African Journal of Basic & Applied Sciences 6 (2): 43-49, 2014
ISSN 2079-2034

DOI: 10.5829/idosi.ajbas.2014.6.2.85192

# Epidemiological Survey on Small Ruminant Fasciolosis in Hawassa Zuria and Dale Districts, Sidama Zone, Southern Ethiopia

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**Abstract:** A cross sectional study was conducted in Dale and Hawassa Zuria districts from November 2011 to June 2012, to estimate the prevalence of *Fasciola* spp infection and assess the associated risk factors in sheep and goats based on faecal examination. For this purpose, a total of 755 sheep and goats were coprologically examined, 379 from Dale and 376 from Hawassa Zuria districts. Data about the assumed risk factors were also obtained from the animals' owners during faecal sample collection. Data were analyzed using Stata 9 software. Accordingly, an overall prevalence of 9.8% was observed (12% in sheep and 7.5% in goats). There was no significant difference ($P > 0.05$) in the prevalence of *Fasciola* infection between Dale (8.2%) and Hawassa Zuria (11.4%) districts. In the initial univariable analysis of the assumed risk factor; species, age and body condition score showed a significant association ($P < 0.05$) with prevalence of *Fasciola* spp infection, whereas sex, district and grazing area were not significantly associated ($P > 0.05$). However, in multivariable logistic regression analyses, only age of the animals and body condition score were found to be significantly associated with *Fasciola* infection in small ruminants ($P < 0.05$ for each factor).. Small ruminants greater than one year old showed 3.1 times higher level of infection than those of one year old or less. In addition, animals with poor body condition score were 8.2 times more likely to harbor *Fasciola* infection than those with good body condition score. No direct association was observed between *Fasciola* infection and fecal consistencies in this study. In conclusion, this study has revealed that *Fasciola* spp are important parasites affecting small ruminants in the study area and favorable environmental conditions are available in the area for the breeding and survival of the snail intermediate host. Therefore, concerned professionals and local stakeholders should give due attention towards the control of the parasite with particular emphasis on mature poorly conditioned animals.

**Key words:** Small Ruminant · Fasciolosis · Prevalence · Dale · Hawassa Zuria · Sidama · Ethiopia

## INTRODUCTION

In Ethiopia, sheep and goats are important livestock sector with the population of 24 million, providing up to 63% of cash income and 23% of food substance value obtained from livestock production. Despite all the contribution of this sub-sector to the country economy, attention given towards health management is relatively low. Endo-parasitic infection and management problems are known to be the main factors that affect productivity [1]. Economic losses resulting from mortality and morbidity (reduced meat, milk and wool production and reproductive inefficiency) impose serious limitations on small ruminant production in Ethiopia [2].

Fasciolosis is an economically important parasitic disease of cattle, sheep & goats caused by *Fasciolidae* trematodes of the genus *Fasciola*. The two most important species of this genus, *F.hepatica* and *F. gigantica,* are commonly known as liver flukes and their distribution is worldwide [3]. The geographical distributions of trematode species directly depend on the distribution of suitable species of snails. The genus *Lymnae* in general and *L.truncatula* in particular is

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the most common intermediate hosts for *F. hepatica.* This species of snail was reported to have a worldwide distribution [4].

Infection of domestic ruminants with *F.hepatica* and *F.gigantica* causes a significant economic loss estimated over US$ 200 million per annum to the agricultural sector worldwide with over 600 million animals infected [5]. Fasciolosis caused by both species is one of the most prevalent helminth infections of ruminants in Ethiopia. It causes significant morbidity and mortality. In Ethiopia, *F.gigantica* is found at altitudes below 1800 m a.s.l.; while *F.hepatica* is found from 1200-2560m a.s.l [6]. Mixed infections by both species can be encountered from 1200-1800 m a.s.l.

The direct impacts of *Fasciola* are liver lesions, reductions in feed utilization efficiency, deprivation of the animal from digested nutrients and reduced feed intake through loss of appetite and discomfort leading to reduced feeding time [7]. Livers are often condemned in abattoirs due to fasciolosis.

The prevalence and economic impact of small ruminant fasciolosis were reported by several workers at different locations in Ethiopia [1, 2, 5-14]. Financial losses due to ovine fasciolosis alone had also been estimated to be 48.4 million Ethiopian birr per year, of which 46.5, 48.8 and 4.7% were due to mortality, productivity (weight loss) and liver condemnation, respectively [7].

Most of the available reports of small ruminant fasciolosis in Ethiopia were from the Central, Western and Northern highlands and there were no data about the situation of the disease in Southern Ethiopia despite huge potential of small ruminant production and high meat consumption trend in the area. The objective of this study was to investigate the prevalence of small ruminant fasciolosis in Hawassa Zuria and Dale districts, Sidama zone and identify the potential risk factors associated with the occurrence of *Fasciola* spp in the area.

## MATERIALS AND METHODS

**Study Area:** The study was carried out from October 2011 to June 2012 in selected sites of Dale and Hawassa Zuria districts located in Sidama zone of Southern Nations, Nationalities and Peoples' Regional State. Hawassa is a regional city of South Nations and Nationalities People Region (SNNPRs). The city found 275 km south of Addis Ababa. Whereas Hawassa Zuria district is represented by kebeles that surrounds the city and Dalle district is 40kms away from Hawassa town. Geographically, Hawassa Zuria and Dale districts are laid between 4.27° and 8.3°N latitudes and 34°21' and 39°1'E longitudes. The altitude ranges from 1,700-1,850 meter above sea level. The climate is characterized by long rainy season (June to September, accounting for 75% of total rainfall), a short rainy season (February/March to April/May) and a dry season period ranges from October up to January. The area receives an average rainfall of 900-1,200 mm annually. The annual average temperature ranges from 12.6 up to 25°C the annual rainfall is from 800-1000 mm [15]. Selected peasant associations (PAs) from Dalle and Hawassa Zuria districts were used for this study.

**Study Population:** The study populations were all ages and sex group of indigenous breeds of sheep and goats owned by practiced small holders in mixed crop-livestock production. The animals were kept in small flocks of seven to eight animals per household and were used mainly for income generation and meat production. As in many parts of the country, the feed sources were natural grazing and crop residues with minimum extra supplement and health intervention. Moreover, the quality and supply of feed resources were seasonally variable, the problem being serious in the dry season.

**Study Design and Sampling Methods:** A cross-sectional study design was used to investigate the prevalence and risk factorsfor *Fasciola* infection in small ruminants in the study area. The sample size required for the study was determined using the simple random sampling technique [16]. The formula used to calculate the required sample size was: $n = 1.96^2 p_{exp} (1- p_{exp})/d^2$; Where: n= sample size; 1.96= the value of Z at 95% confidence interval; $P_{exp}$= Minimum expected prevalence (56% according to Michael, 2004); d= desired precision (5%). Accordingly, 379 small ruminants were sampled from Dalle district and another 376 samples were taken from Hawassa Zuria to maximize the reliability of the information. Overall, 755 small ruminants were sampled from the two districts during this study period.

**Sampling Strategy:** Study animals were selected from randomly selected peasant association (PAs) of each district. PAs are the smallest administrative units in Ethiopia. Nine and five PAs were picked from Dale and Hawassa Zuria, respectively. Number of animals to be sampled was allocated proportionally. Individual animals were sampled systematically from selected PAs until the sample size attained.

**Sample Collection:** Fecal samples were collected directly from the rectum of animals using disposable plastic gloves. The samples were placed in a universal bottle containing 10% formalin after labeling and stored at 4°C refrigerator until the specimen processed and examined for parasite eggs.

During sampling, information about individual animals were collected with regard to age, sex, body condition score, species, feeding system and fecal consistency and other relevant factors. Body condition scoring (BCS) was made according to ESGPIP [17] using a BCS ranging from 1-5 and these scores were categorized as poor, moderate and good.

**Laboratory Examination:** In the laboratory the fecal samples were processed by the sedimentation technique as described by Hansen and Perry [18].

**Data Analysis:** Data collected from each study animal and the laboratory results were entered into Microsoft Excel spreadsheet. Descriptive statistics were summarized. All statistical analyses were performed on Stata 9 software [19]. The prevalence was calculated for all assumed risk factors as the number of infected individuals divided by the number of individuals sampled multiplied by 100. Factors thought to be associated with the prevalence of *Fasciola* infection were analyzed first by Pearson's chi-square test and then by multivariable logistic regression to account for confounding and interaction between variables. In the analyses, the confidence level was held at 95% and *P*-value less than 0.05 was considered as significant.

## RESULTS

**Overall Prevalence of *Fasciola* spp:** The overall prevalence of *Fasciola* infection in the two districts was 9.8% (74/755) and there was no significant difference ($P > 0.05$) between Dalle and Hawassa Zuria districts.

A total of 379 fecal samples of sheep and goats were examined in Dale district, of which 31 animals were found to be positive for *Fasciola* giving a prevalence of 8.2% [CI= 5.7, 11.5].

An attempt was made to see the prevalence of *Fasciola* spp in different PAs of Dale district and accordingly 8.6% in Soyama, 12% in South Mesenkela, 7.1% in South Kegei, 7.1% in Abosto, 2.9% in Yirgalem, 10% in Arada, 8.5% in Halenkena, 5.1% in Awada and 13.6% in Bera were recorded as shown in Table1. Among the nine PAs, high prevalence was observed in Bera and South Mesenkela, however there was no significant difference ($P > 0.05$) among PAs where samples were taken from. All sites were on the same altitudinal ranges i.e. mid land and there was no micro ecological variations like water lodging areas or ponds (Table 1).

Prevalence of *Fasciola* spp in small ruminant was also determined in selected PAs of Hawassa Zuria district. A total of 376 small ruminants (188 sheep and 188 goats) were randomly sampled from five PAs: namely Tula subcity, Woranch, Bushelo, Chefea and Tukur wuhea. The overall prevalence of *Fasciola* in the district was 11.4% (14.9% in sheep and 8% in goats). The prevalence was varying in the study sites. Bushalo, Worancha, Chefea and Tukur wohua had prevalence of 14, 21, 8.3 and 11.5%, respectively while no positive animal was detected in Tula subcity (Table 2).

Table 1: The geographical location, number of animals sampled and prevalence of *Fasciola* spp. at each PA selected from Dale district

| | | *Geographic position* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Location* | *Alt* | Lat | Long | Direction | *N* | *No. Pos* | *P (%) 95% CI* | $x^2$ | *P* |
| Soyama | 1781 | 06°82’ | 038°37’ | 062°NE | 58 | 5 | 8.6[3.1, 14.2] | | |
| South Mesenkela | 1728 | 06°79’ | 038°37’ | 062°NE | 50 | 6 | 12[5.6, 18.4] | | |
| South Kegei | 1751 | 06°77’ | 038°37’ | 062°NE | 42 | 3 | 7.1[2.1, 12.2] | | |
| Abosto | 1784 | 06°74’ | 038°37’ | 062°NE | 56 | 4 | 7.1[2.1, 12.2] | | |
| Yirgalem | 1766 | 06°75’ | 038°40’ | 062°NE | 35 | 1 | 2.9[0, 6.2] | | |
| Arada | 1773 | 06°75’ | 038°42’ | 062°NE | 30 | 3 | 10[4.1, 15.9] | | |
| Halenkena | 1801 | 06°74’ | 038°44’ | 062°NE | 47 | 4 | 8.5[3.0, 14.0] | | |
| Awada | 1778 | 06°75’ | 038°37’ | 062°NE | 39 | 2 | 5.1[0.8, 9.5] | | |
| Bera | 1818 | 06°74’ | 038°46’ | 062°NE | 22 | 3 | 13.6[6.9, 20.4] | | |
| Overall | | | | | 379 | 31 | 8.2[5.7, 11.5] | 3.93 | 0.86 |

Table 2: The geographical location, number of animals sampled and prevalence of *Fasciola* spp. at each PA selected from Hawassa Zuria district

| | | *Geographic position* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Location* | Alt | Lat | Long | Direction | *No. Sample* | *No. +ve* | *P% [95% CI]* | $x^2$ | *P* |
| Tula Subcity | 1703 | 06°82' | 038°37' | 061°NE | 50 | - | - | | |
| Bushelo | 1719 | 06°79' | 038°37' | 061°NE | 50 | 7 | 14 [6.3, 27.4] | | |
| Worancha | 1698 | 06°77' | 038°37' | 061°NE | 70 | 15 | 21 [12.9, 33.2] | | |
| Chefea | 1878 | 06°74' | 038°37' | 062°NE | 84 | 7 | 8.3 [3.7, 16.9] | | |
| Tukurwohua | 1710 | 06°82' | 038°37' | 062°NE | 122 | 14 | 11.5 [6.7, 18.8] | | |
| Overall | | | | | 376 | 43 | 11.4 {8.5, 15.2} | 4.62 | 0.20 |

Table 3: Univariable analyses of the prevalence of *Fasciola* infection with the assumed risk factors

| Variables | Sample size | No +Ve | P,% [95%CI ] | OR[95%CI] | *P*-value |
|---|---|---|---|---|---|
| District | | | | | |
| Dalle | 379 | 31 | 8.2[5.7, 11.5] | 1 | |
| Hawassa zuria | 376 | 43 | 11.4[8.5, 15.2] | 1.5[0.9, 2.4] | 0.13 |
| Species | | | | | |
| Caprine | 362 | 27 | 7.5[5.1, 10.8] | 1 | |
| Ovine | 393 | 47 | 12.0[9.0, 15.7] | 1.7[1.0, 2.8] | 0.04 |
| Sex | | | | | |
| Females | 406 | 46 | 11.3[8.5, 14.9] | 1 | |
| Males | 349 | 28 | 8.0[5.5, 11.5] | 0.7[0.4, 1.1] | 0.12 |
| Age | | | | | |
| Young ≤ 1year | 260 | 13 | 5.0[2.8, 8.6] | 1 | |
| Matured > 1year | 495 | 61 | 12.3[9.6, 15.6] | 2.7[1.5, 5.1] | 0.002 |
| BCS | | | | | |
| Poor | 136 | 17 | 12.5[7.7, 19.5] | 1 | |
| Moderate | 482 | 54 | 11.2[8.6, 14. 5] | 0.9[0.5, 1.6] | 0.7 |
| Good | 137 | 3 | 2.2[0.6, 6.8] | 6.7[1.9, 22.2] | 0.004 |
| Grazing area | | | | | |
| Near river side | 253 | 21 | 8.3[5.3, 12.6] | 1 | |
| Dry land | 270 | 34 | 12.6[9.0, 17.3] | 1.6[0.9, 2.8] | 0.11 |
| Homestead | 232 | 19 | 8.2[5.1, 12.7] | 1.0[0.5, 1.9] | 0.96 |

Table 4: Results of multivariable logistic regression analysis of those variables significant in univariable analysis

| Variable | OR | Std. Err. | z | P>\|z\| | [95% Conf. Interval for OR] | |
|---|---|---|---|---|---|---|
| Species | | | | | | |
| Caprine | 1 | | | | | |
| Ovine | 1.50 | 0.395 | 1.55 | 0.121 | 0.90 | 2.49 |
| Age | | | | | | |
| ≤1 year | 1 | | | | | |
| >1year | 3.10 | 0.99 | 3.48 | 0.001 | 1.63 | 5.79 |
| BCS | | | | | | |
| Good | 1 | | | | | |
| Moderate | 0.76 | 0.23 | -0.89 | 0.376 | 0.42 | 1.39 |
| Poor | 8.20 | 0.08 | -3.25 | 0.001 | 2.30 | 29.30 |

**Univariable Logistic Regression Analysis of *Fasciola* spp Infection with the Assumed Risk Factors:** The results of univariable analyses of *Fasciola* spp infection in small ruminants with the assumed risk factors were given in Table 3 below. It was found that species, age, BCS showed a significant association ($P < 0.05$ for each factor) with *Fasciola* infection, where the confidence interval (CI) of the odds ratio (OR ) was above one, while district of sampling, sex of the animals and grazing area were not significantly associated with *Fasciola* infection ($P > 0.05$ & CI for OR includes 1 for each factor).

**Mutilvariable Logistic Regression Analyses:** As shown in Table 4 below, among the factors shown significant in the univariable analyses, age and BCS of the animals were the only factors remained significantly ($P < 0.05$ for each

Table 5: Prevalence of *Fasciola* spp infection in animals with different category of fecal consistency

| Feaces consistency | Sample size | No +ve | P,%[95% CI] | $x^2$ | *P*-value |
|---|---|---|---|---|---|
| Normal | 364 | 41 | 11.3[8.3, 15.1] | 2.5 | 0.28 |
| Soft | 331 | 26 | 7.9 [5.3, 11.4] | | |
| Diarrhea | 60 | 7 | 11.7[5.2, 23.2] | | |

factor) associated with *Fasciola* infection in the final multivariable logistic regression analyses. It was indicated that adult small ruminants >1 year old were 3.1 times more likely to be infected than younger animals ≤1 year old. It was also observed that animals with poor BCS had 8.2 times higher level of infection than those with good BCS.

**Association of *Fasciola* Spp Infection in Small Ruminants with Faecal Consistency:** *Fasciola* spp prevalence was compared with fecal consistency. The consistency of feces was categorized as normal, soft and diarrheic. Accordingly, a prevalence of 11.3 [8.3, 15.1], 7.9[5.3, 11.4] and 11.7[5.2, 23.2] was found in animals with normal, soft and diarrheic faeces, respectively, without significant difference ($P > 0.05$) among the different consistencies of feces (Table 5).

## DISCUSSION

The overall prevalence of *Fasciola* spp infection in small ruminants observed in this study was 9.8%. On animal species basis, the prevalence was 12% in sheep and 7.5% in goats without significance difference between the two species ($P > 0.05$). The current prevalence observed in sheep was much smaller than that reported by previous similar studies in the country, viz: 13.2% - 56% in Awash River Basin [1, 8], 14.6% in Jimma area [9], 14.6% in and around Hirna town [10], 45.6% in Oda Bultum district, Western Hararghe [11], 49% in and around Dawa-Cheffa, Kemissei area [12], 39.5% in Adigrat [13] and 43.75% in Haru district, western Ethiopia [14]. Similarly, previous studies conducted in different parts of the country have reported a higher prevalence ranging from 8.8% to 9.4% [9, 10] in goats than the present study. This clear and high variation was probably due to the difference in agro-climatic conditions conducive for the intermediate host and the parasite. Only few swampy and water lodging areas were observed in the present study area and the water sources for the animals were mainly small ponds. The season of study might be another factor for the lower prevalence in the current study because the study was carried out in dry season when most of the snail habitats were dried up. The feeding system of the animals in the present study area could also be another possible factor for the low prevalence as the animals were observed to depend entirely on grazing on open dry lands and tethered at homesteads, which might have reduced the chance of exposure to *Fasciola* infective stage (encysted metacercariae).

The present study had shown lack of significant ($P > 0.05$) variations in the prevalence of *Fasciola* infection between the two districts or among the PAs from which the animals were sampled. This could be attributed to lack of significant altitudinal variation between the districts or among the PAs. Observations in other research works had shown a significantly higher prevalence of *Fasciola* in small ruminants in high altitude areas than low altitude [6, 8,10, 14]. The climatic factors in the highland areas are more favorable for the propagation and activity of the snail and progression of the parasite life cycle in most of the time, as compared to the lowland areas [3].

Although the initial univariable analyses showed the presence of significant association between *Fasciola* infection and three host factors (animal species, age and BCS), age and BCS were the two factors remained significantly associated by the final multivariable logistic regression analyses. It was observed that animals >1 year old and those with poor BCS had a significantly ($P < 0.05$) higher prevalence of *Fasciola* infection than their contemporaries. The odds of *Fasciola* infection was 3.1 times higher among animals >1 year than those ≤1 year old.. The increase in the level of *Fasciola* infection with age might be associated with the possibility of higher chance of movement of animals for grazing away from homestead to *Fasciola* infested areas. On the other hand, younger small ruminants were not often driven with adults to watering and grazing points, instead they were kept at homesteads where the chance of exposure to *Fasciola* infective stages was much more less. Furthermore, it might be due to a long period of life cycle of *Fasciola* in the host in which infection at younger age could be detected at adult age that shedded eggs in feces. Similar results were also reported by previous studies [1, 10, 11, 14].

The odds of *Fasciola* infection in the current study was 8.2 times higher among small ruminants with poor BCS than those with good BCS. This finding agreed with other researches [10, 11, 13]. There were different possible causes for this variation. Firstly, it might be due to the effects of the parasite on the animal host. Since the adult

parasite depended on feeding on blood from the liver, this finally might cause loss of body condition when it became severe [22]. The second and even more convincing factor might be inadequate nutrient supply. This study was conducted in the dry season where there was extreme shortage of feed for small ruminants in most parts of the study area due to deterioration of grazing land. It was well established that poor nutrition of animals contributed much for poor body condition and thereby led to immune deficiency which could result in higher level of infection. Consistent with this, Dawes [21] and Dunn [22] stated that small ruminants under poor body condition were vulnerable to parasitic diseases.

In contrast to previous works which showed a significantly higher level of infection in sheep than goats [10], this study failed to reveal significant variation between sheep and goats ($P > 0.05$). There is a general understanding that sheep and goats differ in their feeding habits. Naturally, goats depend on browsing plants for their nutrition and thus, they are less exposed to the infective larval stages of parasites including *Fasciola* spp. In spite of this fact, nowadays in Ethiopia goats had changed their feeding behavior from browsing to grazing on the same pasture along with sheep because of shortage of browsing plants associated with bush clearing for expansion of crop agriculture and human settlement. This had resulted in equal exposure of goats to infective larval stages of *Fasciola* spp and consequently, to similar level of infection as in sheep.

Grazing area and feeding system were assumed to be risk factors for *Fasciola* infection. The developmental stages of *Fasciola* spp and the snail intermediate host need watery area and favorable climatic conditions like temperature and moisture for their survival and development. Those animals grazing around riverside area had a chance of taking the infective stage with herbage during grazing [3]. However, no significant association was seen between *Fasciola* infection and different feeding system in the current study. This might be due to limited watery and swampy grazing lands. In addition, the present study was conducted in dry season, where the climate did not favor the progression of the intermediate host.

## CONCLUSION AND RECOMMENDATION

The result of this study has indicated that *Fasciola* spp is an important parasite in sheep and goats in Hawassa Zuria and Dalle districts. Though the prevalence in current study is low as compared to other research findings, the study has clearly shown the existence of host-parasite-vector and environment interactions in the area. Low prevalence in the present study may be due to the season or examination procedure and/or the study designed employed. Prevalence was determined based on the results of the conventional coprological examination. This procedure has its own limitations due to the intermittent output of eggs by host. This study has revealed age and body condition score of the animals as the major risk factors for *Fasciola* infection in the study area. Therefore, these factors should be taken into account whenever a control intervention is launched in the area. Furthermore, it is recommended that a further longitudinal study need to be conducted in the study area in order to collect a complete epidemiological data about the parasite, intermediate host and environmental interaction.

Based on the present finding and general knowledge of the disease, it is recommended that preventive measures rather than curative treatment need to be carried out in order to reduce *Fasciola* infection in sheep and goats. This should be done by an integrated approach through combination of strategic chemotherapy and destruction of accessible snail habitats. Supplementation of important nutrients in the feed of the animals in the dry season is also of paramount importance to avoid stress conditions that affect the host resistance. It is also important that awareness creation activities, such as training should be conducted to animal owners about the economic importance of the parasite and locally feasible control and preventive measures.

## ACKNOWLEDGEMENT

Hawassa University research directorate is acknowledged for financial support given during this study period.

## REFERENCES

1. Ahmed, E.F., K. Markvichitr, S. Tumwasorn, S. Koonawootrittriron, A. Choothesa and S. Jittapalapong, 2007. Prevalence of fasciola species infections of sheep in the middle awash river basin, Ethiopia. Southeast Asian J. Trop. Med Public. Health, 38: 51-57.
2. Njau, B.C. and R.G. Scholtens, 1988. The role of traditionally harvested hay in the transmission of ovine fasciolosis in the Ethiopian highlands. Veterinary Research Communication, 15(5): 369-372.

3. Soulsby, E.J.L., 1982. Helminthes, Arthropods and Protozoa of Domesticated Animals, 7th edition. Bailliere Tindall, London, UK, pp: 40-52.
4. Urquhart, G.M., J.D. Armour, J.L. Duncan, A.M. Dunn and F.W. Jennings, 1996. Veterinary Parasitology. 2nd Ed. Oxford Longman Scientific and technical press, UK, pp: 100-109.
5. Lemma, B., F. Gabreab and S. Tedla, 1985. Studies on fasciolosis in four selected sites in Ethiopia. Veterinary Parasitology, 18: 29-37.
6. Yilma, J.M. and J.B. Malone, 1998. A geographical information system forecast model for strategic control of fasciolosis in Ethiopia. Veterinary Parasitology, 78: 103-127.
7. Ngategize, P.K., T. Bekele and G. Tilahun, 1993. Financial losses caused by ovine fasciolosis in Ethiopian highlands. Trop. Anim. Hlth. Prod., 25: 155-161.
8. Michael, A., 2004. Infection prevalence of ovine Fasciolosis in irrigation schemes along the Upper Awash River Basin and effects of strategic anthelmintic treatment in selected upstream areas. MSc Thesis, Addis Ababa University, Department of Biology.
9. Kedir, S., B. Deressa and W. Tigre, 2012. Small ruminant fasciolosis in Jimma area of South Western Ethiopia: Its epidemiology and minimum monetary loss. Global Veterinaria, 9(5): 635-641.
10. Mulatu, H. and M. Addis, 2011. Study on the prevalence and risk factors of fasciolosis in small ruminants in and around Hirna town, Ethiopia. Global Veterinaria, 7(5): 497-501.
11. Tesfaheywet, Z. and K. Negash, 2012. Prevalence of ovine fasciolosis in Oda Bultum Woreda, Western Hararghe, Ethiopia. Global Veterinaria, 9(5): 530-534.
12. Bitew, M., N. Ibrahim and N. Abdela, 2010. Study on the prevalence of ovine fasciolosis in and around Dawa-Cheffei, Kemissei, Ethiopia. African Journal of Agricultural Research, 5(21): 2981-2985.
13. Gebre Izgabeher, E., Y. Amede and M. Bekele, 2012. Prevalence of ovine fasciolosis in Adigrat, North East Ethiopia; Global Veterinaria, 9(1): 92-96.
14. Bogale, B., D. Keno and M. Chanie, 2012. Ovine fasciolosis: episode and major determinants in Haru District, Western Ethiopia. Acta Parasitologica Globalis, 3(1): 07-11.
15. CSA: Central Strategy Agency, 2008. Agricultural sample Enumeration 2001-2002 (1994 E.C). Report on size, characteristics and purpose of Livestock and use of Livestock Products, Central Statistical Agency of Ethiopia, 2008-08-05.
16. Thrusfield, M., 2005. Veterinary Epidemiology, 3rd edition. University of Edinburg, Black well Science.
17. ESGPIP, 2008. Body condition scoring of sheep and goats. Ethiopian Sheep and Goat Productivity Improvement Program. Technical bulletin, pp: 8.
18. Hansen, J. and B. Perry, 1994. The Epidemiology, Diagnosis and control of parasite of Ruminants: A handbook. Animal Production and health division, FAO, Rome, Italy, pp: 171.
19. Stata 9, 2007. Stata corp. 4905 Lake Way drive college Station, TX, 77845, USA.
20. Radostits, O.M., C.C. Gay, K.W. Hinchclift and P.D. Constable, 2007. Veterinary Medicine: A textbook of the diseases of cattle, horses, sheep, pigs and goats. 10 edition, Saunders Ltd, Elsevier.
21. Dawes, B., 1960. A study of the miracidium of *Fasciola hepatica* and an account of the mode of Penetration of the sporocyts in to *Lymnae truncatula*. In Lilro Hmenaje, pp: 95- 111. Mexico
22. Dunn, A.M., 1978. Fasciolosis In: Veterinary Helminthology, 2nd Ed. Butler and Tanner, Ltd. London, UK, pp: 15-159.