

Gastro-intestinal Tract Nematodes of Small Ruminants: Prevalence and Their Identification in and Around Alage, Southern Ethiopia

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Abstract: A cross sectional study was conducted in small ruminants kept under extensive management system in and around Alage Agricultural Technical Vocational Educational and Training (ATVET) College from October to May, 2018/19. The objectives were set to estimate the prevalence and types of recovered parasites at genus level and assessment of their association with the animal risk factors. A total of 310 randomly collected fecal samples of small ruminants (206 goats and 104 sheep) were examined by simple floatation. In the study area, the overall prevalence of GIT nematodes in small ruminants was 79.68% (247/310). Species specific prevalence of GIT nematode was 78.2% (161/206) and 82.7% (86/104), goats and sheep, respectively. The result showed the existence of single as well as mixed parasitic infections. Accordingly, higher proportion of *Haemonchus* in sheep (33.72%) and *Trichostrongylus* in goats (31.1%) represent single infections while *Haemonchus* with *Trichostrongylus* in sheep (5.8%), and *Trichostrongylus* with *Oesophagostomum* in goats (4.35%) were mixed parasitic infections. Conversely, *Bunostomum* and *Trichuris* appeared to be the lowest in proportions in goats (3.73%) and sheep (2.33%) as a single infection whereas *Haemonchus* with *Bunostomum* in goats (0.62%) and *Trichostrongylus* with *Bunostomum* in sheep (1.2%), as mixed parasitic infections. Analysis of risk factors (species, age, sex and body condition score) revealed that only sex and BCS had significant association with occurrence of parasitic infection ($p < 0.05$). Accordingly, females and those with poor BCS were more likely to have parasitic burden than others ($p < 0.05$). However, rest of risk factors (species and age group) had no statistical association ($p > 0.05$) for parasitic infection. In general, the occurrences of high prevalence of nematodes in the study area suggest that GI nematodes are major constraints for production and productivity of small ruminants. Therefore, application of strategic control measures is recommended to reduce the impact of nematodes in ruminants in the current area.

Keywords: Alage ATVET, Flotation Technique, Goat, GI-Nematodes, Prevalence, Sheep

1. Introduction

Sheep and goats are among the major economically important livestock in Ethiopia. There are about 23.62 million sheep and 23.33 million goats [1] in the country playing an important role in the livelihood of small holder farmers. Traditionally, sheep and goats have served as a means of ready cash and a reserve against when there is

economic and agricultural production decreased. However, the proximity of Ethiopia to large Middle Eastern markets demanding export quality sheep and goat carcasses and an increase in the domestic demand for small ruminant meat is leading to a change in the importance and scale of sheep and goat production. However, the full exploitation of these resources is hindered due to prevailing diseases, poor nutrition, poor genetic potential of the animals and the

traditional system of husbandry [2]. Their benefit to the owners is mainly due to smaller requirements of investment, shorter reproduction cycles, faster growth rates and high environmental adaptability as compared to that of cattle. Therefore, they provide a significant economic integrity in all agricultural system throughout the country [3].

Nematode infections are very high in low-income traditional husbandry systems affecting both sheep and goats and they belong to several super families of veterinary importance. These include *Trichostrongyloidea*, *Strongyloidea*, *Metastrongyloidea*, *Ancylostomatoidea*, *Rhabditoidea*, *Trichuroidea*, *Filarioidea*, *Oxyuroidea*, *Ascaridoidea* and *Spiruroidea*. The GIT nematodes of greatest importance in small ruminants are members of the order *Strongylida*, which contains the first four super families, but most belong to the superfamily *Trichostrongyloidea*. All grazing sheep and goats are infected with a community of these strongylid nematodes, whose combined clinical effect is the condition known as parasitic gastroenteritis [4]. Furthermore, no indication of the identities of most of the common worm genera can be obtained during the performance of faecal egg count, with the exception of those with morphologically distinct ova, for instance, *Strongyloides* spp., *Nematodirus* spp. and *Trichuris* spp. But Ova of the genera *Haemonchus*, *Ostertagia*, *Teladorsagia*, *Trichostrongylus*, *Oesophagostomum*, *Chabertia* and to some extent *Cooperia*, *Bunostomum* and *Gaigeria* are either difficult or impossible to differentiate without measurements and calculations that are impractical in the field. Because of large differences in the pathogenicity of the common worm genera, identification to at least the level of the genus of nematodes are essential in evaluating the importance of worm infection or the efficacy of anthelmintic treatment [5].

Gastrointestinal parasitism is one of the major health problems severely limiting the productivity of animals [6]. Parasitic gastro-enteritis continues to pose a serious health threat and limitation to the productivity of small ruminants due to associated morbidity, mortality, cost of treatment and control measures on a clinical and sub-clinical level [7]. Ruminants get infected with a variety of parasites due to improper care, unhygienic environment, extreme climate and close contact with infected animals [8]. Nematodes adversely affect ruminants, causing hematological and biochemical disturbances, anorexia, weight loss, poor reproductive performance, leading to decrease resistance to diseases. This in turn leads to and can even cause severe mortality thus leading to heavy loss. Gastrointestinal parasites of small ruminants are more prevalent during wet season than dry seasons. The parasites may even be devastating at subclinical level. The impact of gastrointestinal tract (GIT) parasitism causes different forms of losses that exist in two forms as a direct or indirect loss. Direct losses from parasitism are due to their effect as acute illness and death, forced premature slaughter and rejection of parts of the carcass at meat inspection in abattoirs. However, indirect losses are emanated mainly from sub-clinical levels of parasitism and the

existence of parasite does not cause obvious clinical signs [9].

Economic losses from GIT parasitism are mainly from their subclinical effect. Unlike acute diseases, subclinical diseases are mainly a flock or herd problem and tends to affect animals on a low plane of nutrition as well as lactating does and ewes. Additionally indirect effects of parasitism caused by subclinical parasitism are manifested by the reduction of potential productivity and reduce feed conversion of small ruminants. Moreover, stunted growth, poor weight gain and poor feed utilization eventually end up in low productivity small ruminants [10].

Small ruminants under different (intensive and extensive) production systems are extremely susceptible to the effects of wide range of helminthes endoparasite. Most of the GIT nematode parasite studies in Ethiopia have basic limitations in its scope and coverage to any of the agro-ecological zones of the country. The present study is, therefore, aimed to determine the prevalence and identification of gastrointestinal nematodes in genus level in relation to the main risk factor in small ruminants (sheep and goat) in and around Alage ATVET college. Additionally, this study was aimed to estimate the rate of infection in herd of sheep and goat under study.

2. Materials and Methods

2.1. Study Area

The study was conducted at Alage Agricultural Technical Vocational and Education Training (ATVET) College located at 217 km Southwest of Addis Ababa. The area has an altitude ranging from 1580 to 1600 masl, at 070 42' N latitude and 380 28'E longitude in the agro-ecologically semi-arid Southwestern part of the Ethiopian mid Rift valley. The area receives an average annual rainfall ranging from 700 to 900 mm. The area has three distinct seasons, namely; main rainy (June to September), short rainy (March to May) and dry (October to February) seasons. The average maximum and minimum daily temperature were 32±1.88°C and 15.5±1.96°C, respectively [11].

2.2. Study Animals

The study was performed on 310 small ruminants; 206 goat from Alage ATVET College's and 104 sheep from its localities. Both sheep and goats were managed in extensive husbandry management system. The animals were grouped into three classes on the basis of age, i.e., the age of animals was determined based on dental eruption pattern as described by Gatenby [12]. For simplicity the sampled animals were categorized as <2 years, [2-4] years and >4 years. Additionally, the body condition score was classified into three levels (poor, medium and good) as described by Pant *et al.* [13]. Different variables (risk factors) such as species, sex, age group, and body condition were considered and registered on the sheet prepared for this purpose.

2.3. Study Design, Sample Size and Sampling Methods

A cross-sectional study design was used in this study. The sample size was determined according to the formula given by Thrusfield [14]. The expected prevalence of 71.88% was taken from Jiregna *et al.* [15] conducted in Ziway, Dugda district, Eastern Arsi Zone of Oromia Regional State. With 95% confidence interval and 5% precision level; a total of 310 small ruminants were the sample size in this study by the formula given by Thrusfield [14]. Goats were more in number in the study sites than sheep and the division of the sample size was made based on this fact. Accordingly, two-third of the total sample size (small ruminants) was goats (206) and the remaining was sheep (104) selected randomly and examined for GI nematode infection.

2.4. Parasitological Techniques

Faecal samples were collected directly from the rectum of the animals using disposable plastic gloves. Faecal samples were kept in the universal bottle that was labelled with animal identification. The samples were brought to the Alage ATVET College Parasitology laboratory on the same day for nematodes egg identification by floatation technique by using sodium chloride (NaCl) floatation fluid and if remained, faecal samples were kept at 4°C for the next day processing. Faecal samples positive to floatation technique were cultured from 7 to 10 days (but the parasites were also recovered 7 to 20 days of culture) to see the nematodes larvae (L3) after incubation at 27°C. Then identification of the most important nematode genera in sheep and goats were followed by using Baerman technique. For this process approximately 10gm moist and crumbly feces were broken-up finely from the positive sample using pestle and mortar and cultured by using clean petridish. During the period of incubation, the cultured faeces were stirred continuously on each day to prevent the growth of fungi and finally L3 larvae were recovered using the Baerman technique [16].

2.5. Statistical Analysis

Data collected from each study animal and the laboratory analyses were coded and analyzed using Stata 11 Corp. The prevalence was calculated as the number of infected

individuals divided by the total number of sampled animals. Risk factors (species, sex, age, and body condition score (BCS)) were evaluated for potential significance as predictors of infection. In all the analyses, the confidence level was held at 95% CI and the level of significance was determined looking for P-value.

3. Results

Out of 310 small ruminants (206 goats; 104 sheep) sampled in the study area, 247 (79.78%) were found to be positive for presence of nematode eggs in their feces. The prevalence in each species of animals were, 78.2% (161/206) and 82.7% (86/104) in goats and sheep, respectively. From those sampled animals, the parasitic infections were specifically seen at genus level and the parasitic infections were analyzed in relation to risk factors. The predominant GIT nematodes identified in goat and sheep in the study area were *Haemonchus*, *Trichostrongylus*, *Oesophagostomum*, *Strongyloides*, *Bunostomum* and *Trichuris* with the prevalence of 22.58%, 20.97%, 12.9%, 7.74%, 2.58%, and 2.25% respectively. Mixed nematode parasite were also examined and recovered beside the single type of nematode larvae. These were *Haemonchus* with *Bunostomum*, *Trichostrongylus* with *Oesophagostomum*, *Haemonchus* with *Oesophagostomum*, *Haemonchus* with *Trichostrongylus*, and *Trichostrongylus* with *Bunostomum* with the prevalence of 0.97%, 3.55%, 2.26%, 2.9% and 0.97% respectively in examined small ruminants (Table 1). From the table below, the proportional numeric expression of a variable such as proportion of species, sex, age and body condition score of the study animals (goat and sheep) were illustrated. Generally, Sheep and goat fecal parasitic test revealed relatively high parasitic infestation for both species. Parasite infection of the host, goat and sheep, as a whole, in decreasing order were *Haemonchus*, *Trichostrongylus*, *Oesophagostomum*, *Strongyloides*, *Bunostomum* and *Trichuris*, in single infection and *Trichostrongylus* with *Oesophagostomum*, *Haemonchus* with *Trichostrongylus*, *Haemonchus* with *Oesophagostomum*, *Haemonchus* with *Bunostomum*, and *Trichostrongylus* with *Bunostomum*, respectively (Table 1).

Table 1. Results of faecal examination considering proportion of species, sex, age, body condition as a major associated risk factor with parasite egg positivity of both goat and sheep in the study area (N=310).

Types of Variable	No variable	Proportion
Species		
Caprine	206	66.45%
Ovine	104	33.55%
Sex		
Female	190	61.3%
Male	120	38.7%
Age		
<2 years	94	30.3%
2-4 years	159	51.3%
>4 years	57	18.4%
BCS		
Good	102	32.9%
Moderate	171	55.2%

Types of Variable	No variable	Proportion
Poor	37	11.9%
Type of L3		
Haemonchus	70	22.58%
Trichostrongylus	65	20.98%
Oesophagostomum	40	12.9%
Strongyloides	23	7.7%
Bunostomum	8	2.58%
Trichuris	8	2.26%
Haemonchus with Bunostomum	3	0.98%
Trichostrongylus with Oesophagostomum	10	3.55%
Haemonchus with Oesophagostomum	7	2.26%
Haemonchus with Trichostrongylus	10	2.9%
Trichostrongylus with Bunostomum	3	0.98%

The table below, shows the percentage of individual and mixed parasite infection that were recovered during the study period in relation to type of parasite larvae in those examined and parasite positive small ruminants. In due course, goats were highly infested with *Trichostrongylus* parasite and least

infested with *Bunostomum* and *Trichuris*, which were 31.1%, 3.73% and 3.73% respectively. Sheep were highly infected with *Haemonchus* and least infected with *Bunostomum* and *Trichuris*, which accounts about 33.72%, 2.33% and 2.33%, respectively (Table 2).

Table 2. The prevalence of single and mixed larvae recovered from small ruminants.

Types of L3 parasite	Animals risk factor									
	Species		Sex		Age (Years)			BCS		
	Caprine	Ovine	Female	Male	< 2	[2-4]	> 4	Good	Mod.	Poor
Haem.	25.47%	33.72%	29.5%	25.9%	16.7%	29.7%	43.75%	8.45%	31.9%	54.3%
Tricho	31.1%	17.44%	23.5%	32.1%	21.85%	32.2%	18.75%	36.6%	23.4%	17%
Oesoph.	19.3%	10.5%	19.8%	8.64%	21.85%	12.4%	16.7%	16.9%	17%	11.4%
Stron.	6.2%	15.12%	7.8%	12.35%	21.85%	4.95%	0	15.5%	7.8%	2.9%
Bun.	3.73%	2.33%	3.6%	2.5%	1.3%	4%	4.2%	7%	2%	0
Trich.	3.73%	2.33%	3%	3.7%	3.8%	2.5%	4.2%	2.8%	4.3%	0
Haem. & Bun.	0.62%	2.33%	1.2%	1.23%	1.3%	0.83%	2.1%	1.4%	0.7%	2.9%
Tricho&Oesoph.	3.6%	4.94%	3.6%	4.94%	5.13%	4.96%	0	2.82%	4.96%	2.9%
Haem. &Oesoph.	1.24%	5.8%	2.41%	3.7%	1.3%	4.96%	0	5.6%	2.13%	0
Haem. &Trich.	3.1%	5.8%	4.22%	3.7%	5.14%	2.5%	6.3%	2.82%	3.55%	8.6%
Trich. & Bun.	1.24%	1.16%	1.2%	1.23%	0	0.83%	4.2%	0	2.13%	0

Haem.: *Haemonchus*, Tricho.: *Trichostrongylus*, Oesoph.: *Oesophagostomum*, Stron.: *Strongyloides*, Bun.: *Bunostomum*, and Trich.: *Trichuris*

From the table below, *Haemonchus* (22.58%) were more prevalent while *Bunostomum* (2.58%) and *Trichuris* (2.58%), parasites were least prevalent from single infection in both

sheep and goat. For mixed infection, *Trichostrongylus* with *Oesophagostomum* were the most prevalent mixed infection both in sheep and goat (Table 3).

Table 3. The proportional amount of all recovered larvae both in single and mixed infection in small ruminants (N=310)..

Recovered parasites	Type of parasites	No of animal positive	Prevalence
Single infection	<i>Haemonchus</i> spp.	70	22.58%
	<i>Trichostrongylus</i> spp.	65	20.97%
	<i>Oesophagostomum/Chabertia</i> spp.	40	12.9%
	<i>Strongyloides</i> spp.	23	7.74%
	<i>Bunostomum</i> spp.	8	2.58%
	<i>Trichuris</i> spp.	8	2.58%
Mixed infection	<i>Haemonchus</i> with <i>Bunostomum</i>	3	0.97%
	<i>Trichostrongylus</i> with <i>Oesophagostomum/Chabertia</i> spp.	10	3.55%
	<i>Haemonchus</i> with <i>Oesophagostomum/Chabertia</i> spp.	7	2.26%
	<i>Haemonchus</i> with <i>Trichostrongylus</i>	10	2.9%
	<i>Trichostrongylus</i> with <i>Bunostomum</i>	3	0.97%

As shown from the Table 4, the potential risk factors such as sex, male with respect to female and body conditions, poor body condition and moderate body condition with respect to good body condition of study animal revealed a high statistical significant difference at (p-value < 0.005) with the occurrence of the parasite while the age, adult animal (sheep and goat) were statistically significant association with respect to the

young, (p value < 0.05) but old animal have not statistical significant difference with respect to young (p value > 0.05) and species of the animals such as sheep have not statistically significant association with respect to goat (p value > 0.05). From the examined small ruminants of the current study, the Ovine revealed higher prevalence rate (82.7%) than the Caprine which revealed (78.2%) prevalence rate. The old small

ruminants and those with poor body conditions were the highest affected group with 84.2% and 94.6%, prevalence rate respectively. In contrast, caprine from species, male from sex,

adult from age, good from body condition, of the animal risk factor were the least infested with parasitic infection with respect to the corresponding category.

Table 4. The prevalence of GIT nematodes in relation to the animal risk factors.

Risk factor	No of animal	No of positive (%)	OR (95% CI)	P value
Spp.				
Caprine	206	161 (78.2%)	1	
Ovine	104	86 (82.7%)	1.55 (0.81-2.99)	0.187
Sex				
Female	190	166 (87.4%)	1	
Male	120	81 (67.5%)	3.47 (1.87-6.45)	0.000
Age (years)				
<2	94	78 (82.98%)	1	
[2-4]	159	121 (76.1%)	2.02 (1.00-4.04)	0.049
>4	57	48 (84.2%)	2.69 (0.95-7.61)	0.061
BCS				
Good	102	71 (69.6%)	1	
Mod.	171	141 (82.46%)	2.26 (1.20-4.26)	0.012
Poor	37	35 (94.6%)	8.05 (1.67-38.75)	0.009

Spp.: species, BCS: body condition score, Mod.: moderate

4. Discussion

The overall prevalence of gastrointestinal nematodes in small ruminants (goat and sheep) during the study period was 79.68%. Among these, goat and sheep account for 78.2% and 82.7%, respectively. The current finding is in line with the previous studies conducted in different areas of Ethiopia such as 76.3% in Central Ethiopia [17], 79.09% in Debre Berhan [18], 82% in Genchi district [19]. However, the current finding was slightly lower than the findings of Mideksa *et al.* [20] (86.7%) and Dereje [21] (86%) from different parts of Ethiopia. Furthermore, the current prevalence was significantly lower than the previous reports from Southwest Ethiopia [22] (96.7%), Kaffa and Bench Maji Zones [23] (95.6%), and Eastern part of Ethiopia [24] (91.3%). The higher prevalence of parasitic infection of small ruminants observed in different parts of Ethiopia may be due to over stocking, poor nutrition, poor management practice or lack of sanitation and frequent exposure to the common grazing lands that have been contaminated. Additionally, the existing difference could also relate to the variations in geographical and climatic condition, management difference and the difference of health care activity. This could be related to the country's extremes temperature and rainfall which is the most important factor that influence the development, distribution and survival of nematode parasites [25, 26].

In the present study slightly higher prevalence of GIT nematode parasites were observed in sheep than in goats. Prevalence of GI nematode with regard to species in the present study was 78.2% and 82.7% in goat and in sheep respectively. In relation to species, these are relatively close with previous observation reported by Mideksa [20], 89.2% in sheep and 88.4% in goats, in and around Haramaya University. This could be attributed to the grazing habit of sheep which graze closer to the ground which increase opportunity of exposure to parasites [27]. On the other hand, this study disagree with the reports of Muluneh *et al.* [28]

(41.49% in sheep and 49.2% in goats) and Dilgasaet *et al.* [29] (68.4% in sheep and 70.7% in goats). The analysis of risk factors showed a significant difference in GIT nematode infection in relation to sex differences and a higher prevalence of nematodiasis in female animals (87.4%) than male (67.5%). The present study agrees with the previous studies conducted in different parts of the world with higher prevalence in females than male [30, 31, 32]. However, different studies reported a higher prevalence in male than female animals [19, 33, 34, 35]. Some of the previous studies gave notion that females are more prone to helminthes (nematodes) infestation compared to male small ruminant. Additionally, it is assumed that sex is a determinant factor influencing prevalence of parasitism [36] and females are more prone to parasitism due to their physiological factors including pregnancy and pre-parturient period in which that period exposes them to stress and decreased immune status [30, 37].

In the present study, the prevalence was significantly lower in age group of [2-4] years/adult (76.1%) as compared with >4 years/old animals, (84.2%) and <2 years/young (82.4%), for nematodiasis. This could be related to their higher susceptibility of early and late age group of animals for parasitic infection. The higher prevalence of GIT parasite infections in older animals is in agreement with Gonfa *et al.* [38], who reported, old small ruminants were highly infested than adult ([2-4] years) and young. This finding disagrees with the hypothesis that older (> 4 years) animals are immuned against GIT parasites which has been supported experimentally by different studies [39, 40]. Similarly, a number of studies demonstrated an increased in prevalence of young age than old age [41, 42]. The higher prevalence in old animals may be due to the waning of immunity as animals get older coupled with the poor management system [43]. This finding was not in agreement with different finding [34, 44, 45, 46] who reported that young animals are more susceptible to parasitic infections than older ones. This may

be due to immune-suppression of goat and sheep when being older and the young age group of goat and sheep may not develop matured immunity after cessation of maternal immunity that were taken from doe or ewe after birth and the adult small ruminants develops immunity through gradual and repeated exposure of different parasite. Further analysis of risk factors association with the parasites showed a significant difference between different BCS of animals in their parasitic burden. Accordingly, about 94.6% of poor BCS small ruminants harbor the parasites which was significantly higher compared to animals with medium (82.5%) and good (69.6%) BCS ($p < 0.05$). Accordingly, this result agrees with different studies as they found poor BCS animals prone to parasitic infection [38, 44, 47, 48, 49, 50, 51]. This finding also revealed that small ruminants with medium and poor body condition score have higher prevalence rate of nematodiasis infection. This might be due to either well-fed animals have good immunity or parasitic infection leads to poor immunological response to the fecundity of the parasites. Moreover, Radostits *et al.* [43] and Odoiet *al.* [52] indicated that animals with poor condition are highly susceptible to infection and may be clinically affected by worm burdens as compared to well-fed healthy animal.

5. Conclusion and Recommendation

The present study showed that ovine and caprine gastrointestinal nematodes were the major causes of helminthiasis in and around Alage area. In the present study, the overall prevalence of GI nematodes was 79.68% in small ruminants. The predominant GIT nematodes parasite identified were *Haemonchus*, *Trichostrongylus*, *Oesophagostomum*, *Strongyloides*, *Bunostomum* and *Trichuris* parasite in genus level as a single and/or mixed infection. These parasites affect all different species, age group, sex and BCS with different prevalence. Additionally, the significant difference between age and BCS existed with young and poor BCS animals more prone to the parasites. Furthermore, overall management in terms of animal health services can significantly affect the parasite distribution. This is mainly the practice of mixed farming that leads to communal grazing with many species of animals. The fact that drought power is from cattle that forced small ruminants to graze in overstocked areas and get less attention relatively. This could lead them graze close to the ground leading them to uptake a higher number of infective larvae in contaminated pasture. Therefore, creating awareness on improved animals husbandry coupled with periodic deworming are suggested as a recommendation to tackle the parasitic burdens in the area.

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References

- [1] Institute of Biodiversity Conservation (IBC), 2004. The state of Ethiopia's farm animals' genetic resources: Country report. A contribution to the first report on the state of the world's animal genetic resources, Addis Ababa, Ethiopia.
- [2] Yami A. and Merkel R. C. 2008. Sheep and Goat Production Handbook for Ethiopia. Ethiopia sheep and goat production improvement program (ESGPIP). Pp. 38-62.
- [3] Sissay M. M. Uggla A., Waller P. J. 2007. Epidemiology and seasonal dynamics of gastrointestinal nematode infections of sheep in a semiarid region of eastern Ethiopia. *Veterinary Parasitology*. 143: 311-321.
- [4] Zajac A. M. 2006. Gastro-intestinal nematodes of small ruminants: life cycle, anthelmintics, and diagnosis. *Veterinary Clinics, Food Animal Practice*. 22, 529-541.
- [5] Van J., Wyk J., Cabaret L. M. and Michael T. 2004. Morphological identification of nematode larvae of small ruminants and cattle simplified: ELSVIER *Vet. Parasitol*. 119: 277-306.
- [6] Jegede O. C., Adejoh A., Obeta S. and Olayemi D. 2013. Gastrointestinal parasites of ruminants slaughtered in Gwagwalada abattoir, Federal Capital Territory, Abuja, Nigeria. *Nigerian Jouirn. of Parsitol.* 34 (1): 55-59.
- [7] Nwosu C., Madu P., and Richards W. 2007. Prevalence and seasonal changes in the population of gastrointestinal nematodes of small ruminants in the semi-arid zone of North-Eastern Nigeria. *Vet. Parasitol*. 144: 118-124.
- [8] Gadahi J. A., Arshed M. J., Ali Q., Javaid S. B., and Shah, S. I. 2009. Prevalence of gastrointestinal parasites of sheep and goat in and around Rawalpindi and Islamabad, Pakistan. *Vet. World*. 2 (2): 51-53.
- [9] Barger I. A. 1994. Rotational grazing for control of gastrointestinal nematodes of goats in a wet tropical environment. *J. Vet. Parasitol*. 53: 109-116.
- [10] Pedreira J., Paz-Silva A. and Sánchez-Andrade R. 2006. Prevalence of gastrointestinal parasites in sheep and parasite control practices in North-West Spain. *Prev. Vet. Med*. 75: 56-62.
- [11] CSA, 2008. Federal Democratic Republic of Ethiopia. Central statistical Agency, Agricultural sample survey report on livestock and livestock characteristics. Volume II, Addis Ababa Ethiopia.
- [12] Gatenby R. 1991. *The Tropical Agriculturalist*, Macmillan (London) and CTA (Wageningen). 32: 6-11.
- [13] Pant K., Rajput M. K. S., Kumar J., Sahu S., and Gangwar P. 2009. Prevalence of helminthes in small ruminants in Tarai region of Uttarakhand. *Vet. World*. 2 (7): 265-266.
- [14] Thrusfield M. 2005. *Veterinary Epidemiology*. 3rd ed. Singapore, Black well Science, Pp: 233.
- [15] Jiregna D., Abdela H., Abriham K. and Chala M. 2018. Prevalence and Associated Risk Factors of Gastrointestinal Nematodes of Sheep and Goats in ZiwayDugda District, Eastern Arsi Zone of Oromia Regional State, Ethiopia. *ARC J. of Animal and Vet. Science*. 4: 6-14.

- [16] Ministry of Agriculture, Fisheries and Food (MAFF), 1986. Manual of Veterinary Parasitological Laboratory Techniques. Reference Book 418. HMSO, London.
- [17] Moti W. 2008. Prevalence of gastrointestinal nematode of sheep and goat in and around Welinchity, Central Ethiopia. DVM thesis, Faculty of Veterinary Medicine, Haramaya University, Haramaya, Ethiopia.
- [18] Achenef M. 1997. Observation on ovine gastrointestinal Nematodiasis and Coenurosis in sheep populations of Ethiopian highland, Debre Berhan, North Showa, DVM thesis, AAU, Faculty of Veterinary medicine, Debre Zeit, Ethiopia.
- [19] Emiru B., Amede Y., Tigre W., Feyera T. and Deressa B. 2013. Epidemiology of Gastrointestinal Parasites of Small Ruminants in Gechi District, Southwest Ethiopia. *Adv. Biol. Res.* 7 (5): 169-174.
- [20] Mideksa S. Mekonnen N., and Muktar Y. 2016. Prevalence and Burden of Nematode Parasites of Small Ruminants in and Around Haramaya University. *World App. Scie. Jour.* 34: 644-651.
- [21] Dereje G. 1992. Investigation of common Gastrointestinal parasite of small ruminant in and around Wolaita Soddo, DVM thesis, Faculty of Veterinary medicine, Addis Ababa Univ. Debre-Zeit, Ethiopia.
- [22] Gizaw H. 2015. Study on Prevalence of GI Nematodes in Indigenous Bonga Sheep Breed at three Selected Agro Ecologies of Kaffa and Bench Maji Zones, Ethiopia; Bonga Agricultural Research Center, Bonga, Ethiopia. *J. Bio., Agri and Healthcare.* 5: 77- 85.
- [23] Abebe W. and Esayas G. 2001. Survey of ovine and caprine gastro-intestinal helminthosis in eastern part of Ethiopia during the dry season of the year. *Revue de Medicine Veterinaire.* 152: 379-384.
- [24] Tefera M., Batu G. and Bitew M. 2011. Prevalence of gastrointestinal parasites of sheep and goats in and around Bedele, S-Western Ethiopia. *J. of Vet. Med.* 8: 2. 20.
- [25] Yilma J. M. and Malone J. B. 1998. A geographic information system forecast model for strategic control of fasciolosis in Ethiopia. *Vet. Parasitol.* 78: 103-127.
- [26] Biffa D., Jobre Y. and Chakka H. 2007. Ovine helminthosis, a major health constraint to productivity of sheep in Ethiopia. *Animal Health Research Reviews* 7 (1/2): 107-118.
- [27] Andrews S. 1999. The life cycle of *Fasciola hepatica*. *J P Dalton.* 1-29.
- [28] Muluneh J., Bogale B. and Chanie M. 2014. Major Gastrointestinal Nematodes of Small Ruminants in Dembia District, Northwest Ethiopia. *Eur. J. of App. Sci.* 6: 30-36. 19.
- [29] Dilgasa L., Asrade B. and Kasaye S. 2015. Prevalence of Gastrointestinal Nematodes of Small Ruminants in and Around ArsiNegele Town, Ethiopia. *American-Eurasian Journal of Scientific Research.* 10: 121-125.
- [30] Dagnachew S., Amamute A. and Temegen W. 2011. Epidemiology of gastrointestinal helminthiasis of small ruminants in selected sites of North Gondar, zone, Northwest Ethiopia. *Ethiop. Vet. J.* 15: 57-68.
- [31] Bashir A. L., Chishti F. A. And Hidayatullah T. 2012. A Survey of Gastrointestinal Helminthes Parasites of Slaughtered Sheep and Goats in Ganderbal, Kashmir. *Global Veterinaria.* 8: 338-341.
- [32] Lone B. A., Chishti M. Z. and Ahmad F. 2011. Prevalence of Coccidia and Gastrointestinal Nematode infections in goats of Baramulla District of Kashmir Valley. *Global Veterinaria.* 7: 27-30.
- [33] Ghanem Y. M., Naser M. H., Abdelkader A. H. and Heybe A. 2009. An Epidemio-coprological study of protozoan and nematode parasites of ruminants in tropical semi-arid district of Somalilan D (North of Somalia). *Vet. Med. Journal.* 3rd Science Congress. Pp: 768-787.
- [34] Zvinorova P. I., Halimani T. E., Muchadeyi F. C., Matika O., Riggio V. and Dzama K. 2016. Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe. *Small Ruminant Research.* 143: 75-83.
- [35] Hassan D., Mbap S. T. and Naibi S. A. 2013. Prevalence of Worm Infection in Yankasa sheep and West African dwarf goats in Lafia Town and Environs, Nigeria. *J. of Agri. and Vet. Science.* 4: 84-90.
- [36] Maqsood M. and Chaudhry A. 1996. Prevalence and intensity of haemonchosis with reference to breed, sex and age of sheep and goats Pakistan. *Vet. J.* 16: 41-43.
- [37] Gauly M., Schackert M., Hoffmann B. and Erhardt G. 2006. Influence of sex on the resistance of sheep lambs to an experimental *Haemonchus contortus* infection. *Deutsche Tierärztliche Wochenschrift.* 113: 178-181.
- [38] Gonfa S. Basaznew B. and Achenef M. 2013. An Abattoir Survey on Gastrointestinal Nematodes in Sheep and Goats in Hemex-Export Abattoir, Bishoftu, Central Ethiopia. *J. Adv. Vet. Res.* (3): 60-63.
- [39] Gamble H. R. and Zajac A. M. 1992. Resistance of St. Croix lambs to *Haemonchus contortus* in experimentally and naturally acquired infections. *Vet. Parasitol.* 41: 211-225.
- [40] Knox D. P. 2000. Development of vaccines against gastrointestinal nematodes. *Parasitol.* 120: 43-61.
- [41] Gupta G. C., Joshi B. P., and Rai P. 1976. Some aspects of biochemical studies in calf diseases, ascaridiasis and scour. *Indian Vet. J.* 53: 436-441.
- [42] Raza M. A., Iqbal Z., Jabbar A. and Yaseen M. 2007. Point prevalence of gastrointestinal helminthiasis in ruminants in southern Punjab. Pakistan. *J. Helminthol.* 81: 323-328.
- [43] Radostits M., Gay C., Hinchcliff W. and Constable D. 2006. Nematode diseases of the alimentary tract. In: *Veterinary Medicine, A textbook of the diseases of cattle, horses, sheep, pigs and goats*, 10th ed. Pp: 1541-1553.
- [44] Regassa F., Teshale S., Reta D. and Yosef K. 2006. Epidemiology of gastrointestinal parasites of ruminants in Western Oromia, Ethiopia. *Int. J. Appl. Res. Vet. Med.* 4 (1): 51-57.
- [45] Colditz I. G, Watson D. L., Gray G. D, Eady S. J. 1996. Some relationships between age, immune responsiveness and resistance to the parasites in ruminant. *Int. jour. for parasitol.* 26: 869-877.
- [46] Kanyari P. W. N., Kagira J. M. and Mhoma R. J. 2009. Prevalence and intensity of endoparasites in small ruminants kept by farmers in Kisumu Municipality; *Livestock Res. Rural Dev.* 21 (11), 01-11.

- [47] Tesfaheywet Z. 2012. Helminthosis of sheep and goats in and around Haramaya, southeastern Ethiopia. *J. of Vet. Med. and Ani. Health*. 4: 48-55.
- [48] Nigatu K. 2008. Gastrointestinal Helminthosis of Sheep in Awi Zone northwestern Ethiopia. *J. Glob. Veterinaria*. 12: 121-129.
- [49] Keyyu J. D., Kassuku L. P., Msalilwa J. and Kyusgaard N. C. 2006. Cross sectional prevalence of helminth infections in cattle on traditional, small scale and large-scale dairy farms in Iringa district, Tanzania. *J. Vet. Res. Comm*. 30: 45-55.
- [50] Van-Wyk A. Hoste H., Kaplan M., and Besier B. 2006. Targeted selective treatment for worm management-How do we sell rational programs to farmers? *J. Vet. Parasitol*, 139: 336-346.
- [51] Negasi W., Bogale B. and Chanie M., 2012. Helminth parasites in small ruminants: prevalence, species composition and associated risk factors in and Around Mekelle Town, Northern Ethiopia. *Europ. J. Biol. Sci*. 4 (3): 91-95.
- [52] Odoi A., Gathuma M., Gachuri K. and Omore A. 2007. Risk factors of gastrointestinal nematode parasite infections in small ruminants kept in smallholder mixed farms in Kenya. 3 (6): 1186-1746.