Hydatidosis of cattle and sheep, its economic importance and *Echinococcus granulosus* among stray dogs in South Wollo, Ethiopia

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Abstract

In this crossectional survey the prevalence, fertility, size of hydatid cyst in cattle and sheep, economic losses due to hydatidosis in cattle, and prevalence of *Echinococcus granulosus* in dogs were studied in South Wollo, Ethiopia. for the purpose Each animal carcass was inspected carefully, hydatid cysts of each organ were counted, measured and examined microscopically to determine the fertility and determination of infection of *Echinococcus granulosus* in the dog involved in the study was done by standard post-mortem procedure. Of the total of 312 cattle and 197 sheep examined 56 (17.95%) and 15(7.61%) were found to be infected with hydatid cysts respectively. The prevalence in cattle tended to be high, though the difference was not statistically significant ($P > 0.05$, $X^2=1.006$). Lung was found to be the most commonly affected organ in case of cattle, liver in case of sheep with a value of 66.25%and 82.36% respectively. Spleen and heart were found to be less commonly affected organs in cattle and lung in case of sheep, cysts were not observed in the kidney in both species. Studies on the condition of the cysts revealed that medium sized cysts predominate in case of cattle with an abundance rate of 54.9%, followed by small cysts (40.8%) and large cysts (4.3%). All of the cysts found in sheep were small and majority of them showed calcification. Cyst fertility rates were 36.2% and 45.5% in lung and livers respectively ($z = 0.46$, $P = 0.643$). Out of 10 stray dogs euthanized and examined at necropsy 2(20%) were found to be infected with adult *E.granulosus* with a mean worm burden of 30. An annual loss of 464,900 Eth.birr was estimated to be caused by bovine hydatidosis from organ condemnation and carcass weight losses. In conclusion this zoonotic cestode need deserve due attention in order to safe guard the public and reduce the economic losses in animals,

thus relevant control measures pertinent to the prevailing socioeconomic factors in the area were recommended.

Keywords: Cattle, *Echinococcus granulosus*, Ethiopia, Hydatidosis, Prevalence, Sheep

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Introduction

Cystic hydatidosis is a disease of zoonotic importance, caused by larval stage of *Echinococcus granulosus,* where dogs are the definitive hosts. Various animals including sheep, goats and cattle act as intermediate hosts (Schantz, 1990). The disease has been reported from many African countries including Uganda, Rwanda, Burundi, Togo, Nigeria, Zimbabwe, Zair, Kenya and South Africa (Gracey, 1986). Hydatidosis of sheep and cattle is the major disease frequently reported from many parts of Ethiopia (Nigatu Kebede *et al*., 2011; Endrias Zewdu *et al.*, 2010; Feyessa Regassa *et al*., 2010 Gebretsadik Berhe, 2009; Nigatu Kebede *et al.*, 2009). Hydatidosis in animals is of economic importance due to the losses caused by the condemnation of organs of slaughtered animals, and because of the indirect losses from their reduced capacity for work or permanent incapacity; losses due to mortality and social consequences of disability and mortality(FAO, 1982).

Different infection rate of *E. granulosus* among dogs in different parts of Ethiopia has been reported with a prevalences of 20.2%, 20.8%, and 54.8% by Tsegaye Tadesse (1995) at Debre-Berhan area, Fikre Lobago (1994) at Konso and Alemayehu Lemma (1990) in Arsi area, respectively.

The financial loss reports due to hydatidosis in cattle and sheep shows great variation from place to place in this country for example, Endrias Zewdu *et al*., (2010) reported annual loss of 160,032.23 Ethiopian Birr in Ambo municipal abattoir in central part of the country, whereas Kebede

Woldegiorgis *et al*., (2009) documented annual loss of 25, 608 Ethiopian Birr in Mekele municipal abattoir northern Ethiopia.

The fertility of hydatid cysts occurring in various intermediate host species is one of the most important factors in the epidemiology of the disease (Himonas *et al.*, 1994; Bortoletti *et al.*, 1990; Irshadullah *et al*., 1989). The fertility of hydatid cysts varies depending on intermediate host species and geographical areas (Saeed *et al*., 2000; Kamhawi *et al*., 1995; Farah, 1987; Abdel-Hafez *et al*., 1986). Currently there are no recent data about the status of ruminant hydatidosis and *E. granulosus* in dogs in and around Kombolcha (South Wollo, Ethiopia). The objectives of this study were to determine the prevalences of hydatidosis in cattle and sheep slaughtered in the abattoir and to assess the cyst fertility, viability and size; to determine economic losses due to cattle hydatidosis and to establish the occurrence of *E. granulosus* among stray dogs in Kombolcha town.

Materials and Methods

Study area

The study was conducted in South Wollo, specifically in and around Kombolcha, located in the Northern part of Ethiopia about 375 kms North East of Addis Ababa. The human population of Kombolcha and its environs is estimated at 85,333 (CSA, 2008). The area is featured by numerous mountains, plateaus, hilly and sloppy areas, rivers, streams and lakes. The altitude varies from 1500-2600 meters above sea level. The area has a bimodal rainfall, with a mean value varying between 39.63 to 1000mm. The maximum and minimum daily temperature is 23.9^{o}C and 11.6 ^{o}C, respectively. The relative humidity of the area ranges between 23 to 79%.

In the region there are three main seasons in a year: the dry season ("Belg") that lasts from October to the beginning of January, the small

rainfall of 100-300mm, and the big rainy season ("Kiremt") from July to the end of September which has got an average rainfall of 200-800mm. there is also a small dry period in May and June (BoARD, 2006).

Study animals

From November 2007 to February 2008 post-mortem examination was conducted on cattle and sheep. These animals were bought from different market places found in and around Kombolcha town. All of the animals examined in this particular study were males and reared in extensive management.

Sample size and sampling methods

The minimum sample size desired required for the study was calculated using the formula given by Thrustfield (1995) with 95% confidence level and at 5% absolute precision with 28.3% and 14.8% expected prevalences for cattle and sheep according to the previous reports of Yilkal Asfaw (1989) and Daniel Ferede (1995) respectively.

$$N = \frac{1.96^2 .Pexp\ (1-Pexp)}{d^2}$$ (Where, N=Required Sample, Pexp=Expected Prevalence d=Desire Absolute Precision)

Accordingly total of 312 cattle and 197 cattle and sheep presented for slaughter were subjected for routine meat inspection at Kombolcha ELFORA meat factory. In addition 10 adult stray dogs were euthanized to assess the status of Echinococcus infection in the definitive host in the region. It was not possible to examine more numbers stray dog population, because of less cooperation from the municipal and district veterinary officials at Kombolcha town.

Regular visits were made to the ELFORA Kombolcha meat Factory. During each visit systematic random sampling method was followed to select the study animals, visceral organs particularly the lungs, liver,

spleen, heart and kidneys were also systematically inspected for the presence of hydatid cysts and registered. Hydatid cysts were carefully removed and separately collected in clean containers whenever they are accessible up on visual inspection and palpation. Numbers of hydatid cysts per organ and per species of animal were registered. Further laboratory examinations were carried out on 88 randomly selected fluid filled cyst 30 hydatid cyst specimen from cattle were used to determine the fertility and viability of cysts at Kombolcha regional veterinary laboratory.

Cyst characterization procedures

Cyst size classification

Individual cyst diameter was measured classified into three groups as small, medium and large if the diameter of the cyst was < 4cm, 4 - 6cm and > 8 cm, respectively (Nigatu Kebede *et al*., 2008; Oostburg *et al*., 2000).

Determination of cyst fertility and viability

Individual cysts were grossly examined for degeneration and calcification. Then, non calcified hydatid cysts were randomly selected for fertility study. The surface of each cyst was sterilized with alcoholic iodine solution. The cyst wall was then penetrated, using a large size needle and a cut given with scalpel and scissors then the contents were transferred in to a sterile container. The contents were examined under a microscope (40X) for the presence of protoscolices. The cysts which contained no protoscolex were considered as unfertile cysts. The viability of the protoscolices was assessed by motility of flame cells as well as ease of staining with 0.1% aqueous Eosin solution and examination under a light microscope (Daryani *et al*., 2007; Smyth and Barrett, 1980). Live protoscolices did not take the dye whereas, the dead ones did. The fertility rates of cysts were calculated from the numbers of viable and dead protoscoleces assessed by relating the number found in the 1000 µl examined to the total volume of cystic fluid.

Postmortem examination of dog for *E. granulosus*

Ten stray dogs, 8 male and 2 female were euthanized with the help of Kombolcha city sanitarians, then the alimentary tract was dissected out. For the purpose of searching *E. granulosus*, about half a meter of the anterior part of the small intestine after both ends were tied, longitudinal incision was made to open it followed by washing and scraping of the mucosa into a 10% formalin solution using universal bottle. The suspension was transferred to conical flask to allow gravitational sedimentation. The supernatant fluid discarded and replaced with formalin solution and this procedure was repeated until clear sediment was left. The sediment was examined under the microscope for the presence of *E. granulosus*. Identification and counting was made as described by Georgi and Theodorides (1980).

Monetary loss estimation

An attempt was made to estimate the economic significance of hydatidosis on cattle from the cost of the offal's condemned (liver and lung) (direct loss), and carcass weight losses from it (indirect loss). The retail market price of average sized zebu liver, lung and the cost of 1kg of beef were estimated based on the information gathered from local butchers in Kombolcha. The average retail market prices were 2, 6 and 40 Ethiopian Birr for a single lung, liver and a kilo of meat during the study period. According to the information obtained from ELFORA Kombolcha meat factory an average of 10, 000 cattle are slaughtered annually (2003-2006). One hundred twenty five kg was taken as a dressing weight for local zebu cattle (ILCA, 1979) to calculate the direct loss on the formula described below as described by Ogunrinade and Ogunrinade (1980). A 5% estimated carcass weight loss due to bovine hydatidosis as described by Polydorous (1981) was used for the indirect loss from carcass weight loss.

Estimation of direct monetary loss from organ condemnation

The annual financial loss due to livers and lungs condemned due to hydatidosis

$[(pI_1. T_k. C_1)+ (pI_2. T_k. C_2)]$

Where: pI_1 = Percent involvement of lung of total lungs examined
pI_2 = Percent involvement of the liver of total livers examined
C_1 = Mean price of each lung in Kombolcha
C2=Mean price of each liver in Kombolcha
T_k = the mean annual kill in ELFORA Kombolcha Meat Factory

Estimation of indirect monetary loss from carcass weight reduction

The annual cost of carcass weight loss due to Hydatidosis = $Ns (C_1. P_A)$

Where: Ns = total number of cattle slaughtered annually and positive for Hydatidosis in ELFORA Kombolcha meat Factory
C_1 = Carcass weight losses in individual animal due to hydatidosis,
P_A = Average market price of one kg of beef in Kombolcha

The estimated annual economic loss from both direct and indirect losses equals the sum of the two, i.e., $[(P_{I1}. T_k. C_1) + (pI_2. T_k. C_2)] + NS (C_I. P_A)$.

Data analysis

The data obtained from postmortem and laboratory findings were entered in to Ms excel sheet, and then analyzed by using STATA version 8. The main outcome variable was the case of hydatid cyst detected during the routine meat inspection. Univariate screenings were done by Chi-square for species difference in prevalence; Z-test was used for comparing the fertility rate (proportion) liver and lung. In addition other data were subjected to descriptive statistics. The 95% confidence intervals (CI) were also calculated. All value of $P < 0.05$ were considered significant.

Results

Prevalence

From a total of 509 animals examined (312 cattle and 197 sheep), 56(17.95%) cattle and 15(7.61%) of sheep were found to be infected with hydatid cysts. No significant difference (P>0.05) was observed in prevalence between the two species (Table 1).

In this study the lung was found to be the most commonly affected organ in cattle and liver in case of sheep (Table 2). In cattle heart and spleen were the least affected organs where as in sheep lung was the least affected, spleen and heart were found to be uninfected (Table 2).

Table 1. Prevalence of hydatidosis in cattle and sheep

Species	Number examined	Number positives	Prevalence (%)	95% CI
Cattle	312	56	17.95	13.85-22.66
Sheep	197	15	7.61	4.30-12.18
Total	509	71	19.95	

($p > 0.05$, $\chi^2 = 1.006$)

Cyst characterization

Size

Out of the 88 randomly collected hydatid cysts (72 form cattle and 16 from sheep), 29(40.8%) were small, 39(54.9%) medium and 3(4.2%) were large for cattle. In case of sheep all of the cysts observed were small sized. High distributions of medium sized cysts were observed in the lungs of cattle where as in case of sheep only small cysts were recorded. In sheep cysts were found in liver and lung, and no cysts were observed in heart and spleen (Tables 3 and 4).

Table 2. Organ level distribution of hydatid cysts among infected cattle and sheep at Kombolcha Elfora abattoir.

Organ (S)	No Affected organs		Proportion among infected		Overall percent infected	
	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep
Lung	53	2	66.25	11.77	16.99	1.02
Liver	15	14	18.75	82.36	4.81	7.11
Lung and Liver,	10	1	12.5	5.89	3.2	0.5
Lung and Spleen	1	0	1.25	0	0.32	0
Lung, Liver, spleen and Heart	1	0	1.25	0	0.32	0
Total	80	17	100	100	25.64	8.63

Table 3.Distribution of hydatid cysts in different organs based on their size among infected animals.

Organ involved	Total Number of cysts examined		Small cyst No (%)		Medium cyst No(%)		Large cyst No (%)	
	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep
Lung	53	2	22 (41.5)	2 (100)	29(54.7)	-	2(3.8)	-
Liver	15	14	5 (33.3)	14 (100)	9(60)	-	1(6.7)	-
Heart	1	0	1(100)	-	0(0)	-	0(0)	-
Spleen	2	0	1(50)	-	1(50)	-	0(0)	-
Total	71	16	29 (40.8)	16(100)	39(54.9)	-	3(4.3)	-

Fertility and sterility of cysts

A total of 30 hydatid cysts were randomly selected from lung and liver of cattle. The cysts recovered form sheep were not that much in good shape to be subjected for fertility test. The number and proportion to of total cysts collected from cattle were subjected for fertility test, in each examined location. The fertility rate in liver and lung shows no significance deference ($P > 0.05$) Table 4.

Table 4. Fertility rate hydatid cyst in liver and lung of cattle

	Lung (n=19)	**Liver (n= 11)**
No. fertile cysts	7	5
No. sterile cysts	12	6
Fertility rate (%)	36.2	45.5
Sterility rate (%)	63.8	54.5

$Z = 0.46$, $p = 0.643$

Prevalence of *Echinococcus granulosus* among examined dogs

Out of the total of 10 stray dogs killed and examined 2 (20%) were found to be infected with adult *E. granulosus* with worm count of 11 and 47

Economic loss evaluation

Direct loss from organ condemnation

The estimated annual loss of livers and lungs condemned due to hydatidosis =$[(P_1. T_k. C_1) + (pI_2. T_k. C_1)]$. The mean price of lung (C_1) and one liver (C_2) was 2.00 and 6.00 Eth. Birr, respectively. The mean annual killed (T_K) in the ELFORA Kombolcha meat Factory is estimated to be 10,000 based on the three months recorded data = [(0.17 x 10,000 x 2) + (0.048x 10,000 x6)] = 6,280 Eth. Birr.

Indirect loss from carcass weight reduction

The estimated annual cost of carcass weight loss due to hydatidosis
= Ns. ($C_I.P_A$)
= 10,000 x17.95% x 126x 5% x 40
= 452,340 Eth. Birr.

The estimated annual economic loss from both direct and indirect losses equals the sum of the two, i.e.6,280 + 452,340 = 464,900 Eth. Birr/annum, which is 46.49 birr per head of slaughtered cattle.

Discussion

Prevalence of cattle hydatidosis (17.95%) in the present study agrees with previous findings in different corners of the country and other parts of the World, such as the works of Jemere Bekele and Berhanu Butako (2011) (16.85%) in Wolayita Sodo, Nigatu Kebede *et al*., (2011) (15.2%) in Birre Sheleko and Dangila areas of North-western Ethiopia, Eisa *et al*., (1982) (19.14%) in Sudan and Dhote *et al*., (1992) (12.4%) in India. However, the prevalence of hydatidosis recorded in cattle in this study can be seen as a lower level of infection when compared to the highest recent prevalence reports else where in Ethiopia (Getaw *et al*., 2009; Nigatu Kebede *et al*., 2009; Tadele Tolosa *et al*., 2009; Endrias Zewdu *et al*., 2010). Cattle hydatidosis studies in other countries also show higher prevalence than the present study including that of 38. 9% in Pakistan (Khan *et al*., 1990), 56.6% in Greece (Hi-Monas *et al*., 1994), 48.7% in Tanzania (Ernest *et al*., 2008).

The overall prevalence of sheep hydatidosis found in this study was 7.61%, and it is very close to the previous findings in Ethiopia (Yemane Gidey, 1990 and Nigatu Kebede *et al*., 2009) and elsewhere including Sudan, Pakistan and India (El-Badawi *et al*., 1982; Riaz and Khalid, 1986; Biswas *et al*., 1989; Hafeez *et al*., 1994). On the contrary, 21.8% was reported by Alemayehu Lemma (1990) in Arsi, Ethiopian. Similarly very high prevalences were reported by Abdel-Hafez and Al-Yaman, 1989 (78.8%) in Jordan, Bortoletti *et al*., 1990 (91.3%) in Italy,

Chobanov *et al*., 1991 (61-67%) in Azerbaijan; Bersissa Kumsa, 1994 (22.2%) in Nekemet Southwest Ethiopia, Himonas *et al*.,1994 (100%) in Greece and Yildiz and Gurcan, 2003 (50.9%) in Turkey.

The variation in prevalences of cattle and hydatidosis discussed above may be due to the changes in the environmental and epidemiological factors, which could affect the rate of transmission of echinococcosis/hydatidosis. Apart from the mentioned variables, factors such as, difference in culture, social activities and attitude to dogs contribute to the variations in prevalence rates (Arene, 1985).

With regards to the distribution of hydatid cysts in different organs of the infected cattle and sheep, as it true in many similar abattoir studies done previously, the liver and the lungs are the most commonly infected organs both in cattle and sheep. The reason is that they are the first large capillary fields encountered by the blood – borne onchospheres (Angus, 1978 and Urquhart *et al*., 1996). In this study, spleen and heart were the least affected in cattle and were not found to be involved in case of sheep. In addition no kidney has been found infected with hydatid cyst in both species of animals.

When we consider the type of cyst found in relation to their, in case of sheep the majority of the cysts recovered during the study were found to be small sized cysts However, all the three types of cysts were identified in case of cattle, with high percentage of medium and small size cysts and least number of large cysts, in relation to this, Nigatu Kebede *et al*., (2009) also reported a low percentage of large cysts (1.3%) among the 147 cyst they examined in cattle. The reason for the considerable and high proportion of the small size in cattle (40.8%) and sheep (100%) respectively may be associated with the host immunological response, which might prevent further expansion of the cyst (Torgreson *et al*., 1998 and Larrieu *et al*., 2001).

The fertility rates of cysts collected from lungs and livers of cattle were

36.2% and 45%, respectively, indicated the importance of cattle in the transmission of *E. granulosus* in the study area. The fertility rate we found in cattle was higher than the recent reports of Tadele Tolosa *et al*., 2009(19.0%), Nigatu Kebede *et al*., 2009(29%) and Gebretsadik Berhe *et al*., 2009(10.6%) and close to the findings of Endrias Zewdu *et al*., 2010 (31.39%). On the other hand author like Arene, 1985 documented fertility rate of hydatid cyst in the range of 86.5% up to 96.9% in cattle in South Africa and Zimbabwe. The reasons for the variation in the fertility levels of hydatid cysts might be related to the age of the intermediate hosts and to the strain of *E. granulosus* (Soulsby, 1982; Arene, 1985; Thompson and Lymbery, 1990), in that strains may differ in traits such as host preference, development rate, infectivity, pathogenesis, antigencity and drug resistance.

The finding of *E. granulosus* in two of the examined stray dogs in this study is not surprising, because in Ethiopia there is wide spread backyard slaughter of animals, the corresponding absence of rigorous meat inspection procedures, the long standing habit of feeding domesticated dogs with condemned offal and the subsequent contamination of pasture and grazing fields. This can facilitate the maintenance of the life cycle of *E. granulosus* which is the causative agent of cystic hydatidosis and consequently (Yilma Jobre *et al*., 1996). Due to the small number of dogs involved in this study it would be very to make comparison and conclusion prevalence of *E. granulosus* in stray dogs of the study area.

The economic loss due to bovine hydatidosis at ELFORA Kombolcha meat Factory from offal condemnation and carcass weight loss, estimated to be about 464,900 Eth. Birr per annum, which correspond to a loss of 46.49 Eth. Birr per head of slaughtered cattle in study area. This figure is by far greater than the previous study by Asrat Goshema (1996) in the same area and less than the recent report of Feyessa Regassa et al, 2010 (1,791,625.89 Ethiopian Birr) in Hawassa, South Ethiopia.

In conclusion, the high prevalence of hydatidosis in cattle and sheep and monetary losses due to the disease in cattle indicates that hydatidosis

appear to be economically important disease in South Wollo and its surroundings. To reduce infection and prevent transmission of this cestode to cattle and sheep attention should be given to such consideration such as proper disposal of infected offal in abattoir, control of stray dogs population and cestocidal treatment for household dogs in the study area

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