Original Research Article

STUDY ON PREVALENCE AND ECONOMIC IMPORTANCE OF CYSTICERCUS TENUICOLLIS IN SMALL RUMINANT SLAUGHTERED AT JIGJIGA MUNICIPAL ABATTOIR.

ABSTRACT

A cross sectional study was conducted between November 2019 and April 2020 with the aim of determining the prevalence of cysticercus tenuicollis in sheep and goat, assessing potential risk factors associated with it and estimating the magnitude of the direct economic losses associated with condemned organs. A total of 545 sheep and goats slaughtered at Jigjiga municipal abattoir were randomly selected and managed through ante-mortem and post-mortem examinations. From the total inspected shoats 98(17.9%) of them were found to be affected with C. tenuicollis. Out of the 349 goats inspected C. tenuicollis was detected in 71(20.3%) and from 196 inspected sheep C. tenuicollis was observed in 27 (13.8%). The prevalence of C. tenuicollis based on their sex was higher in male sheep 16(14.9%) and goat 51(22.6%) than female sheep 11(12.35%) and goat 20(16.12%). Infection rate of C. tenuicollis with respect to age group showed that higher prevalence was recorded in adult goats 60(22%) and sheep 20(14.3%) than young goats 11(14.4%) and sheep 7(12.2%). Goats 27(26.2%) and sheep 8(20.5%, originated from Babile were more infected compared to goats and sheep from Jigjiga (23.7%, 17.3%) and Kebribayah (10.8%, 7.3%) respectively, with statistically significant difference ($P<0.05$) among goats coming from different areas. Related to body condition scores and the disease, higher prevalence was recorded in poor body condition of sheep and goat (18.6%, 27%) than medium (13.7%, 19.6%) and good (10.6%, 14%) body scores respectively, with significant difference in goat ($P<0.05$). Anatomical distribution of Metacestode showed the highest proportions of C.tenuicollis in omentum followed by liver of goats and sheep than any other organs. Totally about 385,621.236 ETB (10,810.8 USD$) was lost from organs condemnation during the active abattoir survey. The results suggest that C. tenuicollis is common and may constitute a health problem in shoats and a source of economic loss in the country. This signifies the need for the

control of stray dog population, deworming of dogs and avoidance of backyard slaughter and proper disposal of infected viscera to curtail the problem.

Key words: Jigjiga; Financial losses, C .tenuicollis; Prevalence; Sheep and Goats.

1. INTRODUCTION

Ethiopia is believed to have Africa's largest livestock population with an estimated 57.83 million of cattle, 28.89 million of sheep, 60.51 million of poultry, and 29.7 million of goats, excluding nomadic areas (1). The sub sector contributes about 30% of the national Gross Domestic Product (GDP) and 45% of the agricultural GDP (2). It also contributes 15% of the export earnings (3).

Small ruminants are important components of the livestock subsector as they provide more than 30 % of the local meat consumption and form a vital source of income for small-scale farmers in the country (4). 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 (5).

However, the benefits obtained from sheep and goats to date do not match their tremendous potential and significant losses resulted each year from the death of animals as a result of lack of appropriate veterinary services, lack of attention from government and wide spread endemic diseases which are considered as bottleneck for development of this sector (6, 7, 8 and 9).

In Ethiopia, Parasitic diseases including Cysticercus tenuicollis in small ruminants were implicated as cause of organ condemnation in Abattoir enterprise leading to significant economic loss in the country (10). Cysticercus tenuicollis is the larval stage of the taeniid cestodes Taenia hydatigena. The adult worms are found in the small intestine of canines such as dogs and foxes, while the metacestodes are found in large number of domestic and wild intermediate ruminant hosts (11).

The final host is infected by eating infected meat with larval stage which their scolex librated and adherence to mucosal layer of intestine and become mature after 51 days (12). But the pathogenicity of adult parasites is not high for definitive hosts (13). The mature tapeworm, T. hydatigena, lays eggs which pass out in the faeces of the host and are ingested by the ruminant intermediate host during grazing (14).

The ingested eggs hatch in the small intestine of the intermediate hosts and the released oncospheres enter liver through blood circulation. The metacestode migrate through the hepatic parenchyma to the peritoneal cavity (15). It matures over a period of five to eight weeks and it is then found attached as a bladder worm called C. tenuicollis to the mesentery, serosal surface of the abdominal organs, and omentum (16).

Mostly the disease is perpetual and asymptomatic which cannot be detected until slaughter (17). The migrating larvae in live small ruminants could result hepatitis, burrowing canal, granular degeneration, deposition of serofibrinous exudates and in lungs it causes pneumonia (18, 19). And in very heavy infections, it may results eosinophilic infiltration and severe inflammation that may prove to be fatal (20).

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 uncontrolled wild carnivore population (21). The prevalence of 37.03% and 27.29% have been reported in sheep and in goats, respectively in India (22). And in Nigeria, a prevalence of 21.4% in sheep and 34.2% in goats has been reported by (23). In Iran, a prevalence of 12.84% in sheep and 18.04% in goats was obtained by (24). In Ethiopia a prevalence of 40.0% and 46.6% in sheep and goat was reported by (25). respectively, at Addis Ababa abattoir.

Even though various investigations have been conducted in Ethiopia to determine the prevalence of parasitic diseases resulting in organ condemnation (26). most of them paid little attention to the study of C. tenuicollis. Therefore the objectives of this study were-

- To determine the prevalence and associated risk factors of C. tenuicollis in sheep and goat slaughtered in Jigjiga municipal abattoir.
- To assess the monetary loss of visceral organs condemnation due to the parasite in the study.

2. MATERIALS AND METHODS

2.1. Descriptions of study area

The study was conducted in Jigjiga municipal abattoir from November, 2019 to April, 2020. Jigjiga is the capital city of the Somali Regional State (SRS), Ethiopia and it is found in Eastern part of the country at 630 km from Addis Ababa. Jigjiga is situated at an altitude ranging from 1,660 to 1,710 meters above sea level at geographic coordinates of approximately 9020^0 North latitude and 45056^0 East longitudes. The climate of Jigjiga is semi-arid type which is characterized by high temperature and low rainfall and receives an annual rainfall of 300-500mm with the mean minimum and maximum annual temperatures of 20^oc and 28°C, respectively. The mean annual temperature and mean annual rainfall are about 22^o C and 543 mm respectively (27).

2.2. Study Population

A total of 545 small ruminants brought from Jigjiga, Babile and Kebribayah districts to the abattoir for slaughter purpose were randomly selected and identified by species, sex, origin, body condition and age. Animals were grouped in to two species (sheep and goats), two sexes (male and female), and two age groups (young and adult) based on dentition standard given by (28). Body condition scoring was carried out based on the handbook given by Ethiopian Sheep and Goat Productivity Improvement Program (5).

2.3. Study Design

A cross-sectional study was designed to perform from November, 2019 to April, 2020 with the aim of study of C. tenuicollis, associated risk factors with it and to assess its direct financial losses on sheep and goats slaughtered at Jigjiga municipal abattoir.

2.4. Sampling Method and Sample Size Determination

The study animals were selected in the livestock market by using simple random sampling method. The randomly selected animals were recorded, marked and followed up through the completely slaughtering process in the abattoir. The sample size for each species required for this study was determined based on the formula given by (29). With 95% confidence interval and 5% desired absolute precision.

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

Where, n = required sample size

P_{exp}= expected prevalence and

d= desired absolute precision

According to the above formula, with previously studied prevalence of 15% and 35% of sheep and goat respectively (30). the calculated sample was 545.

2.5. Study Methodology

2.5.1. Ante-mortem inspection

Pre slaughter examinations of small ruminants were conducted in the lairage by grouping the animals based on species, age, body scores and place of origin. Ante mortem inspections were conducted on individual animals while the animals were entering into the lairage and after they entered in to the lairage in mass. Both sides of the animals were inspected at rest and in motion. Moreover, the general behavior of the animals, nutritional status, cleanliness, and sign of diseases and abnormality of any type were registered according to the standard ante mortem inspection procedures by (31). Following the judgments passed by (32). animal fit for human consumption were allowed for slaughter.

2.5.2. Post-mortem examination

Post-mortem examination was conducted thorough visual inspection, palpation and systemic incision of each visceral organ particularly the lungs, kidneys, liver, spleen, heart, omentum, and mesentery for the presence of C. tenuicollis (33, 9). Cysts were identified based on their morphological basis and predilection sites.

2.6. Assessment of Financial Loss

In assessing the economic losses, only the direct financial loss due to rejection of liver was considered. The analysis was based on annual slaughter capacity of the abattoir considering market demand, average market price on international market and the rejection rate of liver. Financial loss was then computed mathematically by using the formula of (34). for liver rejection as follows:

$EL = \Sigma Srx*Coy*Roz$

Where, EL = Estimated annual economic loss due to organ and carcass condemnation from international or domestic market.

Srx = Annual sheep/ goats slaughter rate of the abattoir

Coy = Average cost of each sheep or goats liver/lung/heart/kidney/brain/carcass.

Roz = Condemnation rates of sheep/goats liver/lung/heart/kidney/brain/carcass.

2.7. Data management and analysis

All data were coded and entered in to Microsoft excel 2013 program and analyzed using STATA 20.0 version. Pearson's chi-square (χ^2) was used to evaluate the association present among the different variables. P-value less than 0.05 (at 5% level of significance) were considered as significant in all analysis.

3. RESULTS

3.1. Over all prevalence

Out of 545 small ruminant slaughtered and examined at Jigjiga municipal abattoir, 98(17.9%) of them were positive for Cysticercus tenuicollis. The prevalence of C. tenuicollis was relatively higher in goats 71(20.3%) than in sheep 27(13.8%) but there was no statistically significant difference (P>0.05) (Table 1).

Table 1: Prevalence of C. tenuicollis in slaughtered sheep and goats

Species	**Examined number**	**Prevalence (%)**	χ^2	**P-value**
Ovine	196	27(13.8)	3.672	0.063
Caprine	349	71(20.3)		

3.2. Risk Factors and Prevalence of C. tenuicollis in Small Ruminants

3.2.1. The prevalence of C.tenuicollis between sex of the species

Cysticercus tenuicollis with respect to sex revealed that higher prevalence in male and lower prevalence in female of both species but statically no significant difference (P>0.05) (Table 2).

Table 2: The prevalence of C.tenuicollis in relation to sex species

Species	**Sex**	**Examined number**	**Prevalence**	χ^2	**p-value**
Ovine	Male	107	16(14.9)	0.275	0.680
	Female	89	11(12.35)		
Caprine	Male	225	51(22.6)	2.108	0.166
	Female	124	20(16.12)		

3.2.2. The prevalence of C. tenuicollis with in age groups of animals

Regarding the age of animals higher prevalence of C. tenuicollis was recorded in adult sheep and goats 20(14.3%), 60(22%) as compared to the young ones 7(12.2%), 11(14.4%), respectively, There was no statistically significant difference between age categories and the disease (P>0.05) (Table 3).

Table 3: The prevalence of C. tenuicollis in relation to age

Species	**No. examined**	**Age**	**Prevalence (%)**	χ^2	**p-value**
Ovine	196	Young (57)	7(12.2)	0.151	0.821
		Adult (139)	20(14.3)		
Caprine	349	Young (76)	11(14.4)	2.066	0.197
		Adult (273)	60(22)		

3.2.3. The prevalence of C. tenuicollis in goats and sheep with different origin

Furthermore, sheep and goat coming from Babile (20.5%, 26.2%) followed by Jigjiga (17.3%, 23.7%) respectively, were highly infected by C. tenuicollis but the least prevalence was recorded in animals coming from Kebribayah district. The difference in prevalence among goat coming from different districts was statistically significant (P<0.05) (Table 4).

Table 4: The prevalence of C.tenuicollis in goats and sheep in relation to origin

Species	**No. examined**	**Origin**	**Prevalence (%)**	χ^2	**P-value**
Ovine	196	Jigjiga(75)	13(17.3)	5.169	0.081
		Babile(39)	8(20.5)		
		Kebribayah(82)	6(7.3)		
Caprine	349	Jigjiga(135)	32(23.7)	9.158	0.010
		Babile(103)	27(26.2)		
		Kebribayah(111)	12(10.8)		

3.2.4. Body condition score and prevalence of C. tenuicollis

Related to body condition the highest prevalence was in poor followed by medium and good body condition scores. There was statistically significant difference between body condition score and the occurrence of C. tenuicollis in goat (P<0.05) (Table 5).

Table 5: Prevalence of C.tenuicollis in goats and sheep in relation to body condition

Species	**Examined**	**Body condition**	**Prevalence (%)**	χ^2	**p-value**
Ovine	196	Good(66)	7(10.6)	1.402	0.511
		Medium(87)	12(13.7)		
		Poor(43)	8(18.6)		
Caprine	349	Good(115)	16(14)	6.354	0.042
		Medium(112)	22(19.6)		
		Poor(122)	33(27)		

3.2.5. Prevalence and organ distribution of C. tenuicollis in sheep and goat

Omentum followed by liver were the most frequently infected organs in both species with a prevalence of goat (17.7% omentum &16.3% Liver) and sheep (12.7% omentum &10.7% Liver). Only few cysts were observed to be attached to the surface of the lung of both goats and sheep (Table 6).

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

Visceral organs	**Caprine**		**Ovine**		χ^2	**P-value**
	Positive	**Prevalence**	**Positive**	**Prevalence**		
Liver	57	(16.3%)	21	(10.7%)	3.230	0.076
Omentum	62	(17.7%)	25	(12.7%)	2.348	0.144
Peritoneum	33	(9.45%)	12	(6.1%)	1.841	0.197
Mesentry	48	(13.7%)	18	(9.1%)	2.463	0.133
Lung	12	(3.4%)	4	(2%)	0.860	0.436

3.3. Estimation of Direct Economic Losses

The average mean annual small ruminants slaughter rate was estimated to be 25200 heads, average liver condemnation rate of the current study was 78(14.3%) and the average international recent market price of single liver was 3USD. Therefore, by substituting all the values in the following formula,

$EL = \Sigma Srx*Coy*Roz$

EL = (25200*3$*0.143)

EL = 10810.8 USD

Total loss = 385621.236 ETB.

The annual financial loss due to liver condemnation was estimated to be 10,810.8 USD$ i.e., approximately 385621.236 ETB (1USD= 35.67 ETB).

4. DISCUSSION

In the current study, out of 545 inspected small ruminant 98 of them were positive for C. Tenuicollis with an overall prevalence of 17.9%. This finding is considered relatively higher than the findings of 15.7% (24). In Iran, 14.6% (35). In (36). Who reported 4.22% from north India. It was lower than the findings of 64.6% by (37). In Bishoftu Elfora Export Abattoir, 39% by (38). in Addis ababa abattoir, and (39). in three export abattoirs (Elfora, Helmex and Luna), (40, 41). in Dire Dawa municipal abattoir who reported 25.8%, 37.1%, 32.7% and 24.6%; respectively. The main reasons of variation in the prevalence mainly accounted to management system prevailing in the local areas and the grazing behavior, and the main causes of the persistence of the disease is the presence of stray dogs in pastures and beside abattoirs(42).

In this study higher prevalence of Cysticercus tenuicollis was found in goats (20.3%) as compared to sheep (13.8%). However, this difference was not found statistically significant. This result is in agreement with the findings of (43). Who reported prevalence of 8.4% in goat and 5% in sheep at Debrezeit, HELMEX Abattoir, (44). With prevalence of 53.9% in goats and 45% in sheep at Bishoftu, Elfora Export Abattoir, and **(45)**. Who recorded a prevalence of 15.8% in goats and 7.81% in sheep at Addis ababa. Similar reports were recorded by (46). (goats 61.1% and sheep 42.2%) in Tanzania,**(47)**. (goats 34.2% and sheep 21.4%) in India and Oryan et al. (2012) recorded the prevalence of 17.52% in sheep and 55.05% in goats in Fars, Southern Iran. The reason behind low prevalence of sheep than goat might be due to the fact that most sheep develops protective immunity earlier than goats which develops the immunity more slowly (48).

Sex-related distribution of C. tenuicollis infection of the slaughtered shoats in this study showed that more males of sheep and goat (14.9%, 22.6%) than female sheep and goat (12.35%, 16.12%) respectively, were infested. This finding is in agreement with the reports of (20). Who recorded a prevalence of 13.66% in male than 11.54% of female and (41). Who found that the highest infection rate was observed in male animals (25.5%) compared to females (23.6%). While this result disagreed with (11). who reported higher prevalence of 17% in female sheep and 21% in female goat than 7% in male sheep and 13% in male goat. Moreover (49). also reported a higher prevalence of 6.54% in female sheep and 6.47% in

female goat than 2.27% in male sheep and 3.15% in male goat. The variations in prevalence rate might be due to physiological and hormonal effect (50).

In this study high prevalence was recorded in adult sheep (14.3%) and in adult goats (22%); whereas, the lowest prevalence was recorded in younger sheep (12.2%) and in younger goats (14.4%). This result agreed with the findings of (51). who reported higher infection rates in adult sheep (38%) and goats (47.2%) compared to young sheep (34.6%) and goats (32.9%), (52). who reported a prevalence of 41.66% and 37.5% in adult goats and sheep, and 29.16%, and 27.5%, in young goats and sheep respectively, and (53). reported higher prevalence of C.tenuicollis in adult sheep and goat (6.36% and 23%) than young sheep and goat (6% and 11.6%) respectively. The highest infection rate in older animals than in younger ones might be due to decreased immunity in older animals than younger ones (54).

In this study the prevalence of C. tenuicollis based on animal origin was relatively higher for goats (26.2%) and sheep (20.5%) originated from Babile than goats and sheep from Jigjiga (23.7%, 17.3) and kebribayah (10.8%, 7.3%) respectively. There was statistically significant differences in goats ($P<0.05$) coming from different areas while among sheep was non-significant ($P>0.05$). This was in agreement with the findings of (55). who reported high prevalence of sheep and goat (60.07% and 68.06%) brought from highland than those from lowland (53.47%, 59.725) respectively. Similarly, (25). reported the prevalence of (58.1%) in goats and (46.5%) in sheep from highland areas in compared to goats (35.2%) and sheep (33.8%) from lowland areas. The difference in the prevalence of different places in this study may be due to the difference in management practice, environmental factors, and the presence of stray dogs, and uncontrolled movement of wildlife.

In the current study, C. tenuicollis in relation to body conditions higher prevalence was recorded in poor body condition of sheep and goat (18.6%, 27%) than medium (13.7%, 19.6%) and good (10.6%, 14%) body scores respectively, with significant difference in goat ($P<0.05$). This finding is in line with the report of (48, 56 and 57). from Northern Jordan, Turkey and Central Ethiopia respectively. When all studied animals considered together, still the prevalence significantly varied ($P < 0.05$) with body condition. This variation may be due to 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 conditioned animals (41).

Among the predilection sites observed during this study omentum followed by liver were found to be the predominant sites for C.tenuicollis. This agreed with the observations of (58, 59 and 60). Who reported that omentum is predominant predilection site for C. tenuicollis. While this result disagreed with the findings of (49 and 61). who found that the cysts were significantly present in the liver than any other organ. Omentum preference by C.tenuicollis may be due to the fact that omentum covers larger surface area in the peritoneal cavity than other tissues. On the other hand C. tenuicollis preference of liver may be due to the presence of large amount of protein, carbohydrates and other essential elements which absorbed by the parasite (62).

The economic losses incurred during this study as a result of condemnation or rejection of organ from sheep and goats infested by C. tenuicollis was estimated to be: 10,810.8USD$ i.e. approximately 385,621.236ETB. This result was lower than the report of (36). With estimated economic loss of 1836100ETB and (56). Who estimated an economic loss of 1,044317.79 ETB from condemned liver.

5. CONCLUSIONS AND RECOMMENDATIONS

Cysticercus tenuicollis is the larval stage of adult worm T. hydatigena which infects canines like dogs as final host and a number of ruminants as intermediate host. Besides its animals health risk this metacestode attributed to meaningful financial losses from organ condemnation. The abattoir survey evidence of the present study showed that the disease is prevalent in the study area with an overall prevalence of 17.9% and this result in extensive financial loses about 385,621.236ETB. However, the prevalence in this study was lower as compared to previous studies performed in other parts of Ethiopia. Lack of knowledge about the disease, the presence of freely roaming stray dogs on grazing land, the deep rooted habit of feeding dogs with ruminant offal, backyard slaughtering of animals and inappropriate disposal of abattoir materials were potential predisposing factors which contribute to persisting of the disease in the study area. Based on these conclusions, the following recommendations are worth mentioning:

- Backyard and road side slaughtering practices should be prevented by putting the law and regulation of meat inspection into action.
- Immediate, safe and controlled elimination of all condemned abattoir materials and the sale of contaminated offal and heads as dog's feed should be prohibited by law.
- Enhances the awareness of the animal attendants, farmers, customers, abattoir works and butchers about proper disposal of condemned offal`s by giving them country wide education in collaboration with the government.
- Regular deworming of small ruminants and dogs.
- Elimination of stray dogs should be practiced.

DECLARATION

Ethical approval

This research was approved by the Research Ethics Review Committee of school veterinary medicine, Jigjiga University. The study was conducted in compliance with the ARRIVE 2.0 guidelines. All methods were carried out in accordance with relevant guidelines and regulations. Before conducting the study, the objectives, expected results, and benefits of the study were explained to the abattoir workers and the required permission was obtained from Jigjiga city municipality.

Consent for publication

Not applicable

Availability of data and materials

The datasets during the current study are available from the corresponding author on reasonable request.

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