

Full Length Research Paper

Prevalence and economic importance of liver parasites: Hydatid Cyst, *Fasciola* species and *Cysticercus tenuicollis* in sheep and goats slaughtered at Addis Ababa abattoir enterprise in Ethiopia

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This research was designed to determine the prevalence of *Cysticercus tenuicollis*, *Fasciola* and Hydatid cyst and to estimate the magnitude of the direct financial losses attributed to the condemned liver of sheep and goats slaughtered in the abattoir. Ante-mortem examination was done to determine the origin and age of animals slaughtered. Post-mortem inspection was conducted on a total of 1152 animals comprising 576 sheep and 576 goats and (288/1152) 25% livers were condemned due to parasitic induced gross lesions. From 176 (30.6%) positive sheep, 45 (7.81%) were infected by *C. tenuicollis*, 108 (18.75%) by *Fasciola* and 23 (3.99%) by Hydatid cyst. Similarly from 112 positive goats, 91 (15.8%), 13 (2.26%) and 8 (1.39%) *C. tenuicollis*, *Fasciola* and Hydatid cyst were recorded. *Fasciola* was leading cause of liver condemnation in sheep and *C. tenuicollis* in goats. Hydatid cyst was responsible for lowest condemnation rate. A statistically significant difference was observed between species and origin of small ruminants for *Fasciola*, *C. tenuicollis* and Hydatid cyst with $P < 0.05$. The abattoir's financial losses due to condemnation of liver by parasitic induced gross lesions accounts approximately 157,684 ETB annually.

Key words: Prevalence, liver, *Fasciola*, Hydatid cyst, *C. tenuicollis*, sheep, goats, Addis Ababa.

INTRODUCTION

Small ruminants are important domestic animals in tropical animal production system (Devendra and Mecerrey, 1990). Ethiopia has the largest livestock population in Africa, which plays an important role in the lives of its people. It owns huge number of small ruminants, about 26.1 million sheep and 21.7 million goats (CSA, 2004).

The lowland part constitutes 65% the country's area where 25% sheep and close to 100% goats' population exist (Abebe, 2003).

It accounts for only 7% of the average total capital invested in livestock in the mixed crop-livestock production system, but they account on average for 40% of the cash income and 19% of the total value of subsistence food derived from all livestock production (ESGPIP, 2008).

Hence an increase in small ruminant's production could contribute to the attainment of food self-sufficiency in the country particularly in response to the protein requirement for the growing of human population as well as to enhance the export earnings. Although this sector much contributes to national economic growth, development of the sector has different constraints. These constraints

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Abbreviations: **AAAE**, Addis Ababa Abattoir Enterprise; **ETB**, Ethiopian Birr; **ESGPIP**, Ethiopia Sheep and Goat Production Improvement Program; **FAO**, Food and Agricultural Organization of the United Nation; **NMSA**, National Metrology Service Agency; **PACE**, Pan African Program for the Control of Epizootic diseases; **WHO**, World Health Organization.

included animal disease, poor nutrition, husbandry, and infrastructure, shortage of trained man power and lack of government policies, rampant disease and parasitism (Gryseals, 1988; PACE- Ethiopia, 2003).

Parasitic diseases in the tropics are responsible for great losses in the meat industry than any other infectious or metabolic disease (Perry et al., 2002). Like many other African countries, it is known that *Fasciola* species, Hydatid cyst and *Cysticercus tenuicollis* are major parasites responsible for low productivity in Ethiopia livestock industry due to imposing poor weight gains, condemnation of organs and carcass and lower milk yield of sheep and goats (Abebe, 1995).

Fasciolosis is known to be one of the most important parasitic diseases in Ethiopia that lowers productivity in ruminants. It is caused by the genus *Fasciola*, which migrate through the hepatic parenchyma, establish and develop to the adult stage in the bile ducts. The parasite lives parts of its life in intermediate host mainly snails of the genus *Lymnaea*. Which is found in and around wet areas, such as water holes, farm animals are likely to pick up the parasite if they drink from these sources (Okewole et al., 2000)? Fasciolosis causes significant morbidity and mortality (Okewole et al., 2000; WHO, 1995).

Fasciolosis occurs worldwide in acute, sub-acute and chronic forms. Large number of young flukes causes acute swelling and congestion of the liver producing an acute paranchymatous hepatitis in which the serous capsule of the liver may be sprinkled with hemorrhages and covered with fiber. In chronic Fasciolosis of sheep, the liver becomes irregularly lobulated and distorted, but the bile ducts through thickened dilated, distended, and of bluish color (Gracey et al., 1999).

Financial losses due to ovine fasciolosis alone was estimated at 48.8 million Ethiopian birr per year which 6.5, 48.8 and 4.7% were due to mortality, productivity and liver condemnation respectively (Negategize et al., 1993).

On the other hand, fasciolosis is an emerging zoonotic infection of humans associated primarily with the eating of water cress contaminated with metacercaria (Margrad, 1975; Rojo-Vazquez et al., 2012). Hydatidosis is a term used to describe infection of different animals species and humans with larval or metacestodes stage of *Echinococcus* species (Grant and McManus, 2003; Parija, 2004). Ungulates, including sheep, cattle, goats, pigs and horses are intermediate hosts in which Hydatid cysts occur. Adult of the genus *Echinococcus* are found in the small intestines of dogs and other carnivores (Kassai, 1999). Four species are currently recognized within the genus *Echinococcus*; *E. granulosus*, *E. multilocularis*, *E. oligarthus* and *E. vogeli* (Thompson, 1986). The parasites are perpetuated in life-cycles with carnivores as definitive hosts, which harbour the adult egg-producing stage in the intestine, and intermediate host animals, in which the infective metacestode stage develops after infection with eggs (WHO, 2004).

Hydatid cyst in livestock leads to considerable econo-

mic losses due to condemnation of edible offal's primarily liver and lung (Arene, 1983). This condemnation of edible offal's primarily due to development of Hydatid in these organs (Fischer and say, 1989). This organism in liver and lung may degenerate to form cheesy mass encapsulated in multilocular may resemble tuberculosis, but the laminated cuticular membrane is still present even after the cyst has degenerate and can be readily picked up with a pair of forceps (Gracey et al., 1999).

The loss due to condemnation of organs by Hydatid cyst, particularly liver and lung in some countries is very considerable (Gracey et al., 1999). These losses are of especial significance in countries of low economic output, where sheep and goat production is of particular importance (Torgerson, 2002).

Though Hydatidosis, constitutes a public health problem worldwide, yet causes a particularly heavy burden in developing countries (Eckert, 1986). The distribution *E. granulosus* is higher in rural communities of developing countries where there is close contact between definitive host, the dog, and various domestic animals, acting as intermediate hosts (Eckert and Deplazes, 2004).

Cysticercus tenuicollis is a larvae of *Taenia hydatigena* which is the most important parasite of sheep and goats is found in a large number of hosts throughout the world. The intermediate host becomes infected by ingesting of proglottids or the egg passed in the faeces of the dog in pasture or feeding areas (Soulsby, 1986; Kaufmann, 1996). Larvae migrating through the liver cause hemorrhagic tracts commonly called hepatitis cysticercosa. Massive infestation can kill animals within 19 days (Reinecke, 1983).

C. tenuicollis fibrous scars resulting from the migration of the larvae lead to condemnation of the viscera and disposal of other offals to which the mature bladder worms attach. There is no human health hazard, but the liver lesions are unsightly and affect the texture of the tissue, making it unsuitable for human consumption and the economic losses associated with condemnation of affected organs are significantly high (Hall, 1986).

Thus this study was conducted to determine the prevalence of Hydatid cyst, *Fasciola* species and *C. tenuicollis* in liver of small ruminants slaughtered at Addis Ababa Abattoir; and to estimate the magnitude of the direct economic losses caused by these parasites as consequence of liver condemnation

MATERIALS AND METHODS

Study area

The study was conducted at Addis Ababa Abattoirs Enterprise (AAAE). Addis Ababa is located at 9.03° North latitude and 38.8° East longitudes with an average altitude of 2400 m above sea level. Addis Ababa covers about 54,000 ha of land with an average population of more than 3 million. It has an average temperature during winter 6°C minimum and 23 °C maximum and during summer 10°C minimum and 24°C maximum with an annual temperature of 15.9°C. It also receives an annual rain fall of 1089

mm or 91 mm per month with 60.1% annual relative humidity which ranges from 49% in February to 82% in July (NMSA, 2007).

Addis Ababa and its peri-urban areas have more than 60,000 bovine, 20,000 ovine, 7000 equine, 5,000 caprine and 330,000 avian species. The main purposes of the Abattoir are processing of one or several classes of livestock in to fresh meat for human consumption, hygienic processing and storage of meat and edible by products, ensuring close control over environmental conditions at all stages of processing and prevent the transmission of zoonotic meat borne diseases through meat inspection.

Sample selection

The study was carried out on a total of 1152 apparently healthy small ruminants (576 sheep and 576 goats) slaughtered at Addis Ababa Abattoirs (AAA). The slaughtered animals were males and females and originated from different parts of the country which include Arsi, Debre Birhan, Bale, Afar, Shoa, Ogaden, Wollo, Omo, Borena parts of Ethiopia

Study design

A cross sectional type of study was conducted December 2011 to April 2012 to determine the prevalence of fasciolosis, Hydatid cyst and *C. tenuicollis* induced lesion in liver of small ruminants slaughtered at AAAE.

Sampling and sample size determination

By using systematic random sampling methods and 95% confidence interval with required 5% precision, the sample size of both species of animals were determined by the formula of Thrusfield (1995).

$$n = \frac{1.96^2 * P_{exp}(1 - P_{exp})}{d^2}$$

$$n = \frac{1.96^2 * 0.5(1 - 0.5)}{(0.05)^2} = 384 * 3 = 1152$$

Accordingly, the minimum sample size was 384 but in order to increase precision, it was multiplied by three and 1152 liver samples were taken for study.

Study methodology

Ante-mortem Inspection

Pre-slaughter examinations of small ruminants were conducted in the lairage in order to determine the species, age and origin of animals. The age grouping was performed based on arbitrary classification according to Steele (1996) and Gatenby (1991). The age grouping was based on dentition. Those which have not erupted permanent incisor teeth, were classified as young, while those with one pair or more permanent incisor teeth were classified as adults (Gatenby, 1991; Steele, 1996).

Postmortem examination

During post-mortem livers were thoroughly inspected by visualization, palpation and making systemic incisions where necessary

for the presence of cysts, parasites and other abnormalities. Pathological lesions were differentiated and judged according to FAO (2000) meat inspection manual for developing countries guidelines and the results were recorded

Assessment of financial loss

The estimation of financial loss is based on the annual slaughter capacity of the abattoirs considering market demand, average market prices in local market and the rejection rates of liver. The annual slaughter rate of AAAE is 76,295 sheep and 22,673 goats with a total of 98,968. The economic loss due to liver condemnation was estimated by the formula set by (Ogunrinade and Ogunrinade, 1980) as follows:

$$EL = \sum Srx * Coy * Roz$$

Where

EL = Annual economic loss estimated due to liver condemnation from local market.

Srx = Annual sheep/ goats slaughter rate of the abattoir

Coy = Average cost of each sheep or goats liver.

Roz = Condemnation rates of sheep/goats liver.

Data management and statistical analysis

The data collected from the study area were recorded in the format developed for this purpose and later on entered in to Microsoft excel 2007 program and analyzed using STATA 7.0 version. Liver condemnation rates defined as proportion of condemned liver to the total number of liver examined. The data obtained during the study was subjected to chi square statistical analysis to see the association between rejection rates of liver, origin, age groups, sex and species of animals and differences were regarded statistically significant if the p value < 0.05.

RESULTS

Prevalence study

A total of 576 sheep and 576 goats were examined at AAA for the presence of Hydatid cyst, *Fasciola* spp and *C. tenuicollis*. Of these animals, the livers of 176 (30.6%) of sheep and 112 (19.4%) of goats were rejected due to parasitic causes (Table 1).

The prevalence of Hydatid cyst, *Fasciola* and *C. tenuicollis* based on species of animals indicated that the prevalence of *Fasciola* 108 (18.75%) and *C. tenuicollis* 45 (7.81%) was higher in sheep followed by Hydatid cyst 23 (3.99%). In goats, the prevalence of *C. tenuicollis* 91 (15.8%) and *Fasciola* 13 (2.26) was higher followed by Hydatid cyst 8 (1.39%). For all of the parasites identified the results indicate significant difference with $p < 0.05$. So there is high positive association between liver parasites and species (Table 2). Analysis of the result on the basis of age indicated that the prevalence of *C. tenuicollis* was higher in adult goats 78 (18.62%) than the young ones 13 (8.28%), similarly the prevalence was found to be high in adult sheep 40 (8.75%) compared to the young 5 (4.20%)

Table 1. Overall prevalence of major liver parasites in sheep and goats slaughtered at AAEE.

Species	Total examined	Total positive	Prevalence (%)
Ovine	576	176	30.6
Caprine	576	112	19.4
Total	1152	288	25

Table 2. Prevalence of major Hydatid cyst, *Fasciola* spp and *tenuicollis* based on species.

Major liver parasites	Species			χ^2	P-value
	Ovine (n=576) (%)	Caprine (n=576) (%)	Total (%)		
Hydatid cyst	23 (3.99)	8 (1.39)	31 (2.69)	7.4588	0.006
<i>Fasciola</i>	108 (18.75)	13 (2.26)	121 (10.5)	83.4304	0.00
<i>C. tenuicollis</i>	45 (7.81)	91 (15.8)	136 (11.8)	17.6415	0.00
Total	176 (30.6)	112 (19.4)	288 (25)		

Table 3. The prevalence of Hydatid cyst, *Fasciola* spp and *C. tenuicollis* based on age.

Species	Number of animals examined	Prevalence (%)			Total (%)
		Hydatid cyst	<i>Fasciola</i> spp	<i>C. tenuicollis</i>	
Ovine	Young (119)	3 (2.52)	14 (11.76)	5 (4.20)	22 (18.5)
	Adult (457)	20 (4.38)	94 (20.57)	40 (8.75)	154 (33.7)
	χ^2	0.8478	2.7152	4.8039	-
	P-value	0.357	0.099	0.028	-
Caprine	Young (157)	1 (0.64)	0 (0)	13 (8.28)	14 (8.91)
	Adult (419)	7 (1.67)	13 (3.10)	78 (18.62)	98 (23.4)
	χ^2	0.8910	4.9836	9.1710	-
	P-value	0.345	0.026	0.002	-
Total		31 (2.69)	121 (10.5)	136 (11.8)	288 (25)

with a statistically significant difference ($P < 0.05$). The prevalence of *Fasciola* was higher in adult 13 (3.10%) than in young 0 (0%) among goats which is statistically significant ($P < 0.05$), but among sheep prevalence was higher in adult 94 (20.57%) sheep than in young sheep 14 (11.76%), which has not statistical significant difference ($P > 0.05$). Hydatid cyst is not statistically significant in both age groups of sheep and goats (Table 3).

The prevalence of *Fasciola* 101 (20.7%) and *C. tenuicollis* 39 (7.99%) was higher in sheep coming from highland areas followed by Hydatid cyst 22 (4.51%) than sheep coming from lowland areas 7 (7.95%), 6 (6.82%) and 1 (1.14%) respectively. In goats coming from highland areas highest infection rate was due to *C. tenuicollis* 36 (20.11%), followed by *Fasciola* 10 (5.59%) and while Hydatid cyst were found to be the least frequently recorded. There was a statistical significant difference ($P < 0.05$) in the prevalence rates of *Fasciola* and Hydatid cyst and origin of animals. However, no statistical significant difference ($P > 0.05$) in the prevalence rates of *C. tenuicollis* and origin of animals (Table

4). Hydatid cyst, *Fasciola* spp and *C. tenuicollis* are not statistically significant in both sex groups of sheep and goats (Table 5).

Estimation of financial losses

By applying the formula stated previously the annual financial loss associated with *Fasciola* spp, *Hydatid* cyst and *C. tenuicollis* are calculated as follows:

- 1) Annual slaughter rate of AAEE is 76,295 sheep and 22,673 goats.
- 2) Average rejection rate of sheep liver is 24.1%
- 3) Average rejection rate of goat's liver is 5.73%.
- 4) Average cost of sheep and goat liver is 8 birr.

Annual slaughtered sheep at AAEE was 76,295. On this study, from 576 samples 139 livers were totally condemned due to *Fasciola* spp, Hydatid cyst and *C. tenuicollis* and from 76,295 annually slaughtered animals average

Table 4. The prevalence of Hydatid cyst, *Fasciola* spp and *C. tenuicollis* based on origin.

Species	Number of animals examined	Prevalence (%)			Total (%)
		Hydatid cyst	<i>Fasciola</i> spp	<i>C. tenuicollis</i>	
Sheep	Highland (488)	22 (4.51)	101(20.7)	39 (7.99)	162 (33.2)
	Lowland (88)	1 (1.14)	7 (7.95)	6 (6.82)	14 (15.9)
	χ^2	2.2111	7.9459	0.1426	-
	p-value	0.137	0.005	0.706	-
Goat	Highland (179)	7 (3.91)	10 (5.59)	36 (20.11)	53 (29.6)
	Lowland (397)	1 (0.25)	3 (0.76)	55 (13.85)	59 (14.9)
	χ^2	12.0583	13.0519	3.6319	-
	P-value	0.001	0.000	0.057	-
Total		31 (2.69)	121 (10.5)	136 (11.8)	288 (25)

Table 5. The prevalence of Hydatid cyst, *Fasciola* spp and *C. tenuicollis* based on sex.

Species	Number of animals examined	Prevalence (%)			Total (%)
		Hydatid cyst	<i>Fasciola</i> spp	<i>C. tenuicollis</i>	
Sheep	Female (361)	18 (4.99)	62 (17.17)	29 (8.03)	109 (30.2)
	Male (215)	5 (2.33)	46 (21.40)	16 (7.44)	67 (32.2)
	χ^2	2.4881	1.5758	0.0654	
	P-value	0.115	0.209	0.798	
Goat	Female (253)	3 (1.19)	7 (2.77)	40 (15.81)	50 (19.8)
	Male (323)	5 (1.55)	6 (1.86)	51 (15.79)	62 (19.2)
	χ^2	0.1359	0.5316	0.000	
	P-value	0.712	0.466	0.995	
Total		31 (2.69)	121 (10.5)	136 (11.8)	288 (25)

rejection rate was 24.1%. One liver on local market costs 8 Birr. So, the financial losses of condemned liver due to *Fasciola*, Hydatid cyst and *C. tenuicollis* from sheep were estimated to be 147,292 Birr.

On the other hand, annual slaughtered goats at AAAE were 22,673. In the current study, 33 livers were totally condemned from a sample size of 576. From 22,673 annually slaughtered animals average rejection rate was 5.73%. One liver of sheep on local market costs 8 Birr. So, the financial losses of condemned liver due to *Fasciola*, Hydatid cyst and *C.tenuicollis* from goats were estimated to be 10,392 Birr.

DISCUSSION

An important function of meat inspection is to assist in monitoring the diseases by providing feedback information to the veterinary service to control or eradicate diseases, to produce wholesome products and to protect the public from zoonotic hazards (Gracey et al., 1999). In the present study, the prevalence of Hydatid cyst,

Fasciola species and *C.tenuicollis* in liver of small ruminants slaughtered at Addis Ababa Abattoir was investigated and the magnitude of the direct economic losses caused by these parasites as consequence of liver condemnation was estimated. The prevalence of *C. tenuicollis* within species was higher in the liver of goats 15.8% than sheep 7.81%. This difference was found to be statistically significant. Previous studies have indicated that goats were more infected with *C. tenuicollis* than sheep (Sisay et al., 2007). According to Torgerson et al. (1998), high infestation of *C. tenuicollis*, results in the development of protective immunity early in life and this immunity regulate the parasite population, where as goat develops the immunity more slowly. This considerable degree of immunity against *C. tenuicollis* infection in sheep may be the reason for low prevalence of the parasite in comparison to goats.

The prevalence of *C. tenuicollis* in sheep and goats was relatively lower when compared to the finding of Sisay et al. (2007) in different abattoir. The prevalence was also lower than the reports from other countries. For instance, in Egypt, a prevalence of 34.5% of *C. tenuicollis*

in sheep (Abu-Elwafa et al., 2009); in Nigeria, a prevalence of 21.4% in sheep and 34.2 and 33.3% in goats (Dada and Bellino, 1978; Nwosu et al., 1996) were reported. In Iran a prevalence of 34.2% in goats, 21.4% in sheep (Solaymani et al., 2003) was also reported. The relatively lower prevalence in this study could be due to the variation in temperature, environmental condition, the degree of pasture contamination because of uncontrolled dog movement and the way of raising and grazing of these animals that may contribute to the transmission cycle between ruminants, dogs and other wild canines.

The statistical significant variation of *C. tenuicollis* prevalence between young and adult of both sheep and goats may be because that the adult animals (sheep and goats) lived longer and picked large numbers of eggs during grazing as compared to the young which only live for a short period of time.

The prevalence of *C. tenuicollis* based on animal origin was relatively higher for highland originated sheep than lowland originated sheep. Similarly, the prevalence of *C. tenuicollis* was higher for highland originated goats than lowland originated goats. The relative prevalence difference between the two areas may be due to high temperature and low humidity in the lowland area which is adverse conditions for the survival of the eggs of *T. hydatigena* and also the presence of uncontrolled movement and high dog population in highland area which is related to high human population.

The overall prevalence of liver flukes in small ruminants encountered in this study was 10.5%. When compared to previous studies (Hossain et al., 2011; and Rahmeto, 2010). This may be due to the absence of conducive ecological factors for intermediate host, snails over much of the areas where the study animals originate.

The prevalence of *Fasciola* in sheep was higher than in goats which were 18.75 and 2.26% respectively, which is statistically significant ($P < 0.05$). Previous studies, also reported similar results (Lotfi, 1995; Ezana, 2008). The difference in feeding or grazing behavior of the two species could be the responsible factor for the higher prevalence of fasciolosis in sheep than goats. Goats are browsers and do not usually graze marshy areas where there is a high chance of picking the metacercaria along with the grass.

The statistically significant variation in the prevalence of fasciolosis in sheep and goats from highland than lowland areas may be due to the existence of relatively many marshy and water logged areas as well as the presence of favourable climatic condition which metacercaria favor survival of the snail intermediate host and the metacercaria in highland. The study also showed higher prevalence of fasciolosis in adult goats (3.10%) but not found in young goats (0%) and among sheep 20.57 and 11.76%, respectively. This result is statistically significant in goats ($P < 0.05$) but not in sheep.

Statistical analysis of infection rates on the basis of sex indicated that sex has no impact on infection rate that is both male and female animals are equally susceptible to

the infection. Similar results that support the present finding were reported by Mulualem (1998) and Rahmeto (1992). The prevalence of Hydatidosis was statistically significant ($P < 0.05$) between sheep and goats. This difference could be due to the feeding behaviour of goats as they usually prefer browsing than grazing which may reduce the chance of acquiring the *E. granulosus* infective egg from the ground.

Age-wise prevalence of Hydatidosis showed higher prevalence in adult animals. This is in agreement with previous study finding (Helina, 2012). The study also showed higher prevalence of Hydatid cyst in highland area sheep and goat than lowland area sheep and goat. This result is statistically significant in goats ($P < 0.05$) but not in sheep.

The financial loss incurred during this study as the result of condemnation of sheep and goats livers were estimated about 157,684 ETB. According to this result financial loss associated with liver condemnation due to Hydatidosis was 26,874.6 Birr which is higher than the finding of Helina, (2012), who reported 9790.01 ETB, financial loss in the same abattoir. In this study the estimated financial loss due to Fasciolosis in small ruminants slaughtered in AAEE is very high. This finding is in agreement with previous study of Nigategize et al (1993).

CONCLUSION

This study indicated liver parasites (*Fasciola* sp., *C. tenuicollis*, *Echinococcus granulosus*) as cause of high liver condemnation rates in slaughtered sheep and goat. The prevalence of *Fasciola* spp, Hydatid cyst and *C. tenuicollis* varies according to age, sex, species and origin of the animals. Prevalence was significantly higher in highland than lowland animals and in adults than young animals but there was no association in prevalence of liver parasites with relation to the sex of animals. The high prevalence of parasitic diseases in liver results extensive financial loss about 157,684 ETB per annum due to the condemnation of affected livers.

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