

Full Length Research Paper

# Prevalence of hydatidosis in small ruminants and its economic significance in Modjo Modern Export Abattoir, Ethiopia

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This study was conducted from November 2009 to April 2010 with a purpose to assess the prevalence and economic significance of hydatid cyst in slaughtered sheep and goats at Modjo Modern Export Abattoir (MMEA), Ethiopia. The result of this study revealed that a total of 1115 small ruminants (348 sheep and 767 goats) were randomly sampled and examined after slaughter for the presence of hydatid cysts in the visceral organs (lungs, livers and hearts) and on muscles of the animals using the standard meat inspection procedures, where 97 (8.7%) were positive. The positive samples were taken to the laboratory for the cyst identification; fertility and viability test were performed. The study indicated that the prevalence of the hydatid cyst in the study area was 28 (8.05%) in sheep and 69 (8.99%) in goats which showed no significant variation between the two species. The distribution of cysts in the internal organs showed little significant variation between two organs (Lung and liver) in both animal species ( $\chi^2 = 0.272$ ,  $P > 0.05$ ). From the total examined sheep, 22 (78.6%) of the lung, 9 (32.1%) of liver and 1 (3.6%) of the heart which in goats was, 37 (53.6%) for lung, 27 (39.1%) liver, 0 (0%) heart and 4 (5.6%) muscles, respectively. Lung was the most commonly affected organ both in sheep and goats. Retrospective data in the abattoir from 2005 to 2009 showed an overall prevalence of 5.4 and 11% in sheep and goats, respectively. With a total of 599685 small ruminants slaughtered, 15807 of lung and 9099 of the liver were found infected with hydatidosis. The total annual economic loss incurred due to hydatidosis in small ruminants slaughtered in Modjo modern export abattoir during the study periods was 69,139.77 Ethiopian Birr (ETB). Hence, this study supports evidence to stress the economic consequences and pathological patterns of hydatidosis at the facility and some recommendations suggested.

**Key words:** Ethiopia, hydatidosis, prevalence, economic significance, abattoir.

## INTRODUCTION

Hydatidosis/Echinococcosis is a cosmopolitan zoonosis caused by larval stages of cestode belonging to the genus *Echinococcus* (family taeniidae). Larval infection (hydatidosis) is characterized by long term growth of metacertode (hydatid cysts) in the intermediate host. In Ethiopia, livestock production is a major component of the agricultural economy, contributing about 30% to the

agricultural gross domestic product (GDP) and 17% to export earning (Tegegn and Gebrewold, 1997). Additionally, livestock supports rural and urban population with milk and meat, employment, investment opportunities and draft power for crop production (Demeke and Tesfay, 1997). Despite their huge potential resource, Ethiopian livestock productivity is lower than the African average. As a result, the contribution of livestock sector to the national economy in general and to the improved living condition of the people in particularly is minimal. The major biological and economical constrains contributing to low productivity include low genetic potential of animal,

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poor nutrition and the prevalence of various disease including hydatidosis/echinococcosis. Factor governing the prevalence of hydatidosis in a given locality may be associated with prevailing specific social, cultural, environmental and epidemiological, and the dynamics of transmission differ between the dog and its intermediate host and human (Macpherson, 1985).

The public health and economic significances of hydatidosis lies on the cost of hospitalization, medical and surgical fees, loss of income and productivity, permanent or temporary incapacity to work social consequence hydatidosis of disability and mortality (Macpherson et al., 1985). In food animal hydatidosis has an adverse effect on production causing decreased production of meat, milk, wool, reduction in growth rate and predisposition to other diseases (Hubbert et al., 1975).

The disease incurs economic losses in meat sector, effective control and prevention measures should be introduced to minimize the risk of public health hazard and curb the incurred economic losses. The current first drug of choice is praziquantel, which is recommended for goats and sheep. The drug is highly effective against immature and mature intestinal stages, but the drug is not ovicidal (OIE, 2001). Effective control of hydatid disease is based on presentation by breaking the cycle between definitive and intermediate hosts. This has been demonstrated in a number of well documented control campaigns concerned with *Echinococcus granulosus* maintained in domestic life cycle patterns (Gemmell et al., 1986). The key to success is health educations that elicit community participation (Schantz, 2005). In view of this, the objectives of this study were to determine the prevalence of hydatidosis and to estimate the direct economic losses due to hydatid cyst in various organs in small ruminants slaughtered in MMEA.

## **MATERIALS AND METHODS**

### **Study area**

The study was conducted from November 2009 to April 2010 in the privately owned MMEA in Modjo town. Modjo is found in the Central Ethiopia, Eastern Shoa zone of the Oromia region. This town exists at latitude and longitude of 8°N 39°E with an elevation between 1788 and 1825 m above the sea level. The abattoir exports sheep and goat's meat and its edible organs to Saudi Arabia (Jeddah and Abu dab) Dubai, and Yemen. Daily the abattoir slaughters from 650 to 1800 small ruminants and 80,000 to 600,000 annually (Retrospective data) with a few number of meat inspectors assigned by Ministry of Agriculture and Development.

### **Study animals**

The study was conducted on sheep and goats of local breeds that originated from neighboring provinces such as Nagele Borana, Chiro, Jinka, Yabello, Afar, Bale (Elkere), Babille, Matehara, Hagere Maryyam and Ziwaye.

### **Study design**

A cross-sectional study type was carried out from October 2009 to April 2010 by collecting data on events associated with hydatidosis on sheep and goats slaughtered at Modjo modern export abattoir. A simple random sampling method was employed and the study animals were randomly selected, recorded, tagged and followed up through the whole slaughtering process.

### **Sample size determination**

A simple random sampling method employed and the study animal was determined by the formula given by (Thrustfield, 1995). The sample size required was 384 sheep and goats. But in order to increase accuracy of the study the sample size was increased to 1115 (767 goats and 348 sheep) and examined.

### **Ante mortem examination**

The male sheep and goats were grouped in to different categories of age. The age grouping was based on dentition, for those which have not erupted permanent incisor teeth, are classified as young, while those with pair or more permanent incisor teeth erupted were classified as adult (Alemu and Merkel, 2008).

### **Retrospective study**

An attempt was made to collect data on hydatid cyst recorded in the abattoir from 2005 to 2009 which was used to see the previous existence of the disease during that periods (Table 1).

### **Post mortem examination**

During postmortem examination, organs of the abdominal and thoracic cavities namely liver, lung, heart, kidney and spleen were systematically inspected for the presence of hydatid cysts by applying the routine meat inspection procedures. The inspection procedure used consisted primary examination followed by a secondary examination. If evidence of hydatid cyst were found, the primary examination involved are visualization and palpation of organs and muscles, where as secondary examination involves further incision in to each organ in case where a single or more hydatid cyst where found. The abnormalities on meat inspection for developing countries and the result were recorded.

### **Examination of cyst**

The cyst of each organ were counted and measured. Then according to the size forms of the cyst and infected organs, the surface of the cyst was sterilized by alcoholic-iodine solution to reduce intracystic pressure, and then the cyst wall was penetrated using a large size needle and cut given with scalpel and blade, then the content was transferred into sterile material (container) and examined microscopically (40x) for the presence of protoscolices in the hydatid fluid, cysts will be identified and classified as fertile or infertile according to the method described (Macpherson et al., 1985). Further more fertile cysts will be subjected to viability test which consists of eosin exclusion test for cell death; viable protoscolices do not take up 0.1% aqueous eosin. Protoscolices was further examined for amoeboid like peristaltic motility under microscope while sterile (fluid filled cyst without any protoscolices or calcified (cyst already calcified and produce a gritty sound feeling

**Table 1.** Retrospective result on Hydatid cyst for five years (2005-2009).

Year	Species Slaughtered	Number of animals slaughtered	Organ on which hydatid cysts found and number of organ			Total affected organs	Prevalence %
			Lung	Liver	Muscle		
2005	Sheep	22,368	6,576	136	1	6,713	30.01
	Goats	242,095	19,923	743	1	20,667	8.54
2006	Sheep	20,529	4,133	786	1	4,920	23.96
	Goats	313,611	40,555	2,996	4	43,555	13.90
2007	Sheep	43,226	5,971	216	2	6,189	14.30
	Goats	214,693	22,813	2,508	3	25,324	11.80
2008	sheep	13,861	1,662	492	0	2,154	15.50
	goats	71,283	6,507	2,846	1	9,354	13.12
2009	sheep	357,792	2,913	1,796	1	4,710	1.32
	goats	241,893	12,894	7,303	16	20,213	8.36
Total	Sheep	457,776	21,255	3,426	5	24,886	5.44
	Goats	1,083,575	102,692	16,396	25	119,113	10.99

up or incision according to the method described (Macpherson, 1985). Viability of the protoscolices was assessed by motility of flame cells as well as ease of staining which 0.1% aqueous cosine solution and examination under a light microscope (Symth and Barret, 1980). Lived protoscolices did not take the dye up, whereas the dead ones take up (Macpherson et al., 1985).

#### Financial losses assessment

The economic losses study due to organ condemnation in slaughtered sheep and goats was included in this study. The direct economic loss incurred organ condemnation due to hydatidosis was estimated by using the formula indicated (Ogunirade et al., 1980). The indirect financial losses are result from loss of body weight due to hydatidosis.

$$EL = [S_{SR} \times OC_{Li} \times R_{LU}] + [S_{SR} \times OC_{Lx} \times R_{Lx}] + [S_{SR} \times OC_H \times R_H] + [S_{SR} \times OC_K \times R_K]$$

where EL= Estimated annual economic loss due to the organ examination,  $S_{SR}$  = annual shoats slaughter rate of the abattoir,  $OC_{Li}$  = average cost of liver/cost of rejected liver,  $OC_{Lu}$  = average cost of lung/cost of rejected lung,  $OC_H$  = average cost of heart/cost of rejected heart,  $OC_K$  = average cost of kidney/cost of rejected kidney,  $R_{Li}$  = rejection rate of liver,  $R_{LU}$  = reject ion rate of lung,  $R_H$  = rejection rate of heart,  $R_K$  = rejection rate of kidney.

To calculate the economic loss by using the aforementioned formula the following data was considered; the annual slaughtered rate of the abattoir a, the average of retail market price of an organ in major town and the rejection rate of specific organ.

#### Data analysis

Basic data entry and handling were done using M-excel. Frequency

and descriptive statistics were used in determining the number of hydatid cyst. Prevalence of hydatidosis was calculated as the number of sheep and goats found infected with hydatid cysts expressed as the percentage of the total number of slaughtered. Financial losses were assessed by the formula set by Ogunirade (1980) and variation between origin, age and species were calculated by chi-square ( $\chi^2$ ) test used to determine the presence or absence of association between explanatory variables.

## RESULTS

### Retrospective study

A retrospective data from 2005 to 2009 revealed that the prevalence of hydatidosis was found to be 5.44 and 10.99 in sheep and goats, respectively (Table 1).

### Postmortem examination

During the study, 1115 animals were examined for the prevalence of hydatid cysts. From a total of 348 sheep, 28 (8.05%) and 767 goats, 69 (8.99%) were found infected with hydatid cyst. There was no significance difference with the prevalence of hydatidosis between sheep and goats ( $P > 0.05$ ,  $\chi^2 = 0.272$ ,  $df = 1$ ) in this study. In this study the proportion of hydatidosis in various organs was also determined. Lungs were found to be the commonly affected organ (Table 2).

The total number of organs with one or more hydatid cysts were 32 for sheep and 68 for goats and relative proportion of each organ is as follows: for sheep, lungs 22 (78.6), liver 9 (32.1%), heart 1 (3.6%) and for goats,

**Table 2.** Proportion of hydatidosis in different organs.

Organ	No. examined	No. positive	Prevalence %
Lung	1115	59	5.3
Liver	1115	36	3.2
Heart	1115	1	0.1
Muscles	1115	4	0.4

**Table 3.** Total and average number of cysts per organ and per species of examined animal.

Species	Organs	No. of positive	Total no. of cysts	Percent	Average
Sheep (348)	Lung	22	39	6.3	1.8
	Liver	9	26	2.6	2.9
	Heart	1	1	0.3	1
	Muscles	0	0	0	0
Goats (767)	Lung	37	43	4.8	1.6
	Liver	27	47	3.5	1.7
	Heart	0	0	0	0
	Muscles	4	5	0.5	1.3
Total (overall)		100	161	18	10.3

**Table 4.** Distribution of cysts in different organs based on their size in sheep and goats.

Animal species	Organ	Small cyst (<2 cm)		Medium cyst (2-4 cm)		Large cyst (>4 cm)		Classified cyst		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%
Goats	Lung	11	29.7	14	37.8	5	13.5	7	18.9	37	53.6
	Liver	3	11.1	4	14.8	1	3.7	19	70.4	27	39.1
	Muscles	-	-	2	50	2	50	-	-	4	5.6
	Total	14	-	20	-	8	-	26	-	68	-
Sheep	Lung	6	27.3	11	50	4	18.2	1	4.5	22	78.6
	Liver	2	22.2	4	44.4	1	11.1	2	22.2	9	32.1
	Heart	1	100	-	-	-	-	-	-	1	3.6
	Total	9	-	15	-	5	-	3	-	32	-

lung 37 (53.6%), liver 27 (39.1%), muscles 4 (5.8%) (Table 3).

Out of the total hydatid cysts recorded based on the origin, the major one was recorded from Jinka (12.7%), Chiro (8.5%), Yabello (8.17%), Negele Borana (8.16%) and Bale (Elkere) (7.6%), and Matehara and Afar are least recorded.

In this study from the total hydatid cysts recorded, higher prevalence was recorded in adults, where the

prevalence increases as the age of the animal increases.

### Cyst characterization

#### Cyst size

Out of the total hydatid cysts recorded in goats, 14 were small cysts, 20 were medium cysts and 8 were large

**Table 5.** Fertility rate of hydatid cysts in sheep and goats.

Species	Condition of hydatid cysts					
	Fertile		Sterile		Calcified	
	Total	Percentage	Total N	Percentage	Total	Percentage
Sheep (28)	22	(78.60)	3	10.7	3	10.7
Goats (69)	37	(53.6)	6	8.9	26	37.7
Total	69	-	9	-	29	48.4

**Table 6.** Numbers of organs affected, percent of involvement and their current (2010) value in Modjo modern export abattoir market of sheep and goats organs out of all animals examined.

Types of organ (Both species)	No. of condemned organs	Percentage	Price of each organ (ETB)	Total (ETB)
Lung	59	5.3	0.5	29.5
Liver	36	3.2	6.73	242.28
Heart	1	0.1	4.04	4.04
Total	96	-	11.27	275.82

cysts, while in sheep, 9 were small cysts, 15 were medium cysts and 5 were large cysts. The number of large and medium cysts is higher in the lung than in the liver, and the rate of occurrence of calcified cysts was higher in the livers than in the lungs both in sheep and goats (Table 4).

### Fertility and viability tests

Out of 28 cysts examined in sheep, 22 (78.6%) were fertile, 3 (10.7%) sterile and 3 (10.7%) calcified and in goats, out of the 69 cysts examined, 37 (53.6%) were fertile, 6 (8.9%) were sterile and 26 (37.68%) were calcified (Table 5).

### Financial loss evaluation

#### Direct losses from organ condemnation

Regular visit to Modjo modern export abattoir in this study period facilitated examination of 348 sheep and 767 goats, of these, 8.7% were found infected with hydatid cysts. Observation during this study revealed that 59 lungs (60.8%), 36 livers (37.1%) and 1 heart (1.03%) were condemned out of the total infected animals. The average retail market price of sheep and goats lung was 0.5 birr, liver 6.73 birr and heart 4.04 ETB (Table 6). The annual financial of loss was determined by considering annual slaughter rate (599,685) in 2009 and it was about 69,139.77 ETB annually, which was calculated as follows:

General information's: number of rejected lungs (Rlu) =

15807, number of rejected livers (Rli) = 9099, cost of 1 liver (Oclu) = 6.73 ETB, cost of one lung (Ocli) = 0.5 ETB,

$$\begin{aligned} \text{Solution} &= Rlu \times (Oclu) + (Rli \times Ocli) \\ \text{ETB} &= (15807 \times 0.5) + (9099 \times 6.73) \\ \text{ETB} &= (7,903.5) + (61,236.27) \text{ ETB} = \\ &= (7,903.5) + (61,236.27) \text{ ETB} = \\ &= 69,139.77 \text{ ETB}. \end{aligned}$$

### DISCUSSION

*E. granulosus* shows considerable geographical variation. Factors that contribute to this variation in prevalence include, difference in culture, social activates and attitude towards dogs (Arene, 1985). The results of this study showed high cystic *Echinococcus* infection levels in sheep of 28 (8.05%) and in goats of 69 (8.99%). The present study revealed that, the spreading infection of hydatidosis is an indication of environmental contamination with the eggs of the adult tape worm of dogs. Hydatidosis infection rate showed no significant association ( $\chi^2 = 0.272$ ,  $P=0.602$ ) between sheep and goats. But the prevalence varied between them, because of the difference in origin of slaughter animals, feeding habits environmental and social factors, as well as factors used for transpiration of eggs from place to place such as wind, flooding, birds, insects and the others, especially, due to the differences in the origin of animals brought for slaughter, changes in environment and epidemiological factors, which could affect the rate of transmission of hydatidosis. High number of goats were brought to the abattoir as compared to the sheep, because, the meat of goats are more preferable in Saudi Arabia and Dubai

markets. In addition, sheep brought to abattoir was quite selective and slaughtered once a week. This may also be other factors, which increased the prevalence of hydatidosis in goats. A retrospective data from 2005 to 2009 in this abattoir showed the prevalence of hydatidosis in sheep was 5.4% and in goats 11% and, Gemedda (1988) also reported in Addis Ababa abattoir in sheep prevalence of 40.6% and in goats 70.05%. Hydatidosis was prevalent in 29.3% sheep, and 6.7% goats at Adama municipal abattoir (Getaw et al., 2010).

Varying prevalence rates of hydatidosis have also been reported by various workers in Africa and other different countries. In Libya, 4.3% in sheep (Mohammed, 1985), in Iraq, 4.5 to 44% in sheep and 3.1 to 26.7% in goats (Molan, 1993), in Niger Delta, the infection rate of hydatid cysts was reported, at 42% in goats (Arene, 1985). The

present study revealed that, hydatidosis was among small ruminants coming from Jinka, Yabello, Negele Borana, Chiro and Bale (Elkere). Therefore, in similar origins feeding management is same for the animals, and the finding record shows in this study area, that high prevalence was found in both sheep and goats. This may be due to the origin of the slaughtered animal which in majority of animals comes from Jinka (12.73%) where the environmental conditions such as suitable condition for survival of the eggs of *E. granulosus* exist and there may be large number of stray dogs around Jinka town. For this reason, small ruminants and other intermediate hosts are mostly affected by cystic echinococcosis infection. Similarly, high prevalence rates were obtained by various workers in different regions of Ethiopia, such as, Arsi region, 21.3% in sheep (Alemayehu, 1990), in Nekemte, 22.22% in sheep (Bersisa, 1994), in East Showa, 2.7% in goats (Yemane, 1990), in Gonder, 4.64% in goats and 8.7% in sheep (Tamane, 1986), in Hararge region, 9.38% in sheep and 6.51% in goats (Wubet, 1987), in Jimma abattoir, 10.1% in sheep (Abduljawad, 1988), in Addis Ababa abattoir, 40.6% in sheep and 70.05% in goats (Gemedda, 1988), in Desse, 4.4% in sheep (Yilikal, 1989), in Sodo, 18.8% in sheep and 9.3% in goats (Fikre, 1994), in Addis Ababa, 9% in sheep and 5.9% in goats (Koskei, 1999), in Haramaya municipal abattoir, 17.7% in sheep and 6.8% in goats (Yeshiwork, 2009), Modjo export abattoir, 29.3% sheep and 6.7% goats (Getaw et al., 2010) were reported.

The general trend of age prevalence was that, the infection rate increases as the age of animal increases; in adult (9.8%) and young (7.4%). The reason behind this is that, adult small ruminants may gain access of infection due to longer exposure than young. Thompson and Allsopp (1988) described that; the number of infected eggs ingested by intermediate host is determined by the level of contamination and infectivity of the eggs. Furthermore, the number of eggs that develop in to hydatid cysts is controlled by the immune system of the host.

Among the organs involved, lung and livers are the most commonly infected organs both in sheep and goats, whereas, the muscles and heart are the least affected organs. Similar findings were also obtained by various workers such as in the middle east; the most common location of hydatid cysts in sheep and goats were reported in liver followed by the lung (Al-Yaman et al., 1985; Abo-Shehada, 1993; Kamhawi et al., 1995), and it is indicated that the lung and livers are the most commonly affected organs with hydatid cysts due to the reason that they are the first large capillary fields encountered by the blood born oncospheres (Angus, 1978). In other cases the development of hydatid cysts occurs occasionally. In other organs such as, heart, kidney, spleen and tissue when oncospheres escaped into the general systematic circulation (Urquhart et al., 1988). As for the organs prevalence study, the livers are the most commonly affected organ due to the reflection of the route of parasite entry and seem to support the hypothesis of hepatic portal distribution of oncospheres leading firstly to liver infection (Schwabe, 1986). All the cysts encountered both in sheep and goats were unilocular, indicating that it is the cystic stage of *E. granulosus*, which is by far the commonest type found in the food animals (Gracey, 1986).

The proportion of large and medium sized cysts is higher in the lungs than in the livers. Similar finding were obtained by various workers in different regions of Ethiopia (Alemayehu, 1990; Abebe, 1987; Fikre, 1994; Tsegaye, 1995). The literature indicates that cysts in the lungs tend to attain large size than those in the livers (Hubbert et al., 1975). This may be due to the relatively softer consistency of the lungs, which allows easy growth of cysts (Smith, 1972). Similarly, in the rarer sites such as the abdominal cavity, where unrestricted growth is possible, the hydatid cyst may attain very large size containing several liters of fluid (Urquhart et al., 1988).

The percentage of calcified cysts was found higher in livers than in lungs. This may be associated with the relatively higher reticuloendothelial cell and abundant connective tissue reaction of the organ (Gemmell, 1986), which encapsulates the cyst within a fibrous wall up to 13 mm thick (Gracey, 1986). In case of fertility study, the percentage of fertile cysts was higher in sheep 78.60% and the percentage of sterile cyst was lower than fertile cysts. Jobre (1996), reported fertility rate of 80 to 85% in sheep and 50 to 59% in goats at Bishoftu and Omo areas. The frequency occurrence of fertile cysts is higher in the lungs than in the livers both in goats and sheep. This is similar with the result of other workers and it has been stated that the relatively softer consistency of lung allows easier development due to the pressure of cysts. Fikre (1994) and Yemane (1990), have got higher fertility rate of hydatid cysts in sheep than goats and cattle. Hydatid cyst found in sheep is usually fertile (George, 1985). This variation could be attributed to strain

differences in traits such as host preference, development rate, infectivity, pathogenesis and antigenicity and drug resistance. Moreover, it has been indicated that ovine strain of *E. granulosus* imposes tremendous effect on the health hazard in respect to human population and the presence of fertile cysts on cattle of an apparent ovine strain may constitute an additional public health problem (Thomson and Lymbery, 1988).

The financial loss incurred during this study as a result of condemnation or rejection of organs of ovine and caprine species was estimated at about 69,139.77 ETB in Modjo modern export abattoir. Similarly, in Adama municipal abattoir, 51,544.2 ETB was reported (Getaw, 2008), in Haramaya municipal abattoir, 17,100.98 ETB was reported (Yeshiwork, 2009), in East Shoa, 10,898.64 ETB was reported (Yemane, 1990) and in Nekemte, 14,755.34 ETB was reported (Bersisa, 1994). According to Getaw et al. (2010), the total annual economic loss incurred due to hydatidosis in ruminants slaughtered at Adama municipal abattoir was estimated to be to 52,828 ETB (5869.8 USD).

In conclusion, echinococcosis/hydatidosis is a disease of considerable importance of major economic and public health significant in many countries of the world. The prevalence of the disease and estimated corresponding economic losses in Modjo modern export abattoir from offal condemnation was high and extremely tremendous. The economic losses of about 69,139.77 ETB were recorded this year in Modjo modern export abattoir. The epidemiology of disease varies from country to country. So control measures appropriate in one area are not necessarily effective in another. Hence, it is essential to have adequate knowledge of epidemiology of the disease as to the management, habit customs, diagnostic techniques and attitude towards the dogs.

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