Original Research Article

PREVALENCE, CYSTS DISTRIBUTIONS, ASSOCIATED RISK FACTORS AND ECONOMIC IMPORTANCE OF CYSTICERCUS TENUICOLLIS IN SMALL RUMINANT SLAUGHTERED AT JIGJIGA MUNICIPAL ABATTOIR, JIGJIGA, SOMALI REGION, ETHIOPIA

ABSTRACT

A cross-sectional study was done between November 2019 and April 2020 with the goal of identifying the prevalence of cysticercus tenuicollis in small ruminants, evaluating possible risk factors associated with it, and estimating the amount of the direct economic losses associated with condemned organs. A total of 545 small ruminants 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%) were recorded to be affected with *C. tenuicollis*. From the 349 inspected goats, C. tenuicollis was found in 71 (20.3%), and from the 196 inspected sheep, 27 (13.8%). The prevalence of *C. tenuicollis according to their* sex was higher in male sheep 16(14.9%) and goats 51(22.6%) than female sheep 11(12.35%) and goat 20(16.12%). The infection rate of *C. tenuicollis* in regards to age group revealed that a higher incidence 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 a statistically significant variations ($P<0.05$) among goats coming from various areas. Related to body condition scores and the disease, higher prevalence was noted 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 revealed the highest proportions of *C.tenuicollis* in omentum followed by liver than any other organs. During the active abattoir investigation, a total of about 385,621.236 ETB (10,810.8 USD$) were lost due to organ condemnation. The findings imply that C. tenuicollis is widespread, may cause health Problems for shoats, and may lead to economic loss for the country. This indicates that the problem must be controlled by reducing the number of stray dogs, deworming dogs, avoiding backyard executions, and properly disposing of infected viscera.

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

1. INTRODUCTION

With an estimated 57.83 million cattle, 28.89 million sheep, 60.51 million poultry, and 29.7 million goats, excluding nomadic areas, Ethiopia is thought to have Africa's largest livestock population (1). Approximately 30% of the country's GDP and 45% of the agricultural GDP are contributed by the subsector (2). Additionally, it accounts for 15% of export revenue (3).

Sheep and goats play a significant role in the livestock subsector because they account for more than 30% of the meat consumed locally and are a crucial revenue generator for the nation's small-scale farmers (4). Even though they only make up 7% of the typical total investment of capital in livestock in the mixed crop-livestock production system, they generate 40% of the earnings in cash and 19% of the overall worth of the food produced for subsistence on a yearly basis (5).

Although sheep and goats have enormous potential, their advantages don't yet match their huge potential. Veterinary care, a lack of government attention, and widely prevalent endemic diseases have caused significant losses in the animal industry each year, which are thought to be a bottleneck for the growth of this industry (6, 7, 8, and 9).

The larval stage of the taeniid cestode Taenia hydatigena is known as Cysticercus tenuicollis. Canine animals like dogs and foxes have adult worms in their small intestines, but both domestic and wild intermediate ruminant hosts have metacestodes (10).

Mostly the disease is perpetual and asymptomatic which cannot be detected until slaughter (11). The migrating larvae in live small ruminants could result hepatitis, burrowing canal, granular degeneration, deposition of serofibrinous exudates and in lungs it causes pneumonia (12, 13), And in very heavy infections, it may result in eosinophilic infiltration and severe inflammation that may prove to be fatal (14).

The incidence of the C. tenuicollis infestation varies geographically and is typically higher in nations with less stringent sanitary regulations and an unrestrained wild carnivore population (15). The prevalence of 37.03% and 27.29% have been noted in sheep and in goats, respectively in India (16. In Nigeria, a prevalence of 21.4% in sheep and 34.2% in goats has been found by (17). In Iran, a prevalence of 12.84% in sheep and 18.04% in goats was obtained by (18). In Ethiopia a prevalence of 40.0% and 46.6% in sheep and goat was reported by (19). respectively, at Addis Ababa abattoir.

The parasite Cysticercus tenuicollis in small ruminants caused significant organ condemnation in Ethiopia's abattoir sector, resulting in significant economic loss (20). In spite of the fact that various studies have been carried out to identify the prevalence of parasitic diseases leading to organ condemnation in Ethiopia (21). In most cases, they did not pay much attention to the study of *C. tenuicollis*. however, the purpose of this

study were to identify the prevalence and associated risk factors and economic losses of organ condemnation of *C. tenuicollis* in small ruminants slaughtered in Jigjiga municipal abattoir,

2. MATERIALS AND METHODS

2.1. Descriptions of study area

The study was done in Jigjiga municipal abattoir. Jigjiga, the capital of Ethiopia's Somali Regional State (SRS), is 630 kilometers from Addis Ababa in the country's Eastern region. Jigjiga is situated at roughly 90200 North latitude and 450560 East longitudes, or an altitude of between 1,660 and 1,710 meters above sea level.

2.2. Study Population

A total of 545 shoats brought from Jigjiga, Babile, and Kebribeyah districts to the abattoir for slaughter purposes were randomly selected and identified by species, sex, origin, body condition, and age. Animals were grouped into two species (sheep and goats), two sexes (male and female), and two age groups (young and adult) based on the dentition standard given by (22). Based on the manual provided by the Ethiopian Small Ruminants Productivity Improvement Program (5), body condition scoring was done.

2.2. Study Design

In order to study C. tenuicollis, its risk factors, and determine its direct financial losses on shoats slaughtered at Jigjiga Municipal Abattoir, a cross-sectional study was intended to be done from November 2019 to April 2020.

2.3. Sampling Method and Sample Size Determination

in This study, shoats were chosen in the livestock market by using a simple random sampling method. The randomly selected animals were recorded, marked, and followed up through the entire slaughtering procedure in the abattoir. The formula provided by (23) was used to identify the required sample size for each species in this study. with a desired absolute precision of 5%, and a confidence interval of 95%.

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

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 (24). the calculated sample was 545.

2.4. Study Methodology

2.4.1. Ante-mortem inspection

Sheep and goat were examined in the lairage prior to slaughter by grouping the animals according to species, age, body scores, and place of origin. Both before and after the animals entered the lairage in large groups, ante mortem inspections were carried out on each individual animal. At rest and in motion, the animals' entire sides were examined. Additionally, the animals' general behavior, nutritional status, cleanliness, and any signs of diseases or abnormality of any kind were recorded in accordance with the required ante-mortem inspection procedures by (25). Animals fit for human consumption were approved for slaughter in accordance with the decision made by (26).

2.4.2. Post-mortem examination

Each visceral organ, in particular the lungs, kidneys, liver, spleen, heart, omentum, and mesentery, was thoroughly examined post-mortem for the exsistance of C. tenuicollis through thorough visual inspection, palpation, and systemic incision (27, 9). Based on their morphological foundation and predilection sites, cysts were identified.

2.5. Financial Loss Assessment

Only the direct financial loss caused by the condemnation of the liver was taken into account when calculating the economic losses. The analysis was conducted using the abattoir's annual slaughter capacity while taking market demand, the average market price on the global market, and the liver rejection rate into account. The formula in (28) was then used to mathematically calculate the financial loss. for liver rejection as the following:

$EL = \Sigma Srx*Coy*Roz$

Where EL stands for Estimated Annual financial Loss brought on by Organ and Carcass Rejection from Domestic or International Market.

Srx = the abattoir's annual sheep/goat slaughter rate.

Coy = Average Price of Each Liver, Lung, Heart, Kidney, Brain, and Carcass of Sheep or Goat.

Roz = the condemnation rates for the liver, kidney, heart, lung, and carcass of sheep and goats.

2.6. Analyzing and managing data

All data were coded, put into the Microsoft Excel 2013 program, and analyzed using STATA 20.0 version. To assess the degree of association between the various variables, Pearson's chi-square (χ^2) was employed. All analyses were deemed significant if the P-value was less than 0.05 (at the 5% level of significance).

3. RESULTS

3.1. Overall prevalence

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

Table 1: Prevalence of *C. tenuicollis* in slaughtered shoats

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 of *C. tenuicollis* in small ruminants

3.2.1. The prevalence of *C. tenuicollis* among the species' varies sexes

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

Table 2: The prevalence of *C. tenuicollis* with respect to sex

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* within age groups of sheep and goats

Regarding the age of animals higher prevalence of *C. tenuicollis* was showed 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 variations between age categories and the disease *(P>0.05)* (below Table).

Table 3: The prevalence of *C. tenuicollis* in regards 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 small ruminants 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 goats coming from different districts was statistically significant (P<0.05) (Table 4).

Table 4: 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*

In terms of body condition, poor body condition scores had the highest prevalence, followed by medium and good scores. Body condition score and *C. tenuicollis* prevalence in goats showed a statistically significant difference (P <0.05) (Table 5).

Table 5: Link between *C. tenuicollis* prevalence and body condition in small ruminants

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. Cyst distribution in organs of *C. tenuicollis* *and* Prevalence in shoats

Omentum followed by liver were the most common infected organs in both species, with a prevalence of goat (17.7% omentum and 16.3% Liver) and sheep (12.7% omentum &10.7% Liver). In both goats and sheep, only a few cysts were found to be connected to the lung's surface (Table 6).

Table 6: The differences between prevalence 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
Mesentery	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 Financial Losses

The average mean annual shoats slaughter rate was approximately 25200 heads, average liver condemnation rate of the current study was 78(14.3%) and the average international recent market cost of single liver was 3USD. Thus, by replacing all the values in the following formula,

EL = ΣSrx*Coy*Roz

EL = (25200*3$*0.143)

EL = 10810.8 USD

Total loss = 385621.236 ETB.

The estimated annual financial loss as a result of liver condemnation was 10,810.8 USD$, or roughly 385621.236 ETB (1USD=35.67 ETB).

4. DISCUSSION

In the current study, out of 545 small ruminants inspected, 98 were infected for *C. tenuicollis* with an overall prevalence of 17.9%. This result is considered relatively higher than the findings of 15.7% (18). In Iran, 14.6% (29). In (30). Who reported 4.22% from north India. It was lower than the findings of 64.6% by (31) In Bishoftu Elfora Export Abattoir, 39% by (32) In Addis ababa abattoir, and (33) In three export abattoirs (Elfora, Helmex and Luna), (34, 35) In Dire Dawa municipal abattoir, who reported 25.8%, 37.1%, 32.7% and 24.6%; respectively. The main explanations for differences in the prevalence are primarily attributed to management systems dominant in the local areas and the grazing behavior, and the essential factor leading to the perseverance of the disease is the existence of stray dogs in pastures and beside abattoirs (36).

The current finding, higher prevalence of *Cysticercus tenuicollis* in goats (20.3%) as in contrast to sheep (13.8%). But this variation was not found to be statistically significant. This outcome is higher than the results of (37), Who noted a prevalence of 8.4% in goats and 5% in sheep at Debrezeit, HELMEX Abattoir,and report of (38), Who found a prevalence of 15.8% in goats and 7.81% in sheep at Addis ababa.. The present report was lower than the findings of (39) With prevalence of 53.9% in goats and 45% in sheep at Bishoftu, Elfora Export Abattoir, reports were recorded by (40) with the results of goats 61.1% and sheep 42.2%) in Tanzania, by (41) with results of goats 34.2% and sheep 21.4%) in India and (42) with the prevalence of 17.52% in sheep and 55.05% in goats in Fars, Southern Iran. The low prevalence of sheep compared to goats may be caused by the fact that sheep typically develop protective immunity sooner than goats, whose immunity develops more slowly (43).

According to this study's analysis of the distribution of *C. tenuicollis* infections among slaughtered sheep, more male sheep and goats (14.9% and 22.6%, respectively) than female sheep and goats (11.35 and 16.12%) were infected. This result is inline with the reports of (14), Who recorded a prevalence of 13.66% in males and 11.54% in females and (35), Who showed that the highest prevalence was noted in male animals (25.5%) compared to females (23.6%). This result disagreed with (10), which revealed a higher prevalence of 17% in female sheep and 21% in female goats than 7% in male sheep and 13% in male goats. Moreover, (44) also found a higher prevalence of 6.54% in female sheep and 6.47% in female goats than 2.27% in male sheep and 3.15% in male goats. The variations in prevalence rate might be due to physiological and hormonal effects (45).

In this finding, high prevalence was found in adult sheep (14.3%) and adult goats (22%); whereas, the lowest prevalence was noted in younger sheep (12.2%) and younger goats (14.4%). This result inlines with the findings of (46), who found higher infection rates in adult sheep (38%) and goats (47.2%) contrasted to young sheep (34.6%) and goats (32.9%), (47), who showed 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 (48), who found a higher prevalence of C. *tenuicollis* in adult sheep and goat (6.36% and 23%) than in young sheep and goat (6% and 11.6%) respectively. It is possible that older animals have lower immunity than younger ones, which would explain why they have a higher infection rate (49).

According to animal origin, the prevalence of C. tenuicollis in this study was relatively higher in goats (26.2%) and sheep (20.5%) that were sourced from Babile than in goats and sheep that were sourced from Jigjiga (23.7%, 17.3) and kebribayah (10.8%, 7.3%), respectively. There were statistically significant differences in goats ($P<0.05$) coming from different areas while among sheep were non-significant ($P>0.05$). This was in line with the results of (50), Who found higher prevalence of sheep and goats (60.07% and 68.06%) brought from highland than those from lowland (53.47%, 59.725), respectively, and Similarly, (19), who reported an infection rate of (58.1%) in goats and (46.5%) in sheep from highland areas contrasted to goats (35.2%) and sheep (33.8%) from lowland areas. The variations in prevalence of different places in this study may be due to distinctions in management practice, environmental factors, and the presence of stray dogs, and uncontrolled movement of wildlife.

In regards to the body conditions, in this study *C. tenuicollis* prevalence was noted in poor body conditions of sheep and goat (18.6%, 27%) compared to medium (13.7%, 19.6%) and good (10.6%, 14%) body scores respectively, with significant difference in goat ($P<0.05$). This result is in line with the findings of (43, 51, and 52), which were conducted in Northern Jordan, Turkey and Central Ethiopia respectively. This might be because animals' immune systems are weakened by gastrointestinal internal parasite infections and nutritional deficiency or scarcity. Therefore, it is possible that this explains why the cyst is more common in animals with poor body conditioning (35).

Among the predilection sites noted during this study, the omentum, followed by liver, were shown to be the most common sites for C. *tenuicollis*. This agreed with the observations of (53, 54, and 55), Who found that omentum is the common predilection site for *C. tenuicollis*. While this result disagreed with the findings of (44 and 56), Who found that the cysts were significantly more present in the liver than any other organ. Omentum preference by *C. tenuicollis* is because it may favor omentum because it covers a larger surface area in the peritoneal cavity than other tissues. C. tenuicollis' preference for liver, could be due to the large amount of protein, carbohydrates, and other essential elements that the parasite absorbs (57).

The estimated financial losses incurred during this study as a result of the rejection or condemnation of organs from sheep and goats infected with *C. tenuicollis* were: 10,810.8 USD, or roughly 385,621.236 ETB. This finding was lower than the results of (30), with an estimated financial loss of 1836100 ETB, and (51), Who estimated an economic loss of 1,044317.79 ETB from condemned liver.

5. CONCLUSIONS

Cysticercus tenuicollis is the larval stage of adult worm *T. hydatigena* that infects canines like dogs as final host and a number of ruminants as intermediate host. Besides its animal health risk, this metacestode is attributed to meaningful financial losses from organ condemnation. The abattoir survey data of the current study found that the disease is prevalent in the study area with an overall prevalence of 17.9%, and this resulted in extensive financial losses of about 385,621.236 ETB. However, the prevalence in these results was lower as compared to previous studies performed in other parts of Ethiopia. Lack of awareness about the disease, the existence of stray dogs that roam freely on grazing land, the deep rooted habit of feeding dogs with sheep and goats offal, backyard slaughtering of animals, and inappropriate disposal of abattoir materials were potential causing factors that played a role to the persistence of the disease in the study area.

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.

Competing of Interest

The authors declare that they have no Competing of interest.

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Author's contribution

AA, designed the study, did part of the fieldwork, laboratory works, MA, analyzed part of the data, wrote the manuscript and participated in the write-up. AA, analyzed the data, supervised the study, SA, enriched the manuscript. All authors have read and approved the final manuscript.

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6. REFERENCE

1. Central Statistical Agency (CSA) (2016): Agricultural Sample Survey Report On Livestock and Livestock Characteristics. Addis Ababa, Ethiopia. Pp. 1-188.
2. Roger, B., Robert, C., and Tom, S. (2003): Pro-Poor Livestock Policy Initiative, a study of the role of livestock in poverty reduction strategy papers. A living from livestock PPLPI working paper no. 1.
3. Behnke, R. (2010): The Contribution of Livestock to the Economies of IGAD Member States: Study Findings, Application of the Methodology in Ethiopia and Recommendations for Further Work. UK: Odessa Centre, IGAD Livestock Policy Initiative, Great Wolford; IGAD LPI Working Paper 02-10.
4. ILCA, (2007): International livestock center for Africa annual report. Addis Ababa, Ethiopia.
5. ESGPIP, (2008): Sheep and Goat Production Handbook for Ethiopia. From http://www.esgpip.org/HandBook/Handbook_PDF/00_prelims. Pdf.
6. Dabassa, G., Tefera, M., and Addis, M. (2013): Small ruminant brucellosis: serological survey in Yabello District, Ethiopia. Asian J. Anim. Sci. 7:14-21.
7. Abdela, N., and Jilo, K. (2016): Impact of Climate Change on Livestock Health: A Rev. Glob. Vet. 16(5):419-424.
8. Jilo, K., Abdela, N., and Adem, A. (2016): Insufficient Veterinary Service as a Major Constrants in Pastoral Area of Ethiopia: A Review. J. Biol. Agric. Healthcare 6(9):94-101.

9. Abdela, N. (2016): Important Cattle Ticks and Tick Born Haemoparasitic Disease in Ethiopia. Rev. Acta Para. Glob; 7(1):12-20.
10. Omar, E., Elmajdoub, O., Al-Aboody, S., Elsify, M., Elkhtam, O., & Hussien, A. (2016): Molecular characterization of Cysticercus tenuicollis of slaughtered livestock in Upper Egypt governorates. Asian Pacific Journal of Tropical Biomedicine, 6(8):706-708.
11. Christodoulopoulos, G., Theodoropoulos, G., and Petrakos, G. (2008): Epidemiological survey of cestode-larva disease in Greek sheep flocks. Vet. Para. 153: 368-373.
12. Nath, S., Pal, S., Sanyal, K., Ghosh, C., and Mandal, S. (2011): Histopathology of hepatitis cysticercosa in goat. Journal of Veterinary Parasitology, 25(2):187-188.
13. Shivasharanappa, N., Gururaj, K., Sharma, K., Reddy, B., and Vihan, S. (2011): Acute hepatic and pneumonic cysticercosis in Barbari goats. Indian Journal of Veterinary Pathology, 35:80-81.
14. Saulawa, A., Magaji, A., Faleke, O., Mohammed, A., Kudi, C., Musawa, L., Sada, A., Ugboma, N., Akawu, B., Sidi, S., Lawal, N., and Ambursa, U. (2011): Prevalence of Cysticercus tenuicollis cysts in sheep slaughtered at Sokoto abattoir, Sokoto state, Nigeria. Sokoto Journal of Veterinary Sciences, 9(2):24-27.
15. Budka, H., Buncic, S., Colin, P., Collins, J. (2004): Opinion of the Scientific Panel on Biological Hazards on a request from the Commission related on Revision of Meat Inspection Procedures for Lambs and Goats. EFSA J., 54: 1–49.
16. Pathak, M., and Gaur, N. (1982): The incidence of adult and larval stage of Taenia hydatigena in Uttar Pradesh (India). Vet. Parasitol., 10: 91-95.
17. Dada, J., and Belino, D. (1978): Prevalence of hydatidosis and cysticercosis in slaughtered livestock in Nigeria. Vet. Rec. 103: 311-312.
18. Radfar, H., Jajalli, S., and Jalazadeh, M. (2005): Prevalence and morphological characterization of C. tenuicollis (T. hydatuigena cysticercii) from sheep and goats in Iran. Veterinarski archiv, 75: 469-476.
19. Woinshet, S. and Girma, G. (2010): Prevalence, risk factors and distribution of Cysticercus tenuicollis in visceral organs of slaughtered sheep and goats in central Ethiopia. Trop Anim. Health. Prod. 42:1049–1051.
20. Yehualashet, A., Aklilu, K., and Tsegaye, A. (2012): 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. Journal of veterinary medicine and animal health, 5: 1-7.
21. Yimam, M. (2003): Major causes of organ condemnation in ruminants slaughtered at Gonder abattoir, North-western Ethiopia.DVM Thesis. Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia.

22. Vatta, F. (2005): Goat and Sheep keepers' veterinary manual. Onderstepoort veterinary institute, private bag underreports, South Africa. 98: 26-30.
23. Thrusfield, M. (2005): Veterinary epidemiology (3rd ed.). Blackwell Science Ltd, UK, 182- 198.
24. Sisay, M., Uggla, A., and Waller, P. (2007): Prevalence and Seasonal Incidence of Nematode Parasites and Fluke Infestation of Sheep and Goat in Eastern Ethiopia. Trop. Anim. Health Prod., 39: 521-531.
25. Gracey, F. (1986): Meat Hygiene. 8th edn. Baillere Tindall, London.
26. FAO, (1994): Meat inspection manual for developing countries, Rome, Italy.
27. Getaw, A., Beyene, D., Ayana, D., Megersa, B., and Abunna, F. (2010): Hydatidosis: Prevalence and its economic importance in ruminants slaughtered at Adama municipal abattoir, Central Oromia, Ethiopia. Acta Tropica, 113: 221-225.
28. Ogunrinade, A., and Ogunrinade, B. (1980): Economic importance of bovine fasciolosis in Nigeria. Anim. Health Prod., 12(3): 155-159.
29. Scala, A., Pipia, P., Dore, F., Sanna, G., Tamponi, C., Marrosu, L., Bandino, E., Carmona, C., Boufana, B., and Varcasia, A. (2015): Epidemiological updates and economic losses due to Taenia hydatigena in sheep from Sardinia, Italy. Parasitol. Res.114:3137-3143.
30. Singh, B., Sharma, R., Gill, S., and Sharma, K. (2015): Prevalence and morphological characterisation of Cysticercus tenuicollis (Taenia hydatigena cysts) in sheep and goat from north India. J. Para. Dis. 39(1):80-84.
31. Yalelet, A., Tekalign, T., and Zenebe, R. (2019): Study on Prevalence of Small Ruminant Cysticercus Tenuicollis and its Monetary Loss at Bishoftu Elfora Export Abattoir, Oromia, Ethiopia. Dairy and Vet Sci J.; 9(2): 555759.
32. Bejiga, T., Haile, A., Solomon, T., Sefir, D., and Pal, M. (2016): Prevalence of Cysticercus Tenuicollis in Small Ruminants Slaughtered at Addis Ababa Abattoir, Ethiopia. World. Vet. J. 6(3): 137-142.
33. Adem, A. (2006): Metacestodes of small ruminants: prevalence at three export abattoirs (Elfora, Hashim and Luna), MSc Thesis, FVM, Addis Ababa University, Ethiopia.
34. Endale, M., Shihun, S., Jemere, B., and Desie, S. (2013): Sheep and goats Cysticercus tenuicollis prevalence and associated risk factors, Afri. J. Agri. Res. 8(24): 3121-3125.
35. Mekuria, E., Shimelis, S., Bekele, J., and Sheferaw, D. (2013): Sheep and goats Cysticercus tenuicollis prevalence and associated risk factors. Afri. J. Agri. Res. 8(24): 3121-3125.
36. Morais, F., Ribeiro, L., Feitosa, F., dos Santos, M., Gouveia, R., and Athayde, R. (2016): "Prevalence and~ risk factors for Cysticercus tenuicollis in goats and sheep in Paraíba, northeastern Brazil". Brazilian J. Vet. Parasitol, Jaboticabal. 26(2): 235-238.

37. Hussen, M., Hussen, S., Chali, G., and Abdurahaman, M. (2017): Parasitic Cause of Organ and Carcass Condemnation in Small Ruminant Slaughtered at Helmex Abattoir, Debrezeit, Ethiopia. Inter. J. Res. Stud. Biosc. (IJRSB). 5:22-30.
38. Abdulatif, A., Tsegay, A., and Mammo, B. (2015): Prevalence, Cyst Distribution in Visceral Organs and Economic Loss of Cysticercus tenuicollis in Small Ruminants Slaughtered at Bishoftu, Elfora Export Abattoir: Am-Euras. J. Sci. Res., 10 (4): 210-220.
39. Bayu, Y., Asmelash, A., Zerom, K., and Ayalew, T. (2013): 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. J. Vet. Med. Anim. Health. 5(1): 1-7.
40. Miran, B., Kasuku, A., and Swai, S. (2017): Prevalence of echinococcosis and Taenia hydatigena cysticercosis in slaughtered small ruminants at the livestock-wildlife interface areas of Ngorongoro, Tanzania, Vet. World. 10(4):411-417.
41. Nimbakar, K., Shinde, S., Kamtikar, N., and Muley, P. (2011): Study on Taenia hydatigena in the slaughtered sheep (Ovis bharal) and goats (Capra hircus) in Maharashtra, India. Glob. Vet. 6(4): 374-377.
42. Oryan, A., Goorgipour, S., Moazeni, M., and Shirian, S. (2012): Abattoir prevalence, organ distribution, public health and economic importance of major metacestodes in sheep, goats and cattle in Fars, Southern Iran. Trop. Biomed., 29(3): 349-359.
43. Torgerson, P., Williams, D., and Abo-Shehada, M. (1998): Modelling the prevalence of Echinococcus and Taenia species in small ruminants of different ages in northern Jordan. Vet. Parasitol., 79: 35-51.
44. Mirzaei, M. and Rezaei, H. (2015): Role of goats and sheep in the epidemiology of Cysticercus tenuicollis in Tabriz, Northwest Iran. Comp. Clin. Pathol. J. 24(2):441-444.
45. Mokhtaria, K., Fadela, S., Ammar, M., Belcacem, T., Ammar, A., Ameur, S. & Abdelkader, B. (2018): Cysticercus tenuicollis in small ruminants of Algeria: abattoir survey, biochemical and morphological characterizations. Bulgarian J. Agri. Sci. 24(4): 698–703.
46. Guadu, T., Akalu, A., Fentahun, T., and Chanie, M. (2012): Cysticercus Tenuicollis: Occurrence at Hashim Nur's Meat Export Abattoir, Debre - Zeit, Ethiopia . Advan. Biol. Res. 6(6): 221-225.
47. Haddawee, H., Sulbi, M., and Abass, F. (2018): Prevalence of Cysticercus tenuicollis in slaughtered sheep and goats by season, sex, age, at Karbala abattoir, Iraq. Sci. J. Med. Res. 2 (5): 52-56.
48. Gezahegn, E., Abera, B., Assefa, D., Yunus, H. (2017): Major Causes of Liver Condemenation and its Economic Significance in Small Ruminanats Slaughtered at Luna Export Abattoir, East Shoa Zone, Centeral Ethiopia. J. Vet. Sci. Technol. 8: 422.
49. Bhaskararao, T., Varaprasad, V., and Hafeez, D. (2003): Prevalence of Cysticercus tenuicollis infection in slaughtered sheep and goats at Kakinada, Andhra Pradesh. Para. Dis. J. 27(2):126-127.

50. Wondimu, A., Abera, D., and Hailu, Y. (2011): A study on the prevalence, distribution and economic importance of Cysticercus tenuicollis in visceral organs of small ruminants slaughtered at an abattoir in Ethiopia. J*ournal of Veterinary Medicine and Animal Health,* 3(5): 67-74.
51. Senlik, B. (2008): Influence of host breed, sex and age on the prevalence and intensity of C. tenuicollis in sheep. J. Anim. Vet. Adv., 7(5):548-551.
52. Samuel, G., And Zewde, G. (2010): Prevalence, risk factors, and distribution of C. tenuicollis in visceral organs of slaughtered sheep and goats in central Ethiopia. Trop. Anim. Health Prod., 42:1049-1051.
53. Biu, A. and Murtala, S. (2012): Studies on Cysticercus tenuicollis infection in slaughtered sheep and goats in Maiduguri, Nigeria. Continental Vet. Sci. J., 6(1):14-18.
54. Fahmi, A. (2014): Studies on Larval Cestodes Infecting Sheep and Cattle." M.V.Sc. Thesis presented to Cairo University, Faculty of Veterinary Medicine, Department of Parasitology.
55. Gessese, T., Mulate, B., Nazir, S., and Asmare, A. (2015): Major metacestodes in small ruminants slaughtered at Dessie municipal abattoir, Eastern Ethiopia: prevalence, cyst viability, organ distribution and economic implications. Comp. Clinic. Path. J. 24 (3):659-668.
56. World Organisation for Animal Health (OIE) (2008) OIE Terrestrial Manual 2008, Chap. 2.1.4. In: Echinococcosis/Hydatidosis, Paris, pp 175–189
57. Essa, M., and Al-Azizz, A. ((2011): Studies on cysticercus tenuicollis collected from slaughtered sheep and goats in Basrah abattoir, Iraq. Egypt. J. Exp. Biol. (Zool.). 7(2): 343–347.