European Journal of Biological Sciences 6 (2): 46-53, 2014
ISSN 2079-2085

DOI: 10.5829/idosi.ejbs.2014.6.02.85174

Epidemiology and Chemotherapy of Gastrointestinal Parasites of Sheep in and Around Jigjiga, Eastern Ethiopia

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Abstract: A combination of cross-sectional study and controlled field trial was conducted from July 2012 to December 2013 with the objective of determining the epidemiology of gastrointestinal parasites and evaluating the anthelmintic efficacy of albendazole, ivermectin and tetramisolein sheep in Jigjiga district and its surroundings, Somali Regional State of Ethiopia. The epidemiological study was conducted on 408 randomly selected sheep and the efficacy trial on 24 naturally infested and extensively managed male sheep which was complemented with anthelmintic utilization data collection through a semi-structured questionnaire from 110 sheep owners. With the experimental study, efficacies of the three drugs were tested against gastrointestinal helminthes which was measured using the faecal egg count reduction test % (FECRT). 86.3% (n=352) sheep were found to harbor one or more gastrointestinal (GI) parasites species. The overall prevalence rates of strongyles, trichuris, eimeria, moneizia and mixed infestation respectively were 71.7, 6 5.3, 3 and 8%. A significantly higher prevalence rate was observed in females than males ($p<0.05$; OR=3.14); young than adults ($p<0.05$; OR=4); animals with poor body condition than those with good body condition score ($p<0.05$). The degree of infestation was also significantly associated with body condition and age groups ($p<0.05$). The faecal egg count reduction for albendazole, tetramisole and ivermectin were 97.8, 100 and 100% respectively suggesting an overall very good state of efficacy against gastrointestinal nematodes of sheep. This work evidenced that sheep of the study area harbored a considerable level of GI parasites suggesting a need to institute strategic deworming of sheep and proper utilization of available anthelmintics in the area.

Key words: Eepidemiology · Gastrointestinal Parasites · Sheep · Aalbendazole · Tetramisole · Ivermectin · Jigjiga

INTRODUCTION

Ethiopia, with its great variation in climate and topography, possesses one of the largest ruminant populations in the world holding over 24 million. The arid and semiarid parts particularly hold the majority of sheep (57%) population. In the semiarid areas of Ethiopian Somali Regional State (Eastern part of the country), there exists limited crop cultivation, small ruminants playing an important role in the livelihood and cash income of the community [1].

Despite the immense resource, there is poor productivity due to multiple problems, disease being the most important [2]. Of all diseases, reduced productivity due to gastrointestinal parasites has been reported to tantamount the combined effects of other ill health problems [3]. Production losses attributable to the helminth parasites are often substantial. A loss up to 81.8 million USD was reported annually due to helminth parasites of sheep in Ethiopia [2]. Moreover, in highland Ethiopian sheep, body weight losses due to endoparasitism ranged from 3-8% and caused 28% mortality [4]. Surveys carried out in some parts of Ethiopia on prevalence of helminth parasites show very high higher prevalence of gastrointestinal (GI) parasites. Published works by Muktar *et al*. [5] and Deressa [6] in Sheno [7] in Ogaden [8] in Bako [9] in Haramaya [1] in Ogaden have showed a higher prevalence rate of GI helminthes in sheep.

In recent years, anthelmintic resistance in sheep is becoming a wide spread threat in some African countries. Studies inKenya byWaruiru *et al.* [10] showed resistance occurring on half of 42 farms to at least one anthelmintic group. In South Africa, a country generally regarded as an

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anthelmintic resistance "hotspot", farmers were forced to abandon sheep farming because of chemotherapeutic failure and multiple resistanceproblems [11]. Some studies conducted in different parts of Ethiopia such as [12] in AdamiTullu, [13-15] in Southern Ethiopia, [16] near Addis Ababa, [9] in Hararand [17] in Gonder showed the presence of anthelmintic resistance of varied degree.

Despite the widespread misuse, intensive use and huge circulation of anthelmintic drugs in legal and illegal markets, no single efficacy trial was conducted in the study area. Thus, the objective of this study was to determine the prevalence and associated risk factors of gastrointestinal parasites and to evaluate the anthelmintic efficacy of selected brands of albendazole, ivermectin and tetramisole used in sheep in and around Jigjiga.

MATERIALS AND METHODS

Study Area and Period: This study was conducted from July 2012 to December 2013 in 3 selected districts (Jigjiga, Fafan and Kebribeyah) of Fafan Zone, Ethiopian Somali Regional State, located 620 km East of Addis Ababa [18]. The elevation of the study areas ranged from 1650-1803 meters above sea level. The mean minimum and maximum temperature is 20°C and 30°C respectively and about 52.6% of the land is used for grazing purpose. There is minimum erratic rainfall distribution [19] and 78% of the farmers live on both crops and livestock, 19.88% only grow crops and 1.79% only raises livestock. Latest data indicate that there are 20, 605 Cattle, 62, 700 sheep, 54, 270 goats and 2, 320 camels in the Zone [20].

Study Design and Methodology: The study was conducted using a combination of cross-sectional and farm-based experimental studies.

Cross-Sectional Study: The cross-sectional study was carried out on 408 local sheep breed, kept under extensive traditional management system, which were sampled using multi-stage cluster random sampling procedure to assess the epidemiological aspects of helminthosis. Age was determined using teeth eruption [21] and body condition using methods outlined by AIGR [22]. For this purpose, fecal specimen collected directly from the rectum of the study animals were subjected to coprological examination using standard fecal examination techniques [23]. Positive samples for parasitee eggs were subjected to eggs per gram (EPG) determination using Modified McMaster egg counting method described by Coles [24]. Depending on the degree of GI helminthosis, results of each specimen were categorized as low, moderate and severe for Strongyle-type nematodes based on literature [23].

Experimental Study: A questionnaire survey was conducted prior to the farm based anthelmintic efficacy trial. Structured and pre-tested questionnaires were administered to 110 randomly selected household heads in all the three districts in the study area to gather relevant information regarding anthelmintic frequency of use, source, selection criteria, dosing practices and curiosity of rotation of anthelmintics. For the anthelmintic efficacy testing, 50 Black Head Ogaden sheep (all male and 1 year old) that were fed on parasite-contaminated pasture were selected from four households that were in full consent in the project. Young animals that were not weaned and did not begin feeding on pasture were totally excluded and animals with recent history of treatment were excluded from the anthelmintic efficacy trial. All the 50 sheep were ear-marked and after doing the fecal egg count (FEC) of strongyle type eggs, 24 rams with minimum pre-treatment egg counting of 650 EPG were selected and ear-tagged differently. The 24 sheep were randomly allocated into four groups, each group comprising of six animals after blocking for the mean FEC per group (equivalent mean FEC of groups). The first group was treated with albendazole (7.5 mg kg^{-1} BW); the second with tetramisole (22.5 mg kg^{-1} BW) both orally using calibrated syringes; the third with ivermectin (0.2 mg kg^{-1} BW) administered subcutaneously and the fourth was left untreated control. The efficacy of the drugs was tested according to World Association for the Advancement of Veterinary Parasitology (WAAVP) recommendations for efficacy evaluation of anthelmintics [24] by the percentage reduction of mean egg excretion on the 12th day post-treatment; FECR% = 100 (1 - X_t) % /Xc, where, X_t and Xcare arithmetic means of EPG in the treated (t) and control (c) groups, respectively at day 12 post treatment and day 0 pre-treatment.

Data Management and Analysis: Data generated from the study was analyzed using SPSS version 16 software program.The prevalence data were calculated by dividing the number of animals positive for GI parasite on faecal examination by the total number of animals examined. Analysis of basic descriptive statistics, cross tabulations and chi-square (χ^2) and odds ratio were calculated among categorical variables. For the experimental study, efficacy of anthelmintics used was evaluated by calculating FECR %. Comparison of means among groups was done

using ANOVA and difference between treatments was compared using least square method of multiple comparisons. All the analyses were evaluated at 95% confidence interval to determine the level of significance.

RESULTS

Prevalence Study Output: Of the 408 sheep examined, about 86.3% (n=352) were found to harbor one or more GI parasite species. In positive specimens, strongyle (64%), monezia (3%), emaria (5.3%), trichuris (6%) and mixed infestation (8%) were observed.

Analysis for the presence of association and effect of sex, body condition and age groups in gastrointestinal parasitosis of sheep in this study has shown variable outcomes (Table 1). The analysis revealed that the prevalence of GI parasitosis was found to be significantly higher ($p<0.05$; OR = 0.242) in females (91.5%; n=258) than males (77.3%; n=150). Age wise comparison also revealed a significant ($p<0.05$; OR =3.938) variation of GI parasites prevalence between young animals and older groups, younger sheep being more positive (95.4%; n=173) for GI parasitosis than adult (79.5%; n=235). In addition to age level and sex, the prevalence of the GI parasites was 99.1%, 80.2% and 82.6% in animals with poor, medium and good body condition scores respectively. Statistical test has shown, however, that the association in medium and good body condition animals was not statistically significant ($p<0.05$). However, a significantly higher prevalence of GI parasitosis was oberved in poor body conditioned sheep than those with good body condition ($p<0.05$; OR = 15.926).

This study has also shown that parasite burden is highly related to the body condition of the animals, which can be shown by the fact that almost all severely affected animals were those with poor body condition. The difference was statistically significant ($p<0.05$). Likewise, the difference in the degree of EPG between young and adult sheep was statistically significant ($p<0.05$), younger animals were found to harbor heavier parasite load than adult ones. Nonetheless, sex had no significant association with EPG ($p<0.05$) in the study (Table 2).

Questionnaire Survey Output: All interviewed farmers reported that they have used at least one of anthelmintics to deworm their animals. Albendazole, the most commonly used anthelmintics (56.4%), was easily recognized at a sight by 97.3% (107/110) of respondents in this study, while tetramisole was least utilized (6.4%). Evidence of poor appetite is the most imminent (42.7%) cause of deworming, followed by coughing and loss of body condition (Table 3). On the other hand, over 30% of respondents select the 'appropriate' anthelmintic based on price affordability. Some farmers select an anthelmintic

Table 1: Multinomial regression analysis of sex, age and body condition with gastrointestinal parasitosis

								95% CI	
	Attribute	Total No. of animals examined	Positive (%)	Pearson's χ^2	*Df*	*P*-value	Adjusted OR	Upper	Lower
Sex	Male	150	116(77.3)	16.014	1	0.000	0.242	0.129	0.452
	Female	258	236(91.5)						
Age	Young	173	165(95.4)	21.01	1	0.01	3.938	1.789	8.670
	Adult	235	187(79.6)						
Body Condition	Poor	114	113(99.1)	25.479	2	0.009	15.926	2.022	125.411
	Medium	202	162(80.2)	-	2	0.267	0.681	0.345	1.343
	Good	92	76(82.6)	Constant	2	-	-	-	-

Table 2: Fecal egg count (EPG) relationship with age, sex and body condition

			EPG Category (%)				
	Attribute	Prevalence	Low	Moderate	Severe	Pearson χ^2	*P-value*
Body condition	Poor	99.1% (n=114)	0	8	106	407.4	0.000
	Medium	80.2% (n=202)	118	84	0		
	Good	82.6% (n=92)	82	10	0		
Age group	Young	95.4% (n=173)	47	46	80	77	0.000
	Adult	79.5% (n=235)	153	56	26		
Sex	Male	77.3% (n=150).	79	30	41	3.183	0.204
	Female	91.5% (n=258)	121	72	65		

[Infection by strongyle-type nematodes of the study sheep was categorized as light (50-800), moderate (800-1200) and heavy (>1200) degree of infection]

Table 3: Results of questionnaire survey on anthelmintic usage for sheep in the study area

Attributes on Anthelmintic use	Responses	Frequency (N=110)	Percent (%)
Ever use by respondents	Yes	110	100
	No	0	0
Drug known by responders	Albendazole and Ivermectin	66	60.0
	Albendazole only	37	33.6
	Albendazole, Ivermectin and Tetramisole	7	6.4
Conditions that warranted deworming	Poor appetite	47	42.7
	Coughing and sneezing	31	28.2
	Loss of body condition	17	15.5
	Diarrhea	15	13.6
Frequently used drug	Albendazole	62	56.4
	Ivermectin	41	37.3
	Tetramisole	7	6.4
Selection criteria	Price	34	30.9
	Evidence of efficacy	24	21.8
	Vet advice	23	20.9
	Color	12	10.9
	Size	4	3.6
Rotation among anthelmintic classes	No	110	100.0
	Yes	0	0

Table 4: Faecal egg count reduction test (FECRT) result of the efficacy study

	Mean FEC ±SEM		FECRT (%)			95% confidence interval	
Anthelmintics	On day of treatment	12 days post treatment	Mean	Minimum	Maximum	Lower	Upper
Albendazole	1154.12±13.56	27.5±12.5	97.8	96.5	98.7	94.92	100
Ivermectin	3200± 246	0±0	100	100	100	96.47	100
Tetramisole	2225±258	0±0	100	100	100	96.47	96.47
Untreated control	1891±52	1891±527	NA	NA	NA	NA	NA

based on previous evidences of cure (21.8%) and professional advice (20.9%). All the interviewed respondents indicated that they do not have any idea on anthelmintic rotation and hence never rotate anthelmintics among families.

Faecal Egg Count Reduction Test (FECRT): The results of the FECRT for each anthelmintic are shown in Table 4. Evaluation of the efficacy of anthelmintics under study revealed that ivermectin and tetramisole had both 100% while albendazole had shown 97.8% efficacy against strongyle eggs.

DISCUSSION

The present work has shown fewer types of helminth parasites of sheep so long as diversity goes. Strongyles, eimeria, moneizia and trichuris were the only parasite eggs recovered. Literatures and a number of studies, though, have reported that lung-worms, trichuris, different tapeworms, fasciola and paramphistomum can be recovered [7, 25, 29-32]. The absence of trematode eggs in GI- parasite- infested sheep in our study was probably due to the relatively arid nature of the study area. On top that, following the tough evidences of absence of trematodes during our course of study half way through, we have avoided undertaking sedimentation technique which might have caused some unavoidable degree of random error. The absence of other helminth eggs in our study is hard to explain as most of other works in Ethiopia have reported more diversity of helminth eggs than we did.

Regarding prevalence, helminth parasites of sheep, especially strongyle types, were highly prevalent (71.7%). Studies conducted by Deressa [6] in Sheno [5, 8] in Bako, [7, 25, 33] in Ethiopian Somali Regional State have all showed a higher prevalence rate of GI helminthosis in sheep. Likewise, in a study conducted by Kumsa *et al.* [34] in central Ethiopia, the overall prevalence of nematodes, cestodes, eimeria and trematodes was found to be 86, 12.7, 49 and 0.6%, respectively.

In the present study, the prevalence of GI parasites was found to have significant association with sex, age group and body condition. It is higher in female, young animals and those with poor body condition. In a similar fashion, [8, 35] reported higher prevalence in young.

The reciprocal relationship we observed between the high EPG values for pre-treatment faecal samples and body condition score in the study sheep with naturally acquired infection indicates that gastrointestinal nematodes caused significantly negative effects on growth and productivity in growing young ruminants, which is similar assertions made by different reports [25, 36- 38].

The questionnaire survey output showed that anthelmintic drugs are quite commonly used in the study area although their use is pretty improper.Benzimidazole (albendazole), imidazothiazole (tetramisole) and macrocyclic lactone (ivermectin) are widely available, albendazole being the most commonly used by small holder livestock owners to deworm their sheep. Kumsa, Etana and Megersa [25] and Melaku *et al*. [17] respectively reported similar findings in the Hawasa and Gonder, Ethiopia. [26] also reported similar scenarios in Cuba. The owners ascribed the most imminent (42.7%) cause of deworming to evidence of poor appetite, followed by coughing and loss of body condition. Similar result was reported in Ziway [25] where owners normally have to witness some sort of illness to warrant anthelmintic administration. Similar to the findings in Ziway [25] and in Gonder [17], cost was the most important element owners consider in selecting anthelmintics. In addition, [17, 25- 28] in Gonder, Ziway, Wolaita and Hawasa respectively had reported that visual estimation of animals' weights is utilized in dosing which is consistent with our study. The result of the present work showed that sheep raisers do not have any idea on anthelmintic rotation. The same concern was addressed by other researchers elsewhere in Ethiopia [25- 28].

Studies on the efficacy of anthelmintic drugs are useful for establishing and maintaining effective sustainable control strategies against helminthes, especially in small ruminants. Utilization of limited group of drugs for a long period may favor the development of resistance [39]. Despite their escalating prevalence of GI parasites in several countries of the world, especially in small ruminants, anthelmintic resistance does not seem to be a serious problem in Ethiopia and there are only few reports merely from the University farms [9, 15, 25].

Albendazole was found to show a relatively lower efficacy in the current study. In disagreement to our finding, most other works on small ruminants maintained under extensive type of production by resource in Ethiopia showed a good efficacy of albendazole [9, 25, 28, 40- 42]. Some other studies in different parts of the world [26, 43] also showed good efficacy of albendazole as compared to other anthelmintics. However, there are some other works that showed poor efficacy, [9] in Eastern Ethiopia, [14] in Southern Ethiopia, [15] from Hawasa, concurring with our finding. Even worse in India, unprecedented amount of resistance in Hisar, warranted quadruple and triple combinations of classes of anthelmintics in a university farm [44]. These differences in efficacy may be related with the difference in anthelmintic utilization in different geographical parts. Indeed, such triple and quadruple combinations of benzimidazole, levamisole, macrocyclic lactones and closantel were effective against most strains of gastrointestinal nematodes that were resistant to each of the components when drenched individually in sheep based on postmortem worm counts [45]. The lower efficacy of albendazole against nematodes in this study might be ascribed to several factors like poor quality drugs of low price, continuous under dosages treatments at the sheep dose rate by farmers due to low bioavailability in sheep, misuse and inappropriate treatment by owners. Similar factors have been suggested to contribute to lower efficacy [40, 46, 47].

Reports by Desie and Asha [28] and Kumsa and Wosene [42] who found 100% efficacy of tetramisole are in agreement with our study. There are many other works, however, that recorded lower efficacy of tetramisole [9, 13, 17, 26, 40, 46, 47]. It can be noted from our finding in the questionnaire survey that only 6.7% of the sheep keepers have used tetramisole and compared to the extensively used anthelmintics like albendazole, it is probably logical to draw the assertion that this rare frequency of treatment in sheep had prevented circulations of resistant strains of nematodes in small holder farms. Resistance against anthelmintics is attributed to the high frequency of treatment and low dosage of treatment practices on the farm [17]. Large scale and well controlled trials, however, are needed to strengthen our assertions under different agro-ecology, species of animals and management systems in Ethiopia.

Ivermectin was effective in reducing fecal egg count in our study. In agreement with this finding, [26] reported a 100% efficacy of different formulations in Cuba. However, [9, 15, 17, 44] reported lower efficacy of ivermectin in sheep. This may be related to the difference in the frequency and ways of utilization of the drug among localities.

Anthelmintic resistance in gastrointestinal nematodes against three broad spectrum families (benzimidazole, imidazothiazoles and macrocyclic lactones) has been reported from throughout the world. No new anthelmintics

with different modes of action are expected on the market in the near future, as development and release of new anthelmintic may take 6 to 8 years. Studies on the efficacy of anthelmintic drugs are useful for establishing and maintaining effective sustainable control strategies against helminthes, especially in small ruminants. Utilization of limited group of drugs for a long period may favor the development of resistance [39]. Despite the escalating prevalence of GI parasites in several countries of the world, especially in small ruminants, anthelmintic resistance does not seem to be a serious problem in Ethiopia and there are only few reports merely from the University farms [9, 15, 25].

CONCLUSION

This study revealed that GI parasites of sheep, especially strongyle types, were highly prevalent in the study area. Prevalence of parasitosis had significant association with sex, age group and body condition: higher in female, young animals and those with poor body condition. However, there was reciprocal relationship between EPG values for pre-treatment faecal samples and body condition score in the study sheep. Even though anthelmintics, especially albendazole and ivermectin, were quite commonly used by small holder livestock owners to deworm their sheep. The efficacy trial showed that ivermectin and tetramisole were far very effective in reducing fecal egg output, while albendazole had relatively lower efficacy. Nonetheless, more controlled experimental trials that consider different scenarios and integration of more sensitive methods like larva hatch assays with varieties of anthelmintic brands should be conducted to substantiate this finding. Moreover, Livestock owners should be educated on strategic deworming and combined therapy that should take risk factors in to account.

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