prevalence (%)	No infested	Prevalence (%)	
Tick	12	8.2	14	6.9	26	7.4	0.199(0.656)
Mite	6	4.1	8	3.9	14	4.0	0.004(0.947)
Lice	17	11.6	24	11.8	41	11.7	0.005(0.941)
Fleas	3	2.0	6	2.9	9	2.6	0.285(0.594)
Total	38	25.8	52	25.6	90	25.7	

No =number, n=number of animals examined

In the present study, 20.8% (73/350) of the small ruminants were infested with a single ectoparasite while 4.9% (17/350) mixed infestation was recorded (Table 2).

Table 2. Single and mixed infestation of ectoparasite in sheep and goats

Ectoparasite Infestation	Sheep (n=147) Infested (%)	Goats (n=203) Infested (%)	Total (n=350) Infested (%)	X^2	*p*-value
Single	33(22.4)	40(19.7)	73(20.8)	1.414	0.493
Mixed	5(3.4)	12(5.9)	17(4.9)		
Total	38(25.8)	52(25.6)	90(25.7)		

n=number of animals examined, (%) =prevalence

The prevalence of ectoparasites had no significant association (*p>0.05)* with sex, age and body condition score in goats (Table 3).

Table 3. Prevalence of species of ectoparasites in goats based on, sex, age and body condition score.

Ectoparasite Species	Sex			Age			BCS		
	Female (n=103)	Male (n=100)	χ2 (p-value)	Young (n=86)	Adult (n=117)	χ2 (p-value)	Poor (n=125)	Good (n=78)	χ2 (p-value)
A. variegatum	3(2.9)	2(2.0)	0.176 (0.675)	3(3.5)	2(1.7)	0.653 (0.419)	4(3.2)	1(1.3)	0.735 (0.391)
A. gemma	1(1.0)	3(3.0)	1.082 (0.298)	2(2.3)	2(1.7)	0.097 (0.755)	2(1.6)	2(2.6)	0.231 (0.631)
R. decoloratus	3(2.9)	1(1.0)	0.961 (0.327)	2(2.3)	2(1.7)	0.097 (0.755)	3(2.4)	1(1.3)	0.311 (0.577)
R. evertsi	3(2.9)	2(2.0)	0.176 (0.675)	1(1.2)	4(3.4)	1.050 (0.305)	5(4.0)	0(0.0)	3.199 (0.074)
H. variegatum	3(2.9)	0(0.0)	2.956 (0.086)	2(2.3)	1(0.9)	0.737 (0.391)	2(1.6)	1(1.3)	0.033 (0.855)
S. caprae	2(1.9)	5(5.0)	1.425 (0.233)	1(1.2)	6(5.1)	2.341 (0.126)	4(3.2)	3(3.8)	0.060 (0.806)
D. caprae	1(1.0)	2(2.0)	0.369 (0.544)	1(1.2)	2(1.7)	0.102 (0.750)	3(2.4)	0(0.0)	1.900 (0.168)
L. africanus	7(6.8)	9(9.0)	0.339 (0.560)	8(9.3)	8(6.8)	0.415 (0.520)	13 (10.4)	3(3.8)	2.841 (0.092)
D. caprae	3(2.9)	7(7.0)	1.810 (0.179)	3(3.5)	7(6.0)	0.659 (0.417)	6(4.8)	4(5.1)	0.011 (0.916)
C. felis	3(2.9)	4(4.0)	0.180 (0.671)	5(5.8)	2(1.7)	2.508 (0.113)	5(4.0)	2(2.6)	0.297 (0.585)
C .canis	3(2.9)	0(0.0)	2.956 (0.086)	0(0.0)	3(2.6)	2.238(0.135)	2(1.6)	1(1.3)	0.033 (0.855)
Total	32 (31.0)	35 (35.0)		28 (32.6)	39 (33.3)		49 (39.2)	18 (23.0)	

BCS =body condition score, n=number of animals examined

In sheep, *Rhipicephalus decoloratus* infestation has statistically significant association ($p<0.05$) with body condition while the other species of ectoparasites did not show significant difference with sex, age, and body condition (Table 4).

Table 4. Prevalence of species of ectoparasites in sheep based on sex, age and body condition score

	Sex			Age			BCS		
Ectoparasite Species	Female (n=77)	**Male (n=70)**	X^2 **(p-value)**	**Young (n=63)**	**Adult (n=84)**	X^2 **(p-value)**	**Poor (n=85)**	**Good (n=62)**	X^2 **(p-value)**
A. variegatum	2(2.6)	2(2.9)	0.009 (0.923)	1(1.6)	3(3.6)	0.584 (0.747)	2(2.4)	2(3.2)	0.103 (0.748)
R. evertsi	5(6.5)	2(2.9)	1.069 (0.301)	3(4.8)	4(4.8)	0.051 (0.975)	6(7.1)	1(1.6)	2.344 (0.126)
R. decoloratus	4(5.2)	3(4.3)	0.067 (0.796)	2(3.2)	5(6.0)	0.692 (0.708)	7(8.2)	0(0.0)	5.361 (0.021)
S. ovis	1(1.3)	1(1.4)	0.005 (0.946)	1(1.6)	1(1.2)	0.053 (0.974)	2(2.4)	0(0.0)	1.479 (0.224)
P. ovis	3(3.9)	2(2.9)	0.120 (0.729)	4(6.3)	1(1.2)	2.920 (0.232)	3(3.5)	2(3.2)	0.110 (0.920)
L. africanus	6(7.8)	4(5.7)	0.250 (0.617)	4(6.3)	6(7.2)	0.117 (0.943)	8(9.4)	2(3.2)	2.164 (0.141)
D. ovis	4(5.2)	4(5.7)	0.019 (0.890)	3(4.8)	5(6.0)	0.169 (0.919)	4(4.7)	4(6.5)	0.212 (0.645)
C. felis	1(1.3)	3(4.3)	1.236 (0.266)	1(1.6)	3(3.6)	0.584 (0.747)	3(3.5)	1(1.6)	0.497 (0.481)
Total	**26 (33.8)**	**21(30)**		19 (30.1)	28 (33.3)		35 (41.1)	12 (19.4)	

BCS =body condition score, n=number of animals examined

Discussion

The study revealed that ticks, lice, fleas and mange mites were found to be common ectoparasites of small ruminants in the study area. The prevalence of ectoparasite infestation in sheep (25.8%) and goats (25.6%) in the current study were lower than the previous studies conducted in Western Ethiopia (61.4% in sheep and 57.7% in goats), Northern Ethiopia (50.5% in sheep and 56.4% in goats), Amhara Regional State (50.5% in sheep and 56.4% in goats) and Northern Ethiopia (55.5% in sheep and 58.0% in goats) (Sertse and Wossene, 2007; Mulugeta *et al*., 2010; Sertse, 2004). Such differences may arise from the difference in agro-climatic conditions, season, and the level of management and health provided to small ruminants in the study sites.

In the current study, although no statistically significant difference was observed, sheep relatively harbored higher level of ectoparasites infestation than goats. A study conducted in Northwest Ethiopia by Seyum *et al* (2015) recorded higher prevalence of ectoparasites in sheep (47.7%) than goats (38.5%). Simi-

larly, a study conducted in Wolaita Soddo by Hailu *et al* (2008b) recorded a higher prevalence in sheep (68.7%) than goats (28.4%). Goats are considered to be relatively resistant to ectoparasites probably because of their self-grooming, licking, scratching, rubbing and grazing behavior which could contribute for rapid ectoparasite elimination (Wall and Shearer, 2001; Pegram *et al.,* 2004). Interestingly, Makelesh (2010) and Sertse and Wossene (2007) reported significantly higher prevalence of ectoparasites in goats than sheep.

In the present study, *Rhipicephalus decoloratus* in sheep was highly prevalent in animals with poor body condition ($p<0.05$). A higher prevalence of ticks in poor body conditioned small ruminants has also been reported from eastern parts of Ethiopia (Tamerat and Zeryihun, 2015). The findings of three genera and five species of ixodid ticks on goats and two genera and three species of Ixodid ticks on sheep of the current study is in line with the previous works conducted in different parts of Ethiopia (Abunna *et al*., 2009; Abera *et al*., 2010; Bekele *et al*., 2011). The prevalence of mange mite was 4.1% in sheep and 3.9% in goats. This result is in line with the prevalence of 2.6% in sheep and 3.9% in goats from Sidama Zone (Teshome, 2002); 3.34% in sheep from Haramaya district, East Hararge zone, Ethiopia (Bedru and Tafese, 2017), 2.7% in sheep and 5.7% in goats in Kombolcha (Jarso *et al.,* 2014), and 4% in sheep and 3.2% in goats from Bahir Dar, north-west Ethiopia **(**Amuamuta *et al*., 2012). However, our result was lower than the 11.7% prevalence reported in goats in Kombolcha (Zeryihun and Lemma 2012). This difference could be probably due to strategic control program being taken at the study area to minimize the prevalence of ectoparasites in small ruminants. The reason why mange infestation in this study is relatively high in sheep (4.1%) than in goats (3.9%) might be due to hairy coat of sheep which creates conducive environment (high temperature and humidity) for mite infestation (Panqui, 1994). This result however disagrees with the report of Teshome (2002) from Sidama zone.

The overall prevalence of lice infestation in the present study was 11.6% in sheep and 11.8% in goats which was higher than previous prevalence findings of 1.3% in sheep and 6.1% in goats in southern Ethiopia (Abebe *et al*., 2011),7.45% in sheep and 5.13% in goats in western Ethiopia (Sertse and Wossene, 2007), and 2.0% in sheep, 1.5% in goats in central Ethiopia (Mohammed, 2001), and 2.0% in sheep and 1.5% in goats in Oromia Regional State (Hailu *et al*., 2008a). But it was lower than the findings in northern part of the country

where a 39.80% and 29.20% prevalence in sheep, and in goats, respectively were reported (Sertse, 2004). Such differences may arise from differences in agro-climate, management, and health care of sheep and goats in the study sites and the sensitivity of the diagnostic method used to reveal ectoparasites.

Among the three species of lice (*Linognathus africanus*, *Damalina caprae* and *Damalina ovis*), *Linognathus africanus* was species of lice identified with prevalence of 6.8% and 7.9% in sheep and goats, respectively. Lice infestation was also reported to be higher in debilitated animals that suffer from malnutrition and intestinal parasitism (Pugh, 2002). During questionnaire survey the result of interviewed respondents also showed that small ruminant that had poor body condition were highly susceptible to lice. In the current study, two flea species were identified namely *Ctenocepalidae felis* and *Ctenocepalidae canis* and *Ctenocepalidae felis* was found only in sheep. This study revealed no significant difference ($p>0.05$) for the occurrence of flea species between sheep and goats.

Conclusion

Lice were the most abundant ectoparasites in the study area followed by tick, mange mite, and flea. The presence of these ectoparasites can cause several constraints on the livestock production resulting in important economic loss due to disease transmission, morbidity, and mortality. Good animal management and veterinary services should be practiced to control ectoparasite infestation. Furthermore, detailed studies should be conducted on the seasonal relationship and epidemiology of ectoparasites in order to set appropriate measures.

Conflict of interest

The authors declare that there is no conflict of interest.

References

Abebe, R., Tatek, M., Megersa, B. and Sheferaw, D., 2011. Prevalence of small ruminant ectoparasites and associated risk factors in selected districts of Tigray Region, Ethiopia. *Glob. Vet.* 7(5), 433-437.

Abera, M., Mohammed, T., Abebe, R., Aragaw, K. and Bekele, J., 2010. Survey of ixodid tcks in domestic ruminants in Bedelle district, southwestern Ethiopia. *Trop. Anim. Hlth. Prod.,* 42, 1677-1683.

Abunna, A., Kassa, D., Megressa, B., Regassa, A. and Amenu, K., 2009. Survey of tick infestation in small ruminant of Miesso district, west Hararge, Oromia Region, Ethiopia. *Trop. Anim. Health. Prod*., 41, 969-972.

Amuamuta, A., Kassahun, A., and Fentahun, T.,2012. Occurrence of small ruminant ectoparasites in and around Bahir Dar, Northwest Ethiopia. *Adv. Biol. Res.,* 6(5), 170-176.

ARARI (Amhara Regional Agricultural Research Institute). 2008. Annual report Bahir Dar, Ethiopia.

Ashenafi, H., Hailu, Y. and Yebegaeshet, M. 2013. Impact of sheep and goats ectoparasites on the tanning industry in Tigray region, Ethiopia. *Ethiop. Vet. J.,* 17(2), 63-76.

Bedru, H. and Tafese, W., 2017. Prevalence of mange mites on small ruminants in Haramaya Wereda, East Hararge Zone, Ethiopia. *Int. J. Res. Granthaalayah.*, 5(4), 191-201.

Bekele, J., Tariku, M. and Abebe, R., 2011. External parasite infestations in small ruminants in Wolmera district of Oromia region, Central Ethiopia. *Glob. Vet.*, 10, 518-523.

Beyecha, K., Kumsa, B. and Beyene, D., 2014. Ectoparasites of goats in three agroecologies in central Oromia, Ethiopia. *Comp. Clin. Pathol.*, 23, 21-28.

CSA (Central Statistical Agency), 2017. Federal Democratic Republic of Ethiopia agricultural sample survey report on livestock and livestock characteristics, volume II, Addis Ababa, Ethiopia.

Fthenakis, G.C., Karagiannidis, A., Alexopoulos, C., Brozos, C. and Papadopoulos, E., 2001. Effects of sarcoptic mange on the reproductive performance of ewes and transmission of *Sarcoptes scabiei* to newborn lambs. *Vet. Parasitol.*, 95, 63-71.

Gatenby, R., 1991. The tropical agriculture, London and Beging Stock McMillan Education Ltd. ACCT. Pp. 6-10.

Hailu, Y., Berhe, N. and Ayana, D., 2008a. Prevalence of major skin diseases in cattle, sheep and goats at Adama veterinary clinic, Oromia regional state, Ethiopia. *Acta Parasitol. Glob.*, 159, 455-461.

Hailu, Y., Tefera, Y. and Ayana, D., 2008b. Ectoparasite prevalence in sheep and goat in and around Wolaita soddo, Southern, Ethiopia. *Revue. De. Med. Vet.,* 159, 450-454.

Jarso, D., Sori, T. and Duguma, M., 2014. Prevalence of ectoparasites on small ruminants around Kombolcha, north east Ethiopia. *J. Biol. Sci.,* 6(3), 81-87.

Kleemann, G. 2008. Report on: Consultancy and proposal for the national ectoparasite control program: Report for GTZ-Engineering Capacity Building Program (ECBP) private sector development component and Ministry of Agriculture and Rural Development Ethiopia; Wiesbaden, Germany, September 23, 2008.

Kumsa, B., Beyecha, K. and Geloye, M., 2012. Ectoparasites of sheep in three agro-ecological zones in central Oromia, Ethiopia. *Onderstepoort J. Vet. Res.*, 79(1), 1-7.

Makelesh, T.B., 2010. Survey on ectoparasite of small ruminant in different agro-ecological zones of Tigray region, DVM Thesis, Hawassa University, Faculty of Veterinary Medicine, Hawassa, Ethiopia.

Ministry of Agriculture and Rural Development (MoARD). 2005. Mange, Lice and Sheep Ked control project in Amhara, Tigray and Afar regions, MoARD, Animal Health Department, Addis Ababa, Ethiopia.

Mohammed, H., 2001. Study on skin disease of small ruminants in central Ethiopia, DVM thesis, Faculty of Veterinary Medicine, Addis Ababa University Debrezeit, Ethiopia.

Mulugeta, Y., Hailu, Y. and Ashenafi, H., 2010. Ectoparasites of small ruminants in three selected agro-ecological sites of Tigray region. *Trop. Anim. Hlth. Prod.,* 42, 1219-1224.

Panqui, L.J., 1994. Mange in domestic animals and methods of control. *Rev. Sci. Technol. Offic. Int. Epizo.*, 13, 1227-1243.

Pegram, R., Tatchel, R., Castro, J., Chizyuka, M., Greek, M., McCaskey, P. and Mora, N., 2004. Tick control: URL: http://wwwold.caribvet.net/upload/tickcontrolnewconceptswar2001.pdf).

Pugh, D.G., 2002. Sheep and goat medicine. United States of America, Saunders, Elisever Sci. Pp. 19-25.

Sertse, T. and Wossene, A., 2007. A study on ectoparasite of sheep and goat in Eastern part of Amhara regions, North East Ethiopia. *J. Small Rum. Res.*, 69, 62-67.

Sertse, T., 2004. Investigation on ectoparasites of small ruminants in selected sites of Amhara regional state and their impact on the tanning industry. *J. Small Rumin. Res.,* 47, 77- 82.

Seyum, Z., Tadesse, T. and Addisu, A., 2015. Ectoparasites prevalence in small ruminants in and around Sekela, Amhara Regional state, Northwest Ethiopia**.** *J. Vet. Med.*, Article ID 216085, 6 pages.

Solomon, A., Workalemahu, A., Jabbar, M. A., Ahmed, M. M. and Hurissa, B., 2003. Livestock marketing in Ethiopia. A review of structure, performance and development initiatives, socioeconomic and policy research working paper, Nairobi, Kenya, Pp. 35- 52.

Soulsby, E.J.L. 1992. Helmithes, arthropods and protozoa of demoesticated animals. Bialliere, Tindall, London, Pp. 475-495.

Steele, M., 1996. Goats in: the tropical agriculturalist, London and basing stock, MACLUAN EDUCATION LTD, ACCT. Pp. 79-83.

Tamerat, N. and Zeryehun, T., 2015**.** Prevalence and identification of ectoparasites fauna in small ruminants in selected areas of Eastern Ethiopia. *Afr. J. Basic Appl. Sci.,* 7 (5), 240-246.

Teshome, W., 2002. Study on small ruminant skin diseases in Sidama zone, Southern Ethiopia, DVM Thesis. Faculty of Veterinary Medicine, Addis Ababa Univerity Debrezeit, Ethiopia.

Thrusfield, M.V., 2005. Veterinary epidemiology. 3rd Edition, Blackwell Science Ltd., UK, Pp. 229-245.

Walker, A.R., Bouattour, A., Camicas, L.L., Estrada-Pena, A., Horak, I. G., Latif, A. A., Pegram, R.G. and Preston, P.M., 2003.Ticks of domestic Animals in Africa, a Guide to Identification of species and genus's, Bioscience Reports, 1-221.

Wall, R. and Shearer, D. 2001.Veterinary ectoparasite; Biology, pathology and control.2nd ed.UK. Black Well sciences, Pp. 23-54.

Zeryihun, T. and Lemma, M., 2012. Prevalence of mange mite of goats in and around Kombolcha. South Wollo, Amhara National state, northeastern Ethiopia. *World Appl. Sci. J.,* 19(1), 106-111.