



# Study on Prevalence of Small Ruminant *Cysticercus Tenuicollis* and its Monetary Loss at Bishoftu Elfora Export Abattoir, Oromia, Ethiopia



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## Abstract

A cross-sectional study was conducted on *Cysticercus tenuicollis* in sheep and goats slaughtered at Bishoftu, Elfora export abattoir from November 2017 to April 2018 to determine the prevalence, organ preference and associated risk factors and to estimate direct economic losses attributed to the condemned organs from sheep and goats slaughtered in the abattoir. The statistical analysis was performed using SPSS program. The overall prevalence of *C. tenuicollis* from 500 shoats was found 323 (64.6%) examined by post-mortem examination. During the study, a total of 268 goats and 232 sheep visceral organs were inspected. Of this *C. tenuicollis* was found in Caprine 60 (22.4%) than in sheep 42 (18.1%). The age wise prevalence *C. tenuicollis* showed that the prevalence was higher in young sheep (41.0%) than adult sheep (20.8%). Although organ wise infection rates of both sheep and goat were (19.4%) and (20.5%) (Mesentery), (19.8%) and (18.3%) (Peritoneum), (22.4%) and (18.1%) (Liver), and (18.3%) and (17.2%) (Omentum) and (18.3%) and (21.6%) (Carcass) with no significant statistical difference. The overall percentage of *C. tenuicollis* was higher in young sheep (41.0%) than in adult sheep (20.8%) with significant statistical difference ( $p < 0.05$ ). Small Ruminant *Cysticercus tenuicollis* is an important disease that causes great economic losses due to organ condemnation in the study area. Improvement of awareness of the communities about the economic importance of the parasite and hence reducing the incidence and economic loss incurred by the disease via control program that involves due attention on veterinary activities.

**Keywords:** Abattoir; *C. tenuicollis*; Monetary Loss; Prevalence; Small ruminant

**Abbreviations:** *C. tenuicollis*: *Cysticercus tenuicollis*; ETB: Ethiopian Birr; GDP: Growth Domestic Product; MASL: Mean Above Sea Level; SPSS: Scientific Program Social Science

## Introduction

Ethiopia is a resourceful country endowed with largest live-stock resource in African continent with about 53.99 million cattle, 25.5 million sheep and 24.06 million goats, 1.91 million horses, 6.75 million donkeys, 0.35 million mules, 0.92 million camels, 50.38 million poultry and 5.21 million bee hives [1]. Livestock production is an important integral component of the Ethiopian agricultural production system and plays an imperative role in the development of the country's economy and for the food and nutritional security. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP [2]. Nowadays, parasitic diseases are significant causes of morbidity and mortality in humans as well as in animals [3] and are mostly found in warm tropical and sub-tropical regions of the world [4]. Many parasitic diseases are prevalent in Ethiopia, which are responsible for the low productivity of livestock besides contributing to reduced meat production due to carcass or organ condemnation [5]. In Ethiopia, parasitic diseases including *C. tenuicollis* in small ruminants were implicated as cause of organ

condemnation in Abattoir enterprise leading to significant economic loss [6].

*Cysticercus tenuicollis* is the larval stage of *Taenia hydatigena*, which is a tapeworm of dogs, cats and wild canids [7]. The intermediate hosts for the mature metacestode, *C. tenuicollis*, are sheep, goats, cattle, dromedaries, antelope, rarely pigs and reported in deer and horse monkey [8]. Metacestode stage are frequently found attached to the omentum, mesentery and to the serosa surface of abdominal organs, especially liver [7] and more frequently in the Omentum of goats and sheep [9]. Adult worms have been reported to be found in the small intestines of dogs, cats, mice and wild carnivores, like the *Taenia hydatigena* eggs with their faeces. Herbivores become infested with the eggs because of having feed on contaminated pastures. Possible intermediate hosts for *C. Tenuicollis* are squirrels, cattle, sheep, goats and other wild ruminants and swine. After ingestion, the egg's shell is digested and to 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 Omentum, mesenteries and the Serosal surface of the peritoneal cavity. However, unusual locations like the lungs, the kidneys and the brain, have also been reported [7].

Even though various investigations have been conducted to determine the prevalence of parasitic diseases resulting in organ condemnation in Ethiopia and most of the survey paid little attention to the study of *C. tenuicollis* prevalence only. Therefore, the objectives of the abattoir survey were to determine the prevalence of *C. tenuicollis* in sheep and goats slaughtered at Bishoftu Elfora Export abattoir, to find out the distribution of *C. tenuicollis* in visceral organs of sheep and goats and to assess the relationship between some risk factors and prevalence of *C. tenuicollis* in sheep and goats. Therefore, the objectives of this study were;

- To determine the prevalence, and associated risk factors of *C. tenuicollis*.
- To assess cyst distribution, Organ preference and Monetary Loss of the parasite in the study area.

## Materials and Methods

### Study Area

The study was conducted from November to April 2018 at Elfora Export abattoir in Bishoftu which is located at 90 °N and 40 °E with an altitude of 1880 m.a.s.l in the central highlands of Ethiopia, 47kms southeast of Addis Ababa. It has annual rainfall of 1151.6 mm of which 84% falls during the long rainy season that extends from June to September and the remaining during the short rainy season that extends from March to May. The mean annual minimum and maximum temperatures is 8.50C and 30.70C, respectively and the mean humidity is 61.3% [10].

### Study population and Study Design

The study animals constituted of local breeds of small ruminants destined for slaughter were all males originated from different parts of the country. The animals were purchased from farmers on weight basis and the husbandry practice for these animals was mainly grazing. The study population was grouped into two age categories; based on dentition, for those which have not erupted permanent incisor teeth, are classified as young, while those with pair or more permanent incisor teeth erupted were classified as adult [11]. A cross-sectional study was conducted on 232 sheep and 268 goats at Elfora meat Export abattoir in Bishoftu from November 2017 to April 2018 by collecting data on events associated with *C. tenuicollis* on sheep and goats.

### Sampling Method and Sample size determination

A systematic random sampling procedure was conducted to select individual animals for sampling in the abattoir and the study animals were randomly selected, recorded, mark and followed up through the completely slaughtering process. The male sheep and goats were grouped in to different categories of age. A systematic random sampling method employed by considering 50% expected prevalence and 95% confidence level with a 5% desired absolute

precision and sample size was determined by the formula given by [12]. Even though the required sample size was 384, additional 116 samples were included to increase the precision so that 500 animals were included in the study.

$$n = 1.962 * \frac{P_{exp}}{d^2} (1 - P_{exp})$$

Where, n=required sample size

$P_{exp}$  =expected prevalence

d= desired absolute precision (usually 0.05)

### Sample Collection Method

Pre-slaughter examinations were conducted in the lairage in order to determine the species age, body condition and origin of animals. Identification number was given for each animal to examine after evisceration. During ante-mortem examination animals were clinically examined for any sign of illness while standing and moving. During post mortem examination, visceral organs were thoroughly inspected by applying the routine meat inspection procedure (visualization, palpation and systemic incisions) for the presence of parasites and other abnormalities, paying attention to the visceral organs and tissues in abdominal, thoracic and pelvic cavities.

### Assessment of Financial Loss

An attempt was made in order to estimate economic significance *C. tenuicollis* in small ruminant due to the cost of condemned liver. To calculate the economic loss, the following parameters were taken into consideration: The market demand, mean market price, the rejection rates of liver and annual slaughter capacity of the abattoirs. The economic loss due to liver condemnation was estimated by the formula set by [13] as follows:

$$EL = Srx * Coy * Roz$$

Where

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

Srx = Annual sheep/ goats slaughter rate of the abattoir

Coy = Average cost of each sheep or goat's liver.

### Data Management and Analysis

The data was checked, coded and entered in to Microsoft excel work sheet and was analyzed using IBM SPSS software version 20. Descriptive statistics like percentage was used to express prevalence while chi-square ( $\chi^2$ ) test was used to compare the association of *C. tenuicollis* with different risk factors. In all the cases, 95% confidence level and 0.05 absolute precision errors were considered. A p-value  $\leq$  0.05 will be considered statistically significant.

### Result

Out of 500 small ruminants examined by post-mortem examination 323 (64.6%) of them were positive for *C. tenuicollis*. the prevalence of *C. tenuicollis* was relatively higher in Caprine 60 (22.4%) than in sheep 42 (18.1%) and there was no statisti-

cally significant difference ( $p=0.236$ ) in liver. The prevalence of *C. tenuicollis* was higher in 6-12 months both Caprine and sheep 45(22%) than in the 1-2years 39(20.4%) and greater than two years 18(17.3%), Caprine and sheep without a statistically significant difference of ( $p=0.632$ ). From 268 goats and 232 sheep brought from Somali and Borena 35(18.9%) and 67(21.3%) both Caprine and Sheep were positive respectively. In general, in this study the prevalence of *C. tenuicollis* was higher in goats and sheep originated from Borena parts of the country than Somali. There was no statistically significant difference between these two ori-

gins of animals ( $p$  value =0.817%). There was no significant difference revealed between body condition scores about cyst detection ( $p>0.05$ ) in the organ of liver: In intestine the prevalence was 45(19.4%) in Ovine and Caprine 55(20.5%) and in Peritonium 43(18.5%) in Ovine and Caprine 53(19.8%), in Omentem the prevalence was 40(17.2%) in Ovine and Caprine and in carcass the prevalence was 50(21.6%) in Ovine and in Caprine 49(18.3%). in all organs the age, origin, body conditions were not a statistically significant difference ( $p>0.05$ ). The overall prevalence of organ condemnation was found to be 486/4000 (12.15%) (Table 1).

**Table 1:** Summary of liver condemnation.

Variables		Liver Examined	Liver Condemned (%)	X <sup>2</sup>	P value
Spices	Ovine	232	42(18.1%)	1.406	0.236
	Caprine	268	60(22.4%)		
Age	6-12 months	205	45(22%)	0.916	0.632
	1-2 yr	191	39(20.4%)		
	> 2 yr	104	18(17.3)		
Origin	Somali	185	35(18.9%)	0.397	0.529
	Borena	315	67(21.3%)		
Body condition	Poor	55	14(25.5%)	1.354	0.508
	Medium	380	77(20.3%)		
	Good	65	11(16.9%)		
	Overall	500	102(20.4%)		
Annual Liver cost of goat =0. 224 condemnation rate*65 ETB*100000 goat= 1,456,000 ETB					
Annual Liver cost of sheep =0.18*70 ETB*30,000= 380,100 ETB					

Of the total 500 animals inspected for intestine, 100 (20%) animals had condemned intestine due to *C. tenuicollis*. The intestine condemnation rate was 19.4% and 20.5% in Ovine and Caprine respectively. But there was no statistically significant ( $P>0.05$ ) difference between spices, age, origin of animal and body condition groups (Table 2). Overall peritoneum organ condemnation 96(19.2%) was found higher on animals who brought from Borana 62(19.7%), Caprine 53(19.8%), the age of animals above the age of two years 24(23.1%) and poor body condition 14 (25.5%)

even though there was no statically significance difference among variables (Table 3). Exposure to multiple organ condemnation is found higher on Animals originated from Borane have high number of organ condemnation pre animal, Caprine species have high count of organ condemnation per animal, Generally, number of organ condemnation higher on the 6-12-month age, however one organ condemnation is high on the age category of 1-2 year and also prevalence of organ condemnation is high on the medium body conditioned animals.

**Table 2:** Summary of intestinal condemnation.

Variables		Intestine Examined	Intestine Condemned (%)	X <sup>2</sup>	P value
Spices	Ovine	232	45(19.4%)	0.099	0.754
	Caprine	268	55(20.5%)		
Age	6-12 mo	205	41(20%)	1.34	0.512
	1-2 yr	191	42(22%)		
	> 2 yr	104	17(16.3%)		
Origin	Somali	185	38(20.5%)	0.054	0.817
	Borena	315	62(19.7%)		
Body condition	Poor	55	11(20%)	0.113	0.945
	Medium	380	75(19.7%)		
	Good	65	14(21.5%)		
Overall		500	100(20%)		

**Table 3:** Summary of Peritoneum condemnation.

Variables		Peritoneum Examined	Peritoneum Condemned (%)	X <sup>2</sup>	P value
Spices	Ovine	232	43(18.5%)	0.124	0.725
	Caprine	268	53(19.8%)		
Age	6-12 mo	205	36(17.6%)	1.378	0.502
	1-2 yr	191	36(18.8%)		
	> 2 yr	104	24(23.1%)		
Origin	Somali	185	34(18.4%)	0.128	0.721
	Borena	315	62(19.7%)		
Body condition	Poor	55	14(25.5%)	1.558	0.459
	Medium	380	70(18.4%)		
	Good	65	12(18.5%)		
	Overall	500	96(19.2%)		

**Discussion**

The present investigation showed that Out of 232 sheep and 368 goats examined in liver, intestine, Peritonium, Omentem and Carcass 102(20.4%), 100(20%), 96(16.2%), 89(17.8%), 99(19.8) respectively were found to be positive for *C. tenuicollis*. This finding was in line with the finding of [14,15] (22.8% and 26.4%) from Turkey and Nigeria respectively and [16] (24.6%) in Dire Dawa

municipal abattoir and Tadessena). However, it was relatively lower when compared to the finding of [17] who had reported to be 46.1% in Dessie and [18] (37.1 %,) in Addis Ababa abattoir and relatively higher when compared to the finding of 15.7% [19] and 4.21% [20] in Iran. This variation in the prevalence mainly accounted to the grazing behavior and management system prevailing in the local areas [14] (Table 4).

**Table 4:** Summary of Omentem condemnation.

Variables		Omentem Examined	Omentem Condemned (%)	X <sup>2</sup>	P value
Spices	Ovine	232	40(17.2%)	0.92	0.761
	Caprine	268	49(18.3%)		
Age	6-12 mo	205	37(18%)	0.06	0.97
	1-2 yr	191	33(17.3%)		
	> 2 yr	104	19(18.3%)		
Origin	Somali	185	33(17.8%)	0	0.986
	Borena	315	56(17.8%)		
Body condition	Poor	55	9(16.4%)	0.437	0.804
	Medium	380	70(18.4)		
	Good	65	10(15.4%)		
	Overall	500	89(17.8%)		

**Table 5:** Summary of carcass condemned.

Variables		Carcass Examined	Carcass Condemned (%)	X <sup>2</sup>	P value
Spices	Ovine	232	50(21.6%)	0.836	0.36
	Caprine	268	49(18.3%)		
Age	6-12 mo	205	34(16.6%)	2.668	0.263
	1-2 yr	191	40(20.9%)		
	> 2 yr	104	25(24%)		
Origin	Somali	185	39(21.1%)	0.303	0.582
	Borena	315	60(19%)		
Body condition	Poor	55	11(20%)	0.084	0.959
	Medium	380	76(20%)		
	Good	65	12(18.5%)		

Overall	500	99(19.8%)	
Annual carcass cost/Kg of goat = 0.183 condemnation rate*7.5 kg *130 ETB*100000 goat= 17,842,500 ETB			
Annual carcass cost/Kg of sheep = 0.216 condemnation rate*7.5 kg *130 ETB*30000 sheep= 6,318,000 ETB			

The prevalence of *C. tenuicollis* by species was higher in goats (54.2%) as compared to sheep (35.4%). This may be due to close contact between dogs and goats. According to [21], under condition of high infestation of *C. tenuicollis* most sheep develop protective immunity early in life and this immunity regulate the parasite population, whereas goat develops the immunity more slowly. Similar result was reported in a study done by [22], 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 Data and Jijiga Abattoirs (Table 5).

The prevalence by age revealed that higher infestation rates was recorded in animals with the age of adults (above one year

and two years age) (40.7% in adult and the lowest prevalence was recorded in younger animals (6-month -1-year age) (32.6%) (Table 6). This finding is in line with the finding in three export abattoirs. Although organ wise infestation rate of both sheep and goats were comparable 18.1% and 22.4% (liver). 18.5% and 19.8% (peritoneum), 19.4% and 20.5% (mesentery) and with the lost infestation 17.2% and 18.3% in (Omentum). These results disagree with results of Cysticerci in sheep (84.85%) and goats (82.14%) Omentum by [19]. 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.

**Table 6:** summary of number of organs condemned per single animal.

Variables		Non-condemned	Only one organ	Two organs	Three organs	Four organs	P Value
Origin	Somali	65(36.7%)	71(35.7%)	41(44.6%)	6(23.1%)	2(33.3%)	0.33
	Borane	112(63.3%)	128(64.3%)	51(55.4%)	20(76.9%)	4(66.7%)	
	Overall	177(35.4%)	199(39.8%)	92(18.4%)	26(5.2%)	6(1.2%)	
Species	Ovine	81(45.8%)	95(47.7%)	45(48.9)	9(34.6%)	2(33.3%)	0.68
	Caprine	96(54.2%)	104(52.3%)	47(51.1%)	17(65.4%)	4(66.7%)	
	Overall	177(35.4%)	199(39.8%)	92(18.4%)	26(5.2%)	6(1.2%)	
Age	6-12 mo	81(45.8%)	72(36.2%)	38(41.3%)	11(42.3%)	3(50%)	0.58
	1-2 year	64(36.2%)	81(40.7%)	32(34.8%)	11(42.3%)	3(50%)	
	above 2 y	32(18.1%)	46(23.1%)	22(23.9%)	4(15.4%)	0	
	Overall	177(35.4%)	199(39.8%)	92(18.4%)	26(5.2%)	6(1.2%)	
body condition	Poor	16(9%)	24(12.1%)	11(12%)	3(11.5%)	1(16.7%)	0.96
	Medium	137(77.4%)	147(73.9%)	72(78.3%)	20(76.9%)	4(66.7%)	
	Good	24(13.6%)	28(14.1%)	9(9.8%)	3(11.5%)	1(16.7%)	
	Overall	177(35.4%)	199(39.8%)	92(18.4%)	26(5.2%)	6(1.2%)	

Body condition of sheep was the only risk factor in which the prevalence of *C. tenuicollis* poor body condition (11%) was found most infected significantly varied. sheep with compared to medium (76%) and good (13.8%) body condition. among all other risk factors considered both in sheep and goats except the slight difference in figures of the prevalence statistically no significant variation observed. this finding is in line with the report of poor body condition (39.8 %) medium body condition (21.8%) and good (14.8%) body condition this finding is in line with Togerson [9,14,21] from northern Jordan, turkey and central Ethiopia respectively. when all studied animals considered together, still the prevalence significantly varied. with body condition. Small ruminant with poor body conditions were the most affected

compared to the medium and good body conditions. When animals suffer from shortage or scarcity of nutrition and infected with gastrointestinal internal parasites their immunity compromised. Hence, possibly this can be accounted for the higher prevalence of the cyst in poor body condition animals.

Among the predilection sites observed during this study liver was found to be the predominant one, and it followed by Omentum and peritoneum. Samuel & Zewde [9,14] reported that Omentum is the predominant predilection sites for *C. tenuicollis*. During the study, from the total shoats slaughtered, parasite like *C. tenuicollis* was found to be the major causes that rendered liver rejection from international market. The spreading of infection



is an indication of environmental contamination with the eggs of the adult dog tapeworms. *C. tenuicollis* is the most important and widely prevalent of the four metacestodes recording in small ruminants slaughtered in the study abattoir. Upto 18.1% of the slaughtered sheep and goats were found to be infected with the *C. tenuicollis*. The prevalence of *C. tenuicollis* by species was slightly higher in goats (39.5%) as compared to sheep (36.2%). However, this difference was not found statistically significant. Similar results were reported in goats in Nigeria [15].

In the current study; overall annual economic losses due to a single organ condemnation (liver) from sheep and goats infested by *C. tenuicollis* was estimated to be 1836100 ETB. This result is lower than the report of [23] who estimated an economic loss of 65,269.89 SUA or 1,044,317.79 ETB from condemned liver. The economic loss in the abattoir was relatively high because of its export standard in which any liver with single cyst or calcified liver with cyst was disposed from international market. Such losses are important in Ethiopia, which has low economic output where sheep and goat production are the major livestock industries.

### Conclusion and Recommendation

*C. tenuicollis* was the predominant metacestode causing organ disposal with consequent economic losses in the study of export abattoirs practicing the slaughter of sheep and goat and exporting meat of these animal products. High prevalence of *C. tenuicollis* was recorded in slaughtered sheep and goats. Some of the abattoirs can enhance the continuation of the life cycle between the intermediate host and final hosts without appropriate disposal of abattoir materials. Based on the results of the present study, the following recommendations are forwarded:

- a. Proper 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.
- b. Awareness creation programs should be given for the butchers, abattoirs workers, meat sellers, and dog owners about the danger of the metacestodes for human and animal health.
- c. Strategic application of chemotherapy with appropriate anthelmintic at appropriate time should be implemented.

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.

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