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Small Ruminant Hydatidosis: Occurrence and Economic Importance in Addis Ababa Abattoir

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Abstract: A cross sectional study was conducted on small ruminants from October 2010 to March 2011 at Addis Ababa Abattoir Enterprise (AAAE) to determine the prevalence of hydatidosis, the economic losses attributed to it and to test the viability of cysts. Totally, 500 small ruminants were sampled randomly of these 399 were sheep and 101 were goats and the unbalanced sample of goats was due to low availability of the species. The overall prevalence was 8.6% whereas, in sheep and goats were 8.5% and 8.9%, respectively. The percentage of hydatid cysts in different visceral organs was observed as 48.8% and 6.98%, in lung and liver respectively. Results indicated that host species, viability test, size and volume of cysts did not have significant effect ($P>0.005$) on prevalence of the disease, however, age had statistically significant effect ($P<0.05$) on the disease prevalence. The total annual financial loss due to hydatidosis was estimated at 270,691.01Ethiopian birr (ETB) and this loss was significant. It is concluded that small ruminant hydatidosis is prevalent at AAAE and it has public health importance. It is recommended to increase veterinarians' number in the abattoir to examine lungs and livers.

Key words: *Echinococcus granulosus* · Sheep · Goat · Cyst · Viability Test

INTRODUCTION

The total number of sheep and goats in Ethiopia is estimated to be nearly 48 million. Sheep and goats are widely adapted to different climates and are found in all production systems. They also have lower feed requirements compared to cattle because of their small body size. This allows easy integration of small ruminants into different farming systems. Economic opportunities exist for small ruminant producers to supply animals to both the export and domestic markets. Taking advantage of these opportunities requires overcoming many barriers to increase productivity [1].

Helminths are major causes of animal diseases and loss of productivity throughout the tropics [2]. Moreover, zoonotic diseases common to man and animals continue to have high incidence rates and to cause significant morbidity and mortality. Infections and parasitosis of ruminants can reduce meat or milk production and can lead to death or destruction of the animals, all of which diminishes the supply of available food for man. These diseases are also an obstacle for international trade, as well as a serious financial drain for cattle farmers and, more broadly, for a community's or a country's economy, which can have wide repercussions for a society's health [3].

In Ethiopia, significant losses result each year from death of animals, inferior weight gain, condemnation of edible organs and carcass at slaughters due to helminthes [4]. Echinococcosis is a zoonotic infection caused by adult or larval (metacestode) stage of cestodes belonging to the genus *Echinococcus*, family *Taeniidae* [5]. *Echinococcus granulosus* and its metacestode (hydatid cyst) in herbivores and humans have been recognized as the most important helminth zoonoses with great economic and public health significances in developing countries [6]. It remains persistent and re-emerging problem in countries of low economic status where a resource for an intensive control program is limited [7]. It is associated with sever morbidity and disability,

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and is one of the world's most geographically wide spread zoonotic diseases [8, 9]. The most important intermediate host is sheep, which appears to be the natural intermediate host. Scolices from these animals are the most highly infective for dogs [10].

Certain deep-rooted traditional activities have been described as factors associated with the spread and high prevalence of the disease in some areas of the country. These can include the widespread backyard slaughter of animals, the corresponding absence of rigorous meat inspection procedures, the long standing habit of feeding domesticated dogs with condemned offal and the subsequent contamination of pasture and grazing fields. This can facilitate the maintenances of the life cycle of *E. granulosus* which is the causative agent of cystic hydatidosis and consequently the high rate of infection of susceptible hosts [10].

Infection with the adult stage of *E. granulosus* is generally asymptomatic and non-pathogenic to the canid host. Infection with the larval stage of *E. granulosus* can be pathogenic depending on the localization, size of the cyst, and intensity of infection in the cervid or human intermediate host [11]. In endemic areas where human hydatidosis is of great importance special attention should be paid to the safe destruction of affected organs, the reduction of stray dogs and the anthelmintic treatment of domestic dogs [12]. Several reports are available concerning the impact of hydatidosis in cattle of various parts of the nation [10, 13]. As hydatidosis is the main cause of organ condemnation and causes huge economic losses in Ethiopia [14], information regarding the status of hydatidosis in small ruminants and the economic loss of the disease is limited. Therefore the objectives of the present pager are: determination of the current prevalence of hydatidosis in small ruminants slaughtered at AAAE and estimation of the financial annual losses of hydatidosis in small ruminants slaughtered at AAAE.

MATERIALS AND METHODS

Study Area: The study was conducted in AAAE starting from October, 2010 to March, 2011. It has an area of 51 thousand hectare and located in the central high lands with an average altitude of 2000-3000 meters above sea level, bimodal rain fall with an average of 1800mm, the highest percentage of rain fall is during the long rain season (from June to September) and the short rain season from (February to April), the average annual daily temperature ranges from 10.7°c to 23.6°C minimum and maximum, respectively and relative humidity varying from 70%-80% during rainy season and from 40% to 50% during the dry season .The estimated ovine and caprine population of the city are totally 28,244 [15].

Study Design: A cross sectional study design was used for this purpose and conducted by using systematic random sampling method from October, 2010 to March, 2011 to determine the prevalence of small ruminant hydatidosis at AAAE.

Study Population: A total of 500 animals (399 sheep and 101 goats) destined for slaughter were examined and sample of sheep was higher compared to goats due to less availability of goats than sheep in the abattoir. The study was performed in visceral organs (liver, lung, heart, kidney and spleen) of both sheep and goats. Animals were all females and originated from different parts of the country with different agro ecological zones, these areas are like Borena, Arsi, Wellega, Keffa, Southern part of the country (Wellita, Gamogofa, Kambeta, Hadiya, and Gurage), Wollo, Afar, Harrarge, Addis Ababa and its peripheries.

Sampling Method and Sample Size Determination: The sample size was determined by using the formula given by Thrusfield [16] with expected prevalence 9.7%, level of significance 95% and absolute precision 5%. The previous prevalence of hydatidosis in small ruminants at Addis Ababa Abattoir was 9.7% [17]. Sample size was calculated to be 3855, but to increase the precision of the study, 500 animals were sampled.

Data Collection Procedure: In the abattoir, meat inspection was carried out on different organs of each of sampled animals particularly in those organs in which the cyst is more likely to be appeared. Each organ was assessed macroscopically either by visual inspection or palpation and when necessary one or more incision was carried out in order to detect small hydatid cysts. The infected organs from each positive animal were collected and recorded. By using the classification of Oostburg *et al*. [18], the diameter of each hydatid cyst was measured and classified as small (diameter less than 4 cm), medium (diameter between 4-8cm), and large (diameter greater than 8cm). Moreover, the volume of each hydatid cysts was measured and classified as small (volume less than 5ml), medium (volume between 5-20ml), and large (volume greater than 20ml) [19].

Viability Testing Procedure: From the total positive animals, individual cysts were carefully incised and examined for protoscolices, to assess their fertility. Fertile cysts were subjected to viability test. A drop of the sediment containing the protoscolices was examined microscopically on glass slide covered with cover slip to observe amoeboid like peristaltic movements with 40x objective. For clear visualization a drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices in hydatid fluid on microscope slide with the principle that viable protoscolices should completely or partially exclude the dye while the dead ones take it up [19]. Furthermore, infertile cysts were classified as sterile or calcified based on their characteristics.

Assessment of Direct Economic Loss: The economic loss due to hydatidosis in small ruminants slaughtered at AAAE in Addis Ababa city local market was estimated by considering cysts of condemned visceral organs and 5% reduction in carcass weight loss due to hydatidosis. By taking into account the average number of ruminants slaughtered and the degree of organ condemnation per annum at AAAE the direct economic loss attributed to hydatidosis was made using the formula indicated by Getaw *et al*.[17].

Annual loss = $(N_{ps}\times I_{lu}\times C_{lu})+(N_{ps}\times I_{li}\times C_{li})+(N_{ps}\times I_{he}\times C_{he})+(N_{ps}\times I_{sp}\times C_{sp})+(N_{ps}\times I_{ki}\times C_{ki})$ and

Annual cost of carcass weight loss = $BSA\times P_E\times C_{kb}\times 5\%\times 30$ kg (ILCA, 1993).

Where N_{ps} = Total number of positive animal slaughter

I_{lu} = Prevalence of lung hydatidosis
C_{lu} = Cost of lung
I_{li} = Prevalence of liver hydatidosis
C_{li} = Cost of liver
I_{he} = Prevalence of heart hydatidosis
C_{he} = Cost of heart
I_{SP} = Prevalence of spleen hydatidosis
C_{sp} = Cost of spleen
I_{ki} = Prevalence of kidney hydatidosis
C_{ki} = Cost of kidney
BSA = Average number of small ruminants slaughtered per annum
P_E = Prevalence of echinococcosis at the abattoir
C_{kb} = Average cost of 1 kg mutton and goat meat in Addis Ababa

The total economic loss was calculated as the summation of cost of offal condemned plus the cost of carcass weight losses.

Data Analysis: The collected data during sampling and laboratory findings were entered and stored in MS-excel. Before subjected to statistical analysis, the data were thoroughly screened for errors and properly coded. An intercooled Stata 7 software package [20] was used to perform the statistical analysis. Descriptive statistical analysis like table was used to summarize and present the collected data. Hydatidosis prevalence was calculated as percentage by dividing the number of infected animals to the total number of animal samples. Pearson chi-square (χ^2) test and Fisher exact test were employed to assess the existence of association between the result and different variables included in this study. For this analysis P-value <0.05 were considered significant whereas P-value >0.05 considered as non significant.

RESULTS

In this study about 399 sheep and 101 goats were sampled and thoroughly inspected at postmortem examination for the occurrence of hydatidosis. Out of those sampled animals an overall prevalence of 8.6% were recorded. A prevalence of 8.52% and 8.91% were recorded from sheep and goats respectively. Statistical analysis shows that there is no significant difference among the species (P>0.005) (Table1).

During postmortem examination the major organs like lungs, liver, heart, kidney, and spleen were examined in both sheep and goats. In sheep and goats the highest rate of infection (52.9% and 33.3%) were recorded in lungs and the lowest rate of infection (0%) in kidney and spleen. However, in goats rate of infection in the heart was 0% and only 1 cyst was found in the sheep heart (Table 2).

A significant variation (P <0.005) was observed between lung and liver in their positivity for hydatidosis for both species in which higher prevalence were recorded in lung than liver.

Table 1: Prevalence of hydatidosis in sheep and goats slaughtered at AAAE.

Species	No examined	Hydatid positive	Prevalence (%)
Sheep	399	34	8.52
Goat	101	9	8.91
Total	500	43	8.6

Table 2: Distribution of hydatid cysts in different organs of infected sheep and goats

Species		Lung(Lu)	Liver(L)	Heart(H)	Kidney	Spleen	Lu+L+H	Lu+L
Sheep	Positive	18	1	0	0	0	1	14
	Total	34	34	34	34	34	34	34
	Prevalence	52.9%	2.8%	0%	0%	0%	2.8%	41.2%
Goat	Positive	3	2	0	0	0	0	4
	Total	9	9	9	9	9	9	9
	Prevalence	33.3%	22.2%	0%	0%	0%	0%	44.4%

Table 3: The prevalence of hydatidosis in different age groups in both sheep and goats

		Positive		Total		Prevalence (%)	
Factors	Classification	Sheep	Goat	Sheep	Goat	Sheep	Goat
Age	<3 years	3	0	150	38	2 (8.8%)	0
	≥3 years	31	9	249	63	12.4 (91.2%)	14.3 (100%)

Table 4: Classification of hydatid cysts collected from sheep and goats slaughtered at AAAE Based on size and volume

		Size				Volume			
Species	Organ	Small	Medium	Large	Total	Small	Medium	Large	Total
Sheep	Lung	47	21	1	69	49	20	0	69
	Liver	2	1	0	3	2	1	0	3
	Lu+li	21	5	2	28	22	6	0	28
	Lu+li+H	2	3	1	6	3	2	1	6
	Kidney	0	0	0	0	0	0	0	0
	Spleen	0	0	0	0	0	0	0	0
Total		72	30	4	106	76	29	1	106
Prevalence (%)		67.93	28.3	3.77	100	71.7	27.4	0.94	100
Goat	Lung	8	4	0	12	9	3	0	12
	Liver	3	1	0	4	3	1	0	4
	Lu+li	4	2	0	6	5	1	0	6
	Lu+Li+e	0	0	0	0	0	0	0	0
	Kidney	0	0	0	0	0	0	0	0
	Spleen	0	0	0	0	0	0	0	0
Total		15	7	0	22	17	5	0	22
Prevalence		68.2	31.8	0	100	77.3	22.7	0	100

Table 5: Classification of collected hydatid cysts from sheep and goats slaughtered at AAAE based on Viability test

	Viable		Non viable		Sterile		Calcified		Total	
Organ	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat
Lung	11	2	8	2	20	2	30	6	69	12
Liver	1	0	2	2	0	0	0	2	3	4
Heart	0	0	0	0	0	0	0	0	0	0
Kidney	0	0	0	0	0	0	0	0	0	0
Spleen	0	0	0	0	0	0	0	0	0	0
Lu+Li	13	2	2	3	6	1	7	0	28	6
Lu+Li+He	1	0	3	0	2	0	0	0	6	0
Total	26	4	15	7	28	3	37	8	106	22
Prevalence	24.5	18.2	14.2	31.8	26.4	13.6	34.9	36.4	100	100

From the total sampled animals, overall prevalences of 1.6%, and 12.8% were obtained from young and adult animals of both species respectively. High prevalence was recorded in sheep (12.4%) and goats (14.3%) in an age group categorized as ≥3 years (adults). Statistical analysis shows a significant difference (P< 0.005) between young and adult animals in the occurrence of hydatid cysts.

Referring to the standard size, cysts were categorized as; small (less than 4cm), medium (4-8cm) and large (greater than 8 cm). In general 87 (67.97%), 37 (28.9%), 4 (3.13%), small, medium and large cysts were found, respectively in both sheep and goats. In sheep 72 (67.93%), 30 (28.3%) and 4(3.77%); small, medium and large sized cysts were found, respectively. Where as in goats 15(68.2%), 7 (31.8%), and 0 (0%) small, medium and large sized cysts were found respectively and all are proportional with their respective volume of fluid (Table 4). Statistical analysis shows a significant variation (P< 0.005) in the size of hydatid cysts in sheep and insignificant (P>0.005) in goats.

From sampled sheep, 34 were found positive and all cysts were examined for viability. From sheep cysts, 26(24.5%), 15(14.2%), 28 (26.4%) and 37 (34.9%) were identified as viable, non viable, sterile and calcified, respectively. A total of 9 goat samples were found positive for hydatid cyst from those positives; 4 (18.2%), 7 (31.8%), 3 (13.6%) and 8 (36.4%) were identified as viable, non viable, sterile and calcified cysts, respectively. In both sheep and goats high number of calcified cysts 45 (35.2%) was recorded and high rate of calcification was observed in lungs 36 (80%). Fertile cysts were mostly occurred in lung 23(44.23%) (Table 5). Statistical analysis shows no significant difference (P>0.005) in different viability characteristics in both species. However there is a real significant difference exists in the occurrence of viable cyst among the two species where 86.7% and 13.3% of viable cysts were registered from sheep and goats, respectively.

The total economic loss was calculated by adding the total cost of offal condemned and the cost of carcass weight losses. The annual financial loss due to organ condemnation was estimated at 9790.01 ETB and the annual financial loss due to carcass weight loss was estimated to be 260,901.33 ETB. Therefore, the total annual financial loss was 270,691.34 ETB in the present study.

DISCUSSION

The overall prevalence of hydatidosis in sheep and goats slaughtered at Addis Ababa Abattoir Enterprise in present study was 8.6%. This value is in agreement with the study of Jobre *et al*. [10] and Kebede *et al*. [13], who reported 9.1% and 9.7% prevalence, respectively from the same studying site. But, these findings are somewhat higher when compared with the current study. Even if the proportion of animals sampled in age groups have almost equal in distribution, the variation might be resulted from greater proportion of positivity in adult animals in the current study.

In sheep 8.52% prevalence was recorded and this value is in agreement with Azlaf and Dakkak [8] and Elmahdi *et al*.[21], who reported (10.58%) and (10.3%) prevalence in sheep. However, Haridy *et al*. [22] and Njoroge *et al*. [23] observed lower hydatid cyst infection in sheep; (0.33%) and (3.6%) respectively. On the other hand the prevalence in goats in the present study was 8.91% which is relatively high when compared with the study of Saeed *et al*. [24], (6.2%) and Dalimi *et al*. [25] (6.3%), but is not agree with the study of Haridy *et al*. [22] and Njoroge *et al*.[23], who reported (4.5%) and (3.4%) respectively. Deviation from the current study may be attributed to the climatic conditions, good veterinary practices and the husbandry status of the livestock in the areas of study.

In the present study, the most frequently infected organ in both sheep and goats is lung at prevalence rate of 52.9% (sheep) and 33.3% (goat) followed by liver. This is probably due to the reason explained in literature [26]. They are the first large capillary fields encountered by the blood born onchospheres. The presence of greater capillary beds in lungs than other organs, and soft consistency of the lung might also allow easy growth of cysts. Even if development of hydatid cyst occurs occasionally in other organs and tissues when oncosphere escape into the general systemic circulation Urquhart *et al*. [26] in both kidney and spleen, no cysts were observed from both sheep and goats. Statistical analysis revealed a real significant difference (P< 0.005) between organs and it is in agreement with the literatures [26, 27]. They reported a single infection record of 0.85% in heart muscle and neither spleen nor kidney had an observable cyst.

In the current study an overall prevalence of 1.6%, and 12.8% was obtained from young (<3years) and adult (≥3years) animals of both species respectively. From the same study area (AAAE), Getaw *et al*.[17] reported a prevalence of 3.87% and 29.78% in young (< 3years) and adult animals (≥3years) respectively. In both categories these values are low as compared to the Getaw *et al*. [17] report but agree in their significance (P<0.005) and positive correlation (r=1.0) among the different age categories. This significance and positive correlation are also in line with the study of Ibrahim [28] who reported the level of significance and correlation value of r_s=0.50 (P<0.0001) for sheep and r_s=0.17.

(P<0.006) for goats [28]. The age variation can be translated into differential exposure to infection because older livestock may have been exposed to more infection stages.

Even if statistical analysis shows no significant difference (P>0.005) in different viability characteristics in both species, fertile cysts were mostly occurred in lung; 23(44.23%). This finding is in agreement with that of Dalimi *et al*. [25] and Kebede *et al*. [13] who concluded that the fertility rates of hepatic cysts were lower than that of pulmonary ones. This might be due to the softer consistency of lung tissue that allows easier development of the cyst and the fertility. In contrast to the present study, Ibrahim [28] found that the fertility rates of hepatic cysts of sheep and goats were higher than those of pulmonary ones.

Data on the fertility of cysts in various domestic herbivores provide reliable indicators of the importance of each animal species as a potential source of infection to dogs [29]. In light of this fact, there is a higher prevalence rate of fertile cysts encountered in sheep (86.7%) than goats (13.3%) with a significant difference (P<0.005). This possibly emphasize the enormous role of sheep in the occurrence of hydatidosis and the difference in fertility and the proportion of viable protoscolices from fertile cysts may be related to the difference in immunological response in each host. Moreover, the fertility of hydatid cysts in the intermediate hosts may be also genotype dependant. This finding is in line with the report of [30].

Statistical analysis shows a significant variation (P< 0.005) in the size of hydatid cyst in sheep and insignificant (P>0.005) in goats. Our finding is in agreement with that of Kebede *et al*. [13], who concluded that, the occurrence of cyst size differ significantly in lung and liver in sheep where as not in goats.

The total financial loss due to hydatidosis in the current study is estimated to be 270,691.34 ETB. From the previous work of Teka [31], the estimated loss due to hydatidosis is 15,110.50 ETB from liver and lung in Eritrea. While, Nebiyou [32] recorded a loss of 2,413.00 ETB due to visceral organ condemnation in Bihar-Dar municipal abattoir. Getaw *et al*. [17] estimated a loss of 1,709,406 ETB due to visceral organ condemnation and carcass weight loss from the year of 1985-2003 conducted in 18 municipal abattoirs in different areas of Ethiopia. The difference in economic losses could be due to the variation in the prevalence of the disease, mean annual slaughter rate in different abattoirs and variation in retail market price of organs.

CONCLUSIONS AND RECOMMENDATIONS

Among the different organs in which hydatidosis is more likely to be infected, lung was found to be the most important organ that become infected. Furthermore, among the positive animals, the occurrence of the hydatid cyst varies in size in sheep than in goats. Public awareness should be created about the transmission and the life cycle of hydatid cysts and stray dogs should be killed. Promoting the establishment of intensive farms should be encouraged, since the management system practiced in the region is one factor in predisposing small ruminants to hydatidosis.

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