Journal of Veterinary Science & Animal Husbandry

Open Access

Austin Publishing Group

Research Article

Prevalence of Lungworm Infection of Small Ruminants in and Around Sebeta Town, Central Ethiopia

Abubeker Hassan[1]; Ebisa Mezgebu[2*]

[1]College of Veterinary Medicine and Agriculture, Addis Ababa University, Bishoftu, Ethiopia

[2]Animal Health Institute (AHI), Sebeta, Ethiopia

[*]**Corresponding author: Ebisa Mezgebu**

Animal Health Institute (AHI), Sebeta, PO Box: 04, Ethiopia.

Tel: +251 93 232 0809; Fax: +251 11 338 0220

Email: ebisamnaf@gmail.com

Received: June 26, 2023

Accepted: August 03, 2023

Published: August 10, 2023

Abstract

Lungworm infection is one of the common parasitic diseases that affect small ruminants. It causes great economic losses due to decrement in production and productivity gained from these animals. There was limited information related to this disease in these animals in the study area. Therefore, this study was conducted to determine the prevalence and species of lungworms in small ruminants and to assess the possible risk factors associated with lungworm infection. A cross-sectional study was conducted from November 2019 to May 2020 on small ruminants selected by a simple random sampling technique in and around Sebeta town, central Ethiopia. A total of 406 animals (259 sheep and 147 goats) were sampled and examined to determine lungworm infection prevalence and its species identification. The study showed that 13.8% (56/406) of an overall prevalence of lungworm infection was found in the study area. In another way, a higher prevalence was observed in sheep 18.1% (47/259) than in goats 6.1% (9/147) and there was a significant association (X^2=11.4, p<0.05) between them. Similarly, 14.7% (37/ 251) and 12.3% (19/155), 15.7% (21/134) and 11.7% (16/137), and 14.2% (35/147) and 13.2% (21/159) prevalence were determined between female and male, young and adult, non-dewormed and dewormed animals respectively, but they were not significantly associated with lungworm infection. However, 17.6% (13/74), 13.5% (28/207), and 12% (15/125) prevalence was calculated among poor, good, and medium body-conditioned animals respectively and the difference was not statistically significant (X^2=1.24, p>0.05). *Dictyocaulus filaria* was the only species of lungworm identified in both sheep and goats. This study revealed that lungworm infection was prevalent and affected the production and productivity of small ruminants in the study area significantly.

Keywords: Infection; Lungworm; Prevalence; Sebeta; Small ruminants

Abbreviations: AAU: Addis Ababa University; AHI: Animal Health Institute; BCS: Body Conditions; CI: Confidence Interval; CSA: Central Statistical Agency; E: East; G: Gram; GIT: Gastrointestinal Tract; Km: Kilometer; M: Meter; MM: Millimeter; N: North; P: Probability; Spp: Species; SPSS: Statistical Package for Social Sciences; X^2: Chi-square Test

Introduction

Ethiopia has the largest livestock population in Africa. It has about 61.51 million cattle, 33.02 million sheep, and 38.96 million goats. Of the total sheep population, about 72.86% are females, and about 27.14% are males. Out of the total goats, 72.09% are females and about 27.91% are males. About the age distribution of both the sheep and the goats, the largest portions are in the age group of two years and older (53.65% and 51.8%, in that order). These are followed by the young stock under six months for both sheep and goats, this means about 23.99% and 23.52%, correspondingly. Concerning breed, almost all of the sheep and the goats are indigenous (99.72% and 99.98%, respectively) [1].

The economic gains from these animals remain insignificant when compared to their huge number [2]. The low productivity is a reflection of disease, limited genetic potential, and hus-

Citation: Hassan A, Mezgebu E. Prevalence of Lungworm Infection of Small Ruminants in and Around Sebeta Town, Central Ethiopia. Austin J Vet Sci & Anim Husb. 2023; 10(4): 1126.

bandry standards [3]. Frequently, Sheep and goats are the most numerous domestic livestock in Ethiopia [4].

In Ethiopia, small ruminants as much as providing 33% of meat and 14% of milk consumption, and accounts for about 40% of cash income and 19% of the household meat consumption in sub-Saharan Africa. And also they play a great role in the food supply, as a source of income, foreign currency, and as well as to increase foreign exchange earnings [4]. Moreover, the economic benefits to the farmers generate cash income from the export of live animals, meat, edible organs, skin, and in the central highlands where a mixed crop-livestock production system is practiced [5].

However, productivity is much less when compared with the population size of small ruminants in Ethiopia [6]. The production loss is a direct result of clinical and sub-clinical helminth infection resulting from low productivity due to prevailing disease, as well as, insufficient weight gain, mortality, poor nutrition, and indirect production loss which is associated with general lack of veterinary care [7].

Helminth parasites of ruminants are ubiquitous and prevalent in many tropical and sub-tropical environments of the world providing nearly perfect conditions for their survival and development. However, the clinical signs they cause in infected animals can be less obvious than signs of other livestock diseases. Infections with gastrointestinal and other helminth parasites are among the most neglected areas of veterinary care in many of the developing countries. It has however been established that a high prevalence of the infection with less obvious signs is associated with poor production and unthriftiness [8].

About half of all sheep mortality and morbidity on farms in Ethiopian highlands are caused by pneumonia and endoparasitism including lungworms [9]. These lungworms are widely distributed throughout the world but are particularly common in countries with temperate climates, and the highlands of tropical and subtropical countries, and it is common in Ethiopia [10].

Lungworm infection is called Verminous Bronchitis or Verminous Pneumonia and can be caused by three economically important species of lungworm of sheep and goats namely, *Dictyocaulus filaria (D. filaria)*, *Protostrongylus rufescens (P. rufescens)*, and *Muellerius capillaries (M. capillaries)* [11]. *D. filaria* is the major cause of lungworm infection of small ruminants particularly affects the potential productivity of sheep in the areas where it is prevalent [12]. Verminous pneumonia is a chronic and prolonged infection of sheep and goats caused by any of these parasitic nematodes, characterized clinically by respiratory distress and pathologically by bronchitis and bronchopneumonia due to infection of the lower respiratory tract, resulting in bronchitis or pneumonia or both [13].

The distribution of lungworm infection in small ruminants depends on different factors such as altitude, intermediate hosts, the climate of the area, and favorable ecological conditions such as humidity, temperature, rainfall, and marshy area for grazing, sheep, and goat management system [14]. The control of these parasites is, thus, crucial for releasing the potential of domestic ruminant production. For proper control to be instituted, however, the diseases and their dynamics must be known. At the present state of our knowledge of parasitic diseases, it is difficult and even dangerous to lay down rigid rules for their control that apply to all regions. For this reason, a study of the epidemiology of each parasitic disease should be limited to small areas [15]. The incidence of parasitic diseases, including respiratory helminths, varies greatly from place to place depending on the relative importance of many of the factors. So far the study on the prevalence of lungworm infections and associated risk factors of small ruminants were not studied in the study area. Therefore, this study was targeted with the following objectives:

- To determine the prevalence and species of lungworm infection of small ruminants in and around Sebeta town.
- To assess the possible risk factors associated with the lungworm infection.

Materials and Methods

Description of Study Area

The study was conducted in and around Sebeta town of Oromia regional state from November 2019 to May 2020. Sebeta town is situated 25 km southwest of Addis Ababa. The town is located between 8°44' 59.99"N latitude and 38°39'59.99"E longitude with an altitude range from 1500-3000 m and the total coverage of the area is 103, 758km. This area has mid-subtropical weather and high land temperate type climate accounting for 94% and 6% respectively. Mean annual temperature and rainfall range between 15 to 21°c and 800 to 1199 mm respectively. Agriculture is the main occupation of the population of the area. The agricultural activities are mainly mixed type with cattle rearing and crop production undertaken side by side (Figure 1).

Study Population

The study populations were a local breed of small ruminants of a total of 406 animals (259 sheep and 147 goats) of different ages, sex, and body condition, treatment status history kept under an extensive management system in and around Sebeta town. The age of the study animals was determined by using the history taken from the owner and dental eruption and classified into three age categories as young (less than one year), middle (between one and three years, and adult (greater than three years) for both sheep and goats.

Study Design

A cross-sectional study was conducted to determine the prevalence of lungworm infections of small ruminants and to identify the species of lungworm present in and around Sebeta town from November 2019 to May 2020. A simple random sampling strategy was applied to collect the sample and a coprological examination was performed according to the standard protocols [16]. General information were recorded during sampling to obtain the species, age, sex, history of treatments and body condition of individual animals which were considered as risk factors for the occurrence of lungworm of small ruminants.

Sample Size Determination

Since there was no previous study carried out on the prevalence of the lungworm infection of small ruminants in the study area, the sample size was computed using the formula given by Thrusfield [17]. Therefore, an expected prevalence of 50% was used to estimate the sample size. Using the desired 95% confidence level, 5% precision, the numbers of sheep and goats needed to determine the prevalence of lungworm infection in small ruminants were 384.

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

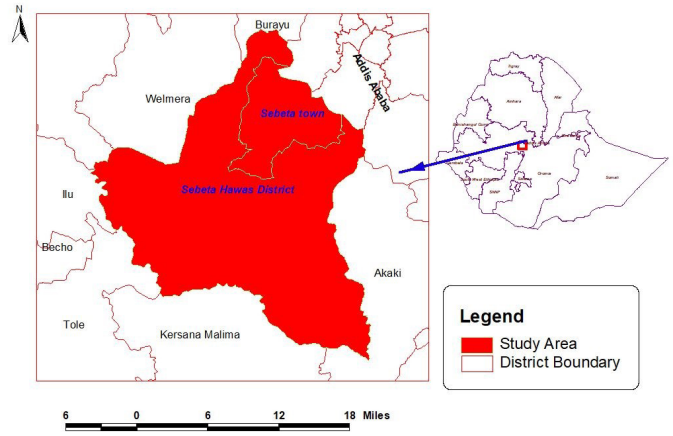

Figure 1: Map of the study area.

Figure 2: *D. filaria* **images taken from a microscope.**

Where,

n = sample size

p = expected prevalence (50%)

1.96= the value of Z at 95% confidence level

Therefore,

$n = 1.96^2 (p) (1-P)/d^2$

$n = 1.96^2 (0.5) (1-0.5)/ 0.05^2$

n = 384 animals

However, to increase the precision, a total of 406 animals (259 sheep) and (147 goats) were sampled.

Sample Collection and Transportation

Animals were restrained during sample collection by manually holding by the owner to protect the risk of the animals. Fresh fecal samples were collected directly from the rectum by two fingers using the disposable plastic glove and stored in a universal bottle packed in an icebox until examination. The date, address, species, sex, and age, history of deworming, and management system, and body condition of the sampled animal were properly recoded during the sample collection for the prepared sample and result recorded sheet. Each bottle was properly labeled corresponding to the animal identity. Then, transported to Helminthology Laboratory of Animal Health Institute (AHI) for Laboratory examination.

Sample Processing and Examination

The sampling process was done by using Modified Barman's Technique. From 10 to 15 grams of fresh fecal samples were weighed and wrapped with a double layer of gauze for performing modified barman's technique [16]. The enclosed faeces in gauze was fixed on a string rod and submerge in a clean glass tube filled with fresh warm water on the modified barman stand. The whole apparatus was remained undisturbed overnight. The larva leaves the faeces by gravity and migrates through the gauze and settles at the bottom of the glass beaker. The next morning, the supernatant were discarded whereas the sediment was collected and examined by stereomicroscope to detect the presence or absence of larvae. If larvae are present under the stereomicroscope, a small amount of specimen transfer into the slide then drop of 1% iodine solution then coverslip was used to immobilize the larvae for identification of the species then transfer to low power magnification of the compound microscope for morphological identification of lungworm larvae [16].

Table 1: Prevalence of lungworm infection in Sheep and Goats.

Risk factor		No. Tested	No. Positive	Prevalence (%)	X^2	P-value
Species	Sheep	259	47	18.1	11.4	0.001
	Goat	147	9	6.1		

Table 2: Prevalence of lungworm infection based on sex.

Risk factor		No. examined	No. positive	Prevalence (%)	X^2	P-value
Sex	Female	251	37	14.7	0.50	0.481
	Male	155	19	12.3		

Table 3: Prevalence of lungworm infection based on age groups.

Risk factor		No. examined	No. Positive	Prevalence (%)	X^2	P-value
Age group	Young	134	21	15.7	0.92	0.631
	Middle	135	19	14.1		
	Adult	137	16	11.7		

Table 4: Prevalence of lungworm infection based on body condition scores.

Risk factor		No. Examined	No. Positive	Prevalence (%)	X^2	P-value
Body condition	Poor	74	13	17.6	1.24	0.539
	Medium	125	15	12		
	Good	207	28	13.5		

Table 5: Prevalence of lungworm infection based on treatment status.

Risk factor		No. Examined	No. Positive	Prevalence (%)	X^2	P-value
Treatment status	Yes	159	21	13.2	0.82	0.366
	No	247	35	14.2		

Statistical Analysis

All collected raw data recorded from this study was entered into a Microsoft Excel spread sheet and analyzed using Statistical Package for Social Science (SPSS) software version 20. The results were analyzed in relation to species of animal, sex, age, body conditions and history of treatments. Descriptive statistics used to determine the prevalence of lungworm infections and a Chi-square tests (X^2) were used to measure the association of small ruminants of lungworm infection with possible risk factors. The statistical significance difference was determined using p-value, and p-value less than 0.05 was taken as significant.

Results

The Overall Prevalence

A total of 406 fecal samples of small ruminants (259 sheep and 147 goats) were collected and examined by the modified Baerman technique at AHI for Laboratory examination. The result showed that 13.8% (56/406) of an overall prevalence of lungworm infection was found in the study area. The identification of the lungworm species was performed depending on the morphology of the larvae by viewing the samples under the Stereo microscope. *D. filaria* was the only lungworm species identified in both sheep and goats in and around Sebeta town (Figure 2).

Prevalence Based on Risk Factors

Prevalence of lungworm infection based on species: The

prevalence based on animal species was revealed to be 18.1% (47/259) and 6.1% (9/147) in sheep and goats, respectively. For this study, the prevalence of lungworm infection was found to be higher in sheep than in goats and this difference was statistically significant (X^2=11.4 p<0.05) (Table 1).

Prevalence of lungworm infection based on sex: The prevalence of lungworm infection based on sex result revealed that the highest prevalence of lungworm infection was found in female animals 14.7% (37/251) than male animals 12.3% (19/155) and the difference was not statistically significant (X^2= 0.5, *P*>0.05) (Table 2).

Prevalence of lungworm infection based on age: The prevalence of lungworm infections based on age groups revealed that the highest prevalence was observed in young animals (<1-year-old) (15.7%) and lowest prevalence was observed in adult animals (>3 years old) (11.7%) and there was no a statistically significance between the age groups in the study area (X^2= 0.92, p>0.05) (Table 3).

Prevalence of lungworm infection based on body condition scores: The prevalence of lungworm infections of the body conditions showed that the highest prevalence in animals were poor body conditions (17.6%), than the animals having medium body condition (12%), and good body condition (13.5%). There was no statistical significance among different body conditions (X^2= 1.24, p>0.05) (Table 4).

Prevalence of lungworm infection based on the history of treatments: The prevalence of lungworm infections based on history of treatments showed that the highest prevalence was found in non-dewormed (14.2%) than the animal in dewormed history (13.2%). There was no statistically significant relationship (X^2=0.82, p>0.05) (Table 5).

Discussion

In the present study, the overall prevalence was 13.8% (56/406). The specific prevalence of lungworms of the two species of small ruminants was 18.1% and 6.1% in sheep and goat respectively. This prevalence was agreed with the previous reports: 13.4% in sheep in Mekelle town of Tigray region [18], 20.2% around Bahir Dar [19], 22.9% in and around Jimma town [20]. However, the result in this study was lower than to 29.13% in Jimma [21], 25.24 % in and around Jimma town, South West Ethiopia [6], 25.78% in Banja District of Awi zone [22], 33.83% in Gondar [23], 26.7 % in and around Jimma town [3], 36.9% in Dessie and Kombolcha districts of northeastern Ethiopia [24].

In another way, this study result was much lower than 53.6% in Northeast Ethiopia [25], 60.8%) in Dale District of Southern Ethiopia [14], 56.3% in in Debre Birhan town [26], 45% in Hitosa Woreda [27], 46.0% in small ruminants in North Gondar zone [28] and 67.4% in Honkolo Wabe District of East Arsi Zone [29].

The differences in the prevalence of lungworms of small ruminants in the above studies for such infection rate variation could be attributed to variation in temperature difference, humidity, nutritional status, level of immunity, agro-ecology, altitude, rainfall, and management practice of the animal and season of examination on the respective study areas, which favor or disfavor the survival of parasite larvae.

Concerning the prevalence of the species level of lungworm, *D. filaria* was the only species of lungworm identified in both sheep and goats in the present study area. The small lungworms, *P. rufescens*, and *M. capillaris* were not detected. The absence of small lungworms in the present study area might be associated with the season and their life cycle during the study. Unlike *D. filaria,* which has a direct life cycle, *P. rufescens* and *M. capillaris* have an indirect life cycle requiring a molluscan intermediate host to complete their development [30]. As this study was conducted in a dry season, the climatic conditions in the study area might not be conducive for the survival and breeding of the intermediate hosts.

Though, statistically significant association with species of study animals and prevalence was higher in sheep (18.1%) than goats (6.1%). This result agreed with [10] in and around Wolaita Soddo town who reported 22.1% of sheep and 19.2% goats. Such variation in prevalence between the two species of small ruminants might be arising from the difference in the grazing behavior of the two species of animals. It was known that sheep predominantly grazer so that they have higher exposure to ingest a large number of infective larvae (L3) in pasture than goats. Goats with their browsing behavior have less exposure to ingest the infective L3) [25].

The result revealed that different prevalence related to sex; 14.7% and 12.3% in females and males respectively. This indicated that female animals were more susceptible to lungworm infection than males. This was in an agreement with the result of [10] as 24.4% female and 19.1%, in and around Wolaita Soddo town, [6] as 43.3% in female and 33.57% in the male in North and South Gondar [23], as 36.22% and 30.43%, in Gondar town, and as 59.3% and 44.4% in Northern Ethiopia [25] in female and male animals respectively. The reason for the difference in the prevalence of two sex groups that were observed in this study might be because the resistance of female animals to lung infection can be reduced at the time of parturition and during early lactation. Per parturient and lactation relaxation of the resistance of animals may result in female animals to unable to expel adult worms, and cause a higher level of larvae detection. The other reason might be due to the ways how males and females were treated in terms of nutrition; males are kept for fattening to be sold except some which for breeding, thus, males received more attention by farmers than females [31].

Concerning age, the level of prevalence was compared between animals of different age groups. This study showed that the highest prevalence of lungworm infection was found in young animals (<1 year old) (15.7% and the lowest prevalence in old animals (>3 years old) (11.7%). The prevalence difference in age groups was not statistically significant (X^2: 0.92, p>0.05). This might be associated with acquired resistance of adult animals. Accordingly, as the age of animal's increased, susceptibility to lungworm infection decreased so that the adults had the lower level of infection.

The body conditions of animals were also showed variation in prevalence. The higher prevalence rate was found in animals with poor body condition (17.6%) than those of medium body conditioned (12%) and good body conditioned (13.5%) animals. The prevalence of lungworm infection with the body condition was not statistically significant (X^2:1.24, p>0.05). This result was not agreed with the work of [3], who reported higher in animals with medium and good body conditions respectively. Generally, in connection to lungworm, it was reported that poorly nourished animals appeared to be less competent in getting rid-off lungworm infection although it is not unusual for well-fed animals to succumb to lungworm infection [15].

The animal's deworming history showed variation in the prev-

alence of lungworms with anthelmintic usage which indicated that, the non-dewormed sheep and goat had a higher prevalence rate, 14.2% than dewormed 13.2% respectively. When the infection prevalence on the anthelmintic usage base was subjected to analysis, the difference in the occurrence of lungworm infection between the dewormed and non-dewormed animals was not statistically significant (X^2:1.24, P>0.05). Even though the dewormed small ruminants were revealed low infection prevalence compared to non-dewormed groups, about 13.2% of them were still infected with lungworm. The reason behind this result was probably, these sheep and goats which had only cough and/or tachypnea were usually in the prepatent age of the disease or had small adult worm burden and the anthelmintic used for the treatment of those small ruminants might be only temporarily suppressed egg production of the adult worms.

Conclusion and Recommendations

A cross-sectional study on lungworm infection in sheep and goats in and around Sebeta town revealed an overall prevalence of 13.8% (56/406). *D. filarial* was, the only lungworm species identified from the studied small ruminants during the study period. Moreover, this study indicated that sheep and goats were found significantly related to the prevalence of lungworm infection of small ruminants at risk. Sex, age and deworming history was not significantly associated with the presence of lungworm infection. Body Condition Score (BCS) was also not significantly associated with lungworm infection with animals with moderate or poor condition being more likely to be infected than animals in good condition. Further research is required to investigate if improving the nutritional status, thereby improving BCS, might lower prevalence of lungworm infection. Hence, it was concluded that lungworm infection is quite prevalent in the present study, and for the researchers, who interested in the diagnosis of lungworms infections, it is better if they do more on both the postmortem and fecal examination to accurately rule out lungworms provided economically feasible results.

Based upon the above conclusive statements, the following recommendations were forwarded:

- Short term training and awareness creation should be given to the impacts of lungworms, its transmission, and prevention measures.
- Good emphasis should be given for advanced control and prevention of lungworm infection.
- Farmers should be kept separately young animals from an older animal.
- Sheep and goats should be kept separately.
- Small ruminants should be well-nourished in order to gain good body condition.
- Regular strategic deworming of animals should be applied.
- Further study about small ruminants lungworm species should be carried out in the study area.

Author Statements

Acknowledgements

The authors acknowledged owners of small ruminants who were participated in this research. We also acknowledged Addis Ababa University College of Veterinary Medicine and Agriculture and AHI for their contribution for the success of this study.

Disclosure

The authors declared that there was no conflict of interest in this work.

References

1. CSA. Report on livestock and livestock characteristics (private peasant holdings): statistical bulletin, volume II, Addis Ababa, Ethiopia; 2019.
2. Muktar Y, Abdureman A, Shiferaw S. Prevalence of lungworm infection in small ruminants in ambo town. Eur J Appl Sci. 2015; 7: 209-12.
3. Weldesenbet D, Mohamed A. Prevalence of small ruminant lung worm infection in jimma town. Glob Veter. 2012; 8: 153-9.
4. Bogale B, Ebre A, Melaku A. Ovine lungworm infection: prevalence, species composition and associated risk factors in Dessie Zuria district, Northeastern Ethiopia. Afr Journ Bas Appl Sci. 2012; 4: 73-6.
5. Asaye M, Alemneh T. Prevalence of lungworm infection of small ruminants in and around Bahir Dar city, Amhara regional State, Ethiopia. Journ Veter Sci Technol. 2015; S12.
6. Fentahun T, Seifu Y, Chanie M, Moges N. Prevalence of lungworm infection in small ruminants in and around jimma town, southwest ethiopia. Glob Veter. 2012; 9: 580-5.
7. Sissay MM, Uggla A, Waller PJ. Epidemiology and seasonal dynamics of gastrointestinal nematode infections of sheep in a semi-arid region of eastern Ethiopia. Vet Parasitol. 2007; 143: 311-21.
8. Zeryehun T, Degefaw N. Prevalence and factors associated with small ruminant's LungwormInfection in and around Mekelle town, Tigray, Northern Ethiopia. Journ Veter Sci Technol. 2017; 8: 1-5.
9. ILRI. Handbook of livestock statistics for developing countries. Socioecon Policy Res Work Pap, no. 2000; 26.
10. Abebe R, Melesse M, Mekuria S. Lungworm infection in small ruminants in and around Wolaita Soddo town, Southern Ethiopia. Journ Veter Sci Technol. 2016; 07: 1-5.
11. Chakraborty S et al. Advances in diagnosis of respiratory diseases of small ruminants. Veter Intern. 2014: 1-16.
12. Ayelet G, Yigezu L, Gelaye E, Tariku S, Asmare K. Epidemiologic and serologic investigation of multifactorial respiratory disease of sheep in the central highland of Ethiopia. Int J Appl Res Vet Med. 2004; 2: 274-8.
13. Gorski P, Niznikowski R, Popielarczyk D, Strzelec E, Gajewska A, Wedrychowicz H. 'Natural parasitic infections in various breeds of sheep in Poland,' Arch Tierz Dummerst. 2004; 47: 50-5.
14. Kebede S, Menkir S, Desta M. On farm and Abattoir study of Lungworm infection of small ruminants in selected areas of Dale District, Southern Ethiopia. Int J Curr Microbiol Appl Sci. 2014; 3: 1139-52.
15. Radostits OM, Gay CC, Hinchcliff KW, Constable PD. Veterinary Medicine: A textbook of the diseases of cattle, horses, sheep, pigs and goats. 10th ed. Veter Med; 2007.
16. Zajac AM, Conboy GA. Fecal examination for the diagnosis of parasitism; 2012.
17. Thrusfield M. J Vet Epidemiol. 2007.

18. Ibrahim N, Godefa Y. Prevalence of ovine lung worm infection in Mekelle town, North Ethiopia. IJVM. 2012; 9: 1-7.

19. Tamire K, Mohamed A. Prevalence of ovine lung worms around Bahir Dar, East Africa, Ethiopia. Act Parasitol Glob. 2013; 4: 71-9.

20. Gebrekidan M, Kemal K, Abdurahaman M. Prevalence of ovine lung worm in and around jimma, south West Ethiopia. Int Journ Res Stud Biosci. 2018; 6: 24-32.

21. Mama A, Gashaw T. A study on prevalence of small ruminants lung worm infection and associated risk factors in and around Jimma town, Southwestern, Ethiopia. Int Journ Adv Res Biol Sci. 2019; 6: 20-30.

22. Tegegne M, Gugsa G, Awol N. Prevalence of ovine lungworm in Banja District, awi Zone, North West, Ethiopia. Act Parasitol Glob. 2015; 6: 8-13.

23. Addis M, Fromsa A, Ebuy Y. Study on the prevalence of lungworm infection in small ruminants in Gondar Town, Ethiopia. Journ Anim Veter Advan. 2011; 10: 1683-7.

24. Regassa A, Toyeb M, Abebe R, Megersa B, Mekibib B, Mekuria S et al. Lungworm infection in small ruminants: prevalence and associated risk factors in Dessie and Kombolcha districts, northeastern Ethiopia. Vet Parasitol. 2010; 169: 144-8.

25. Alemu S, Leykun EG, Ayelet G, Zeleke A. Study on small ruminant lungworms in northeastern Ethiopia. Vet Parasitol. 2006; 142: 330-5.

26. Tefera Y, Mekuria S. Lungworm infection in ovine: prevalence and associated risk factors in Debre Birhan town Ethiopia. J Veterinar Sci Technol. 2016; 07: 1-5.

27. Haji M, Tilahun A, Teshale A, Engedaw D. Study on lungworm and associated risk factors of small ruminants in Hitosa woreda, Ethiopia. Glob Veter. 2016; 17: 303-9.

28. Terefe Y, Tafess K, Fekadie G, Kebede N. Prevalence of lungworm infection in small ruminants in North Gondar zone, Amhara National Regional State, Ethiopia. Journ Parasitol Vect Biol. 2013; 5: 40-5.

29. Abdeta D, Degefa Y. Prevalence of ovine lung worm and associated risk factors in HonkoloWabe district, east Arsi Zone, Ethiopia. Biomed Journ Sci Techn Res. 2020; 28: 21427-34.

30. Taylor MA, Coop RL, Wall RL, Parasitol V. Third edit. Blackwell Publishing Ltd.; 2007.

31. Beyene D, Nigussie S, Ayana D, Abunna F. The prevalence of lungworms in naturally infected sheep of ambo district, Oromia, Ethiopia. Glob Veter. 2013; 10: 93-8.