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Research Article

PREVALENCE, CYST VIABILITY, FERTILITY AND ECONOMIC SIGNIFICANCE OF BOVINE HYDATIDOSIS IN AN ABATTOIR AT KOMBOLCHA, ETHIOPIA

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ABSTRACT

A study was undertaken at ELFORA Industrial Abattoir, Kombolcha, Ethiopia to determine the prevalence and economic importance of bovine hydatidosis. A total of 400 cattle were randomly selected and examined after slaughter for the presence of hydatid cysts in the visceral organs using the standard meat inspection procedures. Hydatid cyst count, characterization and assessment of economic loss were also undertaken. Of the 400 cattle slaughtered, 134 (33.5%) animals were found harboring hydatid cysts. The statistical analysis revealed that there was no significant difference (P>0.05) between the prevalence of bovine hydatidosis and sex of animals. The prevalence of hydatidosis was found to be significant with origin of the studied animals (P<0.05). Of 319 cysts examined, 81 (25.4%), 188 (58.9%) and 50 (15.67%) were calcified, sterile and fertile, respectively. Out of the total fertile cysts, 31 were found to be viable. Of the 145 cysts recorded in the lungs, 20 (13.79%), 95 (65.52%), 18 (12.4%) and 12 (8.28%) were calcified, sterile, viable and non-viable fertile cysts, respectively. Furthermore, of the 160 cysts recorded in the liver, 53 (33.13%) were calcified while 13 (8.13%) were viable. The rate of cyst calcification was higher in the liver than in the lungs, while fertility rate was higher among the cysts of the lungs. The annual financial losses from organ condemnation and carcass weight loss due to bovine hydatidosis at this abattoir were estimated to be 1848849.765 Ethiopian Birr (ETB) (US$1=21.0 ETB). Thus, hydatidosis is considerably a prevalent disease in cattle with considerable losses in the study area. Therefore, initiation and implementation of control measures are necessary in order to alleviate its economic impact as well as zoonotic risks to the humans.

Key words: Abattoir, bovine, cattle, economic loss, hydatidosis, Kombolcha ELFORA, meat inspection, prevalence

Hydatidosis is among the major parasitic diseases contributing to reduced meat production due to carcass or organ condemnation in particular (Regassa *et al*., 2010). Infection with the metacestode hydatid cyst of *Echinococcus granulosus* is recognized as one of the world's major zoonosis affecting both humans and domestic animals (Cringoli *et al*., 2007; Pal and Dutta, 2013). The definitive host of this parasite is dog, which harbors adult tape worms and excretes the parasite eggs in faeces. Livestock and humans are the main intermediate hosts (Oku *et al*., 2004) for whom the outcome of infection is the development of hydatid cysts in the lung, liver or other organs (Muller, 2001; Budke *et al*., 2006). Although *E. granulosus* penetrates deep between the villi of the small intestine of the definitive host, there are no pathogenic effects even in heavy infections suggesting that infected definitive hosts are asymptomatic carriers of the parasite. Furthermore, infections with *E. granulosus* cysts in the intermediate hosts are typically asymptomatic, except for a small number of cases with chronic and heavy infections (Pal, 2007).

There are no reliable methods for the routine diagnosis of infections in living animals, but in rare cases, cysts have been identified by ultrasonography alone or in conjunction with serum antibody detection tests. Hydatidosis causes decreased livestock production and condemnation of offal in slaughter houses (Eckert and Deplazes, 2004). The incidence of hydatidosis in humans and in domestic animals is higher in countries with large dog population and high sheep production (Gracey, 1986). The absence of proper meat inspection procedures and the presence of large stray dog population are thought to contribute significantly to the prevalence of the disease in Ethiopia (Kebede *et al*., 2009a). Mersie (1993) carried out a survey of echinococcosis in eastern Ethiopia in which a total of 171 adult cattle and nine stray dogs were examined for *E. granulosus*; the prevalence of 20.5% and 22% were recorded in cattle and dogs, respectively. Several reports from different parts of Ethiopia indicated that hydatid cyst is prevalent in livestock (Lobago, 1994; Haylemelekot, 1995; Olika, 1997; Yihdego, 1997; Regassa *et al*., 2010) with widespread prevalence in north eastern Ethiopia (Bizuwork *et al*., 2013). However, there is not enough information regarding the prevalence and economic significance of hydatidosis in livestock in South Wollo zone, northeastern part of the country. Therefore, the present study was aimed to determine the magnitude of hydatidosis

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in cattle and to study the localization and fertility/sterility rates of hydatid cysts and to estimate the economic losses at Kombolcha ELFORA Industrial Abattoir, Northeastern Ethiopia.

MATERIALS AND METHODS

Study Area: The study was conducted at Kombolcha, north eastern Ethiopia from December 2014 to April 2015. Kombolcha is situated at 11.08° North latitude, 39.73 East longitude and 839 meters above the sea level. It has an annual rainfall of 500 mm of, which 84% is in the long rainy season (June to September). The dry season extends from October to February. The mean annual maximum and minimum temperatures are 36°C and 21°C respectively, with mean relative humidity of 41.3%. Kombolcha is one of the 22 districts of South Wollo administrative zone, which shares border with Dessie Zuria and Tewuledere districts in the North, with Dessie Zuria and Dessie town in the West, with Kalu and Dessie Zuria in the South and Kalu in the East. The district is divided into eight urban Kebeles and six rural Kebeles. As estimated by the District Office of Agriculture, the district has a total area of 78.6 km^2. About 33.6% of the district's area is under crop production, and 1.47% is serving as a grazing land (DARD, 2010).

Study Population: A total of 400 cattle presented for slaughter at Kombolcha ELFORA Industrial Abattoir were examined for the presence of hydatid cyst. The study was an active abattoir survey, which included cattle brought from different livestock markets to the abattoir.

Sample Size Determination: The sample size was determined according to the method of Thrusfield (1995) by taking 95% confidence interval at a desired accuracy level of 5% and based on previous study prevalence of 17% (Abunna *et al*., 2012). The animals were selected using simple random sampling method.

Postmortem Examination: A total of 400 cattle presented for slaughter at Kombolcha ELFORA Industrial Abattoir were examined for the presence of hydatid cysts following the routine meat inspection procedures. The inspection procedure used during the postmortem examination consisted of two steps, namely primary and secondary examinations. Primary examination involved visual inspection and palpation of organs and viscera followed by a secondary examination if evidence of metacestode was found. The secondary examination involved further incision into each organ if single or more hydatid cyst(s) was found. The liver, lungs, heart, spleen, mesentery, and omentum of each animal were examined grossly. Each organ was also incised once or twice with knife. Whenever, the cysts were present, they were removed, placed in polyethylene bags separately, labeled and taken to the laboratory for further examination. Identification of cysts was done in the Regional Veterinary Laboratory, Kombolcha based on the criteria described by Soulsby (1982). During the study, detailed records of the species, age of the animals, number, location and viability of the cyst(s) were made. All animals slaughtered were local zebu breed of cattle of 4 years of age and above.

Cyst Fertility and Viability: Individual cysts were grossly examined for any evidence of degeneration and calcification. Cysts were selected for fertility studies and to reduce intra-cystic pressure, the cyst wall was penetrated with a needle and opened up with a scalpel and scissor. The contents were then transferred into a sterile container and examined microscopically (40×) for the presence of protoscoleces. Cysts which were not containing any protoscolex as well as heavily suppurative or calcified were considered unfertile. The viability of protoscoleces was assessed by the motility of flame cells together with staining by 0.1% aqueous eosin solution. Living protoscoleces did not take up the stain, unlike the dead ones (Macpherson *et al*., 1989). 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 their content. Typical calcified cysts produced a gritty sound heard at incision (Soulsby, 1982).

Financial Loss Estimation: Direct and indirect losses were the basis for the estimation of the annual economic losses. Direct losses were calculated on the basis of condemned organs, whereas the indirect losses were estimated on the basis of live weight loss caused by hydatidosis (Polydorou, 1981; Torgerson and Dowling, 2001). The parameters considered for the estimation of financial loss were 5% estimated carcass weight loss due to hydatidosis (Polydorou, 1981), slaughter rates of animals at ELFORA Industrial Abattoir, Kombolcha, average carcass weight (dressing percentage) of Ethiopian Zebu cattle breed (126 kg) and the mean retail market price of condemned organs due to hydatidosis such as lung, liver, kidney, spleen. The total financial loss due to hydatidosis was the sum of direct and indirect losses and the losses were calculated on a yearly basis. Average market price of the lung, liver, spleen, kidney, heart and a kilogram of beef was found to be 30, 35, 25, 10, 15 and 120 Ethiopian Birr (ETB), respectively. The mean annual numbers of cattle slaughtered during the last one year were 6510. Average number of cattle positive for hydatidosis as it

was extrapolated from prevalence findings on ELFORA abattoir was 33.5%.

Direct losses were calculated as follows:

$$DL = (AS \times CLu \times PLu) + (AS \times CLi \times PLi) + (AS \times CSp \times PSp) + (AS \times CKid \times PKid) + (AS \times CHr \times PHr)$$

Where, DL=direct losses associated with hydatidosis; AS=estimated mean annual slaughter; PLu=percent involvement of the lung; CLu=local retail price of a lung; PLi=present involvement of the liver; CLi=local retail price of a liver; PSp=present involvement of the spleen; CSp=local retail price of a spleen; PKid=percent involvement of the kidney; CKid=local retail price of a kidney; PHr=percent involvement of the heart; CHr=local retail price of a heart

$$\text{Indirect losses (IL)} = 5\% \ NAS \times PH \times CPB \times 126 \text{ kg}$$

Where, 5%=a reduction of 5% in meat production due to hydatidosis established by Polydorou (1981); NAS=average number of cattle slaughtered annually; PH=prevalence rate of hydatidosis; CPB=current average price of 1 kg of beef at Kombolcha; 126 kg is the dressed average carcass weight of adult Zebu cattle

$$\text{Total economic loss (TL)} = DL + IL$$

Data Analysis: Abattoir data was collected and recorded on paper forms and preliminary analysis was done in Microsoft Excel. The outcome variables for the abattoir study were detected in case of echinococcosis during routine ante mortem and postmortem inspection at the abattoir. The stat software program IBM SPSS version 20 was applied for the statistical analysis of the data obtained from the study. The prevalence of hydatidosis was calculated as the number of positive observation divided by the total sample size multiplied by 100. Correlation with Pearson chi-square test was used to express results and to determine significance of variables with prevalence of hydatidosis. Mean, median, frequencies, and percentages were also calculated.

RESULTS AND DISCUSSION

Of the 400 bovines examined at Kombolcha ELFORA Industrial Abattoir, 134 (33.5%) were found to be infected with hydatid cyst. The statistical analysis showed that there was no significant difference (P>0.05) between the prevalence of bovine hydatidosis and sex of animals presented to the abattoir during the study period (Table 1). Based on origin of animals, the prevalence of hydatidosis was significantly higher in animals of highland origin (55%) than lowland (24.29%; Table 1). The majority of animals presented to the abattoir were poor in body condition and 37.6% and 26.66% prevalence was recorded in poor and good body conditioned animals, respectively (Table 1).

The proportion of organs presented in Table 2 showed that the majority of cysts were recorded in the liver of the study animals. A total of 319 cysts were collected at the abattoir during the study period. Of the total cysts collected, 31 (9.72%) were found to be alive while 288 (90.28%) were dead (Table 2). Of the total cysts examined, 81 (25.4%) were calcified, 188 (58.9%) were sterile, and 50 (15.67%) were fertile.

Table 1
Sex wise, geographical wise and body condition wise prevalence of hydatidosis at ELFORA Industrial Abattoir, Kombolcha during study period

Parameter	Category	Number of animals examined	Animals positive for hydatidosis (%)	Chi-square value (x2)	P-value
Sex	Male	270	94 (34.81)	1.043[a]	0.307
	Female	130	40 (30.77)		
Geographical	Low land	280	68 (24.29)	4.145[a]	0.042
	High land	120	66 (55.00)		
Body condition	Good	150	40 (26.66)	-	-
	Poor	250	94 (37.60)		
	Total	400	134 (33.50)		

Out of the total fertile cysts identified, 31 (9.72%) were found to be viable cysts (Table 2). Out of the total 145 cysts recorded in the lungs (Fig. 1), 20 (13.79%) were calcified, 95 (65.52%) were sterile, 18 (12.4%) were viable, and 12 (8.28%) were nonviable fertile cysts. In the liver, out of 160 cysts, 53 (33.13%) were calcified, and 13 (8.13%) were viable (Table 3). The viability percentage of protoscolices was higher in the lung (12.4%) than in other organs while the percentage of calcified cysts was the highest (33.13%) in the liver (Table 3). From the inspected organs at the abattoir, 17 animals were found to harbor 5 to 15 cysts and one animal harbored 11 hydatid cysts.

Due to cattle hydatidosis, 81 lungs, 67 livers, 10 hearts, 3 kidneys and one spleen were condemned during

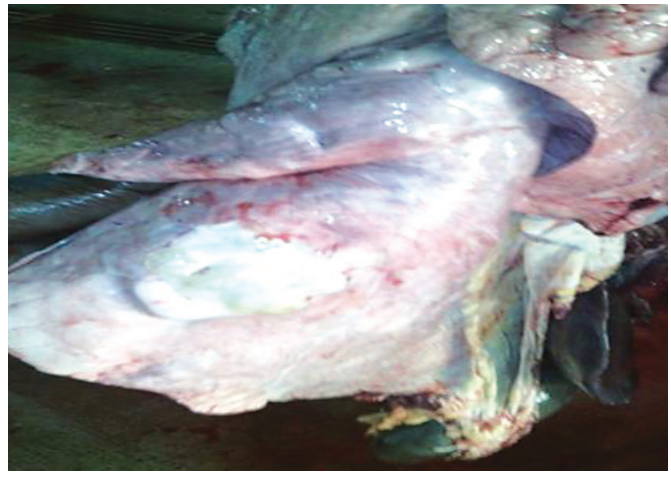

Fig 1. Large sized hydatid cyst found in the lung in a cattle during abattoir survey

Table 2
The total number, relative prevalence and number of cysts in affected organs

Organ	Number of organ infected (% relative prevalence)	Total number of cysts
Lung	81 (50)	145
Liver	67 (41.36)	160
Heart	10 (6.17)	10
Kidney	3 (1.85)	3
Spleen	1 (0.62)	1
Total	162	319

the study period with an economic loss of 2430, 2345, 150, 30 and 25 ETB, respectively (Table 4). This was assessed from the mean retail market price of each organ and the total number of organs condemned during the study period. Annual economic loss on the other hand was estimated considering annual slaughter rate of cattle and prevalence of hydatidosis per organ and was 200127.165 ETB per annum. The estimated economic loss from carcass weight loss due to hydatidosis was 1648722.6 ETB. Therefore, the total estimated annual economic loss in cattle at Kombolcha ELFORA Industrial Abattoir due to hydatidosis during the study period was 1848849.765 ETB (approx. 88040 USD considering one USD=21.0 ETB).

The prevalence of hydatidosis as observed in this study was almost similar to that reported in Bahir Dar (Kebede *et al*., 2009a), Mekelle (Berhe, 2009) and Tigray (Kebede *et al*., 2009d). Low prevalence has also been reported in Hawassa (Regassa *et al*., 2009) and Wolaita Sodo (Kebede *et al*., 2009b) while high prevalence has been reported in other areas of the country such as Assela (Koskei, 1998), Hawassa (Regassa *et al*., 2010), Debre Zeit (Jobre *et al*., 1996) and Debre Markos (Kebede *et al*., 2009c), In general, throughout the world, there had been different magnitude records of hydatidosis in cattle with low medium and high rates of occurrences. Factors such as difference in culture, social activity, animal husbandry systems, lack of proper removal of infectious carcass, and attitude to dogs in different regions might have contributed to the variation in prevalence in different areas of a country (Arbabi and Hooshyr, 2006) in addition to strain differences of *E. granulosus* that exist in different geographical locations (McManus, 2006).

In rural areas most farmers keep at least one dog for guarding the house and the livestock. This is one of the means for the farmers to give infected lungs and other organs to dogs. Meat inspection is practiced only at few sites and there is no proper disposal of condemned organs. There is lack of awareness in the people on the health hazards as well as the economic importance of the disease. The prevalence of hydatidosis differed significantly with origin of animals with no significant difference based on sex of animals presented to the abattoir during the study period. The eggs tolerate a wide temperature range and heat damage does not appear to occur until temperature reaches 38°C and the eggs withstand a temperature as low as –30°C (Gemmell *et al*., 2001). This may be attributed to the religious factor as in most of the lowland areas of Ethiopia, the Muslim people are more privileged and dog is considered as "NEJASSA". So the dogs are rarely domesticated, thus reducing the infection rate of cattle in the lowland areas (Abunna *et al*., 2012).

There was statistically significant difference in the prevalence of hydatidosis with respect to body condition of the animals. Kombolcha ELFORA abattoir is an industrial abattoir and to prolong the shelf life of the canned meat poor body conditioned animals are preferred than the fattened animals. The liver and lung were the most commonly infected organs. The kidney, heart and spleen were the least affected organs in the study animals. Similar findings were also reported by various workers and their findings also indicated that the liver and lungs are the most commonly affected organs with hydatid cysts. This may be due to the reason that there are the first large capillary fields encountered by the blood borne onchospheres. However, development of hydatid cysts occurs occasionally in other organs and tissues when onchospheres escape in to the general systemic circulation

Table 3
Type of hydatid cysts in different organs of affected cattle

Organ	Cyst conditions				Total
	Fertile		Non fertile		
	Viable (%)	Nonviable (%)	Sterile (%)	Calcified (%)	
Lung	18 (12.4)	12 (8.28)	95 (65.52)	20 (13.79)	145
Liver	13 (8.13)	7 (4.36)	87 (54.36)	53 (33.13)	160
Heart	0	0	3 (30.00)	7 (70.00)	10
Kidney	0	0	2 (66.66)	1 (33.33)	3
Spleen	0	0	1 (100)	0	1
Total	31 (9.72)	19 (5.96)	188 (58.90)	81 (25.40)	319

Table 4
Direct economic losses associated with echincoccosis in cattle in Kombolcha ELFORA industrial abattoir

Organ	No. of organs condemned	Price per organ	Total price (ETB)
Lung	81	30	2430
Liver	67	35	2345
Heart	10	15	150
Kidney	3	1	10
Spleen	1	25	25
Total	161	90	4980

(Urquhart *et al*., 1996). The liver infection may be a reflection of the route of parasite entry and seems to support the hypotheses of hepatic portal distribution of the onchospheres leading to the liver infection. The proportion of large, medium and small sized cysts was higher in the lung than in the liver. Similar finding was reported by Abunna *et al*. (2012) in the same study area. In the rare sites such as the abdominal cavity, where unrestricted growth is possible, the hydatid cyst may become very large in size and may contain several liters of fluid (Urquhart *et al*., 1996). The percentage of calcified cysts was found to be higher in the liver than in the lungs. This may be associated with the relatively higher reticulo-endothelial cells and abundant connective tissue reaction of the organ (Gemmell *et al*., 2001), which encapsulates the cyst within a fibrous wall of up to 13 mm thick. In the fertility and viability study, the percentage of fertile cysts was found higher in the lung than the liver. This is due to the relatively softer consistency of the lung, which allows easier development of the pressure cyst; and fertility of hydatid cyst may show tendency to increase (Urquhart *et al*., 1996).

Hydatidosis causes considerable public health hazard (Pal and Dutta, 2013). It is a well known fact that an efficient meat inspection service may lead to control of animal diseases with considerable economic and public health significance mainly in cases of chronic and ill-defined conditions, which are not apparent either to the livestock owners or veterinary surgeons. More importantly, a feedback from the slaughterhouses to the individual farm is of great value in the field of preventive medicine. From this study it can be concluded that bovine hydatidosis is the major cause of organ condemnation at Kombolcha ELFORA abattoir. Nearly one quarter of the slaughtered animals harbored hydatid cysts in one or more of their organs. This relative high prevalence of hydatidosis and associated economic loss calls for serious attention.

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