Vol. 10(12), pp. 266-272, December 2018
DOI: 10.5897/JVMAH2018.0729
Article Number: 1FB039959516
ISSN: 2141-2529

http://www.academicjournals.org/JVMAH

ACADEMIC JOURNALS
expand your knowledge

Journal of Toxicology and Environmental Health Sciences

Full Length Research Paper

Study on prevalence and associated risk factors of mange mite infestations in cattle in Damot Woyde District, Wolaita Zone, Southern Ethiopia

Sitotaw Kolato Koche[1], Gemechu Chala Hunderra[1*] and Aynalem Mandefro Getahun[2]

[1]Faculty of Veterinary Medicine, Hawassa University, Hawassa, Ethiopia.
[2]Samara University, College of Veterinary Medicine, Samara, Ethiopia.

Received 21 September, 2018: Accepted 25 October, 2018

A cross sectional study was conducted from October 2017 to April 2018 in Damot Woyde District of Wolayta Zone to estimate the prevalence of mange mite infestation in cattle and identify the associated risk factors. Out of 375 animals examined, 41 (10.9%) were found positive for mange mite infestations. No statistically significant difference was noted among sex, age, breed and management categories (p>0.05); however, the prevalence differences noted between animals with different body condition score were statistically significant (p<0.05). The highest prevalence was recorded in animals with poor body conditions (27.71%), followed by those with medium (9.97%) and good body conditions (0.83%). Four mite genera were found in the area namely; *Sarcoptes* 19 (46.3%), *Psoroptes* 5 (12.2%), *Demodex* 13 (31.7%) and *Chorioptes* 4 (9.8%). Mange was frequently recovered from dewlap, followed by neck, tail head, face, brisket and leg. The overall prevalence (10.9%) shows that mange is an important disease that needs attention in the area. Therefore, farmers need to be made aware on the strategic use of acaricides following veterinary recommendation. Moreover, there is a need for regular research on the sensitivity of the parasites to the drugs in use.

Key words: Damot Woyde, dewlap, cattle, mange mites, sarcoptes.

INTRODUCTION

Ethiopia has the largest livestock inventories in Africa. About 53.99 million cattle, 25.5 million sheep, 24.06 million goats, 1.91 million horses, 6.75 million donkeys, 0.35 million mules, 0.92 million camel and about 50.38 million poultry are estimated to be found in the country (CSA, 2013). Ruminant livestock are important source of income for rural communities and are one of the nation's major sources of foreign currency from export (Amsalu et al*.,* 2000). It performs multiple functions in the Ethiopian economy by providing food, input for crop production and soil fertility management, raw material for industry, cash income as well as in promoting saving, fuel, social functions and employment (Zekarias and Berhanu, 2018). The sector's contribution to national output is underestimated, because traction power and manure for fertilizer are not valued. Livestock contribute 12 to 15% of total export earnings; the sub-sector is the second major source of foreign currency through export of live animals, meat, hides and skins (Ayele et al., 2003). Hides and skins averaged a yearly export value of $52,160,000; livestock averaged $3,390,000, and meat, $2,380,000. Over this twenty-one year period, hides and skins

*Corresponding author. E-mail: game33chala@gmail.com. Tel: +251941393996.

provided on average 90% of official livestock sector exports, livestock provided 6% and meat 4%. In the 1990s, hides, skins and leather were Ethiopia's second largest export earner after coffee (Fitaweke, 2012).

The development of leather industry requires great quantity of raw materials of various origins, the principal source of which is livestock industry (Zeleke, 2009). Even if much number of tanneries is involved in production of finished and semi-finished leather products, the sector and the country are losing revenue due to a decline in leather quality. A considerable portion of these pre-slaughter defects is directly related to skin diseases or secondary damage that occurs when the animal scratches itself to relieve the itching associated with some of these diseases (Addise and Achenef, 2013). Of the diseases that cause serious problem, parasitism represents a major impact on livestock production in the tropics (Juyal et al*.,* 2011; Sumbria et al*.,* 2016). Among the parasitic diseases, mange mite infestation in domestic ruminants, canines and felines inflicts enormous economic damage to skin resulting in the condemnation of affected organs and lowering of the meat, milk and wool production (Gupta et al., 2009). The major affected organ by mange is the skin (Aujla et al., 2000; Theo, 2003).

Mange mites belong to phylum, arthropoda; class, arachnida and order, acarina. With few exceptions, mites remain in prolonged contact with the skin of the host, causing the condition, generally known as mange (Urquhart et al., 1996). Mange is a contagious skin disease, characterized by crusty, pruritic dermatitis and hair/feather loss, and caused by a variety of parasitic mites burrowing in or living on the skin (Kassahun et al., 2015; Singla et al*.,* 2005). Mites are obligate parasites that most species spend their life cycles, from egg to adult, on the host so that transmission is mainly by contact. Mites are classified according to their location on the host as burrowing and non-burrowing mite (Urquhart et al., 1996).

Common sites of these mites are skin, scales, feathers or fur (Kassai, 1999). They feed on lymph, skin debris or sebaceous secretion and they ingest by puncturing the skin, scavenge from the skin surface (Tefera, 2004). The infestations by these mites are called acariasis and can result in severe dermatitis, known as mange (Wall and Shearer, 2001; Aulakh et al*.,* 2003). Mange mites are the major causes of skin diseases that affect animal production in many areas of Ethiopia. In Ethiopia, different types of skin diseases are responsible for important and multifaceted socio-economic strike of which infestation with mange mites surpasses others. In addition to the degradation of skin and hide quality, skin diseases in general and mange mites in particular induce associated economic losses of the country due to varied reasons (Zekarias and Berhanu, 2018; Teshome and Derso, 2015). Besides causing direct economic loss to the animal owners via mortality, poor growth and reproduction of the respective animals, mange also leads to down grading and rejection of the skin and hide at the tannery that leads to economic losses to the tannery industry and ultimately the country (Ayele et al., 2003).

Despite the existence of several studies on mange mites infestations of ruminants in the country, there are diverse results among the studies on the most important risk factors for the infestations as the differences between age and species-susceptibility to mite infestation as well as the existence of association between mite infestation and a specific agro-ecology (Asmare et al., 2016).

Ectoparasites infestation in general and mange mite infestation in particular brings health ailments and diminution of cattle productivity thereby hampering the economy of the country as a whole (Wubante and Asrat, 2017). Although mange mite infestation of cattle is pervasive in the country and in Damot woyde District no study has been done to identify the parasite, assess its distribution and estimate its prevalence. Hence, the objective of the present study is to estimate the prevalence and associated risk factors of mange mite infestation in bovine in Wolaita Zone, Damot Woyde District.

MATERIALS AND METHODS

Study area

The study was conducted in Damot Woyde District of Wolaita Zone, Southern Region of Ethiopia. It is located at about 406 km from Addis Ababa and along the escarpment of Great Rift Valley; it is bordered on the south by Humbo, on the west by Soddo Zuria, on the northwest by Damot Gale, on the north and east by Diguna Fango districts. The administrative center of this district is Bedessa town.

Damot Woyde District has a total area of 26,550 hectare and lies with an elevation ranging from 1300 to 2200 m above sea level. The district has 24 peasant associations with total human populations of 4894488. Regarding the agro-ecology of the district, out of the total land size 35% is lowland; 55%, midland; and 10%, high land. The annual mean temperature ranges between 16 and 31°C and the annual mean rainfall ranges from 1000 to 1500 mm. According to land utilization data of the region 8,403 ha is cultivated land, 4,380 is grazing land, 2,229.5 ha is forest, and 969.835 ha is covered by bushes and shrub land. According to the unpublished 2016 record obtained from Damot woyde district livestock and fishery bureau, the livestock population of the district is cattle (70,908), sheep (25,692), goats (27,460), equines (7,872) and poultry (81,478).

Study animals

The study was conducted in selected sites of Damot Woyde District based on their respective agro ecologies on animals which are managed under extensive, intensive and semi-intensive types of management. In the current study two breed types were involved, namely local and hybrids.

Study design

A cross sectional type of study was conducted in Damot Woyde

District from October 2017 up to April 2018 in order to determine the prevalence of mange mite infestation in cattle and associated risk factors. Following identification of the herd, animals in herd were systematically selected for clinical examination of mange mite infestation. Bio-data including age, sex, breed, body condition score (BCS), management, agro ecology and site of lesion were recorded using a structured questionnaire format. Body condition scores of the animals were categorized as poor, moderate and good by modifying the system described by Gatenby (1991). For cattle poor body condition score was given to animals with transverse processes project prominently, spines appear sharply; for medium ribs usually visible, little fat cover, dorsal spines barely visible and for good; fat cover in the critical areas can be easily seen and felt; transverse processes cannot be seen or felt (Nicholson and Butterworth, 1986).

Sample size and sampling method

The sample size was determined based on 1.63% expected prevalence (Chalachew, 2001), desired precession of 5% and 95% confidence level as described by Thrusfield (2005).

Accordingly, the minimum calculated sample size was 25; however; to increase the precision of estimate the study was conducted on 375 cattle.

Study methodology

Laboratory and clinical examinations

Animals that are randomly selected from the cattle population were clinically assessed for the presence of mange mite infestation. From each animal skin scrapings were collected from different parts of the body including dewlap, neck, tail head, face, brisket and leg.

Morphology of the parasite was studied in the laboratory with the help of dissecting (4×) and compound (10×) microscope after collecting samples from suspected cases of mange mite using scalpel blade by deep skin scraping until capillary oozing was evident. In cases where nodular skin lesion was suspected to be due to demodectic mange, the content (white creamy pus) was collected and direct smear is made for microscopic examination. The samples were treated with 10% potassium hydroxide solution and examined under light microscope for morphological identifications of mange species. Identification of the mange mite's species was based on morphological characteristics described by Soulsby (1982).

Data management and analysis

Microsoft excel was used for data entry and STATA (version 11) statistical software was used for data analysis. Descriptive statistics such as percentage were used to summarize the prevalence of the different species of mange mites from animals. The hypothesized risk factors and their association with the prevalence of mange mite infestation were analyzed by using logistic regression analysis. In all the analyses, a P value <0.05 was considered for presence of statistically significant association with 95% level of confidence.

RESULTS

Out of 375 cattle examined, 41 (10.9%) were found positive for mange mite infestation. Of these, 18 (9.8%) were males and 23 (12.1%) were females; 8 (15.1%) were young animals <2 years and 33 (10.25%) were adults ≥2 years; 39 (10.95%) were local breeds, 2 (10.53%) were cross breeds; 1 (0.83%) animals had good body condition, 17 (9.97%) medium and 23 (27.71%) had poor body conditions; 37 (11.11%) were in extensive type of management, 2 (13.33%) in semi-intensive, 2 (7.41%) were in intensive type of management (Table 1). Four species of mange mite were recorded in current study. Of these, 19 (46.3%) were sarcoptic manges, 5 (12.2%) psoroptic, 13 (31.7%) demodectic and 4 (9.8%) chorioptic mange cases (Table 2).

There was no statistically significant association among different categories of risk factors, namely sex, age, breed, management and agro ecologies ($p>0.05$) (Table 3). Statistically significant differences ($p<0.05$) were observed among different categories of body condition scoring, with highest prevalence in animals with poor body conditions (27.71%) and lowest in good body conditions (0.83%). Spatial distribution of cattle mange on the body parts revealed that mange was highly prevalent in the dewlap region, followed by neck, tail head, face, brisket and leg.

DISCUSSION

The current study revealed an overall prevalence of mange mite in cattle as 10.9 per cent. This result is higher than previous studies conducted in Gondar (Teshome and Derso, 2015), 2.34%; in Wolayita Sodo (Chalachew, 2001), 1.63%; in Benchi Maji (Onu and Shiferaw, 2013), 0.9%; in Adama (Yacob et al., 2008), 1.88%; in Debre-Zeit (Bogale, 1991), 4.19%; in Hawassa (Addise and Achenef, 2013), 3.13%; in Iceland (Eydal and Richter, 2010), 1.8%; and in southern rangelands (Assegid, 1991), 7.4%. This indicates that bovine mange mite is the most important parasite of cattle in the study area. This might suggest that the study area was conducive for the survival, multiplication and development of mange. The study coincides with Kassahun et al. (2015) who reported overall prevalence of 10.7%. But, it was lower than the previous studies of Tewodros et al. (2012), 13.79%; in Gondar town (Geremew, 1998), 28%; in Bale zone (Mathes and Bukva, 1993) who reported 94% in Mongolia. The differences may be due to agro ecological difference between the study areas.

In this study the prevalence of mange mite varies according to sex of animals. Prevalence of mange was high in females 23 (12.1%) than males 18 (9.8%) in the study area. This result agrees with the study of Matthes and Bukva (1993) who reported 32% in females and 1.22% in male animals. But this report disagrees with the previous work of Yacob et al. (2008) who reported 2.22% in males and 1.67% in female animals, respectively in Adama and the report of Bogale (1991) who indicated 4.57 in male and 3.17% in female animals in Debre Zeit. This might be associated with physiological stress

Table 1. Prevalence of mange mites with respect to different risk factors.

Risk factor	Numbers examined	Number positive (%)	95% CI
Sex			
Male	184	18 (9.8)	6.2-15.0
Female	191	23 (12.1)	8.1-17.5
Age			
<2 years	53	8 (15.1)	7.66-27.58
≥2 years	322	33 (10.25)	7.36-14.10
Breed			
Local	356	39 (10.95)	8.18-14.66
Hybrid	19	2 (10.53)	2.53-34.75
BCS			
Good	120	1 (0.83)	0.11-5.75
Medium	172	17 (9.97)	6.21-15.36
Poor	83	23 (27.71)	19.09- 38.37
Management			
Extensive	334	38 (11.37)	8.14-14.87
Semi-intensive	14	1 (7.14)	3.17-41.92
Intensive	27	2 (7.41)	1.81-25.86
Total	375	41 (10.9)	-

Table 2. Multivariable logistic regression analysis of risk factors for mange mite's infestation.

Risk factors	Number Observed	Prevalence (%)	Odds ratio	P value
Sex				
Male	184	9.8	-	-
Female	191	12.1	0.89	0.755
Age				
<2 years	53	15.1	-	-
≥2 years	322	10.25	0.57	0.297
Breed				
Local	356	10.95	1.21	0.854
Hybrid	19	10.53	-	-
BCS				
Good	120	0.83	-	-
Medium	172	9.97	16.56	0.010
Poor	83	27.71	55.39	0.00
Management				
Extensive	120	11.37	-	-
Semi-intensive	172	7.14	0.634	0.709
Intensive	83	7.41	1.623	0.668
Total	375	10.9	-	-

Table 3. Prevalence of mange with respect to mite genera.

Species of mites identified	Number positive	Prevalence (%)
Sarcoptes	19	46.3
Psoroptes	5	12.2
Demodex	13	31.7
Chorioptes	4	9.8
Total	41	100

conditions during pregnancy and lactation, the lesser emphasis given on feeding of female animal with regard to better feeding habit to male animals by owners since they are used for ploughing, fattening and higher financial gain at the market level.

Prevalence of mange was lower in animals of 2 years and above (10.25%) and higher in animals less than 2 years (15.1%). This was higher than the previous work done by Yacob et al. (2008) who reported 1.06 and 2.04% prevalence in young and adult cattle, respectively. But it was in line with the work of Bogale (1991) who reported 7.95% in young and 2.40% in adult in DebreZeit and Tewodros et al. (2012) who reported 20% in young and 13.25% in adults. This indicates that mange occurred in all age groups with different intensity. The higher prevalence in young animals might be due to poorly developed immune system of young cattle than the rest age categories (Tewodros et al., 2012) and also might be due to the fact that they graze in the pasture with adult animals in most parts of the study area.

There was insignificant variation observed between two breeds of animals in the study. Higher prevalence was found in local breeds (10.95%) and lower prevalence was observed in cross breeds (10.53%). This finding is in agreement with the report of Kassahun et al. (2015) who reported higher prevalence of mange in local breeds (10.1%) and lower in hybrids (0.6%). Yacob et al. (2008) also indicated higher prevalence of mange in local breed (8.8%) and lower in cross breeds (2.2%) in and around Mekelle who reported higher prevalence in local breeds (9.425%) and lower prevalence in cross breed (4.367%) in Gondar town. This might be because cross breeds are usually kept in and around urban areas with good management while local breeds of cattle are reared mostly in rural areas where farmers do not give them good management and most of them are kept under free range communal grazing system which lets them to contact those cattle having mange. This facilitates transmission of mange from infested to healthier cattle. In addition, Yacob et al. (2008) reported a lower prevalence of mange (0.00%) on cross breeds in Adama. The current higher prevalence (10.53%) on cross breed of cattle might be due to difference in agro - ecology of study areas and time of study.

This study revealed higher prevalence in cattle managed under extensive (11.37%) than semi intensive and intensive management systems. This was found lower than the results reported by Yacob et al. (2008) which account for 23.7 and 76.2% for semi intensive and extensive systems, respectively. This difference might be due to a variation in climatic conditions, management and feed accessibility between the two study areas. Additionally, the lower prevalence on those managed under semi-intensive and intensive production systems might be due to the smaller number of sample sizes (14 and 27), respectively, than in those kept under extensive production system (334).

There was statistically significant difference observed between different body conditioned animals. This result is in agreement with previous reports by Mulatu et al. (2017) and Molu (2002). Animals which have poor body condition appear most susceptible to mite infestations (Taylor et al., 2007). This may be due to the fact that poorly nourished animals appear to be less competent in getting rid of infestation as compared to that of well-managed animals or certain mange species like Sarcoptic mange infestation, a major cause of animal emaciation and decrease in immune response and weakness which can lead to even death (Lastras et al., 2000).

In fact this study did not consider the effect of other related factors like season, geographic location on the occurrence and prevalence of cattle mange mites infestation in the study area due to time and budget hindrances. Furthermore, due to the same reason the current study also considered relatively small sample size which might in turn have an impact on the prevalence of cattle mange mites infestation in the study area.

Conclusion

The high prevalence (10.9%) recorded in the study area shows that it affect animal production and quality of skin and hide in the district and country. To minimize transmission of the disease and to increase the productivity of cattle, better cattle management practices should be implemented. Awareness creation must be done for farmers regarding the impact of mange, its transmission, modern prevention and control methods and management practices. In addition, there should be strong collaboration of researchers and animal health

professionals to assess and evaluate the magnitude of the problem at national level as there is increasing prevalence of mange mite.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors are very grateful to Professor Kassahun Asmare for his kind support, guidance and encouragements from the beginning to the end of this paper write up.

REFERENCES

Addise A, Achenef M (2013). Major skin diseases of cattle: Prevalence and risk factors in and around Hawassa, Southern Ethiopia. Journal of Advanced Veterinary Research 3:147-153.

Amsalu DS, Bewket T, Kassa T, Tefera M, Gezahgne M, Dagne and Shihun S (2000). Mange: A disease of growing threat for the production of small ruminants in Amhara National Regional State. The opportunities and challenges of enhancing goat production in Ethiopia, November 10-12.

Asmare K, Abebe R, Shiferaw D, Krontveit RI, Barbara W (2016). Mange mite infestation in small ruminants in Ethiopia: Systematic review and meta-analysis, Veterinary Parasitology 2(18):73-81.

Assegid BB, (1991). Epidemiological study of major skin diseases of cattle: southern Rangelands, DVM thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Aujla RS, Singla LD, Juyal PD and Gupta PP (2000). Prevalence and pathology of mange-mite infestations in dogs. Journal of Veterinary Parasitology 14(1):45-49.

Aulakh GS, Singh J, Singla LD and Singla N (2003). Pathology and therapy of natural notoedric acariosis in rabbits. Journal of Veterinary Parasitology 17(2):127-129.

Ayele S, Assegid W, Jabbar MA, Ahmed MM, Belachew H (2003). Livestock marketing in Ethiopia: A review of structure, performance and development initiatives. Socio-economics and Policy Research Working Paper 52. ILRI (International Livestock Research Institute), Nairobi, Kenya. P 35.

Bogale A (1991). Epidemiological study of major skin diseases of cattle: Southern rangelands. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.

Central Statistical Agency (CSA) (2013). Agricultural Sample Survey Report On Livestock and Livestock Characteristics. Addis Ababa, Ethiopia. pp. 1-188.

Chalachew N (2001). Study on skin diseases in cattle, sheep and goat in and around Wolayta Soddo, Southern Ethiopia. DVM thesis, Addis Ababa University, DebreZeit, Ethiopia.

Eydal M, Richter S (2010). Lice and mite infestations of cattle in Iceland. Icelandic Agricultural Sciences 23:87-95.

Fitaweke M (2012). The Contribution of Livestock to the Ethiopian Economy-Part II. IGAD Livestock Policy Initiative working paper, No. 2-11.

Gatenby MR (1991). Sheep. Coste R and Smith JA (eds.), the Tropical Agriculturalist, Macmillan (London) and CTA (Wageningen) pp. 6-11.

Geremew T (1998). Prevalence of bovine dermatophylosis in and around Robe, Bale-Zone. Doctor of Veterinary Medicine thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Gupta PP, Singla LD, Gupta K, Sood NK (2009). Pathological alterations induced by common tissue dwelling parasites. *Proceedings* of the XIX National Congress of Veterinary Parasitology held from February 03-09, 2009 at GADVASU, Ludhiana pp 22-25.

Juyal PD, Bal MS, Singla LD (2011) Economic impact, diagnostic investigations and management of protozoal abortions in farm animals. In: All India SMVS' Dairy Business Directory 11:39-46.

Kassahun SA, Belete HN, Bemrew AM (2015). Prevalence of Mange Mite Infestation on Cattle in South Achefer District, Northwest Ethiopia. American-Eurasian Journal of Scientific Research 10(4):186-192

Kassai T (1999). Veterinary Helminthology. Oxford: Butterworth-Heinemann.

Lastras ME, Pastor J, Marco I, Ruiz M, Viñas L, Lavin S (2000). Effect of sarcoptic mange on serum proteins and immunoglobulin G levels in Chamois and Spanish Ibex. Veterinary Parasitology 88(3-4):313-319.

Maatthes HF, Bukva V (1993). Features of bovine demodecosis (Demodex Bovis Stiles, 1892) In Mongolia: Preliminary observations. Folia Parasitologica 40(2):154-5.

Molu N (2002). Epidemiological study on skin diseases of the small ruminants in the southern rangelands of Oromia, Ethiopia. DVM Thesis, Addis Ababa University, faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Mulatu A, Hailehizeb C, Tesfu A (2017). Study on prevalence and associated risk factors of bovine mange mites in and around Gondar Town, Northwest Ethiopia. Rep Opinion 9(8):64-70. doi:10.7537/marsroj090817.06.

Nicholson MJ, Butterworth MH (1986). A guide to condition scoring of zebu cattle. International livestock centre for Africa, Addis Ababa, Ethiopia. http://hdl.handle.net/10568/49674

Onu SH, Shiferaw TZ (2013). Prevalence of ectoparasite infestations of cattle in Bench Maji zone, southwest Ethiopia. Veterinary World 6(6):291-294.

Singla LD, Singla N and Parshad VR (2015). Development of concurrent infection of notoedric mange in rabbits infected with *Trypanosoma evansi.* Scandinavian Journal of Laboratory Animal Science 41(2):1-6.

Soulsby EJL (1982). Helminthes, Arthropods and Protozoa of Domesticated Animals, 7th ed.Baileria Tinall, UK. pp. 356-497.

Sumbria D Singla LD and Gupta SK (2016). Arthropod invaders pedestal threats to public vigor: An overview. Asian Journal of Animal and Veterinary Advances 11: 213-225.

Taylor M, Coop R, Wall R (2007). Veterinary parasitology. 3rd ed. London: Black wall Publishing Company pp. 144-223.

Tefera S (2004). Investigation in ectoparasites of small ruminants in selected sites of Amhara Regional State and their Impact on the Tanning Industry. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debre-Zeit, Ethiopia.

Teshome D, Derso S (2015). Prevalence of major skin diseases in ruminants and its associated risk factors at university of Gondar Veterinary Clinic, North West Ethiopia. Journal of Veterinary Science and Technology S13:002. doi:10.4172/2157-7579.1000S13-002.

Teshome D, Derso S (2015). Prevalence of major skin diseases in ruminants and its associated risk factors at university of Gondar Veterinary Clinic, North West Ethiopia. Journal of Veterinary Science and Technology S:S13-002.

Tewodros F, Fasil W, Mersha C, Malede B (2012). Prevalence of ectoparasites on small ruminants in and around Gondar Town. American-Eurasian Journal of science and research 7(3):106-111.

Theo V (2003). The importance of the leather foot wear sector for development in Ethiopia. RLDS policy Brief no. 1. Addis Ababa, Ethiopia: Addis Ababa University Printing Press.

Thrusfield M (2005). Veterinary epidemiology. 2nd edition, Blackwell Science, Oxford pp 182-198.

Urquhart GM, Armour J, Duncan JL, Dunn AM,Jennings FW (1996). Veterinary parasitology, 2nd ed., Blackwell science Ltd, UK.

Wall R, Shearer D (2001). Veterinary ectoparasite biology, pathology and control 2nd edition.

Wubante M, Asrat M (2017). Study on the prevalence of bovine demodecosis and its associated risk factors in and around Bahir Dar, Amhara National Regional State, Ethiopia. Journal of Marine Science: Research and Development 7:1000231.

Yacob HB, Nesanet A, Dinka A (2008). Part II: Prevalence of major skin diseases in cattle, sheep and goats at Adama Veterinary Clinic,

Oromia regional state, Ethiopia. Revue de Médecine Vétérinaire 159:455-461.
Yacob HT, Ataklty H, Barsisa K (2008). Major ectoparasites of cattle in and around Mekelle, northern Ethiopia. Entomological Research 38: 126-130; https://doi.org/10.1111/j.1748-5967.2008.00148.x
Zekarias F, Berhanu MM (2018). Cross-sectional study on the prevalence and risk factors for major skin diseases of cattle in Hawassa city, Southern Ethiopia. Journal of Veterinary Medicine and Animal Health 10(3):89-95.
Zeleke T (2009). Common defects of sheep and goat skin in Ethiopia and cause, Ethiopian sheep and goat productivity. Technical Bulletin 19:1-5.