Bovine Hydatidosis: Prevalence and Economic Significance at Adigrat Municipal Abattoir, Northern Ethiopia

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Abstract: A cross sectional abattoir survey was conducted to determine the prevalence and economic importance of bovine hydatidosis at Adigrat abattoir during the time extending from November to April months. A total of 384 randomly selected cattle slaughtered at Adigrat municipal abattoir were examined and 89 (23.18%) were found harboring the cyst. Bovine hydatidosis infection prevalence at Adigrat abattoir was significantly higher in cattle older than five years and with poor body condition (P<0.05). The lung was the most commonly affected organ followed by liver, heart, kidney and spleen. A total of 198 hydatid cysts collected from the lung, liver, kidney, heart and spleen were also assessed for size, where 83(41.92%) were small (< 6 ml), 45 (22.73%), medium (6-12 ml) and large (> 12 ml) 70 (35.35%) whereas the fertility test showed 41(20.71%) to be fertile, 98 (49.49%) sterile and 59 (29.80%) calcified. From the 41 fertile cysts, 29 (70.73%) were viable whereas 12(29.27%) were not. The majority of cysts on the lung were medium to large and sterile whereas the majority of liver cysts were small and calcified. Fertility rate was higher in the lung than in liver. The total annual economic loss from organ condemnation and carcass weight loss amounted to 102,473.47 Ethiopian Birr.

Key word: Bovine - Prevalence - Hydatidosis - Adigrat Abattoir

INTRODUCTION

Ethiopia owns an estimated 49.3 million heads of cattle scattered over a diverse agro-ecology [1]. But the productivity of these animals is very low. The current average meat production for beef cattle in the world, Africa and East-Africa stands at 212 kg, 156 kg, and 143 kg/head, respectively, whereas the corresponding figure for Ethiopia is merely 110 kg [2]. The major problems that cause the low productivity of the animals are related to malnutrition, a high prevalence of many diseases including hydatidosis, low genetic potential, poor management practice and poor socio-economic development [2-4].

Cystic echinococcosis is a disease affecting both man and agricultural animals with potential economic effects to both agriculture and human health. Therefore, it is imperative to study the prevalence and economic effects of the disease as an economic evaluation of the effects of parasitic zoonoses is an integral part of prioritizing and devising cost-effective disease control programs and fund raising from local governments, donor organizations or non-governmental bodies [5].

Various investigations have shown that hydatid cyst in the liver, lung, kidney and heart is the major causes of organ condemnation in slaughterhouses with associated economic loss equivalent to the costs of the condemned edible offal [6-8]. However, potentially the largest cost to animal health was thought to be due to production losses in the form of a reduction in live weight gain, reduced yield of milk, reductions in the fertility rates and reductions in the value of wool or other products in livestock affected by CE [6]. However, many of these losses can be difficult to estimate as there have been few controlled studies [5]. Nevertheless, earlier studies have showed a reduction of up to 5% in meat and 10% in milk production [9] 20% decrease in hide value and 11% decrease in fecundity [10] due to hydatidosis. Hydatidosis rarely produces clinical signs despite heavy infections in domestic animals. Therefore, abattoirs are important places for confirmatory diagnosis and
epidemiological study of this zoonotic disease in the livestock and to estimate the financial losses incurred through condemnation of affected organs. There are some reports on bovine hydatidosis from different parts of the country but not from Adigrat area. Hence, the objectives of this study were to determine the prevalence and rate of organ condemnation in cattle slaughtered at Adigrat abattoir and to estimate the associated magnitude of economic loss.

MATERIALS AND METHODS

Study Area: The study was carried out in Adigrat slaughter house of Tigray Regional State located at about 893 km north of Addis Ababa. According to the Central Statistical Census Commission (2003), the region has about 2.6 million cattle, 0.68 million Sheep, 1.75 million Goats, 0.45 million Equine and 0.637 million Camels while Adigrat and the surrounding areas own 21,099 Cattle, 24,523 Cows, 53,305 Sheep, 29,872 Goats, 5360 Equine and 57,775 Poultry. Topographically Adigrat is found at an altitude range of 2000-3600 meter above sea level and receives a mean annual rain fall of 305-550 ml and a mean annual temperature of 4-25°C. Rainy season occurs mainly between June and September.

Study Animals: The study was conducted on local zebu breeds brought to the slaughter house by butchers and restaurants owners of Adigrat town. Adigrat abattoir slaughters only bovine species of zebu breed, all of which are male. Most animals sold for slaughter has served for several years as drought oxen. The sample size was determined by 95% confidence level at a desired accuracy level of 5% and with expected prevalence of 50% in order to get the maximum sample size and to increase the accuracy [11]. Accordingly, the determined sample size was 384 cattle.

Ante-mortem Inspection: Ante mortem inspection of individual animals was conducted while the animal is entering into the lairage. Each study animal was given a unique identification number tagged on its body before slaughter and age, sex, breed and body condition score was recorded either during antemortem examination or post mortem for aggressive cattle. The age was determined based on dentition as per [12] and body condition as per [13] categorized in to three broad groups as good (Score 7, 8 and 9), medium (Score 4, 5 and 6) and poor (Sores 1, 2 and 3).

Postmortem Inspection: During meat inspection each internal organ (Liver, lung heart, kidney and spleen) were thoroughly examined by visual inspection, palpation and systematic incision to detect the presence of hydatid cyst. The entire hydatid cysts found in the organs were counted, measured and their fertility status determined.

Cyst Characterization: Pressure of the cysts collected from different organs was reduced by aspirating some fluid using hypodermic needle attached to a syringe. The cyst was then incised using surgical blade and the content was poured in to beaker and put in an incubator at 37°C for about 30 minutes. Few drops of sediments were taken and put on slides, covered with cover slip and examined under microscope for the presence of protoscoleces as per [14]. Based on the presence or absence of broad capsule containing protoscoleces in hydatid fluid, cysts were classified as fertile or infertile as per the method described by Macpherson [15]. The fertile cysts were further examined for viability by putting a drop of the sediment consisting the protoscoleces on microscope glass slide under a cover slip and observing for an amoeboid like peristaltic movement (Flame cell activity) under high power (x40) microscopic lens. When it become doubtful or confusing to confirm such movement, a drop of 0.1% aqueous eosin solution was added to equal volume of protoscoleces containing hydatid fluid on microscope slide and observed under the microscope. The protoscoleces that excluded the dye either completely or partially were identified as viable while the protoscoleces that took the dye completely were classified as dead (Non viable) [15]. Hydatid cysts characterized by smooth inner lining with slight turbidity of the contained fluid were classified as sterile and those cysts that produced a gritty sound and feeling up on incision were taken as calcified cysts. Cyst size measurement was applied on all the cysts collected from different organs based on the conventional arbitrary classification method employing the volume of the cyst content to classify the cysts as small (Cyst fluid measuring less than 6 ml), medium (Fluid measuring from 6-12 ml) and large cyst (Fluid measuring greater than 12 ml).

Assessment of Economic Losses: An attempt was made to estimate economic significance of hydatidosis based on the local price of beef and condemned offal (lung, liver, kidney and heart) and estimated carcass weight loss of 5% due to hydatidosis as described by Polydorou [9].
Annual cost of liver, lung and other offals condemned due to bovine hydatidosis was then assessed using the following formula:

\[ ALC = (AS \times C_{li} \times P_{li}) + (AS \times C_{li} \times P_{li}) + (AS \times C_{sp} \times P_{sp}) + (AS \times C_{kid} \times P_{kid}) + (AS \times C_{he} \times P_{he}). \]

where: \( ALC \) = Annual loss from condemnation of offal; \( AS \) = Estimated mean annual kill; \( P_{li} \) = Percent involvement of the lung; \( C_{li} \) = Local retail price of a lung; \( P_{he} \) = Present involvement of the liver; \( C_{he} \) = Local retail price of a liver; \( P_{sp} \) = Present involvement of the spleen; \( C_{sp} \) = Local retail price of spleen; \( P_{kid} \) = Percent involvement of the kidney; \( C_{kid} \) = Local retail price of a kidney; \( P_{he} \) = Percent involvement of the heart; \( C_{he} \) = Local retail price of a heart.

The annual carcass weight loss due to hydatidosis was calculated as:

\[ ALRCW = AMP \times DCW \times P_f \times 5\% \times C_{lf} \]

where: \( ALRCW \) = Annual loss from reduced carcass weight; \( AS \) = Estimated mean annual kill; \( DCW \) = Mean dressed carcass weight of local Zebu cattle; \( P_f \) = Overall prevalence of hydatidosis in cattle; \( 5\% \) = Percent reduction in meat caused by hydatidosis; \( C_{lf} \) = Mean local retail price of a kilogram of beef.

**Data Analysis:** Data obtained from ante-mortem, postmortem and laboratory examination were recorded on a paper format prepared for individual animal and later transferred and stored in Microsoft (MS) excel spread sheet program from which data was imported to SPSS version 16 software and analyzed. Chi- (\( \chi^2 \)) test was used to test significant variation between different groups.

**RESULTS**

**Prevalence of Bovine Hydatidosis:** From a total of 384 cattle examined at Adigrat abattoir, 89 (23.18%) were infected with one or more hydatid cysts. Of all organs affected by hydatid cysts, the highest infection rate was recorded in the lung 71/384 (18.5%) followed by the liver 10/384 (2.6%), kidney 4/384 (1.0%), heart 3/384 (0.8%) and spleen 1/384 (0.3%). The organ prevalence study showed that lungs are more affected 71/89 (79.78%) than liver 10/89 (11.24%) and all the remaining organs 8/89 (8.99%) (Table 1). The prevalence of hydatidosis was significantly higher in cattle older than five years than in younger than five years. The disease was also highly prevalent in cattle with poor body condition than in good and medium body conditioned cattle (Table 2).

<table>
<thead>
<tr>
<th>No. examined</th>
<th>No. (%) positive cases</th>
<th>Lung</th>
<th>Liver</th>
<th>Spleen</th>
<th>Kidney</th>
<th>Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animals</td>
<td>384</td>
<td>89 (23.2)</td>
<td>71 (18.5)</td>
<td>10 (2.6)</td>
<td>1 (0.3)</td>
<td>4 (1.0)</td>
</tr>
<tr>
<td>Cysts</td>
<td>198</td>
<td>-</td>
<td>160</td>
<td>30</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Average per organ</td>
<td>-</td>
<td>2.25</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 2: Prevalence bovine hydatidosis in different body condition score and age groups**

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>No. examined</th>
<th>No. positive (%)</th>
<th>( x^2 ) (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5 years</td>
<td>130</td>
<td>9 (6.9)</td>
<td>29.162 (&lt;0.05)</td>
</tr>
<tr>
<td>&gt; 5 years</td>
<td>254</td>
<td>80 (31.5)</td>
<td></td>
</tr>
<tr>
<td>Body condition score (BCS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>84</td>
<td>44 (52.4)</td>
<td>51.502 (&lt;0.05)</td>
</tr>
<tr>
<td>Medium</td>
<td>180</td>
<td>27 (15.0)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>120</td>
<td>18 (15.0)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>384</td>
<td>89 (23.2)</td>
<td></td>
</tr>
</tbody>
</table>
**Table 3.** Distributions of various sized cysts in examined visceral organs

<table>
<thead>
<tr>
<th>Organ affected</th>
<th>Total (%) of cysts</th>
<th>Number (%) of cysts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Small (39.38)</td>
</tr>
<tr>
<td>Lung</td>
<td>160 (80.81)</td>
<td>63 (39.38)</td>
</tr>
<tr>
<td>Liver</td>
<td>30 (15.15)</td>
<td>17 (56.67)</td>
</tr>
<tr>
<td>Kidney</td>
<td>4 (2.02)</td>
<td>2 (50.00)</td>
</tr>
<tr>
<td>Heart</td>
<td>3 (1.51)</td>
<td>1 (33.33)</td>
</tr>
<tr>
<td>Spleen</td>
<td>1 (0.50)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>198 (100)</td>
<td>83 (41.92)</td>
</tr>
</tbody>
</table>

**Table 4: Description of cyst fertility and viability in different organs**

<table>
<thead>
<tr>
<th>Organ affected</th>
<th>Motile</th>
<th>Non motile</th>
<th>Sub total</th>
<th>Sterile</th>
<th>Calcified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>25 (75.5)</td>
<td>9 (26.5)</td>
<td>34 (21.3)</td>
<td>87 (54.4)</td>
<td>39 (24.4)</td>
<td>160 (80.8)</td>
</tr>
<tr>
<td>Liver</td>
<td>3 (60.0)</td>
<td>2 (40.0)</td>
<td>5 (16.7)</td>
<td>6 (20.0)</td>
<td>19 (63.3)</td>
<td>30 (15.2)</td>
</tr>
<tr>
<td>Kidney</td>
<td>1 (100.0)</td>
<td>0 (0.0)</td>
<td>1 (25.0)</td>
<td>3 (75.0)</td>
<td>0 (0.0)</td>
<td>4 (2.0)</td>
</tr>
<tr>
<td>Heart</td>
<td>0 (0.0)</td>
<td>1 (100.0)</td>
<td>1 (33.3)</td>
<td>2 (66.7)</td>
<td>0 (0.0)</td>
<td>3 (1.5)</td>
</tr>
<tr>
<td>Spleen</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>1 (100.0)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Total</td>
<td>29 (70.7)</td>
<td>12 (29.3)</td>
<td>41 (20.7)</td>
<td>98 (49.5)</td>
<td>59 (29.8)</td>
<td>198 (100.0)</td>
</tr>
</tbody>
</table>

**Cyst Characterization:** A total of 198-hydatid cysts from lung, liver, kidney, heart and spleen were assessed to identify cyst size and fertility. Out of these 83 (41.92%) were small, 45 (22.73%) medium and 70 (35.35%) large cysts (Table 3). Fertility test performed on 198 cysts revealed that 98 (49.49%) were sterile while 41 (20.71%) were fertile and 59 (29.80%) calcified. From the 41 fertile cysts, 29 (70.73%) were viable and 12 (29.27%) nonviable. From the total number of 198 cysts counted, highest number (160, 80.81%) was found in the lung. The majority of cysts formed on the lung were medium to large in size and sterile whereas the majority of liver cysts were small in size and calcified.

**Assessment of Economic Losses:** The annual economic loss from offal condemnation and carcass weight loss recorded due to bovine hydatidosis for cattle slaughtered at Adigrat abattoir during the study period was 102,473.47 ETB.

**DISCUSSION**

Hydatidosis is an endemic to hyperendemic zoonotic diseases in agricultural countries of Europe, northern, eastern and southern Africa, southern and northern America, Middle East and Asia [16-18]. The prevalence of bovine hydatidosis recorded in this study at Adigrat abattoir during the study period was 23.18%. There had been different magnitude records of bovine hydatidosis prevalence from different parts of Ethiopia. In Ethiopia, a synthesis report based on abattoir survey data collected over a period of 15 years (1985-1999) from 21 different abattoirs located in various parts of the country revealed the widespread occurrence of the disease with a prevalence of 35.15% (8036/22,863) in cattle, 11.78% (768/6518) in sheep, 4.9% (36/1753) in goats, 16.79% (70/417) camels [6]. A comparable magnitude of 22.4% bovine hydatidosis prevalence was reported from Tigray [19]. But slightly higher prevalence of 34.05% from Bahir Dar [20] and 29.69% from Ambo [21] were reported. A lower bovine hydatidosis prevalence of 16.85% [22], 16.0% [23] and 15.4% [24] from Wolayita Sodo and 15.2% from Birr-Sheleko and Dangila abattoirs [25] were reported. The variation in the recorded prevalence in different regions of the country may be attributed to difference in agroecology of the study areas [6] and/or other factors like religion, social activity and attitude towards dogs in different regions [15].
The organ prevalence in this study showed lungs as more commonly affected (79.78%) than liver (11.24%) and other organs combined (8.99%). This is in agreement with various reports [3, 7, 8, 16, 26]. More frequent occurrence of hydatid cyst in cattle lung than in any other organ may be imputed to the practice of slaughtering cattle at older age. Most cattle slaughtered in Ethiopia are drought oxen used to plough land and sold for fattening when they get weak teeth to maintain their body condition on pasture. It is revealed that in older cattle the liver sinusoides are dilated and permits the embryos to traverse the sinusoides and directly pass to the lung and further opinioned that it is possible for embryos to enter the hepatic circulation and be carried, via the thoracic duct and heart, to the lungs so that lungs will be infected before or instead of the liver [27]. Oncospheres of *E. granulosus* are also capable of completing a lymphatic or venous migration [28], enabling them reach the lung bypassing the liver. It was also opined that when cattle are infected with the cattle strain the predominant location of cyst predilection is the lungs [16].

Rate of infection of hydatidosis in different age groups of cattle showed significant difference, with cattle older than 5 years of age more commonly affected than their youngsters. An increase in prevalence of bovine hydatidosis with an increase in age was depicted in previous studies [27]. The increase in infection prevalence with advancing age could be mainly due to longer exposure time to *E. granulosus*. It may also be attributed probably to reduced immunological compatibility of the animals at old age. In this study, significant difference in the infection prevalence of hydatidosis was also observed among cattle of different body conditions where more animals with poor body condition carried hydatid cyst more commonly.

From the total 198 hydatid cysts examined in this study, 83 (41.92%) were small, 45 (22.73%) medium and 70 (35.35%) large. The higher proportion of small cyst is indicative of immunological response of the hosts that reduced the expansion of cyst size. This study also showed that the majority of cysts formed on the lung were medium to large in size and sterile whereas the majority of liver cysts were small in size and calcified. In the other way, the higher proportions of calcified cysts (63.33%) were occurred in the liver as compared to the lung (24.38). The reason for high percentage of medium and large cysts in the lung might be due to softer consistency of the lung that allows easier development and expansion of the cyst while the higher number of small and calcified cysts in the liver could be imputed to relatively higher reticuloendothelial cells and abundant connective tissue presence in the liver. Small cysts were found to be more calcified than medium and large cysts which can be due to the host defense mechanism dealing with parasite more efficiently at the early larvae stage of development [29]. However, the developing and fully developed metacestode are said to be able to escape anti-oncospheral immunity [30].

Out of the total of 198 cysts examined, 20.71% were fertile, 49.49% sterile and 29.80% calcified. This is in agreement with the fact that cysts in cattle are usually sterile and often degenerate and caseating [30]. The proportion of 20.71% fertile cysts in this study is in agreement with the reported 18.9% in cattle from Bahir Dar [20] and (14.65% (29/198) fertile and viable protoscoleces in the present study was close to the reported 10.69% fertile and viable cysts from Mekelle [31]. In this study, lung accounted for higher fertility rate of cysts than liver. The variation between tissue resistances of the affected organs may have influenced the fertility rate of cysts so that fertility rate of the hydatid cysts in the liver is lower. The higher fertility of lung cysts may be imputed to the same reason that allows for easier development of medium and large cysts in the lung. The higher fertility rate of hydatid cyst in the lung goes in line with the existence of higher number of medium and large cysts in the organ which increases with advancing age of the host [29].

The annual economic loss from offal condemnation and carcass weight loss recorded due to bovine hydatidosis for cattle slaughtered at Adigrat abattoir during the study period was 102,473.47 ETB. Different magnitude economic losses from offal condemnation and carcass weight loss due to bovine hydatidosis were reported from different parts of the country. For example, reports show an annual loss of 25,608 ETB (2,807.89 US$) [19] from Tigray region, 410,755.90 ETB (30,202.64 US$) from Wolayita Sodo municipal abattoir [22], 1,791,625.89 ETB (131,737.19 US$) from cattle slaughtered at the Hawassa municipal abattoir [32], 314,756.39 ETB (13,849 US$) [33], from cattle slaughtered at the Jimma abattoir and 52,828 ETB (5,869.8 US$) from cattle slaughtered at the Adama abattoir [8]. The different results in the economic losses incurred at various abattoirs could be imputed to the variation in the prevalence of the disease, mean annual cattle slaughter rate at different abattoirs and variation in the retail market price of the organs and beef.
The cattle strain (G5) has been implicated in some cases of human CE [34]. Although hydatidosis is basically preventable disease, lack of public awareness to zoonotic nature of the disease and its transmission, absence of dog deworming practice, lack of information about the burden of the disease in human, very common practice of backyard slaughtering of ruminant for household meat consumption, throwing of the infected visceral organs to dogs, contamination of the pasture by faeces of dogs used to guard cattle by the farming community are to be incriminated for the maintenance of the cycle of hydatidosis in the area. In some wealthy countries, the occurrence of cystic echinococcosis caused by Echinococcus granulosus was dramatically reduced and even eradicated [16]. One good example is the case of Greece, where the introduction of control program in 1984 has reduced the occurrence of the disease in cattle from 82% to 0% [35].

CONCLUSION

The finding of this study adds to and reconfirms that hydatidosis is a neglected zoonotic disease with widespread occurrence in the livestock in different parts of Ethiopia. Therefore, introducing mass deworming of dogs and educating the local community on the transmission and public health significance of the disease to disrupt the life cycle as well as investigation on the prevalence of the disease on humans residing in the area for implementing evidence based prevention and control program is recommended.

REFERENCES


