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Study on Common Parasites That Cause Lung and Liver Condemnation and its Economic Importance at Asella Municipal Abboittar

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Abstract: A cross-sectional study was conducted from November, 2014 to March, 2015 to determine the prevalence and economic importance of small ruminant hydatidosis, cystcercus teniculosis and fasciolosis at Asella Municipal Abattoir. Routine meat inspection, at ant-mortem and post-mortem was performed on a total of 384 randomly selected slaughtered sheep and goats. Of this total examined, 36(9.4%) of them had harboured hydatid cyst (s) in one or more of their offal's, 34(8.9%) teniculosis in liver and 45(11.7%) fasciola in liver. Species, sex, age,and body condition score of animals were taken into consideration as rik factors. The age, sex and species of animal as a risk factors were statistically significant ($P < 0.05$), but no significant variation was observed with regarding to body condition score of animals ($p> 0.05$) on prevalence of the hydatidosis. The species and age of animal as a risk factors were statistically significant ($P < 0.05$), but no significant variation was observed with regarding to sex and body condition score of animals ($p> 0.05$) on prevalence of the teniculosis.The species and body condition score of animal as a risk factors were statistically significant ($P < 0.05$), but no significant variation was observed with regarding to age and sex of animals ($p> 0.05$) on prevalence of the fasciolosis. Out of the 36 infected animals 7(19.4%) and 5(13.9%) of them had hydatid cysts on their lung and liver alone, respectively while 24(66.7%) animals had hydatid cysts on both liver and lung. The prevalence among different organs involved in harboring of the hydatidcyst was (51.7%) and (48.3%) in lung and liver respectively. The estimated annual financial loss due to direct organ condemnation from small ruminants hydatidosis, teniculosis and fasciolosis in the area was estimated to be 31,363.21ETB. In conclusion, this study indicated that hydatidosis, teniculosis and fasciolosis are an important disease of small ruminants that causes great economic losses due to organ condemnation in the study area. Disposal of affected offal freely for dogs , backyard and road side slaughtering practices of small ruminants and high number of stray dogs indicates that the presence of high possibility of circulation of the parasite between the intermediate host and the final host. Due to these, the awareness of the communities about the disease, restrict meat inspection and condemnation of infected offal and regular treatment of the dogs to eradicate the disease are highly recommended.

Key words: Small Ruminants · Hydatidosis · Teniculosis · Fasciolosis · Prevalence · Asella Abattoir

INTRODUCTION

Small ruminants are important domestic animals in tropical animal production system. Ethiopia has the largest livestock population in Africa, which plays an important role in the lives of the people. There are about 26.10 million sheep and 21.70 million goats [1]. It accounts for only 7% of the average total capital invested in mixed crop - livestock production system but they account on average of 40% of the cash income and 19 % of the total value of subsistence food derived from all livestock production. Hence an increase in small ruminant's production could contribute to the attainment of food self-sufficiency in the country particularly in response to the protein requirement for the growing of human population as well as to enhance the export earnings. Although this sector much contributes to national economic growth, development of the sector has different constraints. These constraints included animal disease, poor nutrition, husbandry and infrastructure, shortage of trained man power and lack of government policies, rampant disease and

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parasitism [2]. Parasitic diseases in the tropics are responsible for great losses in the meat industry than any other infectious or metabolic disease. Like many other African countries, it is known that *Fasciola* species, hydatid cyst and *Cysticercus tenuicollis* are major parasites responsible for low productivity in Ethiopia livestock industry due to imposing poor weight gains, condemnation of organs and carcass and lower milk yield of sheep and goats [3].

Fasciolosis is known to be one of the most important parasitic diseases in Ethiopia that reduces productivity of ruminants. It is caused by the genus *Fasciola*, which migrate through the hepatic parenchyma, establish and develop to the adult stage in the bile ducts. The parasite lives parts of its life in intermediate host mainly snails of the genus *Lymnaea* which is found in and around wet areas, such as water holes; so that farm animals are likely to pick up the parasite if they drink from these sources [4]. Fasciolosis causes significant morbidity and mortality in ruminants [4, 5] and occurs worldwide in acute, sub- acute and chronic forms. Large number of young flukes causes acute swelling and congestion of the liver producing an acute parenchymatous hepatitis in which the serous capsule of the liver may be sprinkled with hemorrhages and covered with fiber. In chronic fasciolosis of sheep, the liver becomes irregularly lobulated and distorted, but the bile ducts through thickened dilated, distended and of bluish color [2].

Financial losses due to ovine fasciolosis alone were estimated 48.80 million Ethiopian birr per annum which accounts 6.50 %, 48.80 % and 4.70 %e due to mortality, reduction of productivity and liver condemnation respectively [6]. On the other hand, fasciolosis is an emerging zoonotic infection of humans associated primarily with the eating of water cress contaminated with metacercaria . Hydatidosis is a term used to describe infection of different animals species and humans with larval or metacestodes stage of *Echinococcus* species [7]. Ungulates, including sheep, cattle, goats, pigs and horses are intermediate hosts in which hydatid cysts infection can occur. Adult of the genus *Echinococcus* are found in the small intestines of dogs and other carnivores. The parasites are perpetuated in life cycle with carnivores as definitive hosts which harbour the adult egg producing stage in the intestine and intermediate host animals in which the infective metacestode stage develops after infection with eggs [8].

Hydatid cysts in livestock lead to considerable economic losses due to condemnation of edible offals primarily liver and lung [9]. Condemnation of edible offal's is primarily due to development of hydatid cysts in these organs. This organism in liver and lung may degenerate to form cheesy mass encapsulated in multilocularis lesions that may resemble tuberculosis but the laminated cuticular membrane is still present even after the cyst has degenerate and can be readily picked up with a pair of forceps [2].

Financial losses due to condemnation of organs by hydatid cysts, particularly liver and lung in some countries are very considerable [2]. These losses are of especial significance in countries of low economic output where sheep and goat production is of particular importance [10]. Though hydatidosis, constitutes a public health problem worldwide, yet causes a particularly heavy burden in developing countries [11]. The distribution *E. granulosus* is higher in rural communities of developing countries where there is close contact between definitive host, the dog and various domestic animals, acting as intermediate hosts [11].

Cysticercus tenuicollis is a larva of *Taenia hydatigena* which is the most important parasite of sheep and goats and is found in a large number of hosts throughout the world. The intermediate host becomes infected by ingesting of proglottides or the egg passed in the feaces of the dog in pasture or feeding areas [12, 13]. The larva migrating through the liver cause hemorrhage commonly called hepatitis cysticercosis. Massive infestation can kill animals within 19 days. *C. tenuicollis* fibrous scars resulting from migration of the larvae lead to condemnation of the viscera and disposal of other offals to which the mature bladder worms attach. There is no human health hazard but the liver lesions are unsightly and affect the texture of the tissue, making it unsuitable for human consumption and the financial losses associated with condemnation of affected organs are significantly high. Major parasitic diseases such as fasciolosis, hydatid cyst, *Cysticercus bovis* and others causes like abscessation and cirrhosis cause significant financial loss by lowering the productivity of animals and condemnation of edible organs.

Several studies have been conducted in Ethiopia through abattoir survey to determine the prevalence and financial loss resulting from organ condemnation due to fasciolosis, hydatid cysts and *C. tenuicollis*. But the prevalence and financial loss caused by these parasites in small ruminants have not been quantified at Asella municipal abattoir. So the present study was planned with the following objectives.

- To determine the overall prevalence of hydatidosis, teniculosis and fasciolosis in lung and liver of small ruminants slaughtered at Asella municipal abattoir.
- To study the association of different risk factors with prevalence of the parasites.
- To determine the organ involvement and distribution of the cysts of the parasites in different visceral organs.
- To determine the magnitude of the direct financial losses due to lung and liver condemnation caused by hydatid cyst, cyst of *C. tenuicollis* and fasciolosis.

MATERIALS AND METHODS

Description of Study Area: The study was conducted from November 2014 to March 2015 in Asella town, at Asella municipal abattoir. Asella is the capital city of East Arsi Zone, located in Oromia Regional State about 175 kms South East of Addis Ababa at an altitude range of 1650 - 3000 meters above sea level. Asella is found between 6°59' and 8°49' N latitude and 40°44' E longitude. The area has highland escarpment, midland and lowland climatic zones. About 37.00 % of the total area Asella town is highland (>2400 m), 52.00 % mid land (1800 – 2400 m) and 11.00 % is lowland (<1800m). The climatic condition of the area is "Weyna - Dega". The area has a bi - modal rainfall occurring from March to April (a short rainy season) and from July to October (long rainy season) with annual range of rain fall from 700 - 1658 mm and annual average humidity ranging from 43% - 60%. The annual minimum and maximum temperature ranges from 10°C to 22.6°C. The daily minimum and maximum temperature ranges from 10°C to 28°C. The area has a total livestock population of 50347 bovines, 16964 equines, 19453 sheep, 6884 goats and 22485 poultry. The area exercises mixed farming system [14]. Fig. 1. below shows the study area.

Study Population: The study animals were small ruminants slaughtered at Asella municipal abattoir during study period. Indigenous sheep and goat breeds managed under extensive management system which had different sex, age and body conditions were used as study population.

Sampling

Sample Size Determination: The sample size required for this study was determined depending on the expected prevalence of the parasite and the desired absolute precision. The sample size was computed using the formula given in Thrusfield [16] as follows.

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

where: N= required sample size; Pexp = expected prevalence; d = desired absolute precision.

Fig. 1: Map of study area
Source: [15]

There was no previous study on prevalence of lung worm infection in different species of small ruminants at Asella municipal abattoir. Therefore, an expected prevalence of 50 % was used to estimate the sample size. Using desired 95 % confidence interval, 5 % precision, the numbers of sheep and goats needed to determine the prevalence hydatid cyst, *Cysticercus tenuicollis* and adult *Fasciola* in small ruminants were 384.

Sampling Method: Simple random sampling technique was used to select study animals from those small ruminants which were slaughtered at Asella municipal abattoir during the study period.

Study Methodology: Cross sectional study was conducted from November 2014 to March 2015 in Asella town, at Asella municipal abattoir. Post mortem examination of liver and lungs of randomly selected small ruminants slaughtered at Asella municipal abattoir during study period were used to determine the condemnation of the lung and liver of small ruminants by the parasites. In addition, the financial loss caused by liver and lung condemnation because of the parasites in small ruminants was also assessed and determined.

The total of 384 small ruminants were examined by postmortem examination for the presence of hydatid cyst, *Cysticercus tenuicollis* and adult *Fasciola* parasite in the lung and liver; in lung, liver, in serosae and in other visceral organs; and in liver respectively. Out of the total 384 small ruminants, 333 were sheep and the rest 51 were goats. The number of sheep and goats which were included in my study was determined by their proportion to the total number of small ruminants those were slaughtered at municipal abattoir during my study period. Risk factors like animal species, sex, age and body condition scores were considered in the study.

Ante - Mortem Inspection: Pre-slaughter examination of small ruminants was conducted in the lairage by grouping the animals based on species, age and body condition scores. During ante mortem examination, age, sex, species and body condition scores of the animals were identified and recorded. The age of small ruminants was determined by dentition formula according to the method described by Sanchez-Andrade *et al.* [17] (Annex 2). Animals were categorized into two age groups; and those animals in which their ages were less or equal to 1 year (<1year) were considered young and while those animals with age of greater than a year(> 1year) were considered as adult. Body condition of animals was classified into three as lean (score 1- 2), medium (score 3) and fat (score 4 - 5) according to Thompson [18] (Annex 3). Both sides of the animals were inspected at rest and in motion. Moreover, the general behavior of the animals, cleanness and sign of diseases and abnormality of any type was registered according to the standard of ante-mortem inspection procedures [2].

Post Mortem Inspection: Post mortem examination of the carcasses of small ruminants was conducted according to Meat Inspection Regulation Notice Number 428, 1972 by Government of Ethiopia [19]. The routine inspection of carcass was conducted as per the procedure stated below.

Tongue: Visual inspection and palpation of the surfaces and a longitudinal ventral incision of the tongue from the tip of the root.

Triceps Muscles: One deep incision into the triceps muscles of both sides of the shoulder

Masseter Muscle: Extensive deep incision into external and internal muscles of masseter parallel to the plane of the jaw.

Heart: Visual inspection and longitudinal incision of the myocardium from base to apex. But more incision can be made when necessary.

Neck Muscle: Visual inspection and 3 parallel incisions into long axes of the neck muscles on both sides

Thigh Muscle: Two parallel incisions on the thigh muscles of both hind legs

Lung: Careful inspection, palpation and two parallel incisions into the diaphragmatic lobes of the lung through the lung substances and visual examination of intercostals muscles and incisions when necessary. One extensive incision into the fleshy part of diaphragm, visual examination, palpation and incision of kidneys, liver, esophagus and associated lymph nodes is crucial.

All animals that undergo post-mortem examination were those which passed ante-mortem inspection. During postmortem inspection liver, lungs, heart, kidney, brain were thoroughly inspected by visualization, palpation and by making systemic incisions where necessary for the presence of cysts, parasites and other

abnormalities. Pathological lesions were differentiated and judged according to guidelines on meat inspection for developing countries and the results were recorded on the predesigned data collection format. The decisions at postmortem inspection were classified in to the following categories of judgments: approved as fit for human consumption, conditionally approved as fit for human consumption, totally condemned as unfit for human consumption and partially condemned as fit for human consumption [20].

Identification of the Parasites: Identification of the parasites was conducted in abattoir by thoroughly post mortem inspection of visceral organs including liver, lung, spleen, kidneys and heart with their associated serosa. Post mortem inspection was conducted by visualization, palpation and by making systemic incisions where necessary to be conducted to determine the presence of cysts, adult parasite (fasciolosis) and other abnormalities.

Financial Loss Assessment: The direct financial loss of the abattoir due to organs condemnation because of the parasites (hydatid cyst, cyst of *Cysticercus tenuicollis* and adult parasite of liver fluke) was assessed and analyzed. The average mean number of small ruminants slaughtered at the abattoir, percent involvement of the two organs from the total condemned organs during study period, percent involvement of each organ from the total condemned organs and the current price of the organs were considered. So that direct financial loss of the abattoir due to organs condemnation because of the parasites under study was calculated using the formula given as follows.

DL= (NAS x PH x PH lung x CP lung) + (NAS x PH x PH liver x CP liver).

where, DL = Direct financial loss; NAS = Mean annual number of small ruminants slaughtered at Asella municipal abattoir; PH = Percent involvement of the two organs from the total condemned organs; PH lung = Percent involvement of lung from the total condemned organs; CP lung = Current price of the lung in Asella; PH liver = Percent involvement of liver from the total condemned organs; CP liver = Current price of liver in Asella town.

Data Management and Analysis: The data were entered and managed in Microsoft Excel work sheet – 2013 program. All the data analysis was done by STATA version 20. Descriptive statics such as percentages and frequency distribution were used to describe the nature and the characteristics of the data. Liver and lung condemnation rates were determined by proportion of condemned liver and lung to the total number of liver and lung examined. Prevalence of the parasites was analyzed using percentages. The association of different risk factors with the prevalence of the parasites was computed by Chi – square (χ^2) test. For all analysis, a P-value less than 0.05(5%) at 95% confidence level were considered as statistically significant.

RESULTS

Overall Prevalence of the Parasites: Out of 384 small ruminants (333 sheep and 51 goats) sampled 28.91 % (111/384) of small ruminants were found harboring with one or more parasites under study in their one or more offals. However, the prevalence of the parasites was different in different species of animals. It was 30.63 % (102/333) in sheep and 17.65 % (9/51) in goats. The overall prevalence of the major liver and lung parasites of different species of small ruminants is presented in Table 1.

Prevalence of Hydatidosis, Fasciolosis and Teniculosis in Lung and Liver of Small Ruminants: Out of the 111 positive animals 32 (28.80 %), 4 (3.60 %), 34 (30.60 %) and 41 (36.90 %) were found harboring hydatid cyst/cysts in their one or more offals; both hydatid cyst and liver fluke; cyst of *Cysticercus tenuicollis;* and liver fluke respectively. The prevalence of hydatidosis, fasciolosis and teniculosis in lung and liver of small ruminants slaughtered at Asella municipal abattoir is presented in Table 2.

Association of the Prevalence of Parasites in Small Ruminants with Different Risk Factors: The association of the prevalence of hydatidosis, teniculosis and fasciolosis with different risk factors like species, age and sex and body condition score of small ruminants was assessed and analyzed.

Association of the Prevalence of Hydatidosis in Small Ruminants with Different Risk Factors: Prevalence of hydatidosis in small ruminants was different in different species of small ruminants; and it was 10.80 % (36/333) and 0.00 % in sheep and in goats respectively. The difference was statistically significant ($\chi^2 = 6.08$; $P < 0.05$)

Table 1: Overall prevalence of major liver and lung parasites in sheep and goats slaughtered at Asella municipal abattoir

Species	Total examined	No of positives	Prevalence (%)
Ovine	333	102	30.63
Caprine	51	9	17.65
Total	384	111	28.91

Table 2: Prevalence of hydatidosis, fasciolosis and teniculosis in small ruminants

Identified cysts and adult parasite	No of positives from the total sampled animals (n = 384)	Prevalence (%)
Hydatid cyst	32	8.30
C. tenuicollis cyst	34	8.85
Hydatid cyst + liver fluke	4	1.04
Liver fluke	41	10.60
Total	111	28.90

Table 3: Association of prevalence of hydatidosis in small ruminants with different risk factors

Risk factors	Total No examined	No of positives	Prevalence (%)	χ^2	P – Value
Species					
Ovine	333	36	10.80	6.08	0.014
Caprine	51	0	0.00		
Age					
Young (< 1year)	59	0	0.00	7.21	0.007
Adult (> 1 year)	325	36	11.10		
Sex					
Female	252	32	12.70	9.53	0.002
Male	132	4	3.00		
BCS					
Lean	60	10	16.70	5.78	0.056
Medium	217	20	9.20		
Fat	107	6	5.60		

as shown in Table 3. It was also observed that the prevalence of hydatidosis was different in two age groups of small ruminants; and it was 0.00 % and 11.10 % (36/325) in young and in adult small ruminants respectively. The difference was statistically significant ($\chi^2 = 7.21$; $P < 0.05$) as shown in Table 3. The prevalence of hydatidosis was also different in two sex groups of small ruminants; and it was 12.70 % (32/252) and 3.00 % (4/132) in female and in male small ruminants. It was observed that the association of the prevalence of hydatidosis in two sex groups of small ruminants was statistically significant ($\chi^2 = 9.53$; $P < 0.05$) as shown in Table 3. Finally, the association of the prevalence of hydatidosis with different body condition category of small ruminants was also assessed; and it was observed that the prevalence of hydatidosis was different in small ruminants with different body condition. The prevalence was 16.70 % (10/60), 9.20 % (20/217) and 5.60 % (6/ 107) in lean, medium and fat body condition category of small ruminants respectively. It was observed that the difference was statistical insignificant ($\chi^2 = 5.78$; $P > 0.05$) as shown in Table 3.

Association of the Prevalence of Teniculosis in Small Ruminants with Different Risk Factors: Association of the prevalence of teniculosis in small ruminants with different risk factor like species, age of animals, sex of animals and body condition of animals was assessed. It was found that the prevalence of teniculosis of small ruminants was different with species of animals; and it was 7.50 % (25/333), 17.60 % (9/51) in sheep and in goats respectively. It was observed that the association of the prevalence of teniculosis in small ruminants with species of animals was statistically significant ($\chi^2 = 5.63$; $P < 0.05$) as shown in Table 4. It was also observed the prevalence of teniculosis in small ruminants was different in different age groups of small ruminants; and it was 1.70 % (1/59) and 10.20 % (33/325) in young and adult animals respectively. Statistical result showed that the association between prevalence of teniculosis with different age groups of animals was statistically significant ($\chi^2 = 4.42$; $P < 0.05$) as shown in Table 4. The prevalence of teniculosis in small ruminants was different in two sex groups and in animals with different body condition scores; and it was 10.30 % (26/252) in female animals; 6.10 % (8/132) in male animals; 11.70 % (7/ 60) in lean body condition animals; 8.30 % (18/ 217) in medium body condition animals; 8.90 % (34/384) in fat body condition animals. It was observed that the associations of the prevalence of teniculosis with two sex category of animals and with animals having different body condition scores were statistically insignificant ($\chi^2 = 1.95$; $P > 0.05$) and ($\chi^2 = 0.69$; $P > 0.05$) respectively as shown in Table 4.

Table 4: Association of prevalence of teniculosis in small ruminants with different risk factors

Risk factors	Total No examined	No of positives	Prevalence(%)	χ^2	P - Value
Species					
Ovine	333	25	7.50	5.63	0. 018
Caprine	51	9	17.60		
Age					
Young (< 1year)	59	1	1.70	4.42	0. 035
Adult (> 1 year)	325	33	10.20		
Sex					
Female	252	26	10.30	1.95	0. 163
Male	132	8	6.10		
BCS					
Lean	60	7	11.70	0.69	0.705
Medium	217	18	8.30		
Fat	107	9	8.40		

Table 5: Association of the prevalence of fasciolosis in small ruminants with different risk factors

Risk factors	Total No examined	No of positives	Prevalence (%)	χ^2	P – Value
Species					
Ovine	333	45	13.50	7.81	0.005
Caprine	51	0	0.00		
Age					
Young(< 1year)	59	3	5.10	2.97	0.085
Adult(> 1 year)	325	42	12.90		
Sex					
Female	252	27	10.70	0.72	0.398
Male	132	18	13.60		
BCS					
Lean	60	14	23.30	20.78	0.000
Medium	217	30	13.80		
Fat	107	1	0.90		

Table 6: Distribution of hydatid cyst in different visceral organs

Visceral organs	No of hydatid cyst observed from the total positive samples (N = 158)	Percent of involvement
Liver	84	53.20
Lung	74	46.80
Total	158	100.00

Table 7: Hydatid cyst distribution in lung and liver

Organ	No of animal affected	% involvement from the total positive samples
Liver only	5	13.90
Lung only	7	19.40
Lung + liver	24	66.70
Total	36	100.0

Table 8: Number of organs condemned, percentage involvement and their current average market price of organs

Organ condemned	No of organ examined	No of organ condemned	Percentage involvement	Average current market price of organ in ETB
Lung	384	31	23.70 %	20
Liver	384	100	76.30 %	25

Association of the Prevalence of fasciolosis in Small Ruminants with Different Risk Factors: The prevalence of liver fluke in small ruminants was also different with different risk factors. In relation to species of animals, the prevalence was different; and it was 13.50 % (45/ 333) and 0.00 % in sheep and in goats respectively. It was observed that there was statistical significant difference ($\chi^2 = 7.81$; $P < 0.05$) in prevalence of fasciolosis within the two species small ruminants as shown in Table 5. The prevalence of fasciolosis was different in two age groups

of animals; and it was 5.10 % (3/ 59) in young animals and 12.90 % (42/ 325) in adult animals. It was observed that the difference was not statistically significant ($\chi^2 = 2.97$; $P > 0.05$) as shown in Table 5. In relation to sex and body condition score of animals, the prevalence of fasciolosis was also different. It was 10. 70 % (27/252) in females and 13.60 % (18/ 132) in male animals; 23.30 % (14/60), 13.80 % (30/ 217) and 0.90 % (1/ 107) in animals with lean, medium and fat body condition score animals. It was observed that the association of the prevalence of fasciolosis in small ruminants in relation to sex of animals had no statistical significant difference ($\chi^2 = 0.72$; $P > 0.05$) but in relation to body condition score of animals, it had highly statistical significant difference ($\chi^2 = 20.78$; $P < 0.05$) as shown in Table 5.

Organ Involvement and Distribution of Cysts: Out of the totals of 384 slaughtered small ruminants examined by post mortem inspection for the presence of hydatid cyst; 60 visceral organs were found to be affected by hydatid cysts. From these organs, 158 hydatid cysts were found. Regarding with their organ involvement and distribution among the infected visceral organs, 84 (53.20 %) and 74 (46.80 %) of hydatid cysts were found in liver and lung respectively. Distribution of hydatid cysts in different visceral organs and in lung and liver is presented in Table 6 and in Table7 respectively.

Direct Financial Loss: The direct financial loss due to condemnation of visceral organs caused by hydatid and *C. tenuicollis* cysts; and liver fluke at Asella municipal abattoir was assessed and analyzed. The average number of small ruminants slaughtered in the abattoir per annum; percent involvement of each visceral organ from the total condemned organs and the current market price of condemned organs were considered to calculate the direct financial loss due to organs condemnation because of cysts and liver fluke infection of lung and liver in the abattoir. Percent involvement of the organs and the current market price of the visceral organs in the area are presented in Table 8.

The direct financial loss of the abattoir due to organs condemnation because of the parasites was calculated using the formula:

DL= (NAS x PH x PH lung x CP lung) + (NAS x PH x PH liver x CP liver).

where, DL = Direct financial loss; NAS = Mean annual number of small ruminants slaughtered at Asella municipal abattoir; PH = Percent involvement of the two organs from the total condemned organs; PH lung = Percent involvement of lung from the total condemned organs; PH liver = Percent involvement of liver from the total condemned organs; CP liver = Current price of liver in Asella town; CP lung = Current price of the lung in Asella town.

DL = (NAS x PH x PH lung x CP lung) + (NAS x PH x PH liver x CP liver)
DL = (4914 x9.40 % x 23.70 % x 20 ETB) + (4914 x 9.40 % x 76.30 % x 25 ETB)
DL = 6242.35 + 25120.89
DL = 1363.24 ETB

So that the annual direct financial loss due to liver and lung condemnation caused by hydatid cyst and liver fluke in Asella abattoir was estimated 31363. 24 ETB.

DISCUSSION

There are many parasitic diseases of small ruminants; and among them hydatidosis, fasciolosis and teniculosis have widely distribution and zoonotic importance. These parasites of small ruminants result in huge economic losses as they increase morbidity, mortality, increase farm inputs via increased treatment expenses and cause reduction in growth rate and possibly weight loss during and after the period of parasitic disease outbreaks. In this study, attempts were conducted to determine the prevalence of hydatidosis, teniculosis and liver fluke; their organ involvement and distribution and the direct financial loss due to condemnation of infected visceral organs by hydatid and *C. tenuicollis* cysts; and by liver fluke was assessed and estimated. The results of the present study showed that 28.91 % of small ruminants were found harboring with one or more parasites in their one or more offal's. However, the overall prevalence of the parasites was different in two species of small ruminants; and it was 30.63 % in sheep and 17.65 % in goats. Further the prevalence of each disease was determined; and it was found that the prevalence of small ruminant hydatidosis was found to be 8.30 %. Almost similar results had been reported by Yitbarek *et al.* [21] which were 11.60 %; study conducted at Mekele municipal abattoir, by Getachew *et al.* [22] which was 8.60 % and 7.70 %; study conducted at Addis Ababa abattoir and at Luna export abattoir, Central Ethiopia respectively. Similar results were also reported by Azlaf and Dakkak [23] which were 10.60 % and by Ismail *et al.*

[24] which were 7.20 % in Turkey sheep; studies which were conducted in Morroco and in New Taif abattoir in Saudi Arabia. However; the current prevalence small ruminant hydatidosis was much lower than many findings that had been undertaken in different areas. Higher prevalence of small ruminant hydatidosis was reported by Zewdu *et al.* [25] which was 26.70 % and by Kebede *et al.* [26] which was 19.90 %; studies conducted at Ambo municipal abattoir and at Bahirdar abattoir respectively. The occurrence of low prevalence of small ruminant hydatidosis in the study area as compared the above studies might be attributed due to the difference in backyard slaughter practice; difference in the population of stray dogs and difference in prevention and control measures that were practiced in the area. Much higher prevalence of small ruminant hydatidosis (83.00 %) was reported by Ripoche *et al.* [27] in Sardinia. This discrepancy and similarity in the prevalence of small ruminant hydatidosis between the various areas might be also attributed principally to strains difference and relationship in *E. granulosus* that exist in different geographical situations [9]. Moreover, additional reasons could be the difference in the level of awareness of the community with regard to methods of its transmission as people used to slaughter small ruminants at home and throw the offal's to the dogs around their villages. Furthermore, difference in culture, social activity and attitude to dog in different regions might have contributed to such inconsistency [28].

Prevalence of small ruminant hydatidosis was different with species, age groups, sex of animals and body condition scores. The prevalence of small ruminants' hydatidosis was different in two species of animals; and it was 10.80 % and 0.00 % in sheep and goats respectively. Accordingly, sheep were seen to had high risk to be infected by hydatidosis as compared to goats The association of small ruminants' hydatidosis with species difference was found to be statistically significant ($P < 0.05$) (Table 3). Almost similar result was reported by Getachew *et al.* [22] which was 8.35 % and 0.00 % in sheep and in goats respectively; study conducted at Luna export abattoir. Perhaps this could be attributed to the browsing nature of goats than sheep which more graze [29].

It was found that the prevalence of small ruminants' hydatidosis was different in two age groups of small ruminants; and it was 0.00 % and 11.10 %, in young (< 1 year) and in adult animals(≥ 1 year) respectively. The result showed that adult small ruminants were found to be highly infected by hydatid cyst than young ones. The association of the prevalence of small ruminants' hydatidosis with different age groups was statistically significant ($P < 0.05$) (Table 3). Similar findings were reported by Azlaf and Dakkak [23] and Alembante [30] studies conducted in Turkey and Morocco and in Ethiopia at Hawassa abattoir respectively. They reported that the prevalence of small ruminants' echinococcosis infection was higher in older animals than young ones. This could be mainly due to the fact that aged animals have longer exposure time to *Echinococcus granulosus* eggs than young ones [31].

The prevalence of small ruminants' hydatidosis was also different in two sex groups of animals; and it was found to be 12.70 % and 3.00 % in female and in male animals respectively. The finding showed that female animals were found to be more infected by hydatid cyst than the male animals. The association of prevalence of small ruminants' hydatidosis with sex groups of animals found to be statistically significant ($P < 0.05$) (Table 3).The reason might be associated with keeping of female animals for a longer time than males for reproductive purpose.

Prevalence of small ruminants' hydatidosis was also different in different body condition score of animals; and it was16.70 %, 9.20 % and 5.60 %, in *lean*, in medium and in fat body condition scores of animals. It was found that the association of the prevalence of small ruminants' hydatidosis with different body condition scores of animals was statistically insignificant ($P > 0.05$) (Table 3). Similar findings were reported by Kebede *et al.* [26] study conducted at Ambo municipal abattoir. The possible reason for this finding might be due to the fact that loss of body weight in small ruminants could not be attributed only to hydatid cyst alone; since other GIT helminthes could be encountered together as mixed infection. So that loss of body weight in small ruminants cannot be attributed only to the hydatid cyst infection alone but it could be due to lack of feed or nutritional and management related problems.

The prevalence of small ruminants' teniculosis was assessed and analyzed. Prevalence of teniculosis in small ruminants was different within species, age and sex and in animals with different body condition scores. In relation to species, it was 7.50 % and 17.60 % in sheep and goat respectively. Higher prevalence of teniculosis was recorded in goats than in sheep; and the difference was found to be statistically significant ($P < 0.05$) (Table 4). This result was also almost in total agreement with previous studies conducted by Sissay *et al.* [32] in different abattoirs of the countries. It was also in total

agreement to those documented by Torgerson *et al*. [10]. According to Torgerson *et al.* [10], high infestation of *C. tenuicollis* results in the development of protective immunity early in life of animals and this immunity regulate the parasite population, whereas goats develop the immunity more slowly. This considerable degree of immunity against *C. tenuicollis* infection in sheep may be the reason for low prevalence of the parasite in comparison to goats.

The prevalence of teniculosis in small ruminants was different in two age groups; and it was 1.70 % and 10.20 % in young (< 1 year) and in adult (> 1 year). It was observed that there was statistically significant difference (P< 0.05) between the prevalence of teniculosis and age groups of animals (Table 4). This difference between young and adult animals might be due to the fact that adult animals (sheep and goats) lived longer and had high probability to be infected by large numbers of eggs during grazing as compared to the young animals which only lived for a short period of time.

It was also observed that the prevalence of teniculosis in small ruminants was different in two sex groups of animals and in animals with different body condition scores; and it was 10.30 % and 6.10 % in female and in male animals; 11.70 %, 8.30 % and 8.40 % in animals with lean, medium and fat body condition score animals. It was found that the associations of the prevalence of teniculosis in small ruminants with sex and in animals with different body conditions were statistically insignificant (P > 0.05) (Table 4). However, the difference in prevalence of lung worm infection between the two sex groups that was observed in this study might be due to the fact that resistance of female animals to *C. tenuicollis* cysts infection can be reduced at the time of parturition and during early lactation. Per parturient and lactation relaxation of the resistance of animals may result in female animals to reduce their immunity and make them to be susceptible to many parasitic diseases including teniculosis. The other reason was the way how males and females were treated in terms of nutrition in the area might also attribute for such difference; because males were kept for fattening to be sold except some which were kept for breeding, thus, males received more attention by farmers than females.

The overall prevalence of liver flukes in small ruminants in the study area was 11.70 % (45/ 384). It was found that, among organs involved in harboring of the hydatid cysts (51.70 %) and (48.30 %) of hydatid cysts were found in lung and in liver respectively. Number of cysts collected from liver was in greater proportion (53.20 %) than from lung (46.80 %). This finding was similar to the findings by Yitbarek *et al.* [21], Azlaf and Dakkak [23], Ripoche [27], Zelalem [33] and El-Ibrahim [34] who reported that larger numbers of hydatid cysts were found in liver compared to other organs. The liver infection might be a reflection of the route of parasite entry and seems to support the hypothesis of hepatic portal distribution of the onchospheres leading to the liver infection [35]. The majority of infected sheep (66.70%) had hydatid cysts in both liver and lungs. Similar finding was also reported also by Yildiz and Gurcan [36]. This could be due to the fact that lungs and livers possess the first great capillaries of sites encountered by migrating *Echinococcus* onchospheres (hexacanth embryo) which adopt the portal vein route. The first large capillaries encountered by migrating blood borne onchospheres and primarily negotiate pulmonary and hepatic filtering system sequentially before any other organ is involved. However, development of hydatid cysts occur occasionally in other organs like spleen, kidney and heart and other organs and tissues when onchospheres escaped into general systemic circulation [35]. From the total numbers of hydatid cysts that were found in liver, the highest number of cysts (44.10 %) were calcified. This could attribute to the presence of relatively high reticulo-endothelial cells and abundant connective tissue reaction of the liver [37].

Each year significant loss results from death of animals, inferior weight gain, condemnation of edible organs and carcass at slaughters. This production loss to the livestock industry was estimated to be more than 900 million USD annually [3, 38]. Many studies in Ethiopia have indicated on annually basis, higher economic loss was due to condemnation of edible organs and carcass due to parasitic causes [6, 38-41]. The present study showed that the annual financial loss due to condemnation of edible organs because of hydatid, *C. tenuicollis* cysts and liver fluke at Asella municipal abattoir was found to be 31363. 24 ETB.

CONCLUSION AND RECOMMENDATIONS

Wide spread of backyard animals' slaughter practices, the corresponding absence of the rigorous meat inspection procedure and feeding of dogs with condemned organ facilitate and maintain the life cycle of the parasites in small ruminants. In Ethiopia, even though there are many parasitic diseases of small ruminants which are the major cause for organs condemnation in most abattoirs, many previous studies showed that fasciolosis,

hydatidosis and teniculosis of small ruminants are the most prevalent ones. Although many previous studies in different abattoirs of the country showed that fasciolosis, hydatidosis and teniculosis of small ruminants were prevalent diseases in small ruminants and caused the major organs condemnation, the prevalence of these diseases were not well quantified in Asella municipal abattoir. With this anxiety, this study was tried to determine the overall prevalence of parasites in small ruminants, organs involvement and distribution of cysts, the prevalence of the parasites indifferent categories of small ruminants (species, age, sex and BCS) and the financial loss of the abattoir due to organ condemnation caused by these parasites. This study showed that the diseases are prevalent in study area and caused high financial loss for abattoir due to of organ condemnation.

In view of this conclusion the following outlooks are forwarded.

- Public awareness creation through education on the means of transmission, prevention and control strategies of the parasites is paramount crucial.
- Disposal of affected offal freely for dogs and wild canids which is the usual practice of the community should be prohibited and all the condemned organs should be either buried or incinerated.
- Backyard and road side slaughtering practices should be prohibited by having the law and regulation of meat inspection into action.
- Regular testing and treatment of dogs should be practiced throughout the country
- Reducing if it is possible eliminating the number of stray dogs should be started to practice in the country.

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ANNEXES

Annex 1: Abattoir data collection format

General Information

Region_____city _____Name of the abattoir_____

Date _____ No of slaughtered animals in the day_____

No of inspected animals_____

	Ante mortem examination						Postmortem examination		
Date	ID.No	Spp.	Sex	Age	Body Temp. (°C)	BCS	Abnormalities observe	Organ/carcass Condemned	Causes of condemnation	Parasite identified

ID.No = Identification number given to animals during ante mortem inspection.
Spp. = Species of animal
Body Temp. (°C) = Body temperature of animals measured in ante mortem inspection.
BCS = Body Condition Scores

Annex 2: Determination of ages of sheep and goats [17].

Aging of Sheep and Goats by appearance of the incisor teeth How to check the incisor teeth 

Milk Teeth: Less than 1 year all temporary teeth 

One Pair Permanent Incisors: About 1 to 1.5 years one pair of permanent incisors with remaining incisors still temporary 

Two Pairs Permanent Incisors: About 1.5 to 2 years two pairs of permanent incisors 

Three Pair Permanent Incisors: About 2 to 3 years three pairs of permanent incisors 

All are permanent incisors or full mouth: About 3 to 4 years 

Worn mouth or broken mouth: about 4 years or more, depending on diet, environment and living conditions 

Gummy: Aged 

Annex 3: When we were determining the age of animals during ante mortem inspection of animals

Annex 4: Body condition score protocol of small ruminants [18].

Rank Condition	Score type	Description
Condition Score 1	Very thin (poor)	Spine prominent and Sharp
Condition Score 2	Thin (poor)	Spine prominent and smooth
Condition Score 3	Average (medium)	Spine smooth and rounded
Condition Score 4	Fat (good)	Spine only detected as a line
Condition Score 5	Very fat (good)	Spine not detectable; fat dimple over spine

Annex 5: Some lesions encountered in visceral organs of small ruminants