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Full Length Research Paper

A study on the prevalence, distribution and economic importance of *Cysticercus tenuicollis* in visceral organs of small ruminants slaughtered at an abattoir in Ethiopia

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This study reports on detection and prevalence of *Cysticercus tenuicollis* in slaughtered sheep and goats at abattoirs of Ethiopia. A total of 1152 sheep and goats (576 sheep and 576 goats) were randomly sampled and examined postmortem after slaughter for presence of *C. tenuicollis* in the visceral organs of the animals using standard meat inspection procedures. Out of 1152 animals examined 127 livers were destroyed as a consequence of gross lesions induced by the *C. tenuicollis.* The economical loss is estimated to be 65,269.89 USD or 1,044,317.79 ETB per year. Out of the 576 goats and 576 sheep inspected for visceral organs, *C. tenuicollis* was found in 63.9% of goats (n=368) and 56.8% of sheep (n=327), respectively. Adult goats (68.8%) and sheep (61.5%) were more infested than kids (59.03%) and lambs (52.1%), respectively. Goats (68.1%) and sheep (60.1%) from highland areas were more infested than goats (59.7%) and sheep (53.5%) from lowland areas. This study also shows that *C. tenuicollis* is more frequently detected in the omentum of goats and sheep than any other visceral organs. Appropriate control measures need to be introduced to reduce the prevalence of these parasites in small ruminants.

Key words: Abattoir, *Cysticercus tenuicollis*, Ethiopia, goats, sheep, prevalence.

INTRODUCTION

Ethiopia with its great variation in climate and topography possesses one of the largest livestock populations in the world, which is managed by smallholder farmer under extensive low input traditional management system and adjunct to crop production. The latest estimate gives 34 million cattle, 24 million sheep, 18 million goats, more than 8 million equines and 59 million poultry (ILCA, 1993). Sheep and goats cover more than 30% of all domestic meat consumption and generate cash income from export of meat, edible organs, live animals and skins. Furthermore, they need only short periods to reconstitute flocks after disaster and respond quickly to the demand (Ibrahim, 1998; Nawathe et al., 1985). Cestodes of the family taeniidae which infest the dogs (definitive host) are transmitted to a range of intermediate host species where they cause cysticercosis. Meat inspection data are a potential source of information and have an important role to play in epidemiology and preventive measure (Gracey et al., 1999). Monitoring disease and other conditions at slaughter has been recognized as one way of assessing the disease status of a herd (Oryan et al., 1993); however this source of information is not being fully exploited worldwide. Infestation with the larval stage of some species of Taenia are of veterinary importance because they cause economic losses due to destroying of infested offal or meat (Flisser et al., 1982; Eckert et al., 2001; Thompson and Lymbery, 1995; Soulsby, 1982).

Cysticercus tenuicollis is the metacestode of the tapeworm *Taenia hydatigena*. Adult worms have been reported to have been found in the small intestines of dogs, cats, mice and wild carnivores, like the wolf and the fox (Abidi et al., 1989). Infested carnivores eliminate

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T. hydatigena eggs with their faeces. Herbivores become infested with the eggs on account of having feed on contaminated pastures. Possible intermediate hosts for *C. tenuicollis* are squirrels, cattle, sheep, goats and other wild ruminants and also swine. After ingestion, the egg's shell is digested and the oncospheres become free to migrate through the intestinal walls, reaching the liver through the hepatic portal system. The oncospheres may remain in the liver or migrate to the omenta, mesenteries and the serosal surface of the peritoneal cavity. However, unusual locations like the lungs, the kidneys and the brain, have also been reported (Taylor et al., 2007). Where they attach and initiate post-oncospheral development (Jorgen and Brain, 1994). Mature Cysticeci have a smooth inner surface and contain only a single invaginated scolex, in contrast to hydatid cysts (Dwight et al., 2003). The existence of *C. tenuicollis* cysts attached to the broad ligament and to the uterine tubes was reported in an abattoir survey on acquired reproductive abnormalities in the ewes. In a certain number of these cases (3: 10), calcified cysticerci occluded the uterine tubes (Troney, 1988).

The prevalence of the *C. tenuicollis* infestation varies according to the geographical areas and generally reaches higher incidences in countries with a lower degree of sanitary control and with an uncontrolled wild carnivore population (Budka et al., 2004). Infestation of small ruminants with cysticerci of *T. hydatigena* is frequently not significant, and most of the times a diagnosis are made at the abattoir. However, the effect of this infestation upon the hosts depends largely on the degree of the parasitism, the organs involved and the existence of other concurrent infections (Urquhart et al., 1996). The presence of cysticercus in ruminants is an indicator of the incidence of *T. hydatigena* among wild and domestic carnivores. The parasite is not transmissible to humans; therefore, the meat of the ruminant is safe for human consumption. Hence the current study was designed to achieve the following objectives:

(i) To determine the prevalence of *C. tenuicollis* in young and adult sheep and goats in the abattoirs, Ethiopia.
(ii) To find out whether there was association between the prevalence of *C. tenuicollis* and selected risk factors.
(iii) To assess the distribution of *C. tenuicollis* in visceral organs of sheep and goats.

MATERIALS AND METHODS

Descriptions of study area

The abattoir is found in Debrezeit town located at 9°N and 40° E with an altitude of 1880 m a.s.l in the central highlands of Ethiopia, lying 47 km south east of Addis Ababa, the capital city. It has annual rainfall of 1151.6 mm of which 84% falls down during the long rainy season. The mean annual minimum and maximum temperatures is 8.5 and 30.7°C, respectively, and the mean humidity is 61.3% (NMSA, 2003).

Descriptions of study animals

A total of 1152 animals (576 sheep and 576 goats) were randomly selected and identified by origin, species and age during ante mortem inspection. The age grouping was based on eruption patterns. Animals with no erupted permanent incisor teeth were classified as young, while those with one pair or more permanent incisors' teeth were classified as adults (Getanby, 1991; Steel, 1996).

Study design

A cross sectional study was conducted from October , 2010 to April, 2011 by collecting data on events associated with *C. tenuicollis* in sheep and goats slaughtered at Hashim Nurs' Ethiopian livestock and Meat export abattoir (HELMEX).

Sample size determination

The sample size was determined using the formula as described by Thrusfield (2005), at 95% confidence interval. The expected prevalence of *C. tenuicollis* in Debrezeit was 384.

$$n = \frac{1.96^2 x Pexp\ (1\text{-}Pexp)}{d^2}$$

Where, n= required sample size, P_{exp}= expected prevalence, d= desired absolute precision. Accordingly, the minimum sample size was 384; but in order to increase precision, it was multiplied by three and 1152 animals' organs samples were taken for study.

Post-mortem examination

During postmortem examination visceral organs were inspected for the presence of *C. tenuicollis* by applying the routine meat inspection procedures (Herenda et al., 2000).

Assessment of economic losses

Direct economic losses assessed by considering market demand, average market prices and the rejection rate of specific organs. Therefore direct annual economic losses assessed by using the following formula set by Ogunrinade and Ogunrinade (1980).

EL= ∑srx x Coy x Roz

Where: EL= Annual economic loss estimated due to organ disposal from international market, ∑srx= Annual sheep and goats slaughter rate of the abattoir, Coy= Average cost of each sheep or goats liver, Roz= Disposal rates of sheep and goats liver.

RESULTS

Abattoir survey

Post mortem inspection

The overall prevalence of *C. tenuicollis* in 1152 goats and

Table 1. The overall prevalence of *C.tenuicollis* in sheep and goats slaughtered at HELMEX abattoir.

Species	No of examined	Prevalence (%)	χ^2	P-value
Goats	576	368(63.9)		
Sheep	576	327(56.8)	6.097	0.0135
Total	1152	695(60.3)		

Table 2. The prevalence of *C. tenuicollis* in young and adult goats and sheep.

Species	No of examined	Age	Prevalence (%)	P-value	χ^2
Goats	576	Young (288)	170(59.03)	0.0151	5.900
		Adult (288)	198(68.8)		
Sheep	576	Young (288)	150(52.1)	0.0232	5.157
		Adult (288)	177(61.5)		

Table 3. The prevalence of *C.tenuicollis* in highland and lowland sheep and goats.

Species	No of examined	Origin	Prevalence (%)	P-value	χ^2
Goats	576	Highland (288)	196(68.06)	0.0373	4.334
		Lowland (288)	172(59.72)		
Sheep	576	Highland (288)	173(60.07)	0.1100	2.554
		Lowland (288)	154(53.47)		

sheep slaughtered at abattoir was found in 695 (60.3%). On the basis of species 368 (63.9%) and 327 (56.8%), was recorded in goats and sheep, respectively as shown in Table 1. The prevalence of *C. tenuicollis* was higher in goats than in sheep with statistically significant difference ($P<0.05$).

The prevalence of *C. tenuicollis* was higher in adult goats and sheep 198(68.8%), 177(61.5%) then in the young ones 170 (59.03%), 150 (56.77%), respectively with a statistically significant difference of ($P<0.05$) (Table 2). The distribution of *C. tenuicollis* in highland and low land areas: from 288 goats brought from highland areas *C. tenuicollis* was found in196 (68.06%) of the goats. From 288 goats from lowland, 172(59.72%) of goats was found *C. tenuicollis*. In 288 sheep that were originated from the highland area and 288 from lowland area *C. tenuicollis* were found to be 173(60.07%) and 154(53.47%), respectively. In general, in this particular study it was revealed that the prevalence of *C. tenuicollis* was higher in goats and sheep from highland than in goats and sheep brought from lowland areas (Table 3).

Goats brought from highland areas 90(62.5%) and 97(68.4%) of young and adult were positive for *C. tenuicollis* respectively. *C. tenuicollis* was found higher in adult goats 92(63.9%) originating from lowland area when compared with young goats from the same area which was only 80(55.6%). High prevalence was detected in adult sheep 88(61.1%) from highland area than in young sheep 78(54.2%) from the same agro climatic zone. Likewise higher prevalence was also detected in adult sheep 84 (58.3%) than young sheep78 (54.2%) in lowland areas (Table 4).

Infestation rate of *C. tenuicollis* in different organs of goats and sheep shows the cysts had a tendency to be located in the omentum than any other organs which was 62.7 and 58.2% this is followed by the mesentery, 12.2 and 10.8%, liver 11.1 and 10.9%, and lowest was found in the lung 2.8 and 2.4% of goats and sheep respectively (Table 5). The infestation rate was higher in the omentum of goats (62.7%) then sheep (58.2%) but was not statistically significant differences ($p>0.05$), (Table 6). The variation between infestation rates of different organs in the two age groups was indicated higher in the omentum of adult sheep (63.2%) then the omentum of young sheep (53.1%) similarly the infestation rate *C. tenuicollis* was higher in the omentum of adult goat (67.4%) then young ones (57.9%) with a statistically significant difference in infestation rates of the omentum

Table 4. The prevalence of *C.tenuicollis* in sheep and goats of difference origin and age.

Species	Origin	Age	Prevalence (%)
Goats 576	Highland (288)	Young (144)	90(62.5)
		Adult (144)	97(68.4)
	Lowland (288)	Young (144)	80(55.6)
		Adult (144)	92(63.9)
Total	576		359(62.3)
Sheep 576	Highland (288)	Adult(144)	88(61.1)
		Young (144)	78(54.2)
	Lowland (288)	Adult(144)	84(58.3)
		Young (144)	78(54.2)
Total	576		328(56.9)

Table 5. Distribution of *C.tenuicollis* in the visceral organs of infested animals.

Animals examined	Organs predilection of cyst				
	Liver (%)	Lung (%)	Peritoneum (%)	Mesentery (%)	Omentum (%)
Goats (576)	64(11.1)	16(2.8)	63(10.9)	70(12.2)	361(62.7)
Sheep (576)	63(10.9)	14(2.4)	47(8.2)	62(10.8)	335(58.2)

Table 6. The variation between infestation rates of specific organs and species.

Visceral organ	Goats (576)	Sheep (576)	P-value	χ^2
	Positive (%)	Positive (%)		
Liver	64(11.1)	63(10.9)	0.9251	0.008
Lung	16(2.78)	14(2.43)	0.7114	0.13
Peritoneum	63(10.9)	47(8.2)	0.1342	2.24
Mesentery	70(12.2)	62(10.8)	0.5814	0.30
Omentum	361(62.7)	335(58.2)	0.2525	1.30

omentum in young and adult goats and sheep ($P<0.05$), (Table 7).

Assessment of financial loss

Direct economic losses associated with disposed organs are significantly high. The annual monitory loss due to rejection of organs and tissue were also calculated was found to be 65,269.89 USD or 1,044317.79 ETB per year in export and local market loss, respectively. Where Unit price of liver for international market 1.5 $/kg, Unit price of liver for local market 1.2$/kg.

DISCUSSION

In developing countries, abattoirs play a major role in providing and serving as a source of information and a references center for diseases prevalence. Fasamni (1997), suggested that governments or other program aimed at controlling or eradicating disease across African countries such abattoir survey result in the planning and control of livestock diseases (EVA, 2002; Gracey et al., 1999; Hinton and Green, 1997, Vanlongestigin, 1993).

During the study period, a total of 1152 sheep and goats (576 goats and 576 sheep) were examined from out of these, 695 (60.3%) small ruminants were found to be positive for *C. tenuicollis* (Table 8). The parasite *C. tenuicollis* was found in 327 (56.8%) and 368 (63.9%) of sheep and goats respectively, were found to be infested with *C. tenuicollis*. The prevalence of *C. tenuicollis* by species was higher in goats (63.9%) as compared to sheep (56.8%). This may be due to close contact between dogs and goats. According to Torgerson et al. (1988), under condition of high infestation of *C. tenuicollis* (Figures 1 to 3) most sheep develop protective immunity early in life and this immunity regulate the parasite

Table 7. The variation between infestation rates of specific organs and age.

Visceral organs	Age	Goats (576)	P-value	Sheep (576)	P-value
		Positive (%)		Positive (%)	
Liver	Young	27(9.4)	0.1849	22(7.6)	0.0112
	Adult	37(12.9)		41(14.2)	
Lung	Young	5(1.7)	0.1282	3(1.04)	0.0304
	Adult	11(3.8)		11(3.8)	
Peritoneum	Young	23(7.9)	0.0232	15(5.2)	0.0097
	Adult	40(13.9)		32(11.1)	
Mesentery	Young	27(9.4)	0.0413	21(7.3)	0.0067
	Adult	43(14.9)		41(14.2)	
Omentum	Young	167(57.9)	0.0200	153(53.1)	0.0143
	Adult	194(67.4)		182(63.2)	

Table 8. Total percentage of organs disposed due *to C.tenuicollis* among the examined liver and lung.

Organs	No. of organs examined	Organs disposed (%)
Liver	1152	127(11.02)
Lung	1152	30(2.6)

population, whereas goat develops the immunity more slowly. Similar result was reported in a study done by Sisay et al. (2007), who has recorded prevalence of 17, 14, 12 and 15% in sheep and 38, 30, 32 and 35% in goats, respectively at Haramaya, Harar, Dire Dawa and Jijiga abattoirs. The result in this study is higher than that reported by other workers. The work done by several authors ovine *C. tenuicollis* prevalence in different part of the country revealed 25.8% in wolyta (Muktar, 1988), 46.1% in Dessie (Yilikal, 1989), 37.1% in Addis Ababa Abattoir (Tekylene, 1988) and 32.7% in three export abattoir (ELFORA, HELMEX and Luna) by Adem (2006). 37.03% in India abattoir (Pathak and Gaur, 1982). The prevalence of *C. tenuicollis* found in goats in this study (63.9%) is higher than the prevalence reported by other authors, such as 18.04% in Iran (Radfar et al., 2005), 16.3% in wolyta (Muktar, 1988) and 46.6% in Debrezeit (Woynshet, 2008). The relatively higher prevalence of *C. tenuicollis* recorded in the study could be due to the variations in agro ecology, the degree of pasture contamination and the way of raising and grazing of these animals which may favors the transmission cycle between ruminants and dogs.

The prevalence by age revealed that higher infestation rates was recorded in animals with the age of adults (above one year and three month age) (61.5% in sheep and 68.8% in goats) and the lowest prevalence was recorded in younger animals (less than one year and three month age) (52.1% in sheep and 59.03% in goats). Compared to other reports, the result of this study higher than the other report for: age above 3 years 37.8% in sheep and 47.2% in goats and in young ones 33.3% in sheep and 33.7% in goats in three export abattoirs by Adem (2006); or 51.8 and 47.4% in adult goats and sheep and 41.4 and 35.8% in young goats and sheep byWoynshet (2008). This may be due to high ingestion of eggs of *T. hydatigena* and more close contact to the final host (dogs), in young's animals, mostly kept indoors, then older animals.

C. tenuicollis in sheep and goats from lowland and highland areas indicate more prevalence in highland goats (68.1%). This may be due to grazing or feeding and management practice. In highland there might be a close contact between goats and dogs (as final host). The lower prevalence in both sheep and goats in this study from lowland areas can be attributed to environmental conditions such as high temperature and low humidity (adverse conditions for the survival of the eggs of *T. hydatigena*). The infestation rate of *C. tenuicollis* in different organs of sheep and goats showed, although, the liver, lung, peritoneum, mesentery were also affected, the cysts had a tendency to be located more in the omentum. This is due to the fact that omentum covers larger surface area in the peritoneal cavity. The observation of El-Azazy and Fayek, (1990) concords our findings.

Although organ wise infestation rate of both sheep and goats were comparable 10.9 and 11.1% (liver). 2.4 and 2.8% (lung), 8.2 and 10.9% (Peritoneum), 10.8 and12.2% (Mesentery) and with the highest infestation 58.2 and

Figure 1. *C. tenuicollis* on the abdominal wall of carcass.

62.8% in (Omentum). These results agree with results of cystcerci in sheep (84.85%) and goats (82.14%) omentum by Radfar et al. (2005). The infestation rate of *C. tenuicollis* was higher in the omentum of adult goats (67.4%) than the young ones (57.9%). Therefore, regarding the infestation rate of *C. tenuicollis*; there was a statistically significant difference between young and adult goats and sheep.

The high prevalence of *C. tenuicollis* in the slaughtered animals also indicated that the cyst causes considerable economic loss due to condemnation of edible organs, especially the liver and lung at slaughter house is estimated at 65,269.89 USD or 1,044317.79 ETB. Such loses are of particular importance in Ethiopia, which has low economic output where sheep and goat production are the major livestock industries.

CONCLUSIONS AND RECOMMENDATIONS

C. tenuicollis was the predominant metacestode causing organ disposal with consequent economic losses in the study of export abattoirs practicing the slaughter of small ruminants and exporting meat of these animal products. High prevalence of *C. tenuicollis* were recorded in slaughtered sheep and goats. Inappropriate disposal of abattoir materials being practiced by some of the abattoirs can enhance the continuation of the life cycle between the intermediate host and final hosts. Based on the results of the present survey, the following recommendations are forwarded:

(i) Immidiate attention should be paid to the safe and controlled elimination of all condemned abattoir materials and the sale of contaminated offal's and organs of sheep and goats, and feeding of dogs should be stopped.
(ii) Awareness creation programs should be launched for the butchers, abattoirs workers, meat sellers, and dog owners about the danger of the metacestodes for human and animal health.
(iii) Strategic application of chemotherapy with appropriate anthelmintics at appropriate time should be implemented.
(iv) A control program should be mounted on the number of stray dogs in the study area due to their involvement in the life cycle of the parasite.

Figure 2. *C.tenuicollis* on the Omentum.

Figure 3. High infestation.

(v) Preventing infected dogs from defecating on pastures grazed by sheep are important measures in lowering the incidence of *C. tenuicollis* in sheep and goats whose final hosts are carnivores, mainly dogs.

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