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Prevalence and Economic Significance of Bovine Cystic Echinococcosis in Debra Tabor Municipal Abattoir, North West Ethiopia

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Abstract: Cystic hydatidosis (*Echinococcosis*) is a disease of zoonotic importance caused by the larval stage of *Echinococcus granulosus.* A cross sectional study aimed at determining the prevalence and associated risk factors, cysts distribution in different organs, fertility and viability test and associated financial losses were conducted from October 2014 to April 2015 on cattle slaughtered at Debre Tabor municipal abattoir. From the total of 403 heads of cattle slaughtered and examined, 97 animals found positive for *Echinococcosis* with an overall prevalence of (24.1%). Risk factors such as breed and sex didn't show any significant differences (P> 0.05). However, age and body condition revealed significant differences (P<0.05) as higher number of infections were detected in old and poor body conditioned animals. From the total of 145 cyst examined, 70 (48.3%) found fertile and 75(51.7%) non fertile. From the total of 70 fertile cysts, 31(44.3%) were non-viable and 39(55.7%) were viable; and from 75 non-fertile cysts, 57 (76%) were sterile and 18(24%) were calcified cysts. Of the 76 cysts recorded from lung, 2(2.3%) were calcified, 40(52.6%) were sterile, 17(22.4%) were viable and 17(22.4%) were non-viable. From the total of 53 cysts recorded from liver, 14(26.4%) were calcified, 13(24.5%) were non-viable, 16(20.9%) were sterile and 10 (18.9%) were viable. Financial loss estimation due to *Echinococcosis* indicates a total of 920,378 ETB (44,678.5 USD) annual losses of which 482,402 ETB (23,417.6 USD) was due to organ condemnation and 437,976 ETB (21,260.97 USD) was due to carcass weight loss. Therefore, initiation and implementation of disease control interventions has paramount importance in the alleviation of economic risks due to the disease and also minimizing of zoonosis.

Key words: *Bovine · Debretabor · Economic losses · Echinococcosis · Prevalence · Risk factor*

INTRODUCTION

The world human population is growing at a rate much faster than food production and this increase is mainly in developing countries which are unable to assure adequate food for their people. Developing countries have nearly two third of the world's livestock population, but produce less than a third of the world meat and fifth of its milk [1].

In Ethiopia ruminant livestock are important source of income for rural communities and are one of the nation's major sources of foreign currency from export. However, this great potential is not properly exploited mainly due to prevailing traditional management, limited genetic potential, feed shortage and rampant animal disease. Of the disease that cause serious problem, parasitism represents a major impact on livestock production in the tropics [2].

Cystic Echinococcosis is known to be one of the most important parasitic infections in livestock worldwide. The disease has a worldwide distribution and is endemic in many countries of the Mediterranean basin, North and East Africa, Western and Central Asia, China, South America and Australia [3].

However, even if the distribution of *Echinococcus granulosus (E. granulosus)* is considered worldwide, it is higher in developing countries, especially in rural communities where there is close contact between dogs and various domestic animals [4]. A wide variety of animal species, both domestic and wild that act as intermediate

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hosts and the domestication spread of some of the animals from Europe to other parts of the world have made *E. granulosus* to be widely distributed across the globe [5].

Echinococcosis is one of the most important parasitic diseases of livestock that has both economic and public health significance. Man becomes infected by accidental ingestion of onchosphers from contaminated food, water and environment whereas; dog is the commonest final host which becomes infected by ingestion of infected offal's [6, 7].

There are four generally recognized species of Echinococcus. *Echinococcus granulosus*, *E. multilocularis*, *E. oligarthus* and *E. vogeli. Echinococcus granulosus* and *E. multilocularis* are the chief agents of hydatid disease throughout the world [8]. The two species *E. granulosus* and *E. multilocularis* are important in veterinary medicine. The larval stage develops in a very wide range of intermediate hosts including man [9].

In Ethiopia it is a common practice to feed dogs and cats with hydatid infected organs and human beings facilitate the maintenance of the perfect life cycle progression in an environment. However, less attention was given towards the disease distribution and associated financial impacts in the country [10]. Abattoir data is an excellent option for detecting diseases of both economic and public health importance especially in ascertaining the extent to which human is exposed [11]. Therefore, this study was aimed to assess prevalence and associated risk factors of bovine Echinococcosis and also estimate the financial losses associated with the disease occurrence.

MATERIALS AND METHODS

Description of the Study Area: The study was conducted in Debre Tabor Municipal abattoir; south Gondar zone of Amhara National Regional State from November 2014 to April 2015. DebreTabor is located at 666 Km far from Addis Ababa at an elevation of 2706 m.a.s.l. The town is located at a latitude of 11°51'N and longitude 38°1'E. It gains a mean annual rain fall and temperature of about 1497 mm and 15°C respectively. The area is characterized by two seasons, the wet season ranges from June to September and dry season from October to May. The farming system in the area is mixed type (Crop-livestock production). Based on the 2007 national census conducted by the CSA of Ethiopia; Debre Tabor has a total human population of 55,596 of which 27,644 are men and 27,952 women.

Study Animals and Their Origin: Study animals include local zebus and cross breed cattle brought from various localities to Debre Tabor municipal abattoir for slaughtering purposes. It was difficult to precisely trace back the exact origin of all animals slaughtered at DebreTabor municipal abattoir and relate the findings on Echinococcosis. Nevertheless, attempts made in this regard revealed that majority of them were brought from Farta; the nearby market.

Sample Size Determination and Sampling Techniques: Due to the absence of previous study on bovine Echinococcosis in the study area, sample size for this study was determined using the formula described below by Thrusfield [12], with the assumption of 50% expected prevalence and 95% confidence level.

$$\text{The formula } n = \frac{1.96^2 \times P_{exp}\ (1-P_{exp})}{d^2}$$

where
n = required sample size
P_{exp} = expected prevalence
d^2 = desired absolute precision (0.05)
1.96^2 - z- value for 95% confidence interval

Accordingly, a total of 384 cattle were sampled. But, to increase the accuracy of the findings, sample size was increased up to 403. Simple random sampling technique was used to identify study animals. During the study period, systematic visits (Four slaughtering days per week) were made to accomplish the anticipated sample size.

Study Design: A cross sectional study was conducted from November 2014 to April 2015 at Debre Tabor municipal abattoir.

Study Methods:

Ante Mortem and Postmortem Examination: During ante mortem examination, each animal was marked for identification by writing a code on its gluteal muscle by un-washable ink. Sexes of the animal, age breed and body conditions were recorded to further characterize nature of the disease in slaughtered animals. Estimation of age was carried out by examination of the teeth eruption using the approach forwarded by De Lahunta and Habel [13]. Those less than or equal to five years of ages were grouped under adults and those above five years were categorized as olds. Most of the cattle that were

slaughtered at Debere Tabor municipal abattoir were local zebu and only few of them were crossbreds. Body condition scoring was made into three categories as lean/poor (Score 1, 2 and 3), medium (score 4, 5 and 6) and fat/good (7, 8 and 9) according to Nicholson and Butterworth [14].

Postmortem examination was carried out through visual inspection, palpation and incision of visceral organs (Lung, liver, heart, spleen and kidney); and the presence of hydatid cysts and their organ distribution were recorded. From each organ, Hydatid cysts were carefully removed and separately collected in clean containers for further cyst characterization. Hydatid cyst characterization was made to assess the status of the cysts.

Hydatid Cyst Characterization: Infected organs from every slaughtered animal were collected and the total number of hydatid cysts were counted per organ and recorded. Of the collected hydatid cysts, the representative hydatid cyst specimens were subjected to cyst fertility and viability studies. The pressure of the cyst fluid was reduced by using a sterile hypodermic needle.

Then, cyst was incised with a sterile scalpel blade and the content was poured into a glass Petri dish and examined under low power microscope (x40) for the presence of protosclices. If protosclices were present, seen as white dotes on germinal epithelium or brood capsule or hydatid sands within the suspension, the cyst were categorized as fertile. Fertile cysts were subjected to viability test. During this case, a drop of fluid from cyst containing the protoscolices were placed on the microscope glass slide and covered with cover slip and observed for amoeboid like peristaltic movements, with X40 objective microscope. For clearer vision, 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 non-viable protoscolices absorb the stain. Furthermore, infertile cysts were further classified as sterile or calcified. Sterile hydatid cysts were characterized by their smooth inner lining usually with slightly turbid fluid in its content. Typical calcified cysts produce a gritty sound feeling up on incision [15].

Financial Loss Evaluation: Financial losses due to bovine Echinococcosis were assessed based on direct and indirect effect of the disease in affected animals. Direct losses were losses due to condemnation of organs (Like liver, lung, heart and other organs) and indirect losses were losses due to reduction in carcass weight. Annual financial loss due to organ condemnation was determined by considering annual slaughter rate of cattle and prevalence of Echinococcosis per organ and an estimated 5% carcass weight loss according to Getaw *et al.* [16]. Average carcass weight of Ethiopian local breed cattle is estimated to be 126 kg [17]. Finally, the total economic loss was calculated as the summation of cost of offal condemned plus the cost of carcass weight losses [1, 16].

Total loss=LOC+LCWL

Annual cost of offal condemned= $(CSR * P_{HLu} * C_{PLu}) + (CSR * P_{HLi} * C_{PLi}) + (CSR * P_{HHc} * C_{PHe}) + (CSR * P_{HKi} * C_{PKi})$. Annual Cost of Carcass Weight loss=$5\%*CSR*P_H*CPB*126$ Kg. Where: LOC=loss due to organ condemnation (Annual cost of offal condemned), LCWL=loss from carcass weight loss (Annual Cost of Carcass Weight loss), 126 KG = Average Carcass Weight of Zebu Cattle, 5%= Carcass Weight Loss in Individual Animal due to Echinococcosis according to Polydorous [18]. CPB = Average Market Price of One Kg of Beef in Debere Tabor, C_{PHe} = Mean Cost of One Bovine Heart in DebereTabor, C_{PKi} = Mean Cost of One Bovine Kidney Condemned, C_{PLi} = Mean Cost of One Bovine Liver Condemned, C_{PLu} = Mean Cost of One Bovine Lung Condemned, CSR = Average Number of Cattle Slaughtered Per Year, P_H = Prevalence of Echinococcosis at Debere Tabor Town, P_{HHc} = Percentage of Heart Condemned, P_{HKi} = Percentage of Kidney Condemned, P_{HLi} = Percentage of Liver Condemned, P_{HLu} = Percentage of Lung Condemned.

Data Analysis: A database was constructed in Microsoft Excel® to store the data. Chi-square (X^2) test is applied to compare the infection status with regard to the hypothesized risk factors. Descriptive analyses were also conducted using SPSS package version 16 to compute epidemiological variables like breed, age and sex and body condition of in affected animals.

RESULTS

Over all Prevalence: Of the 403 heads of cattle slaughtered and examined at Debre Tabor municipal abattoir, 97 (24.1%) were infected with hydatid cyst; harboring one or more cysts involving different visceral organs (Lung, liver, heart and kidney).

Table 1: Prevalence of bovine Echinococcosis on the basis of breed, sex age and body condition

Variables	Categories	No. of Examined	No. of Positive	Prevalence (%)	P-value	X^2	OR
Breed	Local	391	95	75.7%			
	Cross	12	2	16.7%	0.54	0.37	0.72
Sex	ex	Male	352	80	22.7%		
	Female	51	17	33.3%	0.09	2.74	1.93
Age	Adult	34	3	8.8%			
	Old	369	94	25.5%	0.03		42.72
Body Condition	Poor	100	44	44%	0.00		9.04
	Medium	155	41	26.5%	0.00	42.85	4.20
	Good	148	12	8.1%			

Table 2: Statuses of infected organs in age group, body condition, breed and sex category

		Infected organ					
Variables	Categories	Lung	Liver	heart	Lung & liver	Lung& heart	Liver, lung
Breed	Cross	1(8.3%)	0(0%)	0(0%)	1(8.3%)	0(0%)	0(0%)
	Local	41(10.5%)	8(2.1%)	8(2.1%)	8(2.1%)	4(1%)	2(0.5%)
Total		42(10.4%)	32(8%)	8(2%)	9(2.2%)	4(1%)	2(0.5%)
Age	Adult	2(6.1%)	1(3%)	0(0%)	0(0%)	0(0%)	0(0%)
	Old	40(10.8%	31(8.4%	8(2.2%)	9(2.4%)	4(1.1%)	2(0.5%)
Total		42(10.4%)	32(8%)	8(2%)	9(2.2%)	4(1%)	2(0.5%)
Body condition	Poor	19(19%)	17(17%)	3(3%)	3(3%)	2(2%)	0(0%)
	Medium	20(12.9%)	13(8.4%	2(1.3%)	3(1.9%)	1(.6%)	2(1.3%)
	Good	3(2%)	2(1.4%)	3(2%)	3(2%)	1(0.7%)	0(0%)
Total		42(10.4%	32(8%)	8(2%)	9(2.2%)	4(1%)	2(0.5%)
Sex	Female	3(5.9%)	8(15.7%	3(5.9%)	2(3.9%)	1(2%)	0(0%)
	Male	39(11.1%)	4(6.8%	5(1.4%)	7(2%)	3(0.91%)	2(0.6%)
Total		42(10.4%	32(8%	8(2%)	9(2.2%)	4(1%)	2(0.5%)

Prevalence of Hydatid Cyst on the Basis of Age, Sex, Body Condition and Breed: Hydatid infection at different age, sex, body condition and breed in affected groups is described in Table 1. The result indicates that there was statistically significant difference ($P< 0.05$) in age and body condition of affected animals; but no significant difference in between breed and sex.

The Status of Infected Organs in Age Group, Body Condition, Breed and Sex Category: In this study most of the animals that are less or equal to five years of age had shown only lung or liver infection, while those with age group greater than five years had lung, liver and heart infection. The most frequently affected organ was lung (10.4%) followed by liver (8%) and heart (2%). It is worth to mention that infection of both liver and lung is found mostly in bovine of greater than years old as compared to those less than five year olds (Table 2).

Fertility and Viability Study: A total of 145 cysts were collected at the slaughter house during the study period. Among the total cysts collected 70 (48.3%) were fertile of which 31(44.3%) were found to be viable and 39(55.7%) were non viable. On the other hand out of the 75(51.7%) non fertile cysts, 18(24%) were calcified and 57 (76%) sterile. From the total of 76 cyst recorded from lung, 2(2.6%) calcified, 40(52.6%) sterile, 17(22.4%) viable and 17(22.4%) were non-viable fertile cysts. From the total of 53 cysts recorded from liver, 14 (26.4%) were calcified, 13(24.5%) non viable, 16(30.2%) sterile and 10(18.9%) were viable (Table 3).

Table 3: Cyst fertility and viability in different organs

	Fertile		Non fertile	
	Viable	Non viable	Sterile	Calcified
Lung	17	17	40	2
Liver	10	13	16	14
Heart	2	4	0	0
Kidney	2	5	1	2
Total	31	39	57	18

Distribution of Cyst Fertility Based on Body Condition Score, Age, Sex and Breed: Those animals which had poor body condition score and animals which are >5 years have high cyst fertility rate than good body condition animals Table 4.

Table 4: Distribution of cyst fertility in different age, body condition, sex and breed of affected animals

		Cyst condition			
		Fertile		Non fertile	
Variables	Categories	Non viable	Viable	Calcified	sterile
Age	Old	34	27	18	54
	Adult	5	4	0	3
Body condition	Poor	28	24	13	30
	Medium	9	6	4	24
	Good	2	1	1	3
Sex	Male	36	28	15	48
	Female	3	3	3	7
Breed	Local	38	31	17	55
	Cross	1	0	1	2

Economic Loss Evaluation

Economic Loss Due to Organ Condemnation: The direct and indirect economic loss due to organ condemnation and carcass weight loss indicates that a total of 57 lungs, 43 liver, 12 heart and 2 kidneys were condemned due to Echinococcosis with a loss of 482,402 ETB (23,417.6 USD). This was calculated as the average market price of organs sold at Ethiopian markets; like average price of heart and liver was (26 birr), kidney (22 birr) and lung (8 birr) multiplied by the total number of organs condemned during study period.

Economic Loss Due to Carcass Weight Loss: For calculating the indirect loss due to carcass weight reduction, a 5% carcass weight loss brought by Echinococcosis as described by Polydorous [18] and 126 kg, an average carcass weight of an Ethiopian zebu, was considered here to estimate the economic loss and computed result showed a loss of 437,976 ETB (21,260.97 USD).

DISCUSSION

The present study reveals that the overall prevalence of bovine Echinococcosis at Debre Tabor municipal abattoir was found to be 24.1%, which is relatively higher than the report of 20.5% in cattle slaughtered in Eastern and southern Ethiopia and lower than the reports in cattle slaughtered in Kombolcha, north Gondar,Jimma and Debre Zeit with respectively prevalence of 28.3%, 28%, 36.3% 46.5% [19]. The variation in prevalence rate in different regions or localities might be due to the difference in agro ecologic situations, public awareness about tramisstion of the disease, strain difference in *E. granulosus* in the different geographical situations [15] and also other factor like social activity and attitude to dogs [20]. The relatively high prevalence rate recorded in the present study might be ascribed to the presence of higher number of stray dogs, lack of public awareness about the disease transmission, backyard road side slaughtering practices during holidays and improper disposal of condemned organs (Usually left unburied) contributing to the life cycle of the parasite.

In the present study, assessments of Echinococcosis infection was made to establish relationship between ages, body condition, sex and breed of the affected animals. The study result indicated that there was significant difference in infection rates between age groups and body condition ($p<0.05$).The high prevalence of Echinococcosis in animals of above five years old could be linked to the high chance of exposure to the disease (parasitic ova) over a long period of time with an increased possibility of acquiring the infection. This is in line with the findings of Nigatu *et al.* [21], Debas and Ibrahim [22] and Dakkak [23]. Although Abunna *et al.* [24] stated contrary finding stating middle age groups to be affected more.

Prevalence of bovine Echinococcosis was also significantly influenced by body condition score of affected animals. Those animals having poor body condition show higher prevalence (44%) of echinococcosis than animals with medium (26.5%) and good (8.1%) body condition score. This might be due to the fact that animals with poor body condition have low immunity to combat against the disease and poor body condition is probably a reflection of the effect of relatively high cyst burden. However, this finding disagrees with the finding of Abunna *et al*. [24] who reported existence of no statistically significant difference in Echinococcocal infection between the different body conditions of affected animals. Assessments of the disease prevalence were also made in between different sex and breed of slaughtered animals. More than 90% of animals slaughtered in Debre Tabor municipal abattoir were male animals and local breeds hence, comparison for these variables were not considered important for this study.

It is well known that among the organs involved, lungs and livers are the most commonly infected organs by haydatid cysts due to the reason that lungs and livers posses the first large capillary sites encountered by the migratory echinococus Onchosphers (Heacanth embryo). A finding of the present study is also in line with the above reason although more incidence rate of haydatid infection was noticed in lungs than in livers of the examined animals. Similar results were obtained by various

workers Abunna *et al*. [24] and Kebede *et al*. [25]. The higher prevalence in lung might be associated with the fact that cattle that are slaughtered at older age the capillaries of liver dilated and most cysts passed to lung. Besides, it is possible for the hexacanth embryo to enter the lymphatic circulation and carried via the thoracic duct to the heart and lung in such case the lung will be infected before liver. But this result disagree with the finding of Kebede *et al*. [1] who reported that due to the reflection of the route of parasite entry and seem to support the hypothesis of hepatic portal distribution of Onchosphers leading firstly to liver infection and also liver acts as the first barrier for the oncosphere penetrating the intestinal mucosa to reach the portal circulation.

In the present study, the fertility and viability test result of the cyst (i.e. the 75 (51.7%) non fertile cysts, 70 (48.3) fertile cysts, 31 (44.3%) viable cysts, 39 (55.7%) non viable cysts, 18(24%) calcified cysts and 57(76%) sterile cysts indicates that greater proportions of hydatid cysts were infertile. This finding is consistent with the work of Kebede *et al.* [1]. Similarly, in Britain up to 90% of total cysts from cattle were reported to be sterile [15]. The total percentage of fertile cysts in this study was 48.3%. This finding is higher when compared to the fertility report of Zelalem and Yechale [26] who reported 19.3%. However our finding is comparable to the 70% finding in Great Britain, 96.9% report in South Africa and 95% in Belgium [15]. Yet much lower fertility rates of 1.76% around Wolayita Soddo [21] and 6.2% in Bahir Dar were reported [27].

Significant economic loss was registered due to Echinococcosis infection in the present study with an estimated financial loss of 920,378ETB or 44,678.5(USD). This is a considerable loss for the country where its capital income per individual is less than 1USD per day. In addition, Echinococcosis poses substantial economic impact on production and productivity of our livestock like; reduced traction power of oxen which results in reduced crop production, cost of controlling the disease, loss of life due to death in affected ones, treatment cost in humans magnifies the the disease. Our finding of annual economic losses is much higher than the report of Kebede *et al*. [25] who reported annual economic loss of 25, 608 Ethiopian Birr in their finding in Tigray region of Northern Ethiopia. Different financial losses regarding bovine Echinococcosis were also reported from different part of the country. For example, Getaw *et al*. [16] reported 5869.80 USD in Adama municipal abattoir Kebede *et al.* [1] reported 3,201 USD losses per annum in Mekele municipal abattoir, North Ethiopia. The difference in economic loss analysis in various abattoirs\regions may be due to the variations in the prevalence of the disease, mean annual number of cattle slaughtered in the different abattoirs and variations in the retail market price of organs and carcasses that make the currencies unstable.

CONCLUSIONS

Hydatidosis (Cystic echinococcosis) is a disease of zoonotic importance, caused by the larval stage of *E. granulosus.* The disease is one of the highly prevalent parasitic infections of cattle in and around Debere Tabor causing tremendous economic loss. Several factors are posing difficulty in the control of diseases like backyard slaughtering practices in the area, lack of adequate meat inspection techniques and also habit of giving raw offal for pets (Dogs). It is crucial to carry out control strategies so as to prevent losses associated with the disease occurrence.

Recommendations: Awareness should be created for dog owners and butchers for properly disposing of animal waste (Ofalls), controlling of stray dogs and their access to raw offal is crucial, government should give attention towards building of standard abattoir houses with good facilities and also controlling of backyard slaughtering practices.

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