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The Prevalence, Cyst Viability, Organ Distribution and Economic Importance of Bovine Hydatidosis in Cattle Slaughtered at Debre Berhan Municipal Abattoir, North Shewa Zone, Amhara Regional State, Ethiopia

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Abstract: A cross-sectional study was conducted from October 2015 to March 2016 at Debre Berhan municipal abattoir with the aim of assessing the prevalence, cyst viability, organ distribution and economic significance of bovine hydatidosis. Anti mortem and postmortem examination, hydatid cyst characterization and direct and indirect financial loss estimations were conducted. From the total of 415 cattle examined, 148(35.7%.) were found positive for hydatid cyst infection in their visceral organs. There was statistically significant association between age, origin and body condition of the cattle slaughtered and the occurrence of hydatidosis. Higher infection rate was observed in poor (22.89%) than medium (12.99%) and good (10.40%) body condition scoring, in ≥5 years old (40.3%) than 3-5 years old and in Debre Berhan (42%) than Shewarobite (25.8%) area. The anatomical distribution of the cysts indicated as 236 (58.7%), 143 (35.57%), 8 (2%), 5(1.24%) and 10 (2.49%) cysts were counted from lung, liver, heart, kidney and spleen respectively. From the total of 214 cysts collected for laboratory examination, 73 (34.1%) fertile, 107(50%) sterile, 34(15.9%) calcified, 38(17.8%) viable and 35(16.4%) non-viable cysts were found. In the present study, the total annual economic loss due to hydatidosis was estimated to be 136,555.13US$. The result of this study revealed that hydatidosis pose significant economic problems. Therefore, initiation and implementation of appropriate preventive and control measures such as control of stray dogs, public awareness, avoiding of backyard slaughtering, proper meat inspection and disposal of affected offal's are necessary in order to alleviate its economic and public health impact.

Key words: Abattoir · Bovine Hydatidosis · Crossectional-study · Debre Berhan · Economic loss · Prevalence

INTRODUCTION

Among African countries Ethiopia considered to have the largest livestock population (50 million cattle, 25 million sheep and 25 million goats) [1].

However, the contribution from these huge livestock resources to the national income is very small due to endemic disease, traditional management system, inferior genetic makeup and absence of well-developed market infrastructure. Among these, Echinococcosis (hydatidosis) is one of the most important parasitic diseases that have economic and public health significance [2].

Hydatidosis (Cystic echinococcosis), caused by larval stages (hydatid cysts) of cestode belonging to the genus *Echinococcus* and the family Taeniidae, is a common zoonotic parasitic diseases with great economic and public health significance worldwide [3]. Echinococcosis has a worldwide distribution; the reason is mainly due to ability of this tape worm to adapt to a wide variety of domestic and wild intermediate hosts [4].

Echinococcus granulosus (E. granulosus) requires two mammalian hosts for completion of its life cycle. The adult stage of *E. granulosus* inhabits small intestine of definitive hosts mainly dogs and segments containing eggs are passed with feces of the definitive host. The intermediate hosts including humans are infected by ingestion of the infective eggs containing the oncosphere from contaminated foods, pasture and water then hydatid cysts develop in their body [5].

Human beings suffer from the disease if exposed to the egg accidentally or consumed with contaminated green food or water. The definitive host is infected by ingestion of infected offal's of herbivores [6].

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The adult tapeworm in the definitive host is asymptomatic unlike the hydatid cyst in the intermediate host animals that is responsible for immense economic and medical importance in infected hosts [7]. Infections with *E. granulosus* cysts in the livestock intermediate hosts are typically asymptomatic, except a few cases of long-standing and heavy infections. There are no reliable methods for routine diagnosis of the infection in living animals [5].

The major economic impacts caused by cystic echionococcosis in livestock are losses in productivity such as reductions in carcass weight, milk production, fleece and wool value, fertility, birth rate, delayed performance and growth, Condemnation of organs, costs for destruction of infected viscera and dead animals [8,7]. In human, the cyst can reside and grow in liver, lung and other visceral organs. The pathogencity of hydatidosis depends on the extent and severity of infection and the organ on which it is situated. Occasional rupture of hydatid cysts often leads to sudden death due to anaphylaxis, haemorrhage and metastasis [9, 10].

In most Ethiopian abattoirs and slaughter houses, it is one of the major causes of organ condemnation and leads to huge economic losses [9-11]. Human cases of hydatidosis were frequently reported from different part of the country [12].

Debre Berhan municipal abattoir is an area with poor hygiene, raw beef consumption, backyard slaughtering of domestic animals and feeding stray dogs with condemned organs are common practices. Hence, knowledge on the extent of hydatidosis associated economic loss in cattle would have paramount importance in justifying the need of an effective control scheme by considering the public health damages and economic loses. Therefore, this study was aimed at assessing the prevalence of hydatidosis, determining cyst distribution and estimating the direct and indirect financial loss associated with hydatidosis in cattle slaughtered at Debre Berhan municipal abattoir.

MATERIALS AND METHODS

Study Area: The study was conducted from October 2015 to March 2016 at Debre Berhan municipal abattior, North Shewa zone Amhara regional state, Ethiopia. The town is situated at 130 km north east of Addis Ababa north east direction; situated at an altitude of 2750 m.a.s.l. The climatic condition is biannual rainfall and the rainy season of this area extends from February to April and June to September while the dry season extends from November to January. The mean annual temperature of Debre Berhan is 12.9°C. Average annual rain fall is 905.4mm and relative humidity is 62.3% [13].

Study Animals: The study was conducted on both local and cross breeds of cattle coming from different areas and slaughtered at Debre Berhan municipal abattoir. It was difficult to precisely indicate the geographical origin of all animals slaughtered at Debre Berhan municipal abattoir and relate the findings on hydatidosis to a particular locality. However, the majority of them were brought from Debre brehan, Enewari, Jiru and Shewarobit. Slaughtered animals were males and females. In this study, cattle were categorized into three body condition score, poor, medium and good [14] and two age groups, adult (3-5 year) and old (≥5 year) [15].

Study Design: A cross-sectional study was conducted from October 2015 to March 2016 to assess the prevalence, cyst distribution and to evaluate the direct and indirect financial loss of cystic echinococcosis due to carcass condemnation and carcass weight loss in cattle slaughtered at Debre Brehan municipal abattoir which came from different area (Shewarobit, Debre brehan, Jiru,)

Sample Size Determination and Sampling Methods: the required sample size for the study was determined by using the formula described in Thrusfield [16] as follow

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

where
n= required sample size
P_{exp}= expected prevalence
d= desired absolute precision

The expected prevalence of cystic hydatidosis was taken from the previous work of Tsegaye [17] at Debre Berhan municipal abattoir, which was 7.2%.

Accordingly, with 95% level of confidence and at 5% desired level of precision, the sample size was calculated to be 103. However, to increase the precision of the study, a total of 415 cattle were sampled. A systematic random sampling method was employed to select the individual animals for sampling in the abattoir.

Study Methodology

Ante-mortem and Post mortem Examination: Both ante-mortem and post-mortem examination of slaughtered cattle were conducted and kept on a sheet.

During ante-mortem examination an identification number, sex, breed, origin, body condition and age of each study animals were recorded before slaughtered. Based on the body condition scores animals were grouped as poor, medium and good following the guideline provided by Nicholson and Butter worth [14] (Annex-4) and the age of animal's was determined and categorized into adult (3 to 5 years) and old (≥5 years) based on dental formula [15] (Annex-4).

During post-mortem examination abdominal and thoracic cavity organs (liver, kidney, lung, heart and spleen) were inspected through visualization, palpation and incision for the presence of hydatid cysts and the organ distribution of hydatid cysts were recorded. The number of hydatid cysts on each positive organ were counted and recorded and the cysts were carefully removed from organs and transported to Debre Berhan Agricultural Research Center Laboratory for the study of their characteristics.

Fertility and Viability Test: Microscopic examination of the cyst was conducted to observe the presence protoscolices in hydatid fluid. The cyst wall was penetrated using a large size needle and cut with scalpel blade and then the content was transferred into sterile petridish and examined under stereomicroscope for the presence of protoscolices in the hydatid fluid. After that the cysts was identified and classified as fertile (fluid filled cyst contain protoscolices) infertile (fluid filled cyst without any protoscolices) [18]. Further more fertile cysts were subjected to viability test. A drop of cyst fluid was placed on a microscopic glass slide and cover slip was applied and observed for the motility of flame cells activity like peristaltic movement. When it becomes doubtful for motility, a drop of 0.1% aqueous eosin solution was added and examined under Microscope for taking the dye. Live protoscolices do not take the dye whereas; the dead ones do [18].

Financial loss Estimation: The annual economic loss due to hydatidosis in cattle was estimated by both direct and indirect losses from cost of organ condemned and carcass weight loss. The annual direct economic loss as a result of condemned organ due to hydatidosis was estimated by taking into account the average number of cattle slaughtered, percentage of condemned organs and average market prices of each organ. Mean annual slaughter rate of cattle at Debre Brehan municipal abattoir was estimated based on retrospective analysis of two years of data, information gathered from the meat inspector and the number of cattle slaughtered during the study period. The Debre Brehan municipal abattoir usually slaughtered an average of 34 cattle per day and there are five slaughtering days per week. The annual slaughter rates were estimated as, 8225 cattle. The annual cost of the condemned organs due to bovine hydatidosis was assessed by the following formula set by Kebede *et al*. [19].

Annual direct loss= (ASA * Plu* Clu) + (ASA*Pli *Cli) + (ASA * Phe* Che) + (ASA*Pki*Cki) + (ASA*Psp*Csp)

where: ASA is total number of animal slaughter per annum, Plu, Pli, Phe, Pki and Psp are percent involvement of lung, liver, heart, kidney and spleen respectively and Clu, Cli, Che, Cki and Csp are current mean retail price of lung, liver, heart, kidney and spleen respectively in Debre Brehan town. Likewise, The annual indirect losses due to live weight(carcass) loss by hydatidosis was estimated by taking into account, average carcass weight of cattle, total number of cattle slaughtered, prevalence of bovine hydatidosis and average local price of one kg of beef in Debre Berhan town. The cost of one kg beef were obtained based on the information gathered from local butchers. A 5% estimated carcass weight loss due to hydatidosis was used for the indirect loss described by Polydorous [20] and the dressing percentage of cattle was estimated to be 126 kg [21]. The annual cost of carcass weight loss due to hydatidosis was assessed by the following formula set by Kebede *et al*. [19].

Annual cost from carcass weight loss (ACWL) = BCAxPe x Ckb x 5% x126kg

BCA= total number of cattle slaughtered per annum
Pe: prevalence of Echinococcosis at the abattoir
Ck: average cost of 1kg beef in Debre Brehan town
126 kg: average carcass weight (dressing percentage) of adult cattle

Data Management and Analysis: The data collected were coded and entered in to Microsoft Excel 2007 spreadsheet database system and analyzed by using statistical

package for social sciences (SPSS) version 16 software of computer program. The prevalence of cystic echinococcosis was computed with descriptive statistics (percentage). Chi-square (x^2) statistical test was applied to determine the associations between the disease and the various potential risk factors like age, origin and body condition score. Analysis was made at 95% level of confidence and 5% precision and statistically significant association between variables was considered if the p-value is less than 5%.

RESULTS

Prevalence of Hydatidosis: From a total of 415 cattle slaughtered at Debre Berhan municipal abattoir and examined for the presence of hydatid cyst, 35.7% (n=148) were found harboring at least one cyst in their visceral organs. The prevalence of bovine hydatidosis was assessed based on different risk factors such as; sex, breed, age, origin and body condition score of the study animal. Age, origin and body condition score were statistically significant (P<0.05) but breed and sex were insignificant (P>0.05) in this study as shown in (Table 1).

Organ Distribution of Hydatid Cysts: The postmortem examination revealed that from the total of 415 cattle examined, 181 different visceral organs were affected by hydatid cyst in 148 cattle's. Among 148 cattle harboring hydatid cyst, 92.26% of them had hydatid cyst infection only in a single organ whereas the remaining 7.74% occurred in more than one organ. During the post mortem examination a total of 402 cysts were counted from these infected organs. From 402 cysts highest 236(58.7%) cysts were counted from lung and 1owest 10(2.49%) cysts were counted from spleen. The total number and prevalence (%) of each affected organ by cysts are shown in (Table 2).

Fertility and Viability of Cysts: During post mortem examination 214 cysts were taken from lung (113), liver (78), heart (8), spleen (10) and kidney (5). Among 214 cysts 34 were calcified (15.9%), which found in liver and lung and the other cysts were non- calcified. The non calcified cysts were subjected for laboratory examination, 73(34.1%) fertile, 107(50%) sterile, 38(17.8%) viable and 35(16.4%) non-viable cysts were found in different organs. Anatomical distribution, fertility and viability of cysts were shown in the Table 5.

Financial Loss Assessment: In this study, from 415 examined animals, 109 lungs, 55 liver, 7 hearts, 5 kidneys and 5 spleens were condemned due to hydatidosis in Debre Berhan municipal abattoir. The annual slaughter rates were estimated as, 8225 cattle. The cost of one (1) kg beef were obtained from information gathered from local butchers was 150 ETB. The total number, prevalence (%) and average market prices of each condemned organs are indicated in table 6. In this study the annual direct financial losses due to condemnation of affected organs and indirect losses due to live weight loss as a result of hydatidosis were estimated to be 92830.8 ETB (4,420.5 US$) and 2,774,827.13 ETB (132,134.63 US$) respectively, which accounts to a total financial loss of2,867,657.93 ETB (136,555.13US$). The result indicates that the financial loss due to live (carcass) weight loss was greater than loss due to condemnation of affected organs.

Table 1: Prevalence of bovine hydatidosis in different risk factor

Risk factors	Number of observed animals	Number of positives	Percentage (%)	x2	p-value
Breed					
Local	350	129	36.9		0.238
Cross	65	19	29.2	1.390	
Sex					
Male	372	127	34.1		0.57
Female	43	21	48.8	3.629	
Age					
<5 year	172	50	29.1		0.018
≥5 year	243	98	40.3	5.565	
Body condition					
Poor	62	35	56.5	18.579	0
Medium	169	64	37.9		
Good	184	49	26.6		
Origin					
Debre Berhan	183	77	42	6.813	0.033
Enewari & Jiru	166	54	32.5		
Shwarobit	66	17	25.8		

Table 2: Distribution of hydatid cysts in different organs of infected cattle

Infected organs	Examined animals	Nº positive of cases	Percentage
Only lung	415	77	18.6
Only liver	415	27	6.5
Only kidney	415	5	1.2
Only heart	415	5	1.2
Only spleen	415	3	0.7
Lung and liver	415	28	6.74
Lung and heart	415	2	0.5
Lung and spleen	415	2	0.5
Total	415	148	35.94

Table 3: Fertility and viability of hydatid cyst in different organs

Organ	No of positive organ	Nº cyst	Fertile	Sterile	Calcified	Viable	Non viable
Lung	109	113	37(32.7%)	64(56.6%)	12(10.6%)	19(16.8%)	18(15.9%)
Liver	55	78	23(29.5%)	33(42.3%)	22(25.2%)	12(15.4%)	11(214.1%)
Heart	7	8	5(62.5%)	3(37.5%)	0	3(37.5%)	2(25%)
Spleen	5	10	6(60%)	4(40%)	0	4(40%)	2(20%)
Kidney	5	5	2(40%)	3(60%)	0	0	2(40%)
Total	181	214	73(34.1%)	107(50%)	34(15.9%)	38(17.8%)	35(16.4%)

Table 4: Total number, prevalence (%) and average market prices of each condemned organs due to hydatidosis

Organs	No. of Condemned organ	Prevalence (%)	Price (ETB)
Lung	109	26.27	15
Liver	55	13.25	50
Heart	7	1.69	25
Kidney	5	1.2	30
Spleen	5	1.2	5
Total	181	47.8	125

DISCUSSION

Based on the data collected in this cross-sectional study, the prevalence of bovine hydatidosis was found to be 35.7% which was relatively comparable with the findings of Tigest [22] 36.58% at Bahir Dar, Tolossa *et al.* [11] 31.44% at Jimma, Gebretsadik [23] 32.1% at Mekelle and Dechassa *et al*. [24] 40.5% at Addis Ababa municipal abattoir. But the prevalence in this study was lower than the findings of Getaw *et al.* [9] 48.5% at Adama and Fromsa and Jobre [10] 72% at Assela municipal Abattoir. However, the prevalence of hydatidosis recorded in cattle in this study was higher than the findings of Kebede *et al*. [2] 15.2% at Birre-Sheleko and Dangila, Jemere and Berhanu [25] 16.85% at Wolayita Sodo, Genet *et al*. [26] 17.3% at Gondar, Alemu *et al*. [27] 17.5% at Dessie, Jemere *et al*. [28] 11.26% at Mizan Teppi municipal abattoir, Fredrick *et al*. [29] 2.1% in Zambia, Sahar and Atif [30] 2.8% in Sudan and Haridy *et al*. [31] 6.4% in Egypt. The variation in the prevalence of hydatidosis might be due to the contact between large numbers of stray dogs with the herd of cattle. Dogs, which are the primary factor for the disease transmission, are used as guards for herds and are routinely fed with uncooked offal which deemed unfit for human consumption [9]. The other possible reason may be due to strain difference of *E. granulosus* that exist in different geographical situation. Moreover, other factors like inappropriate removal of infectious carcass, backyard slaughtering, livestock management system, seasonal variation, sampling strategy, age of the animal's slaughtered, poor public awareness about the hydatidosis and difference in culture and social activities in different regions may contribute to these variations [2].

The prevalence of hydatidosis in this study shows significance association with age of the slaughtered cattle. Animals ≥5 year of old were highly infected (40.3%) than 3- 5 year of old (29.1%). This finding is in agreement with the reports of Endalew and Nuradddis [32], Genet *et al.* [26] and Miheret *et al*. [33]. This could be mainly due to their longer exposure to *E. granulosus* and lower immunity against the infection [34]. In addition, the reason for lower prevalence in below five years cattle might be slaughtered before exposed to the disease due to less exposure time in the area to the egg of *E. granulosus* and the growth of hydatid cyst is slow, that reach maturity being in 6 to 12 months [4, 35].

There were significant differences in rate of infection among different body condition scores. The prevalence was found 56.5%, 37.9% and 26.6% with poor, medium and good body condition respectively. Animals having poor body condition were found to have high infection rate. This is similar with previous studies reported by Miheret *et al*. [33] and Melaku *et al*. [15]. This could be due to that the disease is chronic disease and cause high live weight loss if the animal exposed to moderate to severe infection and the animal became poor through time. Also animals with poor body condition have high risk of infection due to low immunity. Polydorous [20] explained that in moderate to severe infection the parasite may cause retarded performance and growth, reduced quality and yield of meat and milk as well as live weight loss.

The current study revealed that there was a significant difference ($P<0.05$) in rate of infection among different geographical regions of slaughtered cattle. The prevalence of bovine hydatidosis was found 42%, 32.5% and 25.5% in Debre Brehan, Enewari & Jiru and Shewarobite areas respectively in which animals brought

from Debre Brehan area had high prevalence (incidence) rates. This might be due to the agro ecology of the area, high population of stray dogs, the management system and grazing and feeding practices. The other reason for this higher prevalence attributes to its geographical location since Debre Brihan is high land area moisture and rain fall favors the survival of eggs of *E. granulosus* and at the same time eggs may get chance to be disseminate by flood and contaminate the grazing pasture and animal infected grazed on this pasture [36].

In this study, the result indicated that the occurrence of hydatid cyst was highest in the lungs than other organs and the anatomical infection rate in each organs were found 26.27%, 13.25%,1.69%,1.2% and 1.2% in lung, liver, heart, kidney and spleen respectively. This result is in agreement with similar findings reported by Dechassa *et al*. [24], Alemu *et al.* [27], Endalew and Nuradddis, [32] and Jemere *et al*. [28]. The reason for high prevalence of the cyst in lung is, the immature parasites have no selective affinity for any particular organ and location of hydatid cyst in animal is controlled by filtering action of capillaries, due to the fact that lungs and liver possesses the first great capillaries sites encountered by the migrating Echinococcus onchosphere (hexacanth embryo) which adopt the portal vein route and primarily negotiate hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved, but onchosphers which traverse these will reach the systemic circulation and hydatid have been found in many organs and tissues [37,5,9,19]. Lungs were more infected than liver, probably due to the presence of greater capillary beds in the lungs than liver. Additionally, it is possible for the hexacanth embryo to enter the lymaphatic circulation and be carried via the thoracic duct to the heart and lungs in such a way that the lungs may be infected before liver [38].

The fertility of hydatid cysts in this study revealed that from 214 cysts 73(34.1%), 107(50%) and 34(15.9%) were found fertile, sterile and calcified. From 73 fertile cysts 38 (17.76%) of the protoscolexes were viable and 35 (16.35%) of them were non-viable. The calcified cysts were only found in liver and lung (Table 5). The result indicates lower fertility percentage (34.1%) was identified out of the total cysts examined and 65.9% was identified as infertile (sterile and calcified) which show the importance of cattle in maintaining the cycle is relatively low. This finding is similar with that of Kebede *et al*. [12].

In this study the annual economic loss due to bovine hydatidosis in Debre Brehan municipal abattoir from both direct and indirect loss was estimated to be 136,555.13 US$, which is a significant amount of money for the country like Ethiopia, where the per capita income is very low. In different abattoir different financial losses were reported from different part of the country. When comparing with other finding, this finding is higher than the finding of Regassa *et al*. [34] 89,581.301 US$ at Hawssa, Endalew and Nuraddis [32] 33,704.65 US$ at Gonder, Bekele and Butamo [39] 30,202.64 US$ at Wolayita Sodo, Getaw, *et al*. [9] 5,869.80 US$ at Adama and Kebede *et al*. [12] 3,201 US$ at Mekelle municipal abattoir. However, this economic loss estimation was lower than 277,229.60 US$ and 216,312.47 US$ reported by Zelalem [40] and Fromsa and Jobre [10] at Addis Ababa and Assela municipal abattoir respectively. The difference in economic loss in various abattoirs could be due to the variations in the prevalence of the disease, mean annual slaughter rate, variation in the retail market price of the organs and carcasses and the world financial crises that makes the currencies unstable. Based on the results, we can suggest that bovine hydatidosis is among many of the livestock diseases prevailing in the country incurring both direct and indirect losses to the cattle industry due to condemnation of organs and reduced live weight gain of infected cattle.

CONCLUSION

The present study showed that the prevalence and monetary loss of hydatidosis in cattle slaughtered at Debre Brehan municipal abattoirs was high. This showed that the disease had high economic and public health importance in the study area. Lungs were the most frequently affected organ by hydatid cyst followed by liver. The difference in prevalence is highly significant among poor, medium and good body condition. Factors like presence of more stray dogs that visits the abattoir ground and fed on condemned organs, low public awareness about hydatidosis, the management system, lack of adequate meat inspection and backyard slaughtering favors the maintenance of high level infection and transmission of the disease between animals and human.

Based on the above conclusion the following relevant recommendations are forwarded to reduce the spread of the disease and financial losses and to safeguard the public.

- Awareness should be created in the community about the economic and public health importance of the disease and the role of dogs in transmitting the disease to animals and humans.

- Proper meat inspection and disposal of affected offal's in abattoir should be well practiced and the authority should supervise slaughtering practices in order to prevent the illegal slaughtering of animals.
- Backyard slaughtering practices should be prevented by putting and applying law and regulation.
- The dog population should be control by killing the un-registered stray dogs and by de-worming, cestocidal treatment and tying of the household dogs.
- Further epidemiological study should be conducted on the prevalence of the disease in this area.

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