

Comparative Efficacy of Albendazole, Tetramisole and Ivermectin Against Gastrointestinal Nematodes in Naturally Infected Goats in Ziway, Oromia Regional State (Southern Ethiopia)

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Abstract: A study was conducted to determine and compare the efficacy of the albendazole, tetramisole and ivermectin against gastrointestinal nematodes in naturally infected goats in Ziway in southern Oromia. About 60 male goats were divided into four groups of 15 animals each: the 1st group served as the untreated control, the 2nd was treated with albendazole, the 3rd with tetramisole and the 4th with ivermectin. Faecal samples were collected on day 0 before treatment and again day on 12 post treatment. Efficacy for each anthelmintic was determined by the Faecal Egg Count Reduction Test (FECRT). About 100% efficacy against strongyle and *Trichuris* sp. was recorded in goats treated with albendazole and ivermectin. On the contrary, low efficacy of 90.1 and 63% against strongyle and *Trichuris* sp. was observed respectively in goats treated with tetramisole. Likewise, low efficacy of 62, 38 and 44% against *Moniezia* sp. was recorded in goats treated with albendazole, tetramisole and ivermectin, respectively. Coprocultures from all both pre and post-treatment samples revealed the pre-dominance of *Haemonchus* sp. The results of the study showed the presence of inverse relationship between the body condition score and their respective mean EPG ($R^2 = 0.99$), suggesting the negative effect of parasitic load on the performance of goats. A questionnaire survey conducted to gather information on methods of control practices of nematodes of goats revealed lack of basic awareness among owners of goats about the best use and efficacy of anthelmintics. In addition, it indicated that farmers in the study area apply many practices that may lower the efficacy of anthelmintics and favor the emergence of anthelmintic resistance. Benzimidazoles group of anthelmintics were reported to be used at the most frequency followed by imidazothiazoles and the avermectins were used at lowest frequency. Further detailed investigations are necessary to clarify the current status of efficacy of the widely used anthelmintics in different agroecology, species of animals and management systems in Ethiopia.

Key words: Albendazole, coproculture, ivermectin, infected goat, farmers, Ethiopia

INTRODUCTION

Goats play an important role in Ethiopian economy by supplying meat, milk, cash income, savings, skin, manure and employment for family members. They have merits of high reproductive performance, draught resistance ability and requirement of low capital investment. Parasitic diseases are the major hindrances to the productivity of small ruminants (Fikru *et al.*, 2006; Sissay *et al.*, 2007). In tropical countries, gastrointestinal helminths are responsible for 23-63% reduction in growth (Pralomkarn *et al.*, 1995), up to 25% pre-weaning mortality (Baker *et al.*, 2001), 24-47% reductions in annual off take and 27% loss in meat and 40% loss in wool production (Anker *et al.*, 1998; Osaer *et al.*, 2000). Gastrointestinal

nematodes are one of the most important causes of losses in productivity of goats in Ethiopia. Economic losses incurred by nematodes include reduction in weight gain, low fertility, reduced performance, condemnation of organs, cost of treatment and mortality in severely infected cases. Several previous coprological and abattoir studies conducted in different parts of Ethiopia indicate high prevalence and wide distribution of gastrointestinal nematodes in goats (Abebe and Esayas, 2001; Debela, 2002; Kumsa and Wossene, 2006a; Kumsa and Abebe, 2009; Thomas *et al.*, 2007).

Owing to lack of sound management strategies against helminths of livestock in any of the agroecologies in Ethiopia, control of adverse effects of nematodes on grazing ruminants relies almost exclusively on the use of

anthelmintics. However, efficacy of anthelmintics is continuously constrained by many factors like under dosage, exclusive use of drugs of the same mode of action, substandard drugs and inappropriate use of anthelmintics. There is no anthelmintic use policy in the country as a result misuse and smuggling of anthelmintics in many forms like illegal trading in open markets and irrational administration is a widespread practice. In addition, no method is in use that can preserve and maintain the efficacy of anthelmintics or delay and prevent the emergence of anthelmintic resistance (Hussein *et al.*, 1999; Kumsa and Wossene, 2006b; Kumsa and Abebe, 2009).

In spite of the high use of Albendazole (ABZ), Tetramisole (TTM) and Ivermectin (IVM), there is a paucity of information on the efficacy of these anthelmintics. For this reason, the objective of the present study is to evaluate and compare the anthelmintic efficacy of albendazole, tetramisole and ivermectin against gastrointestinal nematodes in naturally infected goats in rift valley area around Ziway town in southern Ethiopia. It also aimed to obtain information on the current practices used by farmers to control gastrointestinal nematodes of sheep in the study area. Information on the efficacy of the widely used anthelmintics can be used in maintaining effective control of nematodes of small ruminants and sustainable use of these drugs.

MATERIALS AND METHODS

Study area: The current study was conducted from August 2006 through April 2007 on goats originated from around Ziway town, located (7°04'N and 38°31'E) 160 km south of Addis Ababa, Ethiopia. The area is situated at an elevation of 1650 m above sea level and is characterized by sandy loam soils covered with scattered acacia trees and bushes. The main rainy season extends from April to September (EMA, 1988). The average minimum and maximum temperatures of the area are 12 and 27°C, respectively. Cattle and goats constitute the major livestock of the area and are managed under traditional husbandry system in permanent settlements where there is some crop residue and acacia leaves especially for goats. The veterinary services in the area is inadequate (Debela, 2002).

Study animals: Total 60 male Arsi-bale breed goats of 5-6 months of age with uniform size and weight were used for the study. The goats were purchased from the local market in Ziway town and brought to the experimental station of Hawassa College of Agriculture of Hawassa University based at Hawassa town. On arrival Eggs Per

Gram of faces (EPG) for strongyle type nematodes was determined for each goat. In addition, each goat was individually marked with a numbered ear tagged, body weight and body condition score were determined for each goat as per the methods of AIGR (2000). None of the goats received any anthelmintic before the start of the study.

Questionnaire survey: A questionnaire survey on the use of anthelmintics for goats was performed on a total of 80 goat owners and 6 veterinary drug venders in the study area. Information on the widely used anthelmintics, selection criteria, application interval and sources of drugs, methods of dosage determination and rotation of anthelmintic family were all collected and complied.

Experimental design: After acclimatization period of 4 weeks the study goats were divided into one untreated control group and three treatment groups with 15 animals in each group by blocking based on faecal strongyle type egg count (EPG) determined on day 0 before treatment. Goats of each group were housed in isolated concrete floored pen and were fed locally dried hay throughout the study period to preclude accidental infection by parasites. The animals received Rhodes grass hay as a basal diet and supplemented with *Sasbania sesban* hay and had free access to mineral lick and water.

Pre-treatment EPG was determined using McMaster egg counting technique as described by MAFF (1977). The treatment groups were Albendazole, Ivermectin and Tetramisole treated and untreated control. Again 12 days post treatment EPG was determined in goats treated with albendazole, levamisole and ivermectin. Pooled fecal samples were also cultured for respective groups for larvae identification before and after treatment.

Anthelmintics: Study goats were treated according their individual weight with the dose of recommended by manufacturers. The anthelmintics used were Alzole (albendazole 300 mg, 7.5 mg kg⁻¹ Body Weight (BW) manufactured by East African pharmaceuticals), tetramisole (dl-tetramisole, dose 22.5 mg kg⁻¹ BW manufactured by ERFAR S.A) and Noromectin injection (ivermectin, dose 0.22 mg kg⁻¹ BW Norbrook laboratories limited). The first group served as untreated control group. ABZ and TTM were administered orally using calibrated syringes whereas IVM was administered via subcutaneous injection route.

Faecal collection and examination: Rectal faecal samples were collected from each goat in labeled universal bottles on day 0 before treatment and again on day 12 post

treatments. Samples were examined within 2 h of collection for strongyle type of eggs using saturated salt solution with 1.2 specific gravity as a flotation solution in the laboratory of animal science of Hawassa University. A Faecal Egg Count (FEC) was performed for each sample by the modified McMaster egg counting technique. Strongyle type Eggs Per Gram (EPG) were determined using the modified Mc Master technique according to Coles *et al.* (1992) with a sensitivity of 50 eggs g⁻¹ of faeces.

The infection by strongyle type nematodes of the study goats was categorized as light (50-800), moderate (800-1200) and heavy (>1200) degree of infection based on EPG record from pretreatment faecal samples as described by Hansen and Perry (1994).

Efficacy evaluation: Efficacy of each anthelmintic was tested according to the WAAVP recommendations for efficacy evaluations of anthelmintics (Coles *et al.*, 1992). Faecal strongyle Egg Count Reduction percentage (FECRT%) is given using the formula: $FECRT\% = 100 (1 - X_t/X_c)$ where X_t and X_c are the arithmetic mean EPG in the treated (t) and untreated control (c) groups, respectively at day 12 post treatment.

Reductions in efficacy is considered to exist if the FECRT percentage of an anthelmintic treatment is <95% and the lower 95% confidence limit for the reductions is <90% (Coles *et al.*, 1992). If only one of the two criteria is met reductions in efficacy is suspected.

L₃ identification: About 5 g rectal faecal samples from each goat were pooled for each group and incubated at 27°C for 7 days before and after treatment. The L₃ were recovered using Baermann technique. Then, L₃ were counted and identified according to the morphological keys given by MAFF (1977) and Van Wyk *et al.* (2004). Where possible 100 L₃ were differentiated per control and each treatment group.

Data analysis: Descriptive statistics such as percentage, frequency and Chi-square (χ^2) were used to analyze the mean EPG of the helminth egg count and prevalence, pre-treatment and post treatment results. Linear correlation was analyzed between body condition score and EPG counts and EPG of different body scores were compared by pair wise mean comparisons using SPSS 11.5 for window, SPSS Inc. 1989-2002.

The efficacy of the anthelmintics under evaluation, arithmetic mean, percentage reduction and 95% upper and lower confidence limits were all computed as per the recommendations of Coles *et al.* (1992). Chi-square (χ^2) was used to measure the association among prevalence of

different genera of parasites and degree of EPG of strongyle type of nematodes of the study goats. About 95% confidence level and $p < 0.05$ was used to indicate presence of significance.

RESULTS AND DISCUSSION

Questionnaire survey: About 95% of the interviewed farmers considered goat rearing secondary to cattle production whereas 8% of them considered goat as their major source of income. All the farmers kept their goats under small scale owners in extensive type of production system. About 86% of the farmers reported that they used benzimidazoles as the most widely used anthelmintic and 14% used tetramisole as a second most commonly drug in the area.

All of the owners informed that they use anthelmintics only when animals get sick with signs like ruffled coat, decline in body condition or with a potbelly. Farmers select anthelmintics by 47% low price, 31% colors, 7% ease of application, 5% by veterinarians' recommendations. About 61% of the farmers buy anthelmintics from open markets, 8% from illegal sellers in the villages, 9% from private veterinary pharmacies and 24% from government veterinary clinics.

All of the farmers indicated that doses of anthelmintics were determined only by visual estimation of animals weight and their animals get treatment only about once a year. All the interviewed respondents indicated that they do not have any idea about anthelmintic rotation as a result they never rotate anthelmintic families. The interviewed private drug venders informed that they sell benzimidazoles at 89%, imidazothiazoles at 10% and avermectins at only 1% to institutional farms (government and university).

Pretreatment faecal examinations: All the goats bought for the study from Ziway town in the rift valley parts of southern Ethiopia were naturally infected with 100% strongyle type, 80% *Eimeria* sp., 37% *Moniezia* sp. and 27% *Trichuris* sp. (Table 1).

The prevalence of *Trichuris* and *Moniezia* sp. was significantly ($p < 0.05$) lower than that of strongyle type nematodes and *Eimeria* sp. as shown in Table 1. Great proportion of the study goats were with 90% severe degree of infection whereas only small proportion were with 6.7% moderate and 3.3% light degree of strongyle type pretreatment EPG as shown in Fig. 1.

As shown in Fig. 1 and 2, there was inverse linear relationship between both individual and mean EPG of pretreatment faecal count and body condition score in naturally infected study goats (Fig. 3).

Table 1: Prevalence and mean EPG of gastrointestinal parasites from pretreatment samples of goats in Ziway

Treatment groups	Strongyle		<i>Moniezia</i> sp.		<i>Trichuris</i> sp.		<i>Eimeria</i> sp.	
	N (%)	Mean EPG	N (%)	Mean EPG	N (%)	Mean EPG	N (%)	Mean EPG
Albendazole	15 (100)	13900	5 (33)	370	4 (27)	150	12 (80)	ND
Tetramisole	15 (100)	13187	4 (24)	313	5 (33)	200	13 (87)	ND
Ivermectin	15 (100)	12260	6 (40)	320	4 (27)	113	13 (87)	ND
Control	15 (100)	12180	7 (53)	564	3 (20)	350	10 (67)	ND
Total	60 (100)	12882	22 (37)	368	16 (27)	203	48 (80)	ND

N: No. of infected animals; EPG: Egg per Gram of feces; ND: Not Determined

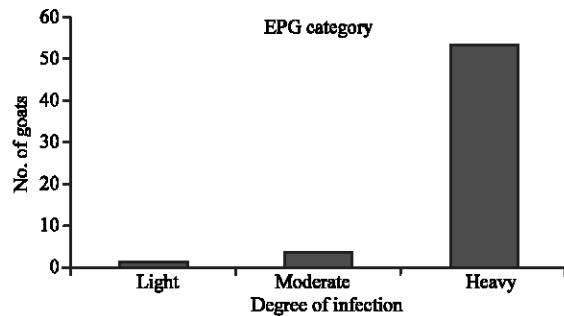


Fig. 1: Degree of infection of study goats based EPG of pretreatment faecal samples

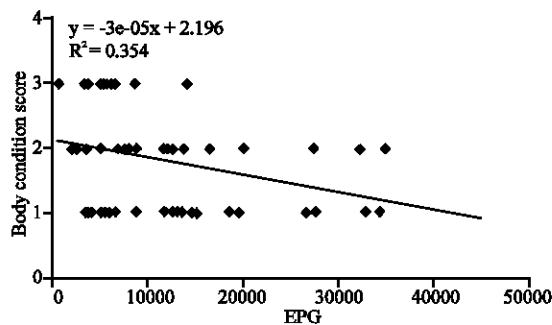


Fig. 2: Linear correlation of body condition score with pretreatment EPG of individual animals showing inverse relationship

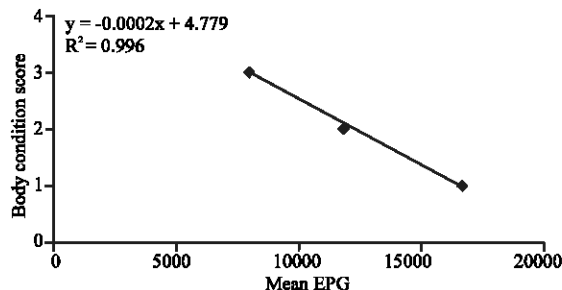


Fig. 3: Linear correlation of body condition score with mean EPG count showing inverse relationship

Efficacy evaluation: Evaluation of the efficacy of anthelmintics under study revealed that both albendazole and ivermectin were 100% effective against strongyle type

nematodes and *Trichuris* sp., whereas only 62 and 44% effective against *Moniezia* sp., respectively (Table 2). On the other hand, tetramisole with FECRT% of 90.2, 38 and 63% against strongyle type nematodes, *Moniezia* and *Trichuris* sp., respectively (Table 2) was found to be less effective than both albendazole and ivermectin.

L₃ identification: Identification of L₃ from pretreatment faecal culture indicated significantly ($p < 0.05$) higher proportions of *Haemonchus* sp. than the other nematodes like *Oesophagostomum* and *Trichostrongylus* sp. as shown in Table 3.

Whereas only *Haemonchus* sp. larvae were identified from post treatment faecal cultures in goats treated with tetramisole (Table 4). The overall prevalence of strongyle type nematodes, *Moniezia*, *Trichuris* and *Eimeria* sp. in the pretreatment faecal samples from naturally infected study goats is very high.

This is due to uniformly young age of 5-6 months of study goats that are managed under extensive system with high stocking density, inadequate nutrition and poor veterinary services condition in the rift valley parts of Ethiopia. For similar reasons, majority of these study goats were with severe degree of infection by strongyle type gastrointestinal nematodes. This observation agrees with previous researchers of Debela (2002), Kumsa and Wossene (2006b), Kumsa and Abebe (2009) and Thomas *et al.* (2007).

The observation of inverse relationship between the body condition score and EPG of pretreatment faecal samples in naturally infected study goats suggests gastrointestinal nematodes are responsible for significant impediments to growth and performance of young growing small ruminants as described by Stear *et al.* (2000) and Magona and Musisi (2002).

The questionnaire survey confirmed the widely believed thought of professional that benzimidazoles are the most widely used anthelmintic family followed by the imidazothiazoles in the study area. It also indicated that the macrocyclic lactone family is used only by institutional farms who keep animals under intensive management system. It also revealed that farmers in the study area perform several practices that may be

Table 2: Results of FECRT against GIT parasites of the study goats in Ziway, southern Oromia

Treatment groups	No. animals	Strongyle			<i>Moniezia</i> sp.			<i>Trichostrongylus</i> sp.		
		N (%)	Mean EPG	FECRT*	N (%)	Mean EPG	FECRT	N (%)	Mean EPG	FECRT
Albendazole	15	0	0	100%	2 (14)	250	62%	0	0	100%
Tetramisole	15	4 (29)	1100	90.1%*	4 (29)	413	38%	1 (7)	150	63%
Ivermectin	15	0	0	100%	5 (36)	370	44%	0	0	100%
Control	15	15 (100)	11250	7 (58)	664	-	3 (17)	400	-	-
Total	60	16 (29)	8713	18 (33)	480	-	4 (5)	338	-	-

N: No. of positive cases, FECRT: Fecal Egg Count Reduction Test

Table 3: Genera of nematodes identified from pretreatment coprocultures of the study goats

Groups	Genera of nematodes in percentage						
	Haem	Oeso	Trich	Telado	Buno	Chab	<i>S. papillosus</i>
Control	54.6	17.0	16.0	5.00	3.1	3.1	1.2
ABZ	49.3	20.4	16.8	7.20	3.0	2.9	0.4
TTM	54.5	12.8	14.0	10.2	2.5	4.3	1.7
IVM	43.5	20.2	15.2	12.1	3.0	4.0	2.0

ABZ = Albendazole; TTM = Tetramisole; IVM = Ivermectin; Haem = *Haemonchus* sp.; Oeso = *Oesophagostomum* sp.; Trich = *Trichostrongylus* sp.; Telado = *Teladorsagia* sp.; Chab = *Chabertia* sp.; *S. papillosus* = *Strongyloides papillosus*

Table 4: Genera of nematodes identified from post-treatment coprocultures of the study goats

Groups	Genera of nematodes in percentage						
	Haem	Oeso	Trich	Telado	Buno	Chab	<i>S. papillosus</i>
Control	55.2	18	15	5.8	2	3	1
ABZ	NL	NL	NL	NL	NL	NL	NL
TTM	100	NL	NL	NL	NL	NL	NL
IVM	NL	NL	NL	NL	NL	NL	NL

ABZ = Albendazole; TTM = Tetramisole; IVM = Ivermectin; Haem = *Haemonchus* sp.; Oeso = *Oesophagostomum* sp.; Trich = *Trichostrongylus* sp.; Telado = *Teladorsagia* sp.; Chab = *Chabertia* sp.; *S. papillosus* = *Strongyloides papillosus*; NL = No Larvae

responsible in lowering the efficacy of anthelmintics that agrees with many earlier studies conducted elsewhere in the world (Arece *et al.*, 2004; Chandrawathani *et al.*, 2004).

Studies on efficacy of anthelmintic drugs are useful to establish and maintain effective and sustainable control strategic against helminthes of livestock, especially for small ruminants.

Efficacy evaluations of the anthelmintics carried out and interpreted as per the WAAVP recommendations provided evidence of susceptibility of strongyle type nematodes to both albendazole and ivermectin hence to benzimidazoles and macrocyclic lactone families. This finding concurs with pervious studies conducted on small ruminants maintained under extensive type of production by resource poor smallholders in some parts of Ethiopia (Kumsa and Wossene, 2006b; Sissay *et al.*, 2006a, b) and with other studies in different parts of the world (Arece *et al.*, 2004; Saddiqi *et al.*, 2006).

Even though the number of positive goats was very small to provide conclusive results all the evaluated anthelmintics were inefficacious the goat tapeworm (*Moniezia* sp.) concurring with the observations of Kates *et al.* (1971). The lower efficacy in teramisole against nematodes of rift valley goats in this study might be caused 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 goats, misuse and inappropriate treatment by owners. Similar factors have already been reported to contribute to lower efficacy (Chandrawethani *et al.*, 2004; Hussein *et al.*, 1999; Saddiqi *et al.*, 2006; Saeed *et al.*, 2007). The observation of predominance of L₃ of *Haemonchus* sp. from pretreatment coprocultures is consistent with the previous reports of (Kumsa and Wossene, 2006a; Kumsa and Abebe, 2009; Sissay *et al.*, 2006a; Sissay *et al.*, 2007).

Likewise, L₃ of *Haemonchus* sp. was the only infective larvae identified from coprocultured faeces after treatment with tetramisole. This finding supports the results of most previous studies that reported association of *Haemonchus* sp. with reduced efficacy of anthelmintics due to greater ecological and biological plasticity of this parasite (Alvarez-Sanchez *et al.*, 2006; Dorny *et al.*, 1994; Kates *et al.*, 1971; Saddiqi *et al.*, 2006; Sissay *et al.*, 2006a, b).

CONCLUSION

In this study the results of the current study revealed that gastrointestinal strongyle type nematodes of goats of the study area are susceptible to benzimidazoles and macrocyclic lactone families. On the other hand, tetramisole showed lower efficacy, especially

against *Haemonchus* sp. in goats of the study area. However, many factors like use of drugs from black market, under dosage, misuse and inappropriate treatments may all hasten failure in efficacy of currently efficacious anthelmintics. As a result to maintain and prolong, the lifespan of the efficacy of available drugs farmers should be educated by proper veterinary extension about the importance of correct use of anthelmintics, annual rotations anthelmintic group and avoiding all factors that favor reduction in efficacy leading to anthelmintic resistance.

RECOMMENDATIONS

It is recommended that farmers and veterinary professionals should start to consider the inefficacy of anthelmintics as a serious problem and the routine diagnosis infections by helminths should be complemented by efficacy evaluation techniques. Large scale studies, however are needed to assess the status of efficacy of the widely used anthelmintics in different agroecology, species of animals and management systems with economic impact of the problem.

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REFERENCES

- AIGR, 2000. Body Condition Score Description. Goat Research and Extension, Langston University, Langston, UK.
- Abebe, W. and G. Esayas, 2001. Survey of ovine and caprine gastro-intestinal helminthosis in eastern part of Ethiopia during the dry season of the year. *Revue. Med. Vet.*, 152: 379-384.
- Alvarez-Sanchez, M.A., J. Perez-Garcia, M.A. Cruz-Rojo and F.A. Rojo-Vzquez, 2006. Anthelmintic resistance in trichostrongylid nematodes of sheep farms in northwest Spain. *Parasitol. Res.*, 99: 78-83.
- Anker, P., P. Itty, J. Zinsstag, S. Trawally and K. Pfister, 1998. Biannual anthelmintic treatments in village Djallonke sheep in the Gambia: Effects on productivity and profitability. *Prev. Vet. Med.*, 34: 215-225.
- Arece, J., M. Mahieu, H. Archimede, G. Aumont and M. Fernandez *et al.*, 2004. Comparative efficacy of six anthelmintics for the control of gastrointestinal nematodes in sheep in Matanzas, Cuba. *Small. Rumin. Res.*, 54: 61-67.
- Baker, R.L., J.O. Audho, E.O. Aduda and W. Thorpe, 2001. Genetic resistance to gastro-intestinal nematode parasites in Gala and small East African goats in the sub-humid tropics. *Anim. Sci.*, 73: 61-70.
- Chandrawathani, P., N. Yusoff, L.C. Wan and A. Ham, 2004. Total anthelmintic failure to control nematode parasites of small ruminants on government breeding farms in Sabah, East Malaysia. *Vet. Res. Commun.*, 28: 479-489.
- Coles, G.C., C. Bauer, F.H. Borgsteede, S. Geerts, T.R. Klei, M.A. Taylor and P.J. Waller, 1992. World Association for the Advancement of Veterinary Parasitology (W.A.A.V.P.) methods for the detection of anthelmintic resistance in nematodes of veterinary importance. *Vet. Parasitol.*, 44: 35-44.
- Debela, E., 2002. Epidemiology of gastro-intestinal helminthiasis of rift valley goats under traditional husbandry system in Adami Tulu district, Ethiopia. *Ethiop. J. Sci.*, 25: 35-44.
- Dorny, P., E. Claerebout, J. Vercruysse, R. Sani and A. Jalila, 1994. Anthelmintic resistance in goats in peninsular Malaysia. *Vet. Parasitol.*, 55: 327-342.
- EMA (Ethiopian Mapping Authority), 1988. National Atlas of Ethiopia. Berhanena Selam Printing Press, Addis Ababa, Ethiopia, pp: 77.
- Fikru, R., S. Teshale, D. Reta and K. Yosef, 2006. Epidemiology of gastrointestinal parasites of ruminants in Western Oromia, Ethiopia. *Int. J. Applied Res. Vet. Med.*, 4: 51-57.
- Hansen, J. and B. Perry, 1994. The Epidemiology, Diagnosis and Control of Helminth Parasites of Ruminants. 2nd Edn., Nairobi, Kenya, Ilrad, ISBN: 92-9055-703-1, pp: 171.
- Hussein, N., A. Hassen and Z. Assayye, 1999. Efficacy of panacure, rental and deoxamine against field infections of gastrointestinal parasites in goats. Proceedings of the 11th Annual Conference of Ethiopian Veterinary Association (EVA), (EVA'99), Addis Ababa, Ethiopia, pp: 15-19.
- Kates, K.C., M.L. Colglazier, F.D. Enzie, I.L. Lindahl and G. Samuelson, 1971. Comparative activity of thiabendazole, levamisole and parabendazole against natural infections of helminthes in sheep. *J. Parasitol.*, 57: 356-362.
- Kumsa, B. and A. Wossene, 2006a. Abomasal nematodes of small ruminants of Ogaden region, Eastern Ethiopia: Prevalence, worm burden and species composition. *Revue Med. Vet.*, 157: 27-32.
- Kumsa, B. and A. Wossene, 2006b. Efficacy of albendazole and tetramisole anthelmintics against *Haemonchus contortus* in naturally infected lambs. *Intern. J. Appl. Res. Med.*, 4: 94-99.

- Kumsa, B. and G. Abebe, 2009. Multiple anthelmintic resistance on a goat farm in Hawassa (Southern Ethiopia). *Trop. Anim. Health Prod.*, 41: 655-662.
- MAFF (Ministry of Agriculture, Fisheries and Food), 1977. *Manual of Veterinary Parasitological Laboratory Techniques*. 2nd Edn., Her Majesty's Stationery Office, London.
- Magona, J.W. and G. Musisi, 2002. Influence of age, grazing system, season and agroclimatic zone on the prevalence and intensity of gastrointestinal strongylosis in Ugandan goats. *Small Rumin. Res.*, 44: 187-192.
- Osaer, S., B. Goossens, M. Eysker and S. Geerts, 2000. The effects of prophylactic anthelmintic treatment on the productivity of traditionally managed Djallonké sheep and west African Dwarf goats kept under high trypanosomosis risk. *Acta Trop.*, 74: 13-24.
- Pralomkam, W., S. Kochapakdee, S. Saithanoo and S. Choldumrongkul, 1995. Effects of supplementation and internal parasites on growth of cross-bred goats under village environments in Southern Thailand. *Thai. J. Agric. Sci.*, 28: 27-36.
- Saddiqi, H.A., A. Jabber, Z. Iqbal, W. Babar, Z. Sindhu and R.Z. Abbas, 2006. Comparative efficacy of five anthelmintics against trichostrongylid nematodes in sheep. *Can. J. Anim. Sci.*, 86: 471-477.
- Saeed, M., Z. Iqbal and A. Jabber, 2007. Oxfendazole resistance in gastrointestinal nematodes of Beetal goats at livestock farms of Punjab (Pakistan). *Acta. Vet. Brno.*, 76: 79-85.
- Sissay, M.M., A. Assefa, A. Uggla and P.J. Waller, 2006a. Assessment of anthelmintic resistance in nematodes of parasites of sheep and goats owned by smallholder farmer in Eastern Ethiopia. *Trop. Anim. Health Prod.*, 38: 215-222.
- Sissay, M.M., A. Assefa, A. Uggla and P.J. Waller, 2006b. Anthelmintic resistance of nematode parasites of small ruminants in Eastern Ethiopia: Exploration of refugia to restore anthelmintic efficacy. *Vet. Parasitol.*, 135: 337-346.
- Sissay, M.M., A. Uggla and P.J. Waller, 2007. Prevalence and seasonal incidence of nematode parasites and flukes of sheep and goats in Eastern Ethiopia. *Trop. Anim. Health Prod.*, 39: 521-531.
- Stear, M.J., S. Mitchell, S. Strain, S.C. Bishop and Q.A. McKellar, 2000. The influence of age on the variation among sheep in susceptibility to natural nematode infection. *Vet. Parasitol.*, 89: 31-36.
- Thomas, N., S. Teshale and B. Kumsa, 2007. Abomasal nematodes of sheep and goats slaughtered in Hawassa (Ethiopia): Species composition, prevalence and vulvar morphology. *Helminthologia*, 44: 70-75.
- Van Wyk, J.A., J. Cabaret and L.M. Michael, 2004. Morphological identification of nematode larvae of small ruminants and cattle simplified. *Vet. Parasitol.*, 119: 277-306.