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Vol. 5(10), pp. 296-304, October, 2013
DOI 10.5897/JVMAH2013.0234

http://www.academicjournals.org/JVMAH

Journal of Veterinary Medicine and Animal Health

Full Length Research Paper

Epidemiology of gastrointestinal nematodes of Horro sheep in Western Oromiya, Ethiopia

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Accepted 2 September, 2013

This study was conducted during May 2011 to December 2012 in Western Oromiya to determine the prevalence of gastrointestinal nematodes in naturally infected Horro sheep and associated risk factors. A total of 1680 faecal samples were examined using flotation and modified McMaster methods. Identification of all isolated nematodes was performed on larvae recovered from pooled faecal cultures and worms collected from slaughtered animals. The overall prevalence was observed to be 24.7% (95% confidence interval: 22.6 to 26.8) and majority of the infected animals (88.9%) had low faecal egg counts per gram (50 to 800). Season, grazing management, age, agro-ecology and body condition scores showed significant association (p < 0.001) with prevalence and mean nematode faecal egg counts recorded. Results revealed that *Haemonchus contortus* was the most prevalent parasite detected followed by *Trichostrongylus* species. The Horro sheep were infected with diversified gastrointestinal nematodes that can seriously affect the health and productivity of the animals. Many animals were sub-clinically infected without attracting awareness of farmers to undertake control measures. Therefore, to improve the production potential of this indigenous breed of sheep and the livelihood of the farmers, control strategies based on the epidemiology of the parasites and production systems should be implemented.

Key words: Horro sheep, gastrointestinal nematodes, epidemiology, prevalence, Oromiya, Ethiopia.

INTRODUCTION

Ethiopia possesses highly diversified indigenous sheep breeds parallel to its diverse agro-ecology and production systems (Galal, 1983). The country is the home to a large population of sheep estimated to be 25.9 million (Central Statistical Agency (CSA), 2010). Horro sheep are one of the prominent indigenous breeds mainly distributed in Western Oromiya Region of Ethiopia. They belong to the long fat tailed breed group. They are uniform in colour having creamy white, dark tan or spotted short smooth hair. It is a large framed local breed and the fat tail is triangular in shape hanging straight down (Kassahun, 2000). They have an estimated population of 3.4 million and wide distribution from highland to lowland in their natural habitat. The breed is a valuable genetic resource usually characterized to have good reproductive performance, fast growth rate and large mature size compared to some of the traditional breeds (Abegaz et al., 2000).

Gastrointestinal (GI) nematode parasites are a major cause of mortality and sub-optimal productivity in grazing livestock in pastoral systems worldwide (Hoglund et al., 2009). As a consequence, the control methods mainly rely on the use of curative or preventive treatment with anthelmintics which, on many farms, lead to an ever increasing anthelmintic resistance problem.

On the other hand in many countries in sub-Saharan Africa including Ethiopia, helminth control options are

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limited. This is mainly an outcome of restricted access to anthelmintics by smallholder farmers, because of expense or shortage and low practices of alternative control methods like grazing management. Under such circumstances exploiting genetic variations in host resistance to gastrointestinal nematode parasites is a relevant option both to control parasites and improve the productivity of sheep industry. Some indigenous breeds reported in Africa including the Nigerian West African Dwarf sheep (Idika et al., 2012), the Red Maasai sheep in Kenya (Baker et al., 1998) and the Djallonkè sheep of West Africa (Goossens et al., 1997) showed superior genetic variations in host resistance to nematode parasites than some other local breeds. However, in Ethiopia on-station comparative studies conducted on two indigenous breeds of Menz and Horro sheep did not show consistent breed difference in nematode faecal egg counts (Tembely et al., 1998; Rege et al., 2002). Hence, further study to generate baseline epidemiological data on nematode infection status of Horro sheep is required to manage the parasites.

In Western Oromiya, sheep are important component of the farming system and reared traditionally by smallholder farmers. Natural pasture is the major feed resource and grazing animals are continuously exposed to nematode parasites which contribute to loss of production and unthriftiness. The humid and warm climatic conditions are virtually favorable for the widespread occurrence of parasitic diseases in the region. However, most of the studies hitherto conducted were directed to other parts of the country. Studies carried out in central highlands (Assefa, 1997), in southern (Asegede, 1990; Amenu, 2005) and eastern parts of the country (Sissay et al., 2007; Dereje, 2008) have generated data on epidemiology and production losses caused by GI nematode parasites in small ruminants but not in Horro sheep. As a result, data available on nematode parasites of Horro sheep in their native habitat are scanty. The objectives of the present study were therefore, to determine the prevalence of gastrointestinal nematodes in Horro sheep and investigate associated risk factors that may facilitate the development and implementation of control strategies relevant to the production systems.

MATERIALS AND METHODS

Study areas

This study was conducted in 6 selected districts of Western Oromiya with different agro-ecological locations. Highland represented by Horro and Jimma Arjo located about 325 and 385 km West of Addis Ababa, respectively. Mid altitude included Guto Gidda, Sasiga and Bedele situated 335, 353 and 480 km West of Addis Ababa in that order. The lowland involved resettlement sites in Jimma Arjo, Bedele, Dabo Hana and Guto Gidda in upper Didessa and Uke/Anger valleys. The elevations are 2000 to 2500, 1500 to2000 and below 1500 m above sea level in highland, mid altitude and lowland, respectively (Ministry of Agriculture (MOA), 1998; Production Estimates and Crop Assessment Division (PECAD), 2013). The mean annual temperature ranges recorded are 10 to 15, 15 to 20 and 20 to 25°C for highland, mid altitude and lowland, respectively. The average relative humidity is above 60.0%. All areas have two distinct seasons with a unimodal rainfall distribution.

The rainy season extends from May to September with the rainfall peak occurring from July to August and dry season from October to April. The areas receive a total annual rainfall of 1200 to 2000 mm (NMA, 2011) with small variations between areas. Vegetation that constitutes natural pasture of the highland area is mainly grass family along with other *Trifolium* species. The common grasses include species of *Andropogon*, *Cynodon* and *Pennisetum.* In the mid altitude natural pasture and crop residues comprise major feed resources and the commonest grasses of the area include *Chloris pychynothrix*, *Cenchrus ciliaris* and *Hyparrhenia* species. Natural pastures provide more than 90% of the livestock feed in lowlands with wide range of grasses, legumes and other herbs (Alemayehu, 2003).

Study animals

Horro sheep of all age and sex groups kept by smallholder farmers were included in the study. Majority of the families possessed on average 5 to 7 animals in a flock. Mating is predominantly uncontrolled and they are year-round breeders. Average age at first service of 7.8 months and age at first lambing of 13.3 months are reported for the female. The lambing interval of 7.8 months and average twinning rate of 40.0% were recorded for the breed (Edea et al., 2012).

Natural pastures from communal grazing lands were the principal sources of feed for sheep and other livestock during rainy season and crop residues were the major supplements available after harvest. Mostly, a large number of different livestock including sheep are grazed together on communal grazing pasture. Some farmers used tethering for sheep in the home vicinity. In some places, sheep grazing on native pasture at 20 animals per hectare all year round was reported (Tesfaye and Diriba, 2006). All sheep are grazed together during daytime and housed at night.

Study design and sample size

A cross-sectional study was carried out to determine the prevalence of GI nematodes. A cluster sampling was used to select the samples (Bennett et al., 1991; Toma et al., 1999) and the required sample size was calculated using a formula (Thrusfield, 2005). Initially the number of clusters equivalent to the number of flocks to be sampled in one agro-ecology was determined. The desired absolute precision was set to be 0.05 and an expected prevalence of 30% was considered (Fekadu B, Regional Veterinary Diagnostic Laboratory, Bedele, personal communication). Based on the relative population size in each agro-ecology, the cluster number was proportionally reallocated for each agro-ecology and 1680 sheep (240 flocks) were sampled for the study.

Method of sampling

In each study area, clusters of sheep or flocks possessed by households were considered during sampling. First, the list of household heads was obtained from the local Development Agents (DA). A lottery system was used to randomly pick a household head and subsequently the flock directly owned by the family was included in the sample. Then all the sheep in the flock were sampled for the study.

Parasitological study

All faecal samples were collected directly from the rectum of the animals (Hendrix, 1998). For individual samples, an average of 5 g of faeces was collected in a screw-capped universal bottle. The samples were clearly labeled corresponding to detailed information recorded and transported to the Regional Veterinary Diagnostic Laboratory in Bedele for analysis. When delay was expected in transport, samples were preserved in 10% formalin to prevent larvae from hatching (Hansen and Perry, 1994). Faeces for pooled culture of 10 to 15 animals were collected separately based on 3 g from each animal and were mixed thoroughly in the laboratory.

Faecal egg counts per gram (EPG) were determined for each sample following the modified McMaster technique described by Ministry of Agriculture, Fisheries and Food (MAFF, 1986) using saturated sodium chloride (specific gravity of 1.2) as flotation fluid. The degree of faecal egg output per gram was determined as described by Hansen and Perry (1994) in mixed infection with different GI nematode species. Six pooled faecal cultures (2 from each agro-ecology) were prepared following the method described by MAFF (1986) and larvae (L_3) were recovered by means of Baermann technique. The larvae were examined under a magnification of 250x and at least 200 identified from each culture using the keys and morphological characteristics described by MAFF (1986).

A total of 12 complete abomasa and intestines were obtained from sheep brought from our study areas and slaughtered in restaurants. All animals were adult males above one year old and 6 of them were slaughtered during rainy season and the other 6 in dry season. Collection of adult nematodes and their developmental stages were done according to method described by Hansen and Perry (1994). Identification was performed in the laboratory based on morphological keys provided by MAFF (1986) and Urquhart et al. (1996).

Questionnaire and body condition scoring

A semi-structured questionnaire was administered to sheep owners to collect some demographic data and grazing management used for the animals. In addition, the parasite control practices exercised in the areas were assessed and recorded based on interviews (Bartley et al., 2003). Body condition scoring (BCS) was done according to Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP, 2009) recommendation by careful visual observation and palpation of muscle mass and fat cover over the lumbar region. Animals of poor condition (BCS ≤2.0) and good condition scores (BCS 3.0 to 5.0) were identified and sampled (Behnke et al., 2011).

Data analysis

All data collected were stored in Microsoft Excel spreadsheet. Percentage was used to measure prevalence of infection and nematode species identified as shown in Tables 1,2,3,4 and 7. The EPG was logarithm transformed as $\log_{10}$ (EPG + 1) to minimize a skewed distribution and used in all procedures of analysis. Chi-square (χ^2) test statistic of SPSS for Windows, Version 16.0 (2007) and IBM SPSS Statistics for Windows, Version 20.0 (2011) were used to compare nematode species distribution and to test the association between nematode infection and each risk factor. The independent-samples t-test was used to compare EPG means within each age group and the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS, 2002), version 9.00 was used to analyze the effects of main factors on least squares means (LSM) nematode faecal egg count. In all analysis, statistical significance was considered at 0.05 or less probability level.

RESULTS

Questionnaire survey and body condition score

According to grazing system, 81.4, 3.8 and 14.8% of sheep sampled were kept under open grazing, tethering and mixed grazing combining both methods, respectively. In the study areas, parasite control practices largely relied upon the use of anthelmintics. Out of 150 farmers interviewed; 143 (95.30%), 1 (0.70%) and 3 (2.0%) responded they use entirely anthelmintics, traditional medicine and both methods to treat their animals against parasite, respectively. The remaining 3 (2.0%) replied that they did not use any method. Among the respondents, 20 (13.30%), 58 (38.70%) and 52 (34.70%) replied they use anthelmintic treatments once, twice and three times a year in that order only targeting the sick or animals in poor conditions. Body condition score assessment revealed that 78.0% of sheep sampled had relatively good condition scores (BCS, 3.0 to 5.0), while 22.0% of the animals scored thin or classified to have poor body condition scores (BCS ≤2.0).

Prevalence of gastrointestinal nematode infections

The overall prevalence of gastrointestinal nematode infections of Horro sheep based on faecal egg count was 24.7% (95% CI: 22.6 to 26.8). The prevalence were higher in the lowland (30.7% [95% CI: 26.2 to 35.2]) and mid altitude (30.7% [95% CI: 26.9 to 34.5%]) which were significantly different ($p < 0.001$) from prevalence recorded in highland (15.7% [95% CI: 12.9 to 18.5%]). Majority of the infected sheep (88.9%) had low nematode faecal egg counts per gram (50 to 800). Only 4.1 and 7.0% of the animals showed moderate (800 to 1200) and heavy (>1200) EPG counts, respectively (Table 1).

The nematode prevalence showed great seasonal variation based on wet and dry period of the year and the difference was significant ($p < 0.001$). As a result, a high prevalence of 41.9% (95% CI: 38.7 to 45.1) was observed during wet season (Table 2). In this study, no significant difference ($p > 0.05$) was seen in nematode infection between male (25.0% [95% CI: 22.5 to 27.5]) and female animals (24.0% [95% CI: 20.0 to 28.0]). The prevalence of 27.0% (95% CI: 23.0 to 31.0), 24.7 (95% CI: 18.1 to 31.3) and 23.7% (95% CI: 21.1 to 26.3) were recorded in lambs, yearlings and adult sheep, respectively. The effect of age was significant ($p < 0.05$) for lambs and adult sheep. But it was not significant ($p > 0.05$) for lambs and yearlings as well as yearling and adult age groups. A prevalence of 50.8% (95% CI: 45.7 to 55.9) was observed in sheep of poor condition score (BCS ≤2.0) compared to prevalence recorded for animals in good condition (BCS 3.0 to 5.0) and the difference was significant ($p < 0.001$) for both populations (Table 3). The grazing system used for the animals had a significant effect ($p < 0.001$) on nematode infection. Sheep grazed

Table 1. Prevalence of gastrointestinal nematode infections and faecal egg counts in Horro sheep based on agro-ecologies.

Agro-ecology	Sample	Prevalence (%)	95% CI (%)	EPG category (%)		
				Light	Moderate	Heavy
Highland	674	106 (15.7)[a]	12.9–18.5	91 (85.8)	6 (5.6)	9 (8.5)
Mid altitude	599	184 (30.7)[b]	26.9–34.5	168 (91.3)	5 (2.7)	11 (6.0)
Lowland	407	125 (30.7)[c]	26.2–35.2	110 (88.0)	6 (4.8)	9 (7.2)
Total	1680	415 (24.7)	22.6–26.8	369 (88.9)	17 (4.1)	29 (7.0)

Values within a column followed by letters a and b: χ^2 (1df, n = 1273) = 40.40, p < 0.001; a and c: χ^2 (1df, n = 1081) = 33.80, p < 0.001 (significantly different).

Table 2. Prevalence of gastrointestinal nematode infections and faecal egg counts in Horro sheep based on seasons.

Season	Sample	Prevalence (%)	95% CI	EPG category (%)		
				Light	Moderate	Heavy
Rainy	955	400 (41.9)[a]	38.7–45.1	354 (88.5)	17 (4.2)	29 (7.3)
Dry	725	15 (2.0)[b]	1.0–3.0	15 (100.0)	0	0
Total	1680	415 (24.7)	22.6–26.8	369 (88.9)	17 (4.1)	29 (7.0)

Values within a column followed by letters a and b: χ^2 (1df, n = 1680) = 351.30, p < 0.001 (significantly different).

Table 3. Prevalence of gastrointestinal nematode infections and faecal egg counts in Horro sheep based on body condition**.**

Body condition score (BCS)	Sample	Prevalence (%)	95% CI	EPG category (%)		
				Light	Moderate	Heavy
Good (BCS 3.0-5.0)	1310	227 (17.3)[a]	15.3 – 19.3	224 (98.7)	0	3 (1.3)
Poor (BCS ≤2.0)	370	188 (50.8)[b]	45.7 – 55.9	145 (77.1)	17 (9.0)	26 (13.9)
Total	1680	415 (24.7)	22.6 – 26.8	369 (88.9)	17 (4.1)	29 (7.0)

Values within a column followed by letters a and b: χ^2 (1df, n = 1680) = 173.90, p < 0.001 (significantly different).

under tethering were more affected than animals kept under open grazing. Similarly, animals reared under mixed grazing of both methods had more infection than free grazers. However, no significant difference was noted between tethered and mixed grazers (Table 4).

Nematode faecal egg counts

In the present study, in all group of animals, the nematode faecal egg output increased during rainy season compared to dry season. The degree of faecal egg count was generally low for both sexes throughout the study period. In male animals, there was virtually higher faecal egg count than female counterparts. However, the differences were not significant between male and female in each age group (Table 5).

The effects of agro-ecology, season, age, grazing system and animal condition were significant for least squares means ± standard error (LSM ± SE) of logarithm transformed faecal egg counts. However, the effect of sex was not significant. There were significant differences between lowland and mid altitude as well as between lowland and highland for LSM ± SE of faecal egg counts (p <0.001). But, no significant variation was seen between mid altitude and highland. Similarly, differences were significant for seasons, lambs and adult sheep, free grazers and tethered animals, animal in good condition and poor condition (Table 6).

Prevalence of nematode species

Identification of third stage larvae (L_3) from coprocultures resulted in a nematode composition presented in Table 7. Among the prevalent worms, *Haemonchus contortus* was the most dominant parasite (31.8%) with significant difference in distribution between lowland and highland as well as between mid altitude and highland. But the distribution was not significantly different between

Table 4. Prevalence of gastrointestinal nematode infections and faecal egg counts in Horro sheep based on grazing management.

Grazing system	Sample	Prevalence (%)	95% CI	EPG category (%)		
				Light	Moderate	Heavy
Open grazing	1369	273 (19.9)[a]	17.8 – 22.0	249 (91.2)	8 (2.9)	16 (5.9)
Tethering	63	33 (52.4)[b]	39.9 – 64.9	30 (90.9)	1 (3.0)	2 (6.0)
Mixed	248	109 (43.9)[c]	37.6 – 50.2	90 (82.6)	8 (7.3)	11 (10.1)
Total	1680	415 (24.7)	22.6 – 26.8	369 (88.9)	17 (4.1)	29 (7.0)

Values within a column followed by letters a and b: χ^2 (1df, n = 1432) = 37.50, p < 0.001; b and c: χ^2 (1df, n = 311) = 1.43, p > 0.05; a and c: χ^2 (1df, n = 1617) = 67.04, p < 0.001.

Table 5. Mean comparison of nematode faecal egg counts between female and male sheep within age group.

Age group	Sex	Sample	No. infected	Means ± SE	t-value	df	p-value
Under 6 months	F	286	77	2.28 ± 0.05	1.43	122	>0.05
	M	173	47	2.41 ± 0.08			
6-12 months	F	112	28	2.14 ± 0.09	0.17	39	>0.05
	M	54	13	2.16 ± 0.13			
Above 1 year	F	828	201	2.21 ± 0.03	0.44	248	>0.05
	M	227	49	2.25 ± 0.07			
Total	-	1680	415	-	-	-	-

Means ± SE for Logarithm transformed faecal egg count (Log_{10} [EPG + 1]), Standard error of the mean (SE).

Table 6. Effects of factors on Least squares means of nematode faecal egg counts of Horro sheep.

Factor		LSM ± SE of Log_{10} (EPG + 1)	F-value	p level
Agro-ecology	Lowland	0.40 ± 0.08[a]	16.73	***
	Mid altitude	0.75 ± 0.06[b]		
	Highland	0.65 ± 0.06[bc]		
Season	Wet	1.09 ± 0.05[a]	213.86	***
	Dry	0.11 ± 0.07[b]		
Sex	Female	0.60 ± 0.05	0.07	NS
	Male	0.61 ± 0.06		
Age	Lamb	0.68 ± 0.06[a]	5.50	**
	Yearling	0.61 ± 0.08[ab]		
	Adult	0.51 ± 0.05[bc]		
Grazing management	Open grazing	0.47 ± 0.03[a]	3.84	*
	Tethering	0.79 ± 0.12[b]		
	Mixed	0.54 ± 0.09[ab]		
Body condition score	Good (BCS 3.0-5.0)	2.05 ± 0.03[a]	98.65	***
	Poor (BCS of ≤ 2.0)	2.49 ± 0.03[b]		

Values within a column followed by different letters (a, b, c) within each factor category are significantly different; Not significant (NS, p > 0.05); *p < 0.05; **p < 0.01; ***p < 0.001.

lowland and mid altitude. The *Trichostrongylus axei* and *Trichostrongylus colubriformis* occurred widely distributing in all agro-ecologies and the difference was not significant between each zone. The *Ostertagia/*

Table 7. Prevalence of nematode species based on coprocultures and distribution in different agro-ecologies**.**

Nematode species	Distribution of nematode species (%)			Mean (%)	χ^2	df	p level
	Lowland	Mid altitude	Highland				
Haemonchus contortus	42.0^a	37.0^a	16.5^b	31.8	33.7	2	0.001
Trichostrongylus axei	10.0^a	9.0^a	6.0^a	8.3	2.3	2	0.32
Ostertagia/Teladorsagia circumcincta	0.0^a	3.0^b	25.5^c	9.5	90.4	2	0.001
Bunostomum trigonocephalum	13.0^a	8.0^{ab}	6.0^b	9.0	6.3	2	0.04
Cooperia curticei	0.0^a	8.0^b	1.5^c	3.2	23.6	2	0.001
Nematodirus filicollis	0.0^a	6.0^b	19.5^c	8.5	51.3	2	0.001
Strongyloides papillosus	3.0^a	4.0^a	0.0^b	2.3	7.6	2	0.02
Trichostrongylus colubriformis	12.0^a	11.0^a	10.0^a	11.0	0.4	2	0.81
Chabertia ovina	5.0^a	2.0^a	3.0^a	3.3	2.90	2	0.23
Oesophagostomum columbianum	15.0^a	12.0^a	12.0^a	13.0	1.1	2	0.58

Values within rows followed by different letters (a, b, c) are significantly different

Teladorsagia circumcincta and *Nematodirus filicollis* were more prevalent in the highland areas.

From abomasa and intestines collected from 12 slaughtered sheep, gastrointestinal nematodes were recovered only from 10 animals. The worm recovery was high and all animals harboured nematodes during the rainy season compared to low or no counts detected in dry season. Mixed infections with two or three nematode species were common and the overall mean worm burden was observed to be 104.50 ± 47.50 (Mean ± SE). The mean worm burden of 165.20 ± 66.30 and 13.50 ± 5.70 were recorded in rainy and dry seasons, respectively which were significantly different ($p < 0.05$). Totally, 7 species of nematodes namely *H. contortus* (60.0%), *Oesophagostomum columbianum* (40.0%), *T. colubriformis* (20.0%), *T. axei* (10.0%), *Bunostomum trigonocephalum* (20.0%), *Trichuris ovis* (20.0%) and *Strongyloides papillosus* (10.0%) were isolated from slaughtered sheep.

DISCUSSION

Prevalence of nematode infections

In this study, 11 species of gastrointestinal nematodes representing 10 genera were detected. *H. contortus* was the predominant parasite of Horro sheep occurring in all agro-ecologies with decreasing prevalence from lowland to highland areas. The *T. colubriformis* and *T. axei* constituted the next most prevalent nematode species followed by *O. columbianum, B. trigonocephalum* and *O./T. circumcincta* in decreasing order. Other species including *N. filicollis*, *Chabertia ovina*, *Cooperia curticei*, *S. papillosus* and *T. ovis* were the nematode species recorded in the study areas. Similarly, majority of the species were reported from indigenous sheep breeds in different parts of the country (Asegede, 1990; Assefa, 1997; Abebe and Esayas, 2001; Dereje, 2008).

Even though few slaughtered animals were studied to generate information about prevalence of nematode species and worm burden in general, 6 similar species of nematodes detected from coprocultures and additionally *T. ovis* were recovered during necropsy examination. The *H. contortus* was the most dominant worm in prevalence occurring in 60.0% of the slaughtered sheep followed by *Trichostrongylus* species which accounted for 40.0%. Other species occurred in less percentage and the species prevalence was in agreement with coproculture results. In this study, a mean nematode burden of 104.50 ± 47.50 was recorded which was lower compared to the mean burden of 1371.60 ± 263.40 reported for indigenous sheep breed in Southern Ethiopia (Amenu, 2005) and a mean burden of 1124.60 ± 669.60 recorded in Afar sheep from Eastern Ethiopia (Dereje, 2008). The mean worm burden of 165.20 ± 66.30 and 13.50 ± 5.70 recorded in wet and dry seasons, respectively complied with the level of prevalence and mean faecal egg count observed in respective season.

Many studies showed several gastrointestinal nematodes of the family Trichostrongylidae parasitize sheep around the world. Particularly, *H. contortus* is the major and economically the most important nematode parasite of small ruminants in the tropical and subtropical regions of the world (Achi et al., 2003; Fontenot et al., 2003; Terrill et al*.,* 2004). These prevalent species, namely *H. contortus* and *O. columbianum* which have intrinsically high biotic potential (Hansen and Perry, 1994) were expected to have considerably contributed to pasture contamination. Furthermore, *H. contortus* with its short generation interval in sheep host might be expected to significantly influence the epidemiology of GI nematodes in the study population. The occurrence of these species was largely influenced by the seasonal variation in rainfall pattern and larval recovery from coproculture was high in rainy season and negligible in dry season parallel to the prevalence recorded. Similar trend of prevalence was reported in Pakistan (Lateef et al., 2005) and in Ethiopia (Sissay et al., 2007).

The overall prevalence of gastrointestinal nematode infection in Horro sheep was found to be 24.7% (95% CI: 22.6 to 26.8) and much of the infection seemed to be sub-clinical and could indirectly cause production losses without apparent clinical signs. Other contrasting findings were also reported in different parts of the country including 16.4% in Central Ethiopia (Bekele et al., 1992), 98.9% in Southern Ethiopia (Amenu, 2005) and 55.0% in sheep and 22.5% in goat flocks in Afar region (Dereje, 2008). These results are compliant with the consensus that prevalence varies greatly from region to region, corresponding to ecological and climatic diversity as well as the existing host ranges (Njau et al., 1990). Yet, a relatively low prevalence recorded in this study should not be overlooked to receive due attention to institute control measures, because, many studies indicated that gastrointestinal nematodes are the leading causes of productivity losses in small ruminant production in Ethiopia (Demelash et al., 2006).

Risk factors

In the present study, some factors influencing the epidemiology of gastrointestinal nematode parasites in Horro sheep have been investigated. The agro-ecology based study revealed a relatively high prevalence in lowland and mid altitude areas as compared to prevalence recorded in highland. Meanwhile, analysis of variance of LSM of logarithm transformed EPG for effects of factors showed significant difference between the agro-ecological zones. The LSM for nematode egg counts were higher in mid altitude and highland zones than in lowland and the difference was significant. But no significant variation was observed between mid altitude and highland. This might be largely the influence of variation in geographic and climatic conditions existing between each zone. The result was also consistent with other reports from Ethiopia (Demelash et al., 2006) and Australia (Waller et al., 1995).

Season was a factor seen critically influencing the epidemiology of gastrointestinal nematodes of sheep in the study areas. Both prevalence and the LSM of EPG were affected by season with significant rise in wet season which declined to a negligible low level in the middle of dry season. Likewise, seasonal fluctuations in nematode faecal egg counts which followed seasonal rainfall pattern were reported from different studies in the country (Fikru et al., 2006; Sissay et al., 2007). Similar to the present result, seasonal influences on worm faecal egg counts were reported in areas with distinct rainy and dry seasons in Kenya (Nginyi et al., 2001) and Tanzania (Keyyu et al., 2005).

The effect of sex on nematode prevalence of sheep was investigated. In this study, no significant variation was observed between male and female hosts despite slightly higher infection noticed in male sheep. Similar finding was reported in grazing ruminants in Western Oromiya (Fikru et al., 2006). However, the result was inconsistent with a finding reported in Pakistan where higher prevalence was observed in female sheep (Lateef et al., 2005). In this finding, the mean EPG was not significantly different between female and male animals. Also, within each age group (lambs, yearlings and adults), there was no significant variation in mean EPG between female and male animals. On the other hand, the mean EPG between lambs and adult sheep varied significantly irrespective of sex. These results are in agreement with the finding reported in Eastern Ethiopia (Sissay et al., 2007). In this study, the mean EPG count for adult females in breeding age including lactating ewes did not show any significant increase over male counterparts during the study periods. This result did not coincide with a view that breeding ewes become more susceptible to helminth infections (Huntley et al., 2004; Houdijk et al., 2006; Al-Shaibani et al., 2008). One possible explanation is that farmers give more attention to animals in production and increase the treatment regimen against endoparasites using anthelmintics which could reduce nematode infection in such group of animals.

The results also showed that, even if the differences were not significant, male animals had more nematode fecal egg counts than females in all age groups. In a study conducted at central highland of Ethiopia, male lambs had higher mean EPG than female lambs (Rege et al., 2002). The reason was not clear, but some evidence from literature supports that entire male animals are more susceptible than females to some helminth infections as a result of androgen activity (Urquhart et al., 1996). The prevalence and LSM of EPG were seen to decrease with increasing age of sheep. Nematode infection and the LSM of EPG were high in lambs with significant difference from adult age group. This complies with the result reported by Hansen and Perry (1994). In contrast, no significant differences were observed between lambs and yearlings as well as between yearlings and adult age group.

The prevalence and LSM of EPG were high for poor body condition scored sheep and significantly different from good body condition scored animals. This result concurs with other reports (Keyyu et al., 2003; Van Wyk et al., 2006). The higher prevalence recorded in the former group supported the local tradition experienced by farmers to select their animals for treatment. Farmers used the loss of conditions in their animals as a marker to identify and present for treatment mainly to minimize the treatment expenses. Possibly this practice deserves further field study perhaps to optimize for use in targeted selective treatment to manage nematode parasites of sheep. Similar field survey based on live weight gain was advocated by Jackson et al. (2009) as one possible tool to identify animals for targeted selective treatment with anthelmintics in an attempt to control anthelmintic resistance problems as a result of exploiting refugia.

The influence of grazing method used for the animals was significant for prevalence of gastrointestinal nematode infections and LSM of EPG count. The study conducted in sheep kept under different grazing management showed high prevalence in tethered animals followed by those maintained under alternate use of tethering and open grazing. On the other hand, low prevalence was recorded in sheep managed under open grazing. The differences between open grazing and tethering as well as between open grazing and mixed grazing were significant. Similarly, the variation was significant for LSM of EPG count between open grazers and tethered population. Farmers used tethering mostly during rainy season when pasture production was relatively surplus. In the study areas, this coincided with the time when pasture contamination with nematode eggs was more likely to occur from infected animals parallel to high prevalence recorded. In tethering of sheep and goats, outbreaks of parasitic gastro-enteritis have been reported in Tanzania, Nigeria, Kenya and Cameroon (Kambarage and Kusiluka, 1996) which was consistent with the present finding. In open grazing system, the low prevalence observed could indicate that animals freely grazed in the extensive grazing field had less exposure to infective larvae on the pasture or may have better resistance to the worm challenge than tethered animals.

In this study, despite the variations observed in prevalence and nematode faecal egg counts as influenced by different risk factors, 88.9% of the sheep sampled had low EPG counts (50 to 800). Only 4.1 and 7.0% of the animals showed moderate (800 to 1200) and heavy (>1200) EPG counts, respectively. Similar observation was also previously reported in the area (Fikru et al., 2006) and in many countries in sub-Saharan Africa (Bekele, 1991). Perhaps this result could be a preliminary indication of the genetic potential of Horro sheep breed that are well adapted and thrive to produce under nematode challenges in their natural habitats.

Alternative treatment of animals with high nematode infections may be considered under the existing production system in the study areas. Farmers developed a tradition of taking their animals to veterinary clinics for treatment against endoparasites when they detect clinically sick, emaciated, diarrheic or animal exhibiting loss of production. This is a kind of targeted selective treatment which could minimize the selection pressure for anthelmintic resistant gastrointestinal nematode populations on farms and treatment expenses for smallholder farmers.

CONCLUSION AND RECOMMENDATION

Conclusively, the results of this study showed that Horro sheep are infected with diversified gastrointestinal nematodes that can seriously affect the health and productivity of the animals. These parasites affected all age and sex groups and their prevalence varied from place to place based on agro-ecology, husbandry practices and seasonal rainfall pattern. Many animals were sub-clinically infected without attracting awareness of farmers to undertake control measures. Therefore, to improve the production potential of this indigenous breed of sheep and the livelihood of the farmers, control strategies based on the epidemiology of the parasites and production systems should be implemented. Improvement of grazing management for the animals particularly where tethering is in practice could minimize the risk of infection for susceptible animals.

ACKNOWLEDGEMENTS

The authors are thankful to Bedele Regional Veterinary Diagnostic Laboratory, for all technical and material assistance provided during the course of study.

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