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Prevalence and Financial Loss Estimation of Hydatidosis of Cattle Slaughtered at Shashemene Municipal Abattoir, South Central Oromia, Ethiopia

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Abstract: A cross-sectional study was carried out from November 2019 to April 2020 for investigating the prevalence and financial loss of bovine hydatidosis in cattle slaughtered at Shashemene municipal abattoir, Oromia, Ethiopia. Out of the total 484 examined cattle via routine meat inspection procedures, 216 (44.6%) animals were found to be positive for hydatidosis. Statistically significant ($p<0.05$) associations was obtained between age groups in which higher number of infection was recorded in older cattle (>5 years) (53.6%). However, insignificant variation ($p>0.05$) was observed regarding breed, body condition and origin of animals. From 216 infected cattle, 83 (17.1%) had cysts in their lung, 13 (2.7%) liver, 6 (1.24%) spleen, 2 (0.4%) heart and 3 (0.6%) kidney. Of 461 recovered cysts, 158 (34.3%), 130 (28.2%) and 47 (10.2%) were small, medium and large cysts, respectively. Additionally, 189 (40.9%) fertile, 146 (31.7%) sterile and 126 (27.3%) calcified cysts were also obtained via laboratory examination. Higher number of calcified (46.4%) and fertile cysts (51.6%) were found in the liver and lung, respectively. The total economic loss from organ condemnation and carcass weight due to bovine hydatidosis was estimated to be 6,524,087.2 ETB (185,080.5 USD) based on the local market price in the study period. The results of this study revealed that bovine hydatidosis was economically important disease in the study area. Therefore, an appropriate control and prevention measures should be practiced in order to minimize the economic loss and zoonotic risks of Bovine hydatidosis.

Key words: Hydatid Cyst · Organ Condemnation · Post Mortem · Zoonotic infection

INTRODUCTION

The highest number of world's livestock population is inhabited by developing countries. However, the contributions from these enormous livestock resources to their national economy as well as productivity of animal populations are insignificant and lower [1]. Ethiopia is one of the developing country and known to have the largest livestock population in the continent, Africa [2]. Livestock sector contributes about 16.5% and 35.6% of Ethiopian national GDP and agricultural GDP, respectively [3]. However, Ethiopian livestock potential is not suitably utilized, chiefly owing to the existing traditional management systems, limited genetic potential and rampant diseases.

Animal diseases are one of the essential concerns responsible for the livestock's lower contribution to the Ethiopian national economy [2, 3]. Internal parasitisms are one of the diseases contributing to the low productivity of animals consequently leading to economic loss and public health hazards in Ethiopia. Among known endo-parasites, hydatidosis is one of the parasitic diseases causing a reduction of meat production and is contributing for both carcass and organ condemnations as well as morbidity and mortality of human beings [4].

Hydatidosis is a zoonotic disease in which domestic intermediate hosts (IH) are the major reservoirs for its transmission to human beings. *Echinococcus granulosus*, larval stage of the dog's tapeworm, is causative agent of the hydatid disease having a chronic nature [5]. Echinococcus is classified under the class (Cestoda), order (Cyclophyllidea), genus (Echinococcus) and species (*E. granulosus*) [6]. Intermediate (IH) and definitive hosts (DH) are the two hosts which are responsible for accomplishment of the life cycle of the causative agent, *E. granulosus* [7]. Carnivores are the definitive hosts

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responsible for the life cycle completion and also harbor mature tape worms in their intestine [8]. Intermediate hosts (IH) also plays a major role in the life cycle of the disease which comprised of livestock's and humans in which the consequences of the diseases depends on the site of development of cysts in different organs including lung, liver, spleen and other organs [9, 10].

Transmission and infection of hydatidosis is mainly occurred by consumption of offal's (oral route) that contained hydatid cysts found in different organs of the intermediate hosts (IH) by the definitive hosts (Carnivores) [11]. After ingestion of the hydatid cysts (found in IH) by DH, the cyst will develop into a mature tapeworms in the DH`s small intestine. A very small adult tapeworms (<6mm) shed gravid proglottids in the faeces of the DH (carnivores) [12, 13].

Echinococcus granulosus is prevalent in all parts of the world including Ethiopia. Different researchers are reported the existence of hydatidosis as endemic status in animals such as dogs and livestock's [14]. According to the report of most African countries, hydatid disease is most commonly recognized in cattle due to their grazing habit in free ranging system and their tight association with domestic dogs. As a result, significant economic damages are occurring due to condemnation of affected organs (lung, liver, spleen, kidney and others) and reductions of animal's meat, milk and wool productions [15, 16].

Condemnations of hydatid affected organs (lung, liver, spleen and etc.), treatment cost of diseased animals and losses associated with animal productions are some of the factors that are causing a huge economic impact in Ethiopia. Due to bovine hydatidosis, annual losses of 25,608 ETB (2,807.89 US$) in Tigray municipal abattoir, 1,791,625.89 ETB (131,737.19 US$) in Hawassa municipal abattoir and 473,173.75 ETB (51,883 US$) in Debre Markos municipal abattoir were reported by Kebede *et al*. [17], Regassa *et al*. [18] and Kebede *et al*. [19], respectively. Different factors are stated for the higher prevalence and huge economic impact of hydatidosis in different parts of Ethiopia. Those factors include poor meat inspection techniques, lack of meat inspectors, poor management systems and awareness of communities on food borne diseases, lack of veterinary services and shortage of abattoirs in the country [20].

Studying about hydatidosis is important for aiding the prevention and control measures of the disease and also used for minimizing the economic impact and public health hazards. However, the recent prevalence and financial loss estimation of Bovine hydatidosis in Shashemene municipal abattoir was neither studied nor well known. Therefore, this study aimed at assessing the prevalence and its associated risk factors of bovine hydatidosis, estimating the financial losses (direct and indirect) as well as showing and characterizing the distribution of hydatid cysts in different organs of examined cattle at Shashemene municipal abattoir, West Arsi Zone, Oromia regional state, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area: The study was carried out in Shashemene municipal abattoir, West Arsi Zone, Oromia regional state, of Ethiopia from November 2019 to April 2020. Shashemene town is situated at a distance of 250 km away from the capital city of Ethiopia, Addis Ababa and 25 Km north of Hawassa, capital of Sidama national regional state. It is located geographically at 7° 12' North and 38° 36' East, having an average elevation of ranging from 1700-2600 meters above sea level and characterized as bi-modal rainfall which comes from long and short rainy seasons. The average minimum and maximum annual temperature ranges between 9°C and 24°C, respectively and the mean relative humidity is about 75% [21]. The study area composed of 244,120 cattle, 69,828 sheep and 105,156 goats [22]. Shashemene town has only one abattoir and in average around eighty (80) cattle were slaughtered per day during the study period.

Study Population: Apparently healthy cattle comprising different kinds of breeds, body condition, origin, sex and age groups were brought from Negelle Arsi, Koffele, Dodola, Bishan Guracha, Shalla and Shashemene districts to Shashemene municipal abattoir. Number was written on the study animals' body with color marker by their owners for identification. Males are higher in number than female animals. Factors encountered in female animals presented for slaughter includes: poor production performance, ended productive life and reproductive problems.

Study Design: A cross-sectional study was conducted with the aims of determining the prevalence and financial losses occurred due to bovine hydatidosis in Shashemene municipal abattoir. Risk factors, organ distribution and cyst characterization in size were also assessed and included in the study. During performing anti-mortem inspection, factors such as breed, origin, body conditions, age and sex of study animals (cattle) were carefully recorded. Systematic (three (3) slaughtering days per week) visits were made to Shashemene municipal abattoir from a period of November 2019 to April 2020.

Sample Size Determination: Based to the method and formula described by Thrustfield [23], the required sample size of the study was calculated and determined by considering 50 % prevalence in the previous study [24], 95% confidence interval and 5% desired absolute precision using the formula below:

$$N = \frac{1.96^2 \times \text{pexp}\ (1\text{-pexp}}{d^2}$$

where, N= required sample, P_{exp} = expected prevalence (50%) and d =desired absolute precision (0.05)

After substituting each value into the above formula, 384 cattle were determined after vigilant calculation. However, additional 100 samples were added in order to increase the precision of the study as well as for a better conclusion. Finally, a total of 484 samples (cattle) were included and examined in the study. The total samples (484) were selected during ante mortem inspection by a systematic random sampling method. Cysts were selected purposively from hydatid infected bovines and cyst sizes were measured as well as fertility and viability status was also evaluated.

Active Abattoir Survey

Ante-mortem Examination: The selected study animals were inspected properly both at rest and in motion before they passed for slaughter. During the period from a month of November 2019 to April 2020, three (3) days per week regular visit were made to Shashemene municipal abattoir. In one day visit on average thirty (30) study animals while in one week around 90 study animals were inspected and examined. Identification number was written on the body of animals (via color mark) at the lairage during performing ante mortem inspection. Through systematic random sampling method, the required study animals were selected and at the same time breed type, age, sex, body condition and origin of the study animals were recorded on suitably prepared ante mortem data recording format. To gather information on the origin of the study animals, owners of the study animals were interviewed. Via examining teeth eruptions based on the method forwarded by De Lahunta and Habel [25], age of the study animals were estimated and less or equal to five years (≤5 years) and above five years (>5years) of age groups were selected and considered. According to Nicolson and Butterworth [26], study animals body condition was classified as poor, medium and good. After examining the health status of animals through clinical examination both at rest and in motion, apparently healthy animals were passed for slaughter.

Post Mortem Examination: Through carefully identifying study animals based on the number written on their body, post mortem inspection was accomplished for detecting hydatid cysts. Post mortem inspection was performed by visual inspection, palpation and incision of organs such as lung, liver, spleen, heart and kidneys of each study animals for detecting the presence of hydatid cysts and their distribution. From hydatid infected study animals, cysts were carefully removed by scalpel blade from each infected organs of thoracic and abdominal cavity (such as lung, liver, heart, spleen and kidney) and collected in clean Ice box for close examination (number and characteristics) as well as all raw data was registered properly.

Hydatid Cyst Characterization: The infected thoracic and abdominal cavity organs of study animals were collected and recorded carefully. In each infected organs, the total number of cysts were identified, counted and recorded on suitably prepared post mortem data recording format. Size, counting, fertility and viability of cysts were also determined through different procedures. According to methods and criteria's forwarded by Schantz [27], the sizes of collected cysts were measured by the ordinary ruler and classified as small, medium and large and recorded (i.e., less than 4 (<4 cm) diameter (small), 4-8 cm diameter (medium) and greater than 8 (>8 cm) diameter (large)).

By using Ice box, the collected cysts (hydatid) were labeled and taken to Hawassa University School of Veterinary Medicine, Parasitology Laboratory for further examination. Firstly, individual cysts were grossly examined for the presence of calcification and degeneration. Non calcified hydatid cysts were selected carefully for assessing the fertility status. Cyst wall was penetrated with sterile hypodermic needle with 10ml syringe in order to reduce intra-cystic pressure and after being punctured, opened up by using scalpel blade and scissors. Then, the fluid contents of cysts were transferred into sterile glass petri dishes and examined for the presence of protoscolices under stereomicroscope (40X). The cysts which contain protoscolex, fertile cysts, were subjected to viability test whereas cysts which did not contain protoscolex were considered as unfertile. For determining viability status of fertile cysts (contain protoscolex), a drop of the sediment (containing the protoscoleces) was placed on a microscopic glass slide and covered with coverslip and then carefully observed for the presence of amoeboid like peristaltic movement (flame cell activity) at objective magnification (40X). A drop of 0.1% aqueous eosin solution for a clear vision,

was added to equal volume of protoscolices in hydatid fluid on a microscopic slide with the principle that protoscolices should completely or partially exclude the dye while the dead once took it up the eosin dye [28]. Additionally, cysts (hydatid) which are not fertile (unfertile) were classified as sterile or calcified. Upon incision of calcified cysts, a gritty sound was heard [29, 30].

Financial Loss Assessment: An attempt was made to determine the total economic losses occurred due to bovine hydatidosis in Shashemene municipal abattoir by considering both direct and indirect losses. Direct losses due to bovine hydatidosis was calculated after getting the average mean price of the internal organs (lung, liver, heart, spleen and kidney) condemned due to infection with hydatid cyst whereas the indirect losses were calculated and assessed based on reductions in the live weight due to the parasitic disease, bovine hydatidosis [31]. Annual slaughter capacity (average) of Shashemene municipal abattoir was obtained from the abattoir manager and market price (average) of each organ (lung, liver, kidney, heart and spleen) was determined after randomly interviewing 20 butchers working in 20 different hotels and restaurants found in Shashemene town. After receiving a record of two (2) years of retrospective abattoir data from the manager of the abattoir and 7510 cattle were estimated to be the annual slaughter (average) of Shashemene municipal abattoir. According to the approaches described by Getaw *et al*. [32], a five percent (5%) estimated carcass weight loss due to bovine hydatidosis was considered. Depending on the estimation described by International Livestock Center for Africa (ILCA) [33], an average carcass weight (dressing percentage) of Ethiopian zebu cattle was taken as one hundred twenty six kilogram (126 kg). Economic loss estimation of bovine hydatidosis was determined by the following formula as calculated by Ogunirale [34].

Direct Monetary Loss: Direct loss from organ condemnation was calculated as:

$$LOC = (NAS \times Plu \times Cplu) + (NAS \times Phr \times Cphr) + (NAS \times Pli \times Cpli) + (NAS \times Psp \times Cpsp) + (NAS \times Pkid \times Cpkid)$$

where, LOC = Loss occurred because of organ condemnation; NAS = Mean number of cattle slaughtered in Shashemene municipal abattoir (annually); Plu = Percent involvement of lung; Cplu = Current mean retail price of lung in Shashemene town; Phr = Percent involvement of heart; Cphr = Current mean retail price of heart; Pli = Percent involvement of liver; Cpli = Current mean retail of liver; Psp = Percent involvement of spleen out of examined; Cpsp = Current mean retail of spleen; Pkid = Percent involvement of kidney out of examined; Cpkid = Current mean retail price of kidney in Shashemene town.

Indirect Loss: Indirect loss was calculated as:

$$LCWL = NAS \times Ph \times CPB \times 5\% \times 126 \text{ kg}$$

where, LCWL = Loss from carcass weight loss; 5% = Estimated carcass weight loss due to hydatidosis; NAS = Average number of cattle slaughtered at Shashemene municipal abattoir; Ph = Current finding of the prevalence of hydatidosis in Shashemene municipal abattoir; CPB = Current average price of one kilogram (1 kg) of beef at Shashemene town (300 Ethiopian Birr); 126kg = Average carcass weight (dressing percentage) of adult Zebu cattle.

Finally, the total economic loss was calculated by summing up costs of direct loss and indirect loss. Thus,

$$\text{Total economic loss} = \text{LOC (Direct loss)} + \text{LCWL (Indirect loss)}$$

Data Management and Analysis: Raw data collected in the study area during ante-mortem, post-mortem and laboratory findings as well as questionnaire survey were recorded on a standard recording format and entered into Microsoft excel sheet computer program, coded and analyzed using SPSS version 17. A 95 % confidence interval and 5 % precision was used to determine the significance and insignificance difference among risk factors and organ affected. Statistically significant and insignificant associations between variables were considered at $p<0.05$ and $p>0.05$, respectively. For determining the associations between the risk factors and the prevalence of hydatid cyst in the selected animals, Chi-square statistical test was used.

RESULTS

Prevalence and Risk Factors of Bovine Hydatidosis: During the study period from a month of November 2019 to April 2020, a total of four hundred eighty four (484) cattle were selected before slaughter through systematic random sampling at Shashemene municipal abattoir and carefully examined for the presence of hydatid cysts after

Table 1: Prevalence of Bovine hydatidosis at Shashemene municipal abattoir based on different variable categories.

Variables	No. of examined	No. of positive	Prevalence (%)	Chi-square (x^2)	p-value
Age Groups					
Group 1 (≤5 years)	221	75	33.9	22.1123	0.001
Group 2 (>5 years)	263	141	53.6		
Breed type					
Local	438	197	44.9	8.7019	0.351
Cross	46	19	41.3		
Sex Groups					
Male	469	209	44.6	8.7124	0.271
Female	15	7	46.7		
Body condition					
Poor	58	18	31.03		
Medium	265	137	51.7	16.256	0.601
Good	161	61	37.9		
Origin of Animals					
Shashemene	105	62	59.04		
Negelle Arsi	180	88	48.9		
Koffele	127	34	26.7	2.6374	0.213
Dodola	57	26	45.6		
Shalla	5	3	60		
Bishan Guracha	10	3	30		
Total	484	216	44.6%		

slaughtered. From the total (484) cattle examined in the study area, 216 (44.6%) were found positive for hydatidosis. Hydatid cysts were obtained in only one (single) or more of their internal organs (lung, liver, heart, kidney and spleen). For the occurrence of Bovine hydatidosis in the study area, variable's taken as a risk factors include body condition, age, breed and origin.

Statistically significant variation ($p<0.05$, $x^2=22.1123$) was obtained regarding age prevalence with greater than five (>5) years old study animals having higher number of hydatid infection than less or equal to five years (≤5) old cattle as shown on Table 1.

Regarding body condition, higher hydatid infections was obtained from cattle having medium body condition (137/265, 51.7%). Cattle having good body condition (61/161, 37.9%) and poor body condition (18/58, 31.03%) were also recorded in the study. Statistically insignificant difference ($p>0.05$, $x^2=16.256$) in cyst detection was obtained among study animals body condition categories.

Prevalence of hydatid disease was higher in local breeds (197/438, 44.9 %) than crossbreeds (19/46, 41.3%) of the study cattle. However, statistically insignificant difference ($p>0.05$, $x^2=8.7019$) was observed between breeds of study animals. Statistically insignificant variation ($p>0.05$, $x^2=2.6374$) was obtained among origin of study animals.

Anatomical distribution of Hydatid Cyst: From the total of 484 study animals, 216 cattle were positive for hydatidosis. i.e., hydatid cyst was obtained from only one (single) or more than one (multiple) internal organs. From the total hydatid cyst harbored cattle (216), single internal organ infections were recorded from one hundred seven (107) cattle and the remaining 109 cattle had infections in two or more organs. From the examined internal organs for the presence of hydatid cyst, the highest proportions were observed in lungs and followed by liver. Out of 216 hydatid infected cattle, 83 (17.1%), 13 (2.7%), 6 (1.24%), 2 (0.4%) and 3 (0.6%) had hydatid cysts only in lungs, liver, spleen, heart and kidney. The remaining 109 (50.5%) study animals had hydatid cysts in more than one internal organ (multiple infections) (Table 2). The present study revealed that hydatid cysts occurred most commonly in the lung (17.1%) as a single infection, followed by the liver (2.7%), spleen (1.2%), kidney (0.6%) and heart (0.4%).

Cyst Characterization: Morphological characterization of cysts were performed after taking a total of 283, 140 26, 8 and 4 cysts from an organs like lung, liver, spleen, heart and kidney origins, respectively. In the current study, 158 (34.3%) small, 130 (28.2) medium and 47 (10.2) large hydatid cysts were obtained through measuring in an ordinary ruler out of the total hydatid cysts taken from

Table 2: Hydatid cyst distribution in major visceral organs of infected animals

	Number of animals		
Organs of animals infected	Examined	No. of cases	Percentage (%)
Lung	484	83	17.1
Liver	484	13	2.7
Heart	484	2	0.4
Spleen	484	6	1.24
Kidney	484	3	0.6
Lung and Liver	484	72	14.9
Lung and Spleen	484	4	0.83
Lung and Heart	484	2	0.4
Liver and Heart	484	2	0.4
Liver and Spleen	484	5	1.03
Lung, Liver and Spleen	484	20	4.13
Lung, Heart and Liver	484	4	0.83
Total Number	484	216	44.6%

Table 3: The size of Hydatid cysts and counts in infected organs of positive animals

	Number (%) of cyst sizes			
Infected Organ	Small	Medium	Large	Total
Lung	92(32.5)	101(35.7)	41(14.5)	283(61.4)
Liver	54(38.6)	17(12.1)	4(2.9)	140(30.4)
Heart	5(62.5)	2(25)	0(0.00)	8(1.7)
Spleen	5(19.2)	9(34.6)	2(7.7)	26(5.6)
Kidney	2(50)	1(25)	0(0.00)	4(0.87)
Total	158 (34.3)	130 (28.2)	47 (10.2)	461

Table 4: The number (%) of fertility and sterility of cysts collected from different organs

Infected Organ	Fertile cyst (%)	Sterile cyst (%)	Calcified (%)	Total (%)
Lung	146(51.6)	88(31.09)	49(17.3)	283(61.4)
Liver	35(25)	40(28.6)	65(46.4)	140(30.4)
Heart	2(25)	5(62.5)	1(12.5)	8(1.7)
Spleen	5(19.2)	11(42.3)	10(38.5)	26(5.6)
Kidney	1(25)	2(50)	1(25)	4(0.87)
Total	189 (40.9)	146 (31.7)	126 (27.3)	461

infected animals and the remaining 126 (27.3) were calcified cysts (Table 3). Through measuring the size of cysts systematically, higher numbers of medium sized (35.7%) and large sized hydatid cysts (14.5%) were found in lungs whereas a higher number of calcified (46.4%) and small sized (38.6%) cysts were found in liver.

Out of the total 461 hydatid cysts recovered from hydatid positive animals for characterization purpose, 189 (40.9%), 146 (31.7%) and 126 (27.3%) were fertile, sterile and calcified cysts, respectively (Table 4). 146 (51.6%) fertile, 88 (31.09%) sterile and 49 (17.3%) calcified cysts in the lung, 35 (25%) fertile, 40 (28.6%) sterile and 65 (46.4%) calcified cysts in the liver, 2 (25%) fertile, 5 (62.5%) sterile and 1 (12.5%) calcified cysts in the heart, 5 (19.2%) fertile, 11 (42.3%) sterile and 10 (38.5%) calcified cysts in the spleen and 1 (25%) fertile, 2 (50%) sterile and 1 (25%) calcified cysts of kidney were detected during study period. Higher number of fertile cyst (51.6%) and sterile cysts (31.09) were obtained from the lung while higher number of calcified cysts (46.4%) was obtained from liver.

Viability test was performed on the 189 fertile cysts (obtained after fertility status characterization) and showed, 121 (64.02%) and 68 (35.9%), were viable and non-viable cysts, respectively (Table 5). From fertile cysts (146) obtained from the lung, 93 (63.7%) and 53 (36.3%) were viable and nonviable cysts, respectively. Out of fertile cysts 35 (18.5%) obtained from the liver, 27 (77.1) and 8 (22.9%) were viable and were nonviable cysts, respectively. From fertile cysts 2 (1.06%) obtained from the heart, all are nonviable cysts. Out of fertile cysts 5 (2.6%) obtained from the spleen, 1 (20%) and 4 (80%) were viable and nonviable cysts, respectively. Nonviable cyst (1) was obtained from fertile cyst obtained from the kidney.

Table 5: Associations between viability status and organ involvement of infected cattle

Organ involved	Viable cyst	Nonviable cyst	Total
Lung	93(63.7)	53(36.3)	146(77.2)
Liver	27(77.1)	8(22.9)	35(18.5)
Heart	0(0.00)	2(100)	2(1.06)
Spleen	1(20)	4(80)	5(2.6)
Kidney	0(0.00)	1(100)	1(0.5)
Total	121(64.02)	68(35.9)	189

Financial Loss Assessment: Out of the total study animals (484) selected, 216 (44.6%) were found positive for hydatid disease i.e. harbored hydatid cyst. Among internal organs, 185, 116, 10, 35 and 3 of the hydatid cysts were found from lungs, liver, heart, spleen and kidneys respectively. Therefore, the current prevalence of bovine hydatidosis in Shashemene municipal abattoir and the percent involvement of internal organs (lung, liver, heart, spleen and kidney) were used to calculate and estimate the current total economic loss occurred due to organ condemnation in the study area.

Based on the survey carried out in hotels and restaurants found in Shashemene town, an average market price of lung, liver, heart, spleen, kidney and a one (1kg) kilogram of beef was found to be 10, 30, 25, 20, 30 and 300 Ethiopian Birr (ETB), respectively. After receiving a record of two (2) years of retrospective abattoir data from the abattoir and 7,510 cattle were estimated to be the annual slaughter (average) of the study area. In order to calculate the economic loss of the study area, the formula described in the material and methods section was applied. Direct financial losses (due to condemned internal organs (infected)) and indirect financial losses (due to carcass weight loss) were calculated and then summed up to obtain total economic loss on annual basis.

LOC = (NAS x Plu x Cplu) + (NAS x Pli x Cpli) + (NAS x Phr x Cphr) + (NAS x Pk x Cpk)
= (7510 x 0.53 x 10) + (7510 x 0.33 x 30) + (7510 x 0.03 x 25) + (7510 x 0.1 x 20) + (7510 x 0.009 x 30)
= 39,803+74,349+5,632.5+15,020+2,027.7
= 136,832.2 Ethiopian Birr/annually

LCWL = NAS × Ph × CPB × 5% x 126 kg = 7,510 × 0.45 × 300 x 0.05 × 126
= 6,387,255.00 ETB/annum

Total economic loss= 136,832.2 + 6,387, 255= 6,524,087.2 Ethiopian Birr (ETB)

The direct economic loss occurred in Shashemene municipal abattoir due to organ condemnation was calculated to be 136,832.2 Ethiopian Birr (ETB) per annually. Indirect loss (due to carcass weight reduction) was also calculated by taking 5% carcass weight loss brought by bovine hydatidosis and an average carcass weight of Ethiopian adult cattle (126 kg) and finally the calculated result was found to be 6,387,255 ETB annually. The total economic loss was calculated and obtained by summing up both direct economic loss and indirect economic loss occurred due to bovine hydatidosis at Shashemene municipal abattoir. Thus, total economic loss was 6,524,087.2 ETB (185,080.5 USD). 1 USD= 35.25 ETB (Based on information obtained from National Bank of Ethiopia). This result shows that bovine hydatidosis causes higher indirect financial loss due to carcass weight reduction than the direct loss due to organ condemnation.

DISCUSSION

The present study revealed that the prevalence of bovine hydatidosis at Shashemene municipal abattoir was found to be 44.6% (216/484). This finding was lower than the report of Fikadu [35], Tolossa *et al*. [36], Kebede [37] and Negash *et al*. [38] with overall prevalence of 72.4%, 50.78%, 48.9% and 49.5% in Assela, Dodola, Debremarkos and Shashemene towns of Ethiopia, respectively. However, the present finding was higher than the prevalence of 13.5% in Burdur (Turkey), by Umur [39], 25.16% in Mekelle by Tkubet *et al*. [40], 17% in south Wollo by Bizuwork *et al*. [41] and 18.6% in Adigrat by Assefa and Tesfay [42]. This difference on the prevalence of bovine hydatidosis in different abattoirs might be due to differences in husbandry system, practice of backyard slaughtering of animals, hygiene difference of abattoirs, presence of several stray dogs, lack of proper disposal of infected organs, lack of public awareness and strain differences of *E. granulosus* in different geographic areas of the world [43, 44].

Significant difference ($p<0.05$) was obtained regarding different age groups of cattle. Cattle grouped under age of greater than 5 years were highly affected than cattle with less or equal to 5 years. This might be due to longer exposure time of parasitic ova in aged animals and also a weaker immunity of aged cattle [45]. This finding is similar to the report of Azlaf and Dakkak [46] and Esatgil and Tuzer [47]. 7 (46.7%) females and 209 (44.6%) males were positive for hydatidosis. Statistically insignificant variation was obtained regarding sex groups of study animals ($p>0.05$, $x^2=8.7124$). This might be due to lower number of females than males slaughtered during the study period. Regarding the breed of study animals, prevalence of hydatid disease was higher in local breeds (197/438, 44.9 %) than crossbreeds (19/46, 41.3%) of study

cattle. However, statistically insignificant difference ($p>0.05$, $x^2=8.7019$) was observed between breeds of study animals. This might be due to small number of crossbreds slaughtered during the study period. This result is in agreement with the finding of Temesgen [48].

Statistically insignificant variation ($p>0.05$, $x^2=2.6374$) was obtained among origin of study animals. This might be due to difficulty in getting the exact origin of study animals during the study period. This finding is in agreement with the reports of Tesfaye *et al*. [49] and Nasr and Pal [50]. Highest proportions of cysts were observed in lungs 83 (17.1%). In the study area, majority of slaughtered cattle were aged (>5years). As a result, the liver capillaries are dilated which allows the passing of most oncospheres to the lung and also due to entrance of hexacanth embryo to the lymphatic circulation and then carried to organs such as heart and lung. For this reason, lung can be affected before liver [51]. Nevertheless, there were also development of hydatid cysts in other organs such as liver, heart, spleen and kidney. This can be happened when oncospheres escapes directly into the general circulation. Therefore, the present study is in agreement with report of Alemu *et al*. [52].

Higher numbers of medium sized (35.7%) and large sized hydatid cysts (14.5%) were found in lungs. This might be due to the softer consistency of the lung tissue that enabled the oncosphere to grow into larger hydatid cyst as well as the oncospheres reach the lung via thoracic duct and enter into lymphatic system. Although a higher number of calcified (46.4%) and small sized (38.6%) cysts were found in the liver. This might be due to the liver property which comprises presence of higher reticuloendothelial cells and abundant connective tissue together with prohibition of cyst expansion due to immunological response of the host [53].

The current study revealed the occurrence of fertile cysts to be 40.9%. This finding is lower than the percentage reported in Great Britain (70%), South Africa (96.9%) and Belgium (94%) [51]. However, it is slightly related with the report of 22% by Elmahdi *et al*. [5] in central Sudan. This variation might be due to strain difference of the causative agent, *E. granulosus.*

The total economic loss due to bovine hydatidosis in Shashemene municipal abattoir was found to be 6,524,087.2 ETB (185,080.5 USD). Different researchers were also reported different figure of estimated financial losses in different abattoirs of Ethiopia. A total economic loss of 1,791,625.89 ETB was reported by Regassa *et al*. [18] in Hawassa municipal abattoir, loss of 160,032.23 ETB was reported by Zewdu *et al*. [54] in Gondar municipal abattoir and financial loss of 410,755.90 ETB was reported by Torgerson *et al*. [31] in Wolaita Sodo municipality abattoir. The present economic loss obtained was high compared to different areas of Ethiopia. The variation might occurred due to the difference in the prevalence of bovine hydatidosis, average number of slaughtered cattle and variation in mean retail market price of organs in different places of Ethiopia.

CONCLUSION AND RECOMMENDATIONS

In the present investigation, the prevalence of bovine hydatidosis in Shashemene municipal abattoir was high (216/484 (44.6%)). The results show the potential impact of the disease both in the economy and public health systems of the study area. The current high prevalence was due to the presence of many stray dogs around the abattoir that fed improperly disposed hydatid infected organs, lack of community's awareness about the disease and practice of backyard slaughtering's. Lung and liver were the leading organs condemned due to hydatid cysts. Majority of cysts obtained were fertile cysts. Fertile and viable cysts were obtained in higher number from the lung whereas calcified and nonviable cysts were obtained in higher number from the liver. The estimated financial loss due to organ condemnation and indirect weigh loss in the study abattoir was high. Therefore, the problem deserves effective prevention and control involvements including facilitating an appropriate meat inspection services, proper disposal of condemned organs through either incineration or burying, the abattoir should be properly fenced and access to any carnivores should be denied as well as stray dogs should be controlled, education and public awareness creation should be carried out through extension, mass medias and other sources of information and improving the awareness of the community about regular de-worming of dogs with anthelmintic drugs. Moreover, law should be enacted that prohibits backyard slaughtering and feeding of uninspected and uncooked offal's to dogs.

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