World Applied Sciences Journal 38 (5): 375-385, 2020
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2020.375.385

Metacestodes in Sheep and Goats Slaughtered at Three Selected Export Abattoirs in Central Oromia: Prevalence, Cyst Characterization and Assessment of Financial Losses

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Abstract: A cross sectional study was conducted with the aim of determining the prevalence of metacestodes, organ distribution, fertility rate, cyst burden and assessing financial losses in sheep and goats slaughtered at selected export abattoirs in central Oromia namely, Bishoftu Abyssinia, Elfora and Modjo Allana. Routine ante-mortem and post-mortem examination were conducted using routine procedures. Post-mortem examination was conducted by visual inspection, palpation and systemic incision of each visceral organ. In this study, *Cysticercus ovis, Cysticercus tenuicollis* and hydatid cysts were detected with the overall prevalence of 29.2 % (224/768). Out of 384 goats examined, 8 (2.1%), 44 (11.5%) and 33 (8.6%) were found to be infected with *C. ovis*, *C. tenuicollis* and hydatid cysts, respectively with over all prevalence of 22.1% (85/384). Similarly a total prevalence of 139 (36.2%), 22 (5.7%), 64 (16.7%) and 53 (13.8%) were detected in 384 sheep carcass examined with similar pattern of metacestodes species. Statistically significant variation was observed in prevalence of cystsbased on the body condition and agro ecology of animals ($P<0.05$). In this study, 436 total cysts (34 *C. ovis*, 239 *C. tenuicollis* and 163 hydatid cysts) were counted in total infected in sheep 247 (56.7%) and goats 189 (43.3%) respectively. Meanwhile, *C. ovis* was only found in the heart, while *C. tenuicollis* in slaughtered sheep and goats was found mainly in the omentum while hydatid cysts all detected in the lungs than liver and kidneys. In both sheep and goats, high fertile and viable cysts of *C. tenuicollis* were found in omentum while that of hydatid cysts were found in lungs. Cyst size measurement on a total of none calcified *C. tenuicollis* in goats (105) and sheep (130) shows, 32 and 28 were small, 51 and 65 medium and 22 and 37 large in size in goats and sheep respectively. Out of none calcified hydatid cysts in goats (59) and sheep (85), 15 and 20 were small, 35 and 47 medium and 9 and 18 large in size, respectively. All 34 none calcified *C. ovis* cysts were small in both species. In this study; an overall annual financial losses due to organ condemnation from total infected animals was estimated to be: 1036505 ETB (37018 USD). These results suggest that the occurrence of the metacestodes infection in goats and sheep is a great concern for both medical and veterinary authorities. Thus, the development of effective disease management and awareness creation works among public required to overcome these problems.

Key words: Financial Losses · Goats · Prevalence · Public Awareness · Sheep · Oromia

INTRODUCTION

Small ruminants are widely reared in a crop-livestock farming systems and are distributed across different agro-ecological zones of Ethiopian [1]. They are source of income by providing a vast range of products such as meat, milk, wool, skin and manure [2]. They are also major source of foreign currenciesinseveral export abattoirs that export sheep and goats chilled meat mainly to the Middle East and North and West African countries [3] majority of which are located in Central Oromia (Bishoftu and Modjo).

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Diseases caused by parasites directly affect health and productivity of the animals andhuman beings with consequences for food safety, trade and rural development [4, 5]. In Ethiopia, the overall economic loss from meat industry due to parasitic diseases is estimated at 400 million Ethiopian birr (ETB) annually [6]. Cestodes from family Taeniidae infect dogs and humans as the definitive host and are transmitted to a wide range of ruminants where they cause coenurosis, hydatidosis and cysticercosis [7, 8]. Small ruminants have an increased risk of being infected by different *Taenia* species due to contamination of the grazing environment [9, 10] and they play a vital role in transmission of the disease [11]. Infection with metacestodes represents a serious problem in endemic areas and is known to cause mortality, morbidity and meat condemnation contributing to significant financial losses [12-14]. They have also both aesthetic and food safety implications [15, 16].

Despite of these, there is paucity information on the current status of metacestodes of small ruminants, their financial implications and public awareness in central Oromia. The objectives of this study were therefore to Abule [1] estimate the prevalence of metacestodes in small ruminants slaughtered in three selected export abattoirs of central Ethiopia [2] determine cyst burden, organ distribution and characterization [3] assess the monetary losses from organ/carcass condemned due to metacestodes.

MATERIALS AND METHODS

Description of the Study Area: The study was conducted in three selected export abattoirs namely, Allana, Abysinia and Elfora, which are located in East Shoa Zone of Oromia Regional State. Allana is found in Modjo town, which is located 70 km Southeast of Addis Ababa while Elfora and Abyssinia abattoirs are found in the Bishoftu town at 47 km South East of Addis Ababa [17]. The selected Export Slaughterhouse are a family owned private limited company established which supplies fresh chilled meat of goats and sheep to the Middle East and African countries.

Study Animals: The study was conducted on sheep and goats of local breeds slaughtered selected export abattoirs that originated from neighbouring localities and different regions of Ethiopia. In the areas of their origin, the animals were owned by smallholder farmers reared under traditional management system.

Study Designand Sampling: A cross- sectional abattoir survey was carried out from October 2018 to March 2019 to determine the prevalence of metacestodes, characterize them and assesses the direct financial losses in local breeds of sheep and goats slaughtered at selected export abattoirs.

Questionnaire Survey: Questionnaire survey aiming to assess public awareness about metacestodes of small ruminants and risk factors for their occurrence was carried out at Bishoftu and Modjo towns during the study period. A questionnaire survey was based on the formula recommended by Arsham [18].

The number of animals required for the study was determined using the formula given by Thrusfield [19] using 95% level of confidence, 50% expected prevalence and 0.05 desired absolute precision.Accordingly, the required sample size for this study was 384; but in order to increase precision, it was multiplied by two thus 768 animals (384 sheep and 384 goats) were used for study which were 256 from each abattoirs. The study animals were selected by systematic sampling technique.

Sampling Methods: Each study animal was given an identification number and grouped in to different categories of species, age and body condition score and agro ecology. All selected animals were grouped into 2 age groups (adult and young) based on dentation [20]. The body condition was scored following the guidelines used by Abebe [21] and the animals were categorized in to two agro ecologies based on information from abattoirs personnel. Sex was not considered as risk factor because only male animals were slaughtered throughout the study period. Routine ante mortem and Post-mortem examination was conducted thorough visual inspection, palpation and systemic incision of each visceral organ particularly the lungs, kidneys, liver, spleen, heart, omentum, mesentery and striated muscles for the presence of hydatid cysts, *C. tenuicollis* and *C. ovis* (using procedures applied by Ahmed *et al*. [22]. Cysts were identified based on their morphological basis and predilection sites. Inspection of the skulls and brains was not permitted due to the slaughter houses formalities; therefore it was not possible to assess the status of *C. cerebralis*.

Cyst Collection and Characterization

Fertility and Viability Tests: The individual cysts from each of the infected organs of sheep and goats were grossly examined for degeneration, then cysts were selected, carefully incised and examined for protoscoleces

according to procedures described in Daryani *et al*. [23]. The content of the fluid was aspirated using 18 gauge needle and 20ml syringe into sterile cylinder container to reduce pressure and risk of entering the eye. After the pressure was reduced, the whole cyst content was transferred into beaker. Then a drop of cyst fluid was placed on the microscope slide, covers with cover slip and examined under a microscope (40X) for the presence of protoscolices in the cyst. The cysts which contain protoscolices were classified as fertile cysts [24]. Fertile cysts were further subjected to viability test to observeamoeboid like peristaltic movement. For clear vision, a drop of 0.1% aqueous eosin solution was added to cyst fluid on microscope slide with the principle that viable protoscolices should completely or partially exclude the dye while the dead ones take it up [25].

Cyst Burden and size measurement: The total number of cysts were counted and recorded. The size of the diameter of non-calcified cyst of each metacestodes was measured and classified as large (diameter >10cm), medium (5 - 10cm) and small, diameter < 5cm [25].

Financial Losses Assessment: The direct financial losses incurred organ/carcass condemnation due to metacestodes in slaughtered sheep and goats was estimated by using the formula indicated by Orgunriade and Orgunriade [26]. To calculate the direct financial loss the following data were considered; the annual slaughtered rate of the abattoirs, the percentage of each organ/carcass condemned and the average of market price of an organ.

$$EL = \sum SRX * CoY * RoZ * PM$$

where EL is the annual economic loss estimated due to organ/carcass condemnation, ?SRX is the annual sheep and goats slaughter rate of the abattoir, Coy is the average cost of each sheep and goat organ/carcass, Roz is the percentage of organ condemned.

Data Analysis: Microsoft excel 2013 data base system was used for entry, coding and simple calculation of recorded data. Statistical data analysis was done by using STATA Stastical software Version 13. Burden of the cyst was calculated by using Microsoft excel. The association between metacestode infection and risk factors were determined by multiple logistic regressions. A statistically significant difference between variables exists when $p<0.05$ at 95% confidence level (CI).

RESULTS

Prevalence and Associated Risk Factors: In the present study, *C. ovis, C. tenuicollis* and hydatid cyst in small ruminants slaughtered at Bishoftu Abyssinia, Elfora and Modjo Allana abattoirs were detected with the overall prevalence of 29.2 % (224/768). Out of the 384 goats, 85 (22.1%) metacestodes involving 8 (2.1%) *C. ovis*, 44 (11.5%) *C. tenuicollis* and 33 (8.6%) hydatid cysts were detected at the three selected export abattoirs. Similarly a total prevalence of 139 (36.2%) metacestodes, 22 (5.7%) *C. ovis*, 64 (16.7%) *C. tenuicollis* and 53 (13.8%) were detected in total 384 sheep slaughtered. Abattoir based prevalence show that 73 (28.5%), 70 (27.3%) and 81 (31.6%) of metacestodes was recorded in small ruminants slaughtered at Abyssinia, Allana and Elfora, respectively. Statistical analysis showed sheep was significantly infected with *C. ovis* than goats ($P<0.05$), however, there was no significance difference with infection of *C. tenuicollis* and hydatid cyst in the study animals ($P>0.05$) (Table 1).

Statistically significant variation between metacestode infection and body condition and agro ecology was seen in both goats and sheep, however, it is not statistically significant with the age of both animals as indicated in Table (2) in goats and Table (3) in sheep.

Cyst Burden and Organ Distribution: A total of 436 cysts comprising 34 *C. ovis*, 239 *C. tenuicollis* and 163 hydatid cysts were counted in the total small ruminants harbouring metacestodes. 189 total cysts were counted in total infected goats while 247 cysts in total infected sheep.

Cysticercus ovis was detected only in the heart of both goats and sheep. The result showed *C. tenuicollis* had more tendencies to be located in omentum followed by mesentry, liver, lungs and peritoneum of both goats and sheep while the lungs showed the highest rate of infestation for hydatid cyst followed by liver and kidney (Table 4).

Cyst Characterization

Fertility and Viability Tests: Out of the total 436 cysts, 145 (33.3%) were fertile and contained protoscolices whereas the remaining 268 (61.5%) and 23 (5.3%) were sterile and calcified cysts, respectively. Of the fertile cysts (145), 67 (46.2%) were viable while 78 (53.8%) were non-viable. Cyst fertile and viable results in goats and sheep were presented in Table (5).

Table 1: Logistic regression analysis of metacestodes in goats and sheep at each abattoir

		Identified metacestodes Prevalence (%)			
Abattoirs	Total examined	*C. ovis*%	*C. tenuicollis*	Hydatid cyst	Total prevalence
Abyssinia					
Goats	130	1 (0.8)	15 (11.5)	10 (7.7)	26 (20)
Sheep	126	8 (6.4)	23 (18.3)	16 (12.7)	47 (37.3)
Total	256	9 (3.5)	38 (14.8)	26 (10.2)	73 (28.5)
OR (P-value)		1.26 (0.03)	1.06 (0.8)	1.07 (0.6)	2.3 (0.23)
Allana					
Goats	157	2 (1.3)	13 (8.3)	12 (7.6)	27 (17.2)
Sheep	99	6 (6.1)	17 (17.2)	20 (20.2)	43 (43.4)
Total	256	8 (3.1)	30 (11.7)	32 (12.5)	70 (27.3)
OR (P-value)		1.19 (0.04)	0.99 (0.06)	1.09 (0.9)	0.97 (0.08)
Elfora					
Goats	97	5 (5.2)	16 (16.5)	11 (11.3)	32 (33)
Sheep	159	8 (5.1)	24 (15.1)	17 (10.7)	49 (30.8)
Total	256	13 (5.1)	40 (15.6)	28 (10.9)	81 (31.6)
OR (P-value)		1.6 (0.2)	1.8 (0.07)	1.07 (0.8)	6.3 (0.09)
Over all total	768	30 (3.9)	108 (14.1)	86 (11.2)	224 (29.2)

Table 2: Logistic regression analysis of metacestodes identified in goats by age, body condition and agro ecology at the three selected export abattoirs

		Prevalence (%)			
Risk factors	No. examined	*C. ovis*	*C. tenuicollis*	Hydatid cyst	Total
Age					
Adult	250	6 (2.4)	29 (11.6)	24 (9.6)	59(23.6)
Young	134	2 (1.5)	15 (11.2)	9 (6.7)	26 (19.4)
OR (P-value)		1.01 (0.7)	0.99 (0.1)	1.09 (0.9)	1.1 (0.8)
BCS					
Good	92	1 (1.1)	9 (9.8)	6 (6.5)	16 (17.4)
Medium	198	3 (1.5)	16 (8.1)	10 (5.1)	29 (14.6)
Poor	94	4 (4.2)	19 (20.2)	17 (18.1)	40 (42.6)
OR (P-value)		1.02 (0.01)	1.08 (0.008)	1.11(0.001)	1.4 (0.03)
Agro ecology					
Highland	179	6 (3.4)	28 (15.6)	24 (13.4)	58 (32.4)
Lowland	205	2 (0.98)	16 (7.8)	9 (4.4)	27 (13.2)
OR (P-value)		0.91 (0.1)	0.93 (0.01)	0.92 (0.002)	0.90 (0.004)
Total	384	8 (2.1)	44 (11.5)	33 (8.6)	85 (22.1)

Table 3: Logistic regression analysis of metacestodes identified in sheep by different risk factors at three selected export abattoirs

		Prevalence (%)			
Risk factors	No. examined	*C. ovis*	*C. tenuicollis*	Hydatid cyst	Total
Age					
Adult	220	14 (6.4)	38 (17.3)	32 (14.5)	84 (38.2)
Young	164	8 (4.9)	26 (15.9)	21 (12.8)	55 (33.5)
OR (P-value)		1.3 (0.56)	1.05 (0.57)	1.04 (0.7)	1.1 (0.6)
BCS					
Good	107	4 (3.7)	16 (14.9)	13 (12.1)	33 (30.8)
Medium	187	6 (3.2)	20 (10.7)	18 (9.6)	44 (23.5)
Poor	90	12 (13.3)	28 (31.1)	22 (24.4)	62 (68.9)
OR (P-value)		1.2 (0.00)	1.27 (0.01)	1.3 (0.003)	1.4 (0.002)
Agro ecology					
Highland	235	17 (7.2)	48 (20.4)	41 (17.4)	106 (45.1)
Lowland	149	5 (3.4)	16 (10.7)	12 (8.1)	33 (22.1)
OR (P-value)		0.97 (0.04)	0.92 (0.013)	0.91 (0.009)	0.94 (0.01)
Total	384	22 (5.7)	64 (16.7)	53 (13.8)	139 (36.2)

Table 4: Organ distribution of *C. tenuicollis* and hydatid cysts in slaughtered goats and sheep

	C. tenuicollis		Hydatid cyst Prevalence (%)	
Organ	Goats	Sheep	Goats	Sheep
Liver	6 (1.6)	9 (2.4)	11(2.9)	19 (4.9)
Liver and lungs	1 (0.3)	2 (0.5)	2 (0.5)	3 (0.8)
Liver and omentum		2 (0.5)		-
Lungs	3 (0.8)	4 (1.1)	18 (4.7)	26 (6.8)
Kidney	-	-	2 (0.5)	5 (1.3)
Mesentry	9 (2.3)	10 (2.6)	-	-
Mesentry and omentum	2 (0.5)	4 (1.1)	-	-
Omentum	20 (5.2)	27 (7.1)	-	-
Peritoneum	3 (0.7)	6 ((1.6)	-	-
Total	44 (11.5)	64 (16.7)	33 (8.6)	53 (13.8)
P-value	000	000	000	000

Table 5: Cyst fertility and viability in sheep and goats

Fertility and viability %		*C. ovis*	*C. tenuicolis*	Hydatid cyst	Total
Fertile	Goats	3 (0.7)	30 (6.9)	25 (5.7)	58 (13.3)
	Sheep	10 (2.3)	45 (10.3)	32 (7.3)	87 (19.9)
Sterile	Goats	6 (1.4)	75 (17.2)	34 (7.8)	115 (26.3)
	Sheep	15 (3.4)	85 (19.7)	53 (12.1)	153 (35.2)
Calcified	Goats	0	2 (0.5)	14 (3.2)	16 (3.7)
	Sheep	0	2 (1.2)	5 (1.2)	7 (1.4)
Viable	Goats	1 (0.23)	16 (3.7)	6 (1.4)	23 (5.2)
	Sheep	2 (0.5)	25 (5.7)	17 (3.9)	44 (10.1)
Total No. of cysts	34	239	163	436	

Table 6: Fertility and viability (%) of *C. tenuicollis* in different organs of goat and sheep

	Organ					
Fertility and viability tests	Liver	Lungs	Messentry	Omentum	Peritoneum	Total
Goats						
Fertile	2 (0.5)	6 (1.4)	8 (1.8)	12 (2.8)	2 (0.5)	30 (6.9)
Sterile	6 (1.4)	2 (0.5)	22 (5.1)	39 (8.9)	6 (1.4)	75 (17.2)
Calcified	2 (0.5)	-	-	-	-	2 (0.5)
Viable	1(0.23)	4 (0.9)	4 (0.9)	7 (1.6)	-	16 (3.6)
Sheep						
Fertile	2 (0.5)	8 (1.8)	7 (1.6)	25 (5.7)	3 (0.7)	45 (10.3)
Sterile	5 (1.2)	3 (0.7)	25 (5.7)	42 (9.6)	11 (2.5)	85 (19.5)
Calcified	1 (0.23)	1 (0.23)	-	-	-	2 (0.5)
Viable	-	3 (0.7)	2 (0.5)	19 (4.4)	1 (0.23)	25 (5.7)

Table 7: Fertility and viability (%)ofhydatid cyst in different organs of goats and sheep

Fertility and viability tests	Organ			
Goat	Liver	Lung	Kidney	Total
Fertile	6 (1.4)	18 (4.1)	1 (0.23)	25 (5.7)
Sterile	4 (0.9)	28 (6.4)	2 (0.5)	34 (7.8)
Calcified	10 (2.3)	3 (0.7)	1 (0.23)	14 (3.2)
Viable	1 (0.23)	5 (1.2)	-	6 (1.4)
Sheep				
Fertile	10 (2.3)	20 (4.6)	2 (0.5)	32 (7.3)
Sterile	15 (3.4)	34 (7.8)	4 (0.9)	53 (12.1)
Calcified	4 (0.9)	1 (0.23)	-	5 (1.2)
Viable	3 (0.7)	14 (3.2)	-	17 (3.9)

Table 8: Direct financial losses associated with metacestodes of small ruminants at the selected abattoirs

	Annual financial losses (ETB)			
Abattoir	*C. ovis*	*C. tenuicollis*	Hydatid cyst	Total
Abyssinia	10375	45925	86825	143125
Allana	58020	247080	480480	785580
Elfora	4500	32340	70960	107800
TOTAL	72895	325345	638265	1036505

Where TAL = Total annual losses; ETB = Ethiopian birr

Fertility and viability tests of *C. tenuicollis* in different organs of goats and sheep were indicated in Table 6. In both goats and sheep, more fertile and viable cysts were observed in omentum. Likewise more fertile and viable hydatid cysts were detected in lungs in both animals (Table 7)

Cyst Size Measurement: Out of the total 436 counted metacestodes cysts, 23 were calcified cysts which reduce the total number of cysts to be assessed for size to 413. Accordingly, Out of a total none calcified *C. tenuicollis* in goats (105) and sheep (130), 32 and 28 were small, 51 and 65 medium and 22 and 37 large in size in goats and sheep respectively. Similarly, out of none calcified 59 and 85 hydatid cysts in goats and sheep, 15 and 20 were small, 35 and 47 medium and 9 and 18 large in size, respectively. All 34 none calcified *C. ovis* cysts were small in both goats and sheep. Cyst size in organ of goats and sheep indicated, most of medium and large *C. tenuicollis* were found in omentum than other organs in both goats and sheep while small cysts were high in liver. Likewise, most of medium and large hydatid cysts were found in lungs than liver and kidney in both animals.

Assessment of Direct Financial Losses: For direct financial analysis, both partially and totally condemned organs due to *C. ovis, C. tenuicollis* and hydatid cysts were taken into account. Based on information gathered from hotels and restaurants in Modjo and Bishoftu, mean unit price of heart, liver, lungs and kidney for local market were 5, 10, 3 and 2 ETB respectively. The mean annualsmall ruminants slaughter rate of the three selected export abattoirs was estimate based on observation during study period together with the judgment of meat inspector which was 25000 at Abyssinia, 120000 at Allana and 20000 at Elfora. Based on the formula given by [26], the total annual monitory losses due to rejection of organs at three export abattoirs was estimated to be1036505 ETB which is about 37018USD (Table 8).

DISCUSSION

Metacestode infections, cysticercosis and hydatidosis in small ruminants are important because they are main cause of meat condemnation contributing to a significant financial losses and they cause human infectious disease, especially in poor and developing countries [27-29]. In the present study, *C. ovis, C. tenuicollis* and hydatid cyst in sheep and goats slaughtered at Bishoftu Abyssinia, Elfora and Modjo Allana abattoirs were detected. The 2.1% *C. ovis* in goat agrees with the report of Abebe *et al*. [30] (1.9%), however it is lower than the study by Sissay *et al*. [31] who reported 22% *C. ovis* infection in goats in Ethiopia. However, this result is relatively higher than the study by Hashemnia *et al*. [34] (1.27%) and Oryan *et al*. [35] (0.09%) in Iran by Ali, [36], (0.35%) in Qena, Egypt and lower than that of reports by Sissay *et al*. [31] (26%) and Abebe *et al*. [37] (9.02%) in Ethiopia.

The prevalence of *C. tenuicoolis* in goats (11.5%) in this study is smaller than the reports by many authors as 56.8% [38, 39] and (56.8%) and [40]. The 16.7% prevalence of *C. tenuicollis* in sheep is agreement with the report by Assefa *et al*. [41].

Considering hydatidosis of goats and sheep, the 8.6% prevalence of Hydatid cyst in goats is consistent with the studies conducted by many authors [42-44]. However it is not in line with the prevalence 16%, 4.5% and 3.4% reported by some authors [45, 46]. In sheep, the 13.6% prevalence of hydatid cyst in this study is slightly higher than the previous studies [47]. In all above, the variation of metacestodes in both goats and sheep between this study and the previous study could be attributed to differences in agro ecology, breed and management of studied animals. Difference in population of stray dogs, host age factors are other contributing factors as has been suggested [48].

The lower prevalence of metacestodes in goats than sheep in this study agrees with the several studies [49, 50] reported lower hydatid cyst infection in goats as

compared to infection in sheep. Similarly, in of reports [51, 52] demonstrated lower infection of *C. tenuicollis* in goats than in sheep. The higher prevalence in the present study was most probably due to the fact that goats feed mainly by browsing than grazing unlike in sheep [53].

This finding suggests the importance of sheep as the main reservoir of infection in maintaining and perpetuation of the life cycle of *C. ovis, C. tenuicollis* and hydatid cysts in the region [54]. In contrast, Samuel and. Zewde, [55] reported higher prevalence of *C. tenuicollis* in sheep than goats.

The higher prevalence of metacestodes in adult animals than young ones can be attributed to three factors: firstly, higher age reflects a much longer period of exposure to infective egg stage in the pasture and secondly, the chances of detecting cysts are higher in adult animals due to their bigger size. Indeed, the present study as well many other studies elsewhere [55] have shown higher infestation rates of metacesstodes in adult animals.

In the current study, higher infection rate of *C. ovis, C. tenuicollis* and hydatid cyst were seen in goats and sheep with poor body condition than animals with medium and good body condition, which vary significantly. This finding is in line with some reports [55, 56]. The highest infection in animals with poor body condition can be explained that in moderate to severe infection, the parasite may cause retarded performance and growth, reduced quality and yield of meat as well as live weight loss [56].

In the current study, the prevalence of metacestodes goats and sheep from highland was found to be higher compared with animals from lowland areas. This result is consistent with previous studies by Muhammad Hussien [57].

Regarding organ distribution, in both goats and sheep heart was the only organ infected with *C. ovis* which is supported by study of Taylor *et al*. [58]. Infestation rate of *C. tenuicollis* in different organs of goats and sheep indicates the cysts had an affinity to be located in the omentum than any other organs. Multiple organ distribution was also recorded in both goats and sheep; mesentery and omentum, liver and lungs. The high tendency of *C. tenuicollis* localization in omentum in this study might be due to the fact that the omentum covers a larger surface area in the peritoneal cavity. Lungs were more infected than liver, probably due to the presence of greater capillary beds soft consistency of lung which might also allow easy growth of cysts [59].

With regard to fertility of cysts in different organs of goats and sheep, high fertile cysts of *C. tenuicollis* were found in omentum than the other organs. Similarly higher viable cysts were recorded in omentum in both species. Conversely, high fertile cysts of hydatid cyst were found in lungs followed by liver and kidneys in both goats and sheep. Meanwhile, calcified cysts were found in the liver of both goats and sheep. Likewise, viable cysts of *C. tenuicollis* were higher in omentum while that of hydatid cysts was in lungs when compared to other visceral organ of goats and sheep. The higher fertility and viability rates of cysts in lung due to hydatid cysts in the current study is in agreement with Urquhart *et al*. [60]. In this study, high number of medium and large sized hydatid cysts were found in lungs than in the liver and kidney of both study animals, while the liver harboured higher number of small sized in both goats and sheep. The reason for higher percentage of medium and large sized cysts in lungs might be related to soft consistency of the lung which allows easier development of the cyst [61].

Based on species of animals, fertile, sterile and viable cysts were found in both goats and sheep while morecalcified cysts were detected in goats than sheep. The relative lower number of fertile and viable cysts and higher number of calcified cysts in goats than sheep which might be due to immunological response of the goat that might result in degeneration of the cysts [62].

In the current study; overall annual financial losses due to organ condemnation from goats and sheep infested by *C. ovis*, *C. tenuicollis* and hydatid cyst in three selected abattoirs was estimated to be 1036505 ETB (37018 USD). The huge economic loss in the abattoirs in this study shows the fact that standard in which any organ harbouring cysts were detected and bound from market. The current result is line with some results from other export abattoirs such as Getachew *et al*. [63].

CONCLUSION AND RECOMENDATIONS

The present finding indicated the occurrence of *C. ovis, C. tennuicolis* and hydatid cyst in sheep and goats slaughtered at the three selected export abattoirs in central Oromia. Besides their animal and public health risks, these metacestodes attributed meaningful financial losses due to edible organs condemnation. The questionnaire survey in this study showed that the major predisposing factors which contribute to persisting of the diseases in the study area were free access of dogs to offal, inappropriate disposal of offal, widespread stray

dogs**,** free grazing goat and sheep and inadequate animal health services. Lack of community knowledge on transmission, zoonosis, treatment and control of metacestodes were potential factors for public health risk. Therefore, effective control strategies against metacestodes should be designed and implemented. Focused awareness creation program is required to avoid the improper disposal of condemned offal's, denying access of dogs into raw offal, stray dogs and appropriate animal management. Further detail epidemiological studies involving different species of livestock, dogs, wildlife and humans in different zones of Ethiopia is required to establish a clear information system for launching a control programme.

ACKNOWLEDGEMENTS

We are very much grateful to Addis Ababa University, Directorate for Research and Technology Transfer for funding the cost of this research work through thematic research project "*Market-Oriented Livestock and Public Risk Assessment through Investigating and Mitigating Major and Economically Important Diseases and Devising Interventional Strategies*, *MOLS-TR*".

We would like to extend our sincere gratitude also to the staff of Abyssinia, Allana and Elfora Abattoir workers, for their collaboration, enthusiasm and willingness to share their experiences during this study.

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