American-Eurasian Journal of Scientific Research 11 (2): 145-151, 2016
ISSN 1818-6785
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DOI: 10.5829/idosi.aejsr.2016.11.2.22785

Acta Parasitologica Globalis Study on Prevalence of Ovine Lungworm in Gomma District, Jimma Zone, South West Ethiopia

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Abstract: A cross-sectional study was carried out in Gomma district, Jimma Zone from November, 2014 to March, 2015. The purposes of study were to determine the prevalence and identification of species lungworm circulate in study sites in ovine through coproscopic and associated risk factors for lung worm infection occurrences. Samples were randomly collected from 384 sheep of different age groups of both sexes, kept under extensive management systems and examined using a Modified Baerman technique. Of these animals 201 were found to be positive for lungworm infection with an overall prevalence of 52.3%. The prevalence of species of lungworm in infected sheep were *Dictyocaulus filaria* (32.0 %), *Muellerius capillaries* (9.1%), *Protostrongylus rufescens* (4.4%) and 6.7 % of mixed infection. Therefore, *Dictyocaulus filaria* was also found to be the dominant lungworm species. There was statistically significant difference ($P< 0.05$) observed in infection rates between the study sites. Analysis on the basis of age and body condition of the animals indicated that there was a statistically significant difference ($P<0.05$) observed between young and adult ($X^2=7.304$, $P =0.007$) with the prevalence of 59.5 % and 45.7%, respectively and animal with poor condition more affected than moderate and good with their respective 65.8%, 44.4% and 36.0% prevalence. There was also highly significant difference ($P<0.05$) between animals that have manifested clinical respiratory signs and that do not manifest with the prevalence of 91.2 % and 12.6 %, respectively. In conclusion, the present study revealed that lungworms belong to the major parasites that affect the health and productivity of sheep in the area; therefore, attention should be given for the control and prevention of lungworm infections.

Key words: Lungworm · Prevalence · Ovine · Gomma · Jimma · Ethiopia

INTRODUCTION

Helminthes parasite of ovine is ubiquitous, with many tropical and sub-tropical environment of the world providing nearly perfect conditions for their survival and development [1]. Helminthosis is one of considerable significance in a wide range of agro-climatic zones in Sub Saharan Africa and constitute one of the most important constraints to small ruminant production [2]. The production loss is a direct result of clinical and subclinical helminth infections resulting in low productivity due to stunted growth, insufficient weight gain, poor feed utilization and mortality and indirect losses associated with treatment and control costs [3, 4].

In the highland areas, infection with lungworm parasites is the common cause of high mortality and morbidity in sheep population [5]. Lungworms are parasitic nematodes known for infection of the lower respiratory tract, characterized by respiratory distress, trachaeitis, bronchitis and pneumonia [6]. The lungworm in sheep is most commonly caused by three species such as, *Dictyocaulus filaria*, *Muellerius capillaries* and *Protostrongylus rufescens* [7]. These nematode parasites belong to two super family, Trichostrongyloidea (*D. filaria*) and Metastrongyloidea (*P. rufescens* and *M. capillaries*) [7, 8]. Dictyocaulidae and certain Metastrongylidae are known to exist in East Africa (Ethiopia, Kenya and Tanzania) and South Africa (Torncy, 1989). Endoparasites, including *D. filaria*, are major cause of death and morbidity in the Ethiopian highlands. Up to half of all sheep deaths and morbidity on farms in Ethiopia highlands are caused by pneumonia and endoparasites [2].

Primary findings of lungworm infection in Ethiopia were observed in Arsi and Wollo [9], Debre Berhan [10] Asella [11], Chilalo [12] and Tiyo [13], with prevalence of

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59.40%, 73.25%, 39.79%, 30.74% and 57.1 respectively indicated high prevalence in certain parts of the country; however there was nothing research done on Ovine lungworm in Gomma district, Jimma zone, Oromia regional state. Therefore, the objectives of this study were designed to determine the current prevalence of lung worm infection and to identify the circulating species and associated risk factors for lung worm infection.

MATERIALS AND METHODS

Study Area: This study was conducted in Oromia Regional State; Jimma zone; Gomma district which is located 393 kms south west of Addis Ababa at altitude of 1400-2270 m.a.s.l. The area covers 936.6 km^2 in range lands. Topographically, it has 8% high land, 88% 'weynadega', 4% low land. It receives an annual average of rainfall from 2000 mm and the annual temperature range 13.4-28.9. It receives bimodal rainfall occurring from March to April (a short rainy season) and from July to October (long rainy season). It has a total of 135, 487 livestock; of that 40, 122 were sheep [14].

Study Animals: The study population comprises of indigenous local sheep breed from three agro-ecological areas (highland, midland and lowland); kept under similar extensive management system; dewormed and non-dewormed by anthelminthic; kept in forest and non-forest area; categorized into young and adult using dentition and information from the owners; with no clinical respiratory signs and those that appeared apparently healthy were included.

Study Design: A cross-sectional survey was conducted from November, 2014 up to March, 2015 to determine prevalence of ovine lungworm infection and to assess the effect of altitude, anthelminthic, kept area and major host related risk factors on the occurrence of these parasites in sheep of Gomma district, South West of Ethiopia.

Sample Size Determination: The sample size was determined according to the formula given by Thrusfield as follows [15].

$$n = \frac{1.96^2 . Pexp (1-Pexp)}{d^2}$$

where,
n = Required sample size
Pexp = Expected prevalence

With a 50% expected prevalence, 95% confidence level and 5% precision; hence, sample size was 384.

Sampling Technique: Out of 40 villages of Gomma district, three, namely: Kota, Bulbulo and Choche were purposively selected considering their representation of the highland, midland and lowland agro ecological zones of the district respectively. Kota is located at a an altitude of 2700 m.a.s.l.; Bulbulo is situated at altitude of 2400 m.a.s.l. and Choche is located at altitude of less than 1500 m.a.s.l. The households and individual animals were selected using simple random sampling technique. Accordingly, 160 from Kota, 128 from Bulbulo and 96 from Choche villages were selected for the study. During sampling age, sex, dewormation by anthelmintic, manifestation of respiratory sign, grazing area and body conditions of the animals were recorded.

Body Condition Scoring: Body condition of each animal was determined based on the criteria set by Thompson and Meyer [16] using the 5 point scale (1=very thin to 5=obese). Animals were visually assessed followed by palpation of the area around the lumbar vertebrae between the back of the ribs and the front of the pelvic bones.

Determination of Age: Since most smallholder farmers do not usually keep records, it was difficult to obtain information on the age of animals from the owners; hence, age of every sampled sheep was determined based on dentition as indicated by Vatta [17].

Sample Collection and Laboratory Diagnosis: Fresh fecal samples collected from the rectum of the animals were immediately transported to Jimma University College of Agriculture and Veterinary Medicine (JUCAVM), Parasitolgy laboratory for processing. Five grams of feces were weighed from each sample for extraction of larvae using Modified Baerman techniques according to (18). The feces were fully enclosed in cheesecloth fixed with metallic stick rest on the edges of the funnel glass. The glass was filled with clean lukewarm water until the sample became submerged making sure that the corners of the cheesecloth did not hang over the edge of the funnel. The sample was allowed to sit overnight. Larvae were collected and morphologically identified as described by previous studies [8, 18, 19].

Data Management and Statistical Analysis: Raw data and the results of parasitological examination were entered in to a Microsoft Excel spread sheets program and

then were transferred to SPSS version 20 for analysis. The prevalence of lungworm infection was calculated as the number of positive samples divided by the total number of samples examined. Pearson's chi-square (x^2) was used to evaluate the association of different variables with the prevalence of lungworm. P-value less than 0.05 (at 5% level of significance) were considered significant in all analysis.

RESULTS

The examination of samples collected from 384 randomly selected animals using a Modified Baerman technique revealed an overall lungworm prevalence of 52.3%. *D. filarial* (32.0%) was the predominant species in the study area followed by *M. capillaris* (9.1%), whereas *P. rufescens* (4.4%) was the least prevalent. Certain proportion of the investigated animals was also suffering from mixed infection as depicted on (Table 1) and (Figure 1).

There was a significant variation (P<0.05) in the infection rate among the various altitudes. The highest prevalence was recorded in the village with high altitude (Kota) and the lowest in low altitude (Choche) (Table 2).

Taking age of the animals as one of the host related risk factors, lungworm infection was significantly higher (P<0.05) in younger sheep as compared to older ones. In relation to the body condition of the animals, the prevalence was significant (P<0.05). As result infection rate was highest (65.8%) in poor body condition followed by medium body condition (48.4%) and least prevalence in good body condition (36.0%). Taking sex of animals as one of host related factors, lungworm infection was insignificant (P>0.05). However infection was higher in male (64.4%) than female (45.5%), (Table 3).

Taking usage and non-usage of anthelminthic as associated with occurrence of disease, lungworm infection was significantly higher (p<0.05) in non-dewormed sheep than dewormed the prevalence of dewormed and not dewormed was (45.6%) and (56.5%) respectively. Taking grazing area as associated with occurrence of disease, lungworm infection was significantly higher (p<0.05) in those which kept on field (65.6%) than forest (30.3%) (Table 4). Taking manifestation of respiratory sign as associated with occurrence of disease, lungworm infection was significantly higher (p<0.05) in sheep with manifested clinical signs (Table 5).

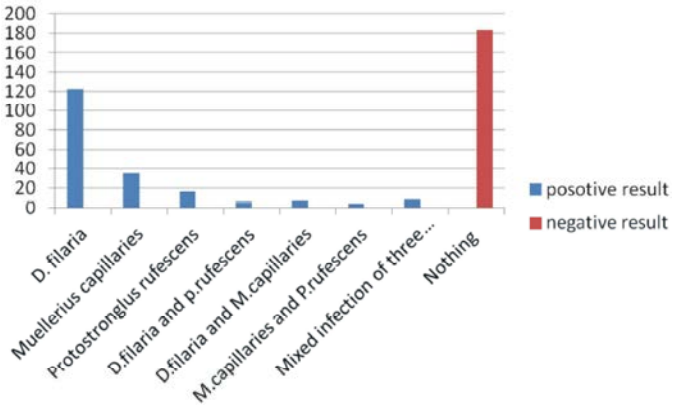

Fig. 1: Species of lungworm identified in Gomma district with its prevalence

Table 1: prevalence of different species of lungworm in Gomma district

Species identified	Prevalence with in positive animals	Total (prevalence)
D. filarial	123(61.1%)	123(32.0%)
Muellerius capillaries	35(17.4%)	35(9.1%)
Protostronglus rufescens	17(8.4%)	17(4.4%)
D.filaria and p.rufescens	6(2.9%)	6(1.5 %)
D.filaria and M.capillaries	7(3.4%)	7(1.8%)
M.capillaries and P.rufescens	4(1.9%)	4(1.0%)
Mixed infection of three species	9(4.4%)	9(2.3%)
Nothing	0%	183(47.7%)
Total	201(100%)	384(100%)

Table 2: Prevalence of lungworm infection based on peasant association with various altitudes

Kebele's with various altitude	No examined	No positive	X^2	(p-value)
Kota (high land)	160	117(73.1%)		
Bulbulo (mid land)	128	53(41.4%)	49.313	.000
Choche (low land)	96	31(32.2%)		
Total	384	201(52.3%)		

Table 3: Prevalence of lungworm based on major host related risk factors

Major host related risk factors	No examined	No positive (out of examined)	X^2	(p-value)
Sex				
Male	164	89 (64.4)		0.514
Female	220	112(45.5%)	0.425	
Total	384	201(52.3%)		
Age				
Young	183	109(59.5%)	7.304	0.007
Adult	201	92 (45.7%)		
Total	384	201(52.3%)		
Body conditions				
Poor	155	102(65.8%)	22.332	0.000
Medium	132	64(48.4%)		
Good	97	35(36.0%)		
Total	384	201(52.3%)		

Table 4: Association between prevalence of lungworm infections and grazing area and antihelmintic usage with response of respondents

Major associated risk factors	No examined	No positive(out of examined)	df	X^2(p-value)
Grazing area				
Forest	145	44(30.3%)	1	45.198.000
Field	239	157(65.6)		
Total	384	201(52.3%)		
Dewormation				
Dewormed	149	68(45.6%)	1	4.3890.036
Not dewormed	235	133(56.5%)		
Total	384	201(52.3%)		

Table 5: Prevalence of lungworm infection based manifestation respiratory signs

Manifestation of respiratory sign	No examined	No positive (out of examined)	df	X^2(p-value)
yes	194	177(91.2 %)	1	
No	190	24(12.6%)		237.764 0.000
Total	384	201(52.3%)		

DISCUSSION

The present study was conducted in three PAs of Gomma district, Jimma Zone indicated that lungworm infection is one of the most common respiratory diseases of sheep with an overall prevalence of 201(52.3%). Of the total infected 32.0%, 9.1%, 4.4% and 6.7% prevalence was due to *D. filaria*, *P. rufescens and M. capillaries* and carried mixed infection with two or all the three species of lungworm, respectively. The overall prevalence of lungworm infection almost agrees with the researchers which were done in Asella by Bekele (9), Wondwossen [11], Paulos, [12], Mihreteab and Aman, [13] Hasen [20], Alemu [21] in Northwestern Ethiopia and Teffera in Dessie and Kombolcha [22] with prevalence of 59.4%, 58.8%, 52.54%, 57.1, 55.10%, 53.6%, 50% respectively.

The current finding however, was lower than the prevalence reported by Eyob and Mathios, [23] in Asella province 72.44%; Yohannes, [24] in DebreTabor Awraja 70.7%; Netsanet, (10) in Debre Birhan73.75% and Sefinew, (25) in six district of Wollo 71.3%. The current finding disagrees very highly with study conducted by Frewengel

[26] in and around Mekele 13.24% and Ibrahim and Degefa, [27] in Mekele town 13.4%. The possible explanation for such infection rate variation could be attributed variation in agro-ecology, altitude, rainfall, humidity and temperature difference and season of examination on the respective study areas, which favor or disfavor the survival of parasite larvae [28-30].

With regard to the species of lungworms, it was observed that *D. filaria* was the predominant species in the area followed by *M. capillaries*, whereas *P. rufescens* were the least prevalent. This finding is supported by Alemu [21], Mihreteab and Aman [13], Netsanet [10] and Nemat and Moghadam [31], who reported *D. filaria* to be the most prevalent in their survey.

In contrast to this finding, Sissay [32] in Bahirdar and Mezgebu [33] in Addis Ababa reported that *M. capillaries* is the most prevalent. The predominance of *D. filaria* in the study area might be attributed to the difference in the life cycles of the parasites. Thus, *D. filaria* has a direct life cycle and requires shorter time to develop to an infective stage. According to Soulsby [29], after ingestion the larvae of these parasites can be shed with feces within five weeks. Compared with *D. filaria*, the transmission of *P. rufescens* and *M. capillaries* is epidemiologically complex event involving host, parasite and intermediate host. *M. capillaries* and *P. rufescens* in sheep require slugs or snails as intermediate hosts, which must be eaten for infection to occur [34]. Mixed infection was observed in the current study as in many previous studies [1, 11, 12]

In the present study, sex dependent variation was not encountered, hence both sexes showed almost equal susceptibility to infection with lungworms. This was coinciding with research study reported by Addis [35], Nibret [36], Eyob and Mathios [23], Dawit and Abdu [37] and Hasen [20] but disagree with report of Alemu [21] and Mihreteab and Aman [13]. These may be due to the fact that improper distribution of sample selection between the two sexes [12]; or else most of the sampled females are not in preparturient period during the study time [8].

The variation with anthelmintic usage is clearly indicating as the non-dewormed sheep have high infection prevalence than dewormed counter parts. When the infection prevalence on anthelmintic usage base was subjected to analysis, the difference is statistically significant ($P<0.05$). The observation noted on the dewormed sheep I n this study was matched with the work of [10, 23-25]. Even though the dewormed sheep revealed low infection prevalence (45.6%) compared to non-dewormed (56.5) of them were infected with lungworm. The reason behind this result probably, the anthelmintic used for the treatment of these sheep may be only temporarily suppressed egg production of the adult worms or parasite may become resistance to anthelminthic [8, 28].

The higher infection prevalence was recorded in sheep showing clinical respiratory signs than those apparently healthy and significantly higher ($P<0.05$). The result coincides with the observation of [12, 20, 23]. Even though apparently healthy sheep low infection prevalence compare to those showing clinical respiratory signs groups, about 12.6% of them are infected with lungworm. The reason behind this result probably, they may in the prepatent stage of the disease or have small adult worm burden or they may be infected with bacterial or viral diseases which cause respiratory signs [38].

The higher infection prevalence was recorded in sheep kept on field with marshy area than those kept in the forest and significantly higher ($p<0.05$).The reason behind this may due to anthelminthic effect of some trees and shrubs [39].

CONCLUSION

Lung worms are one of the most common causes of chronic respiratory disorder in ovine. In the present study the prevalence of lung worms was found to be higher in Gomma district. The major identified lung worm species in the study area were *Dictyocaulus filaria* followed by *Muelleriuscapillaries* and *Protostrongylus rufescens* as well mixed infection was encountered. From this study it has been concluded that young, non-dewormed, those which are kept in field are much prone to lung worm infection; prevalence of lungworm infection increases as altitude increase. Based on the above conclusion, the following recommendations are forwarded:

- Emphasis should be given for the control and prevention to reduce huge magnitude of infection.
- Sheep should be prohibited from grazing swampy areas to protect them from infection.
- They should be dewormed by broad-spectrum anthelmintic at the beginning of rainy season.
- Young age groups should be isolated during the season when pasture contamination expected.
- Those which manifest respiratory should be treated at early stage.

ACKNOWLEDGMENTS

The authors acknowledge Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) for financing the project in the period from November, 2014 to March, 2015.

REFERENCES

1. Hansen, J. and B. Perry, 1996. The epidemiology, Diagnosis and control of Helminths parasites of ruminants, ILRAD, Nairobi, Kenya, pp: 29-31.
2. ILCA, 1990. Annual Report, 1989. ILCA, Addis Ababa, Ethiopia, Institute of Agricultural Research (IAR), 1974. Ethiopian National, Sheep searching development policy report by a technical committee, Addis Ababa, Ethiopia, pp: 37.
3. Ayalew, L., J.L. Frechette, R. Malo and G. Beaukegard, 1973. Studies on the incidence of *D. filaria* in sheep of Ramoski region, Can. Vet. J., 14: 301-303.
4. Demelash, B., J. Yilma and C. Hassen, 1999. Ovine helminthosis in major health constraints to productivity of sheep in Ethiopia, Faculty of Veterinary Medicine, Awassa University, Awassa, Ethiopia, pp: 36-45.
5. FAO, 2002. Production Year Book. Rome, Italy, 54: 200-315.
6. Kimberling, C.V., 1998. Jensen and Swift's Diseases of Sheep, 3rd ed. Lea and Febiger, Philadelphia, pp: 99-101.
7. Radostitis, O.M., C.C. Gay, K.W.H. Cliff and P.D. Constable, 2007. Veterinary Medicine. A Text book of the disease of cattle, horses, sheep, pigs and goats, 10th ed. Bailler, Tindal, London, pp: 1568-1569.
8. Urquhart, G.M., J. Armour, J.H. Duncan and F.W. Jennings, 1996. Veterinary Parasitologica, Glasgow, Scotland, pp: 35-61.
9. Bekele, M., G. Feseha and T. Shibru, 1981. Observation of *D. filaria* in Wollo and Arsi Administrative Region of Ethiopia, J. Agric. Sci., 3: 75.
10. Netsanet, B., 1992. Study on prevalence and control of lungworm in local Ethiopian highland sheep in and around Debere Berhan. DVM thesis, Faculty of Veterinary Medicine Addis Ababa University, Debrezeit, pp: 42.
11. Wondwossen, T., 1992. Prevalence of lungworm in and around Asella. DVM thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit.
12. Paulos, A., 2000. Importance of seasonal dynamics of lungworms infection of small ruminants in Chilalo areas, Arsi Zone. DVM Thesis, Addis Ababa University, Debrezeit, Ethiopia., pp: 15-22.
13. Mihreteab, B. and A. Aman, 2010. Ovine Lungworms in Tiyo District, South-East Ethiopia. Prevalence, Effect of Altitude and Major Host Related Risk factors. DVM Thesis School of Veterinary Medicine, Jimma University, Ethiopia.
14. CSA, 2011. Central Statistical Authority (CSA) Federal Democratic Republic of Ethiopia, Agricultural Sample Survey 2010/20011. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Addis Ababa, pp: 15-18.
15. Thrusfield, M., 2005. Veterinary epidemiology 2nd ed. Blackwell Science, university of Edinburgh, London, pp: 180-188.
16. Thompson, J.M. and H. Meyer, 2002. Body condition scoring of sheep. http://www.orst.edu/dept/animal-sciences/bcs.htm.
17. Vatta, A.F., M.A. Abbot, J.F. Villiers, S.A. Gumede, L.J.S. Harrison, R.C. Krecek, E.F. Thomson and G. Orita, 1988. Seasonal Prevalence of Protostrongylus and Dictyocaulus Species of Lungworms in Awassi Sheep in North-West Syria, Tropical Animal Health Production, 20: 187-189.
18. Anne, M.Z. and A.C. Gray, 2006. Veterinary clinical parasitology. 7thed. Australia, Blackwell Publishing Company, pp: 11-14.
19. FAO, 2004. Resistance Management and Integrated Parasite Control in Ruminants, pp: 9-77.
20. Hasen, A., S. Takele and K. Simenew, 2013. Ovine lungworm infestation rate on fecal larvae recovery basis, Acta. Parasitol. Globalis., 4: 29-33.
21. Alemu, S., E. Gelay, G. Ayele and A. Zeleke, 2006. Study on small ruminant lungworm in North east Ethiopian. J. Vet. Parasitol., 14: 330-335.
22. Teffera, S., 1993. Prevalence of ovine lungworm around Dessie and Kombolcha. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, pp: 65.
23. Eyob, E. and L. Matios, 2013. The prevalence and risk factors associated with ovine lungworm infestation in the Asella province, Central Ethiopia. J. Parasitol. Vector Bio., 5: 118.
24. Yohannes, G., 1989. Epidemiological study and anthelmintic trail of ovine Dictyocaulosisi in Debretabor Awraja. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit.

25. Sefinew, A., 1999. Survey of small ruminant lungworm in six district of Wollo. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, pp: 69.
26. Frewengel, S., 1995. Prevalence of ovine Dictyocaulus in and around Mekelle, DVM Thesis, AAU, FVM, Debrezeit, Ethiopia.
27. Ibrahim, N. and Y. Degefa, 2012. Prevalence of Ovine Lung Worm Infection in Mekelle Town, North Ethiopia, Int. J. Vet. Med., 9: 1-15.
28. Blood, D.C., J.A. Henders and O.M. Radostitis, 1997. Veterinary Medicine, A text Book of the disease of cattle, sheep, goat and horse; lungworm, 3rd ed., London, pp: 1010-1056.
29. Soulsby, E.J.L., 1982. Helminthes, Arthropods and Protozoa of Domesticated Animals, 7th ed. Baillere, Tindal, London, pp: 262-274.
30. Bradford, P., 2002. Large Animal Internal Medicine: disease of horses, cattle, sheep and goats, 3rd ed. Mosby Inc., 514-515; 1452-1455.
31. Nemat, E.A. and G.A. Moghadam, 2010. A Survey on Annual Infestation of Sheep With Lung Worms Based on Fecal Test and Slaughter House Study in Tabriz. J. Vet. Res., 64: 339-342.
32. Sisay, A., 1996. Preliminary study on the prevalence of Ovine lungworm infection in and around Bahirdar. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, pp: 36.
33. Mezgebu, M., 1995. A survey on ovine fasciolosisand lungworm infection in Addis Ababa and the surrounding highland areas. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, Ethiopia.
34. Merck Veterinary Manual, 2011. Lungworm Infection: Introduction (Verminous bronchitis, Verminous pneumonia). Merck Sharp and Dohme Corp., a subsidiary of Merck and Co., Inc., Whitehouse Station, NJ USA.
35. Addis, M., A. Fromsa and Y. Ebuy, 2011. Study on the prevalence of Lungworm Infection in Small Ruminants in Gondar Town, Ethiopia, J. Anim. Vet. Adv., 10: 1683-1687.
36. Nibret, M., B. Basazne and C. Mersha, 2011. Dictyocaulus filaria and Muellerius capillaries are Important Lungworm Parasites of Sheep in Wogera District, Northern Ethiopia, Int. J. Anim. Vet. Adv., 3: 465-468.
37. Dawit, W. and M. Abdu, 2012. Prevalence of Small Ruminant Lung Worm Infection in Jimma Town. Global Vet., 8: 153-159.
38. Gelagay, A., Y. Laekemariam, G. Esayas, T. Selam and A. Kassahun, 2004. Epidemiologic and Serologic Investigation of Multifactorial Respiratory Disease of Sheep in the Central Highland of Ethiopia, Intern. J. Appl. Res. Vet. Med., 2: 274-275.
39. Rahmann, G. and H. Seip, 2006. Alternative strategies to prevent and control endoparasites diseases in Organic Sheep and Goat Farming, pp: 71.