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Lungworm Infection in Small Ruminants: Prevalence and Associated Risk Factors in Debra- Berhan Town, Amhara Region, Ethiopia

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Abstract

The study was carried out in Debra Berhan, Ethiopiato estimate the prevalence of lungworm infection and to investigate some of the risk factors associated with small ruminant lungworm infections. In this Cross-sectional study conducted from November 2017 to April 2018, fecal samples were collected from randomly selected 360 small ruminants (335 sheep and 25 goats) to examine first stage larvae (L1) using modified Baerman technique. The overall prevalence recorded by fecal examination was 54.16 %. The proportions of infection by *Dictyocaulus filaria*, *Muellerius capillaries*, *Protostrongylus rufescens* and mixed were found to be 64.6%, 19%, 2.1% and 14.3% respectively. There was significant difference ($p<0.05$) in the prevalence of lung worm infection with regard to the body condition scores as poor (80.7%),medium (40.9%) and good (31.4%);de-worming status, de-wormed(27.4%) and non-dewormed (70.2%); sex in female (60%) and in males (49.5%), and month; November (72%),December (56%) and January (38.2%). The prevalence of lungwormin different age groups, breed and species was not statistically significant ($p>0.05$).In conclusion, this study revealed the importance of lungworm infection and consequently this can contribute to increase understanding of the situation in the study area. Hence, treating small ruminants with broad-spectrum anthelmintics recommended at least for three or four times per year with special consideration at the beginning and at the end of rainy season in order to overcome the effect of parasite at the area.

Keywords: Debra Berhan, *Dictyocaulus filaria*, Lungworm, *Muellerius capillaries*, Prevalence, *Protostrongylus rufescens*, Small ruminants.

Introduction

In the world, one of the fastest growing parts of the agricultural economy is livestock sector. This sector contributes 40% of the global value of agricultural output and supports the livelihood and food security of almost a 1.3 billion people of the world. Livestock production is also the major component of agricultural economy in developing countries and goes well beyond direct food production. Sales of livestock and their products provide immediate cash income to farmers and foreign exchange to the endowed countries[1, 2].Ethiopia has an extremely diverse topography, a wide range of climatic features and a

multi altitude of agro ecological zones, which makes the country suitable for different agricultural production system. This in turn has contributed to the existence of the large diversity of farm animals' genetic resource in the country [3]. Ethiopia is a leading country in livestock population by ranking9th in the world whilethe sector accounts for about 40% of the agricultural gross domestic product (GDP) and 20% of the total GDP without considering the contribution of livestock in terms of draught power, manure and transport service. Excluding export of live animal and their products, leather and leathery products alone contribute 18% of the total export [4-6].

The livestock population in Ethiopia(in million) is estimated about 44.3 cattle, 23.6 sheep, 18.5 goats 2.3 camels, 6.1 equines, and 42.9 chickens [7].However, economic gains from these animals remain insignificant when it compared to their huge number [4]. Sheep and goats generate cash income to the farming community and significantly contribute to the foreign exchange earnings of about 43% and 5% economy from exports and meat respectively [8].They also provide as much as 30% of meat and milk consumed in sub-Saharan Africa; however, these animals have received much less attention than cattle [9]. The productivity of small ruminants is very low in spite of their large population due to diseases, poor nutrition, poor animal production system and general lack of veterinary care [4]. Morbidity and mortality are high in the traditional agro-pastoral production system. In highland area including Debra Berhan, respiratory lungworm parasites are the most common cause of high mortality and morbidity rates of sheep. Despite the low input extensive management system, an estimated 132,000 tons of small ruminant's meat produced annually, providing more than 30% of all domestic meat consumption [8].

Helminth parasites of small ruminants are ubiquitous with many tropical and sub-tropical environments of the world providing nearly perfect conditions for their survival and development. The parasites are widely prevalent and the clinical signs they showed in infected animals can be less obvious than signs of other livestock diseases [10]. Small-holders or pastoralists may not easily detect the effects of internal parasites on their animals, because of the generally sub-clinical or chronic nature of the helminth infections [11, 12]. Thus, the sub-clinical parasite infections are responsible for significant economic loss, because once clinical disease is noticed in a group of animals, much economic loss in terms of animal productivity has already occurred [13, 14].

Lungworms of small ruminants are parasitic nematodes that belong to phylum nemathelminth's, commonly named as "round worms" and they were classified under two super families such as, Trichostrogyloidea *(Dictyocaulus filaria*), and other two belongs to the metastrongyloidea (*Muellerius capillaries* and *Protostrongylus rufescens*) [12, 15]. Lungworms can result in infection of the lower respiratory tract, usually resulting in Verminous bronchitis or Verminous pneumonia. The common causes of verminous pneumonia in sheep and goats are *Dictyocaulus filaria (D. filaria), Protostrongylus rufescens (P. rufescens)* and *Muellerius capillaries (M. capillaries)*. Although mixed infection may occur in which *D.filaria* predominates in most outbreaks [9, 16].

In the highland areas of Ethiopia like Debra Berhan, infection with lungworm parasites are common cause of high mortality and morbidity in small ruminant's population .Up to half of all small ruminant deaths and morbidity on farms in Ethiopian highlands, are caused by pneumonia and endoparasites [17].However, information on the prevalence and associated risk factors of lungworm parasites of small ruminants in different parts of the country is not sufficient to implement effective infestation control strategy at national level thus important to increase the potential of small ruminant production and to get the maximum benefit from them. Therefore, the objective of the study was determining the prevalence, identifying the species involved and assessing possible risk factors of lungworm infection in small ruminants at the study area.

Materials and Methods

Study area

The study was conducted in Debra Berhantown, the capital city of north shoazone, which is located at a distance of 130 km northeast of Addis Ababa and an altitude of 2780 meter above sea level in Amhara National Regional State. The area has bimodal rainfall consisting of long rainy season "*Kremt*" covering June to September and short rainy season "*Belg"* extending February to March. The annual rainfall of the area is 1728 millimeter and the average minimum ambient temperature is 15.84^{oc}while the relative humidity of

59.6%[18].The record of north shoa zone and agricultural and rural development office shows the livestock population statics of 144638 bovine,97815 sheep,47970 goats, 39038 equine and 96821 poultry at the study area [19].

Study population

Out of 335sheep and 25 goat included in the study, the ratio of male and female sheep were 151 and 184 respectively, whereas the ratio of male and female goats 9 and 16 respectively. The age was determined based on dentition set by Vatta *et al.* [20]. For simplicity, animals ≤1 year as young and >1 year as adult. The study animals were classified as poor, medium and good based on their body condition score as the method used by ESGPIP [21].

Samplingmethod and Sample size determination

Simple random sampling technique was employed to determine the study animals and sample size. The sample size for this study was determined by using Thrusfield M[22].Expected prevalence's of lung worm done by Netsanet B [23] (73.25%) in local Ethiopia highlands sheep in and around Debra Berhan were taken to calculate the sample size. The required sample size was 260 small ruminants by using 95% confidence interval and5%absolute precision. However, to increase the level of precision, the sample size was raised to 360 small ruminants (335 sheep and 25 goats).

Study methodology

Fecal samples were collected directly from the rectum of selected small ruminants and put in to universal bottles (screw capped glass bottles). All samples were clearly labeled with all required data in the study and further laboratory procedures were performed at the veterinary laboratory of Debra Berhan agricultural research center.

In the laboratory, fecal examination for the presence of L1 larvae was conducted using modified Baerman technique. Ten gram of fresh feces was taken and then, the specimen was enclosed with a double layer of gauze fixed on string rod and submerged in a clean class tube filled with warm water. Then the whole apparatus were left for 24 hours(overnight) so that the larvae left the feaces and migrated through the gauze to settle at the bottom of the glass. Finally, the supernatant was discard and the sediment then taken in to a test tube and centrifuged for about two minutes at one thousand revolution per minute. After that, a small amount of (3-5 milliliters) fluid transferred in to microscope slide using Pasteur pipette and examined under low power of microscope [10]. On the positive result, a drop of 1% iodine solution was added to immobilize the larvae for the identification of species [12]. On each step performed above, the result was recorded on the prepared format.

Data analysis

The result from the fecal examination was recorded on special designed forms and preliminary analysis was done in Microsoft excel. The outcome variables for these examinations were the presence of L1 larvae. Logistic regression analysis was employed to analyze the association between different potential risk factors with the occurrence of lungworm infection using STATA 9 statistical software. The degree of association between the infection occurrence and the risk factor was considered on the study.

Results

Prevalence of lungworm infection

Of the total 360 small ruminants for which fecal examination conducted up on the study period, 54.16% (195/360) were found to be positive for L1 larvae of the parasite. The single infection prevalence of lungworm species was found to be 64.6%, 19% and 2.1% for *D.filaria, M.capillaries* and *P. rufescens* respectively. On the other hand, the prevalence of the mixed infection of the lungworm species were 11.8%, 1%, 0.5% and 1 % for the mix of (*D. filarial* and *M. capillaries), (M.capillaries* and *P. rufescens),(D.filaria* and *P. rufescens)* and *(D. filarial, M. capillaries* and *P. rufescens)* respectively (Table 1).

Logistic analysis of risk factors

Different potential risk factors were evaluated in relation with the prevalence of first stage larvae (L1) of all parasites using logistic regression analysis in order to assess the impact of the risk factor. Hence, there were significant difference ($p<0.05$) among the different body conditions score, month, sex and between dewormed and non-dewormed animals.

Furthermore, the prevalence was found to be higher in animals with poor body condition (80.7%), examined in November (72%), non- dewormed (70.2%) and in young (58.7%) animals. However, species, breed and age were found to be insignificant with the occurrence of lungworms (p>0.05) (Table 2).

Table 1- Proportions of single and mixed lung worm species of small ruminants of Debra Berhan Town (n=195)

Species of lung worm		Number of observation	Relative percentage
Single infection	*D. filaria*	126	64.6
	M.capillaries	37	19
	P.rufescens	4	2.1
Mixed infection	*D. filaria*and *M. capillaries*	23	11.8
	M. capillaries and *P. rufescens*	2	1
	D. filarial and *P. rufescens*	1	0.5
	D. filaria, *M. capillaries* and *P. rufescens*	2	1
Total		**195**	**100**

Table 2: Logistic regression analysis of potential risk factors with the presence of lungworm species

Risk factors		n	Positive (%)	OR (95%CI)	P-value
Species	Ovine	335	182(54.3)	1	
	Caprine	25	13(52.0)	1.5 (0.5 , 4.2)	0.429
Sex	Female	160	96(60.0)	1	
	Male	200	99(49.5)	1.9 (1.1 ,3.3)	0.015
Age	Young	167	98(58.7)	1	
	Adult	193	97(50.2)	1.3 (0.8 ,2.3)	0.274
Breed	Local	197	106 (53.8)	1	
	Cross	163	90 (55.2)	1.0 (0.6 ,1.8)	0.863
BCS	Poor	145	117(80.7)	1	
	Medium	110	45(40.9)	5.4 (2.9 , 10.2)	0.000
	Good	105	33(31.4)	9.9 (5.1 , 19.3)	0.000
Dewormed	Yes	135	37(70.2)	1	
	No	225	158(27.4)	5.9 (3.4 , 10.2)	0.000
Month	Nov	86	62(72,0)	1	
	Dec	164	92(56.0)	1.9 (1 , 3.7)	0.070
	Jan	1110	42(38.2)	3.5 (1.7 , 7.2)	0.001

Discussion

Lung worms are wide spread animal health problem and cause significant economic loss to the livestock industry in Ethiopia. The overall lungworm infection prevalence at the study area was 54.16%. This finding were in agreement with that of Alemu et al.[24], Tefera [25] and Sisay[26]who reported 53.6% inWollo,48.2% in Dessei and Kombolcha, 44% in Bahir-Dar respectively. The report of Regassa et al.[27]that scored 36.9% prevalence in Dessie and Kombolcha were the findings with slightly lower variation than the current finding. However, the current report was lower than the findings of Netsanet [23] and Eyob and Matios [28] who reported 73.35%around Debra Berhan and72.44%inAsella respectively.

The species of parasite identified from 195 positive fecal samples taken from sampled small ruminants (sheep, and goats) were *D.filaria*(64.6%), *M.capillaries* (19%) and *P.rufescens* (2.1%). Out of identified species, *D.filaria*was the most prevalent (64.6%) species in the study area. This result agrees with the previous reports of Netsanet [23] around Debra Berhan; Denbarga et al.[29] around Bahir-Dar

and Uqubazgi[30] in Hamase Awreja. In contrast, *M.capillaries* were prevalent in different parts of the country in different period as reported by Sissay [26]; Alemu et al. [24] and Mezgabu [31] but it hold second footing of prevalence in the current study area.This mightbe associated with the difference in the life cycles. *D. filaria* has a direct life cycle and takes less time to reach the infective stage and after ingestion, larvae can appear in the feaces within 5 weeks[32]. While, *M.capillaries* and *P.rufescens* have indirect life cycles with land snails and slugs acting as intermediate hosts. Therefore, their geographical distribution and prevalence are mainly determined by the distribution of the intermediate hosts, which in turn is affected by the availability of suitable environmental condition [15].

According to the species of study animals, higher prevalence of parasite infection was recorded in sheep (54.3%) than in goats (52%) which may be related to the difference in their feeding system. It has been argued that goats are browsers unlike sheep which graze closer to ground and as a result, for sheep, there is high chance of acquiring infective stage of the parasite (L3 larvae) which normally found attached to the grass [32].

Among the potential risk factors assessed in this study, de-wormed (OR=5.9,95% CI (3.4, 10.2),p= 0.000), Male animals in sex(OR=1.9, 95% CI (1.1, 3.3),p=0.015), and animals with medium body condition score (OR=5.4, 95% CI (2.9, 10.2),p=0.000) of sheep and goats as well as January from months (OR=3.5, 95% CI (1.7 , 7.2)p=0.001) were found to have significant association ($p<0.05$) with the occurrence of lungworms. The observed significant difference in the occurrence of the lungworm infection between the de-wormed and non-dewormed animals could be because the larvae count and burden decreased in the strategically dewormed animals with anthelmintics effect[12].The monthly dynamics of lungworm infection showed that prevalence was highest in November (72%) with decline during the dry time (January) with less prevalence (38.2%). This finding coincides with the previous reports of Alemu et al. [24] and Frewengel [33]. The epidemiology of lungworms indicated that a damp and cool environment is very suitable for the development of *D. filaria* and third stage larva (L3) is resistant to cold environment[34].

In the current study, attempts were made to know the influence of sex on the overall prevalence of infection. Accordingly, the study indicated the presence of significant association between different age groups of sheep and goats with the occurrence of lungworms($p<0.05$). This result agrees with Sissay[26] around Bahir-Dar and Sefinew[35] in six district of Wollo who reported significant variation in infection rate among different sexes. However,the reports of Netsanet [23] in and around Debra Berhan and Teffera[25] in and around Dessie show similar susceptibility to infection between male and female in small ruminants.

Body condition score was the other factors with significant association of the parasites ($p<0.05$). The parasites were more common in poor body condition (80.7%) than in medium (40.9%)(OR=5.4,p=0.000) or good body conditions(31.4%) (OR=9.9, p=0.000)). This finding agrees with the reports of Thomson and Orita[36] in North West Syria. The possible explanation for this observation could be due poor body conditions of small ruminants appear to be immuno-suppressed which might be due to the effects of other parasites or malnutrition. Moreover, poorly nourished sheep and goats appear to be less competent in getting rid of lungworm infection[15, 16, 37].Concerning age, all age groups were found to be affected by the infection of lungworms without any significant differences ($p>0.05$).

Conclusion and Recommendation

In the current study, lungworm infection in small ruminants was highly prevalent. The findings confirm the most important respiratory nematode of small ruminants in the study area was lungworm. Moreover, this study indicated sheep and goats with non-de-worming history, poor body condition and examined at November were at higher risk of acquiring lungworm infection than those sheep and goats with deworming history, good body conditions and examined in January. The species of lungworms identified in the study area were *D.filaria*, *M.capillaries* and *P. rufescens*as both single and mixed infection. Hence, due to its impact on sheep and goats, health and productivity, emphasis should be given for the control and prevention of lungworm infection.

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Conflict of interest statement

We declare that we have no conflict of interest.

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