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Prevalence and economic significance of bovine hydatidosis at Adama Municipal Abattoir, Adama, Ethiopia

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A cross sectional study was conducted to assess the prevalence and economic significance of bovine hydatidosis at Adama municipal abattoir. A total of 500 cattle were examined and 191 (38.2%) of them were found infected. Also, 253 visceral organs were found harboring one or more hydatid cyst. Prevalence of lung and liver cyst accounted for 94.5% and the involvement of other organs as many as 20 cysts were recovered from a single lung. Proportionally 35.7, 34.6, 20.8 and 8.82% of the cysts were calcified, small, medium and large sized, respectively. In addition, sterile and fertile cysts represent 46.2 and 18.1%, respectively. The rate of calcification is higher in liver than lungs, while that of most fertile cysts were recovered from lungs. The annual economic loss due to bovine hydatidosis at Adama abattoir is estimated to be about 171,436.36 Eth Birr (ETB). This information shows the risk of hydatid cyst distribution and economic significance in the study area. Therefore, appropriate control measures should be undertaken which include public awareness education program and a more aggressive effort that should include a reduction of stray dog population.

Key words: Adama abattoir, economic significance, hydatid cyst, fertility, prevalence.

INTRODUCTION

Hydatidosis (cystic echinococcosis) is a cosmopolitan food borne parasitic zoonoses caused by the larval stages of cestodes belonging to the genus *Echinococcus* (Family Taeniidae) (Chhabra and Singla, 2009). Larval infection (hydatidosis) is characterized by long term growth of metacestode (hydatid cysts) in the intermediate host. The two major species of veterinary importance are *Echinococcus granulosus* and *Echinococcus multilocularis* which cause cystic Echinococcosis (CE) and alveolar Echinococcosis (AE), respectively. Both CE and AE are serious diseases, the latter especially so, with a high fatality rate and poor prognosis if not managed properly. Hydatid cysts of *E. granulosus* develop in internal organs (mainly the liver and lungs) of humans and other herbivores intermediate hosts (sheep, horses, cattle, pigs, goats and camels) as unilocular fluid filled

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bladders. These consists of two parasites derived layers, inner nucleated germinal layer and an outer acellular laminated layer surrounded by a host-produced fibrous capsule and protoscoleces bud off from the germinal membrane (Thompson and McManus, 2001).

E. granulosus is the smallest of all tape worms with only three proglottids (Eckert and Deplazes, 2004; OIE, 2004). The body or strobila has a number of reproductive units (proglottids), the mature penultimate proglottid and the terminal proglottid (Soulsby, 1982; Adem, 2006). The latter is gravid and is usually more than half the length of the worm. This gravid uterus/proglottid has 12-15 short lateral diverticuli and is usually filled with 100-1500 thick shelled eggs. The gravid proglottids and or eggs are shed in the feaces (McManus et al., 2003). The eggs are brown in color and morphologically indistinguishable from those of other tape worms of the genus *Taenia*. The egg has a single hexacanth embryo, the oncosphere, which has three pairs of hooks (Thompson and McManus, 2001).

Hydatidosis caused by *E. granulosus* is a serious concern in public health which is much more common on the rural areas of Ethiopia where dogs and domestic animals live in a very close association usually sharing the same accommodation with human. Man becomes infected by an accidental injection of onchospheres from contaminated food, water and environments, where as the dog is the commonest final host (FH), which becomes infected by ingestion of infected offals (Urquahart et al., 1996).

The disease has also an advert effect on the productivity of animal with huge economic losses. The level of which has not until now been precisely determined (Polydorous, 1992). In addition to its direct effect on livelihood of domestic animals and man, *Echinococcus* causes great economic losses. The losses due to this parasite is considerable when one considers its effect on the productivity of animals, the condemnation of infected viscera or even the whole carcass and costs incurred for its control (Hubbert et al., 1975).

Several researchers from different parts of the country (Abebe and Yilma, 2011; Kebede et al., 2010, 2011; Jobre et al., 1996) have reported a prevalence range of 13.7 to 72.4% in cattle slaughtered at Dire Dawa, Gonder, Adama and Asella, respectively by indicating its highly importance and existence of the disease. To establish the prevalence and estimated economic loss of hydatid disease in animals depend on mainly collection of data in slaughter houses. Prevalence of the disease in domestic food animals' show that sheep are the most commonly infected domestic intermediated host (IH), though cattle and various other types of live stock are also affected. Infection does not usually result in any sign in livestock (Soulsby, 1986).

Echinococcus parasites are difficult to detect in faeces of definitive host, due to their small size. Diagnosis has been performed by examination of purge contents for the presence of *E. granulosus* even though the techniques have some disadvantage such as poor sensitivity, incomplete purgation, adverse reactions to the drugs in some dogs and infectivity of the purge material for the personal involved. The more recently developed serological tests, for the diagnosis of hydatid disease are enzyme linked Immuno sorbent assay (ELISA), radio immuno assay (RIA), immune electro phoresis (IEP) and indirect haem agglutination (IHA) (Sewell and Brockles, 2002).

In general, different organs lung, liver, spleen, heart and kidney (rarely) involved in hydatidosis of which lung and livers are the primary (most commonly) condemned organs due to hydatidosis, among cattle slaughtered. Nevertheless, study on prevalence and proper evaluations of economic losses due to this disease in different species of animals in the nation is lacking to which other wise is of great relevance where economic realities often determine the type and scope of the control measures to be envisaged. The principal objectives of this study were therefore to determine the prevalence of hydatidosis in cattle at Adama municipal abattoir and to estimate the magnitude of economic losses incurred due to hydatidosis.

MATERIALS AND METHODS

Study area

The study was conducted from November, 2008-May 2009, in Adama town, East Shoa zone of Oromo Regional State, Central Ethiopia. The town is located at 99 km South East of Addis Ababa at 39.1 N and 8.31 E, at an elevation of 1770 m above sea level and receives the annual rainfall raining from 400 to 800 mm; the temperature range is 13.9 to 27.7°C (NMSA, 2016).

Adama town is one of the most populous town ships in the country with important multi directional trade route. The town ship has one municipality Abattoir that supplies the inspected meat to more than 150,000 inhabitants and 61 legally registered butcheries. Backyard slaughter is also significant in spite of some pressure from the government authorities to ban this activity.

Study animal and design

The study was conducted on local breed cattle that originated from neighboring provinces such as Bale, Arsi, Harar, areas around Adama and Borena zone of Ethiopia. Almost all cattle presented for slaughter were male and adult.

A cross-sectional study type was carried out from November, 2008 to May 2009 by collecting data on events associated with hydatidosis in cattle slaughtered at Adama Municipality Abattoir.

Sample size determination

The sample size determined according to Thrustfield (2007) by using expected prevalence of hydatidosis 50% then the sample size required was 384 cattle at 95% confidence level and 5% expected error. But, in order to increase accuracy of the study, the sample sizes were increased to 500 cattle.

Study methodology

Post-mortem examination

During post mortem examination organs of the abdominal and thoracic cavities namely liver, lungs, heart, spleen and kidneys were systematically inspected for presence of hydatid cyst by applying the routine meat inspection procedures. The inspection procedure used during the post mortem examination consisted primary examination followed by a secondary examination if evidence of hydatid cyst were found. The primary examination involved, visualization and palpations of organs and muscles, whereas secondary examination involves further incision into each organ in case where a single or more hydatid cysts were found. Whenever and wherever hydatid cysts were apparent the number and the size of the cysts as well as calcified cysts per organ and per animal were recorded. The size of the cyst was categorized into three groups small (1-5<5 cm) in diameter, medium 5-8 cm in diameter and large (>8 cm in the diameter).

In organs with hydatid cysts, the cysts were carefully removed using a knife, collected in a clean container (ice box) and brought to Asella Regional Veterinary Laboratory then fertility tests of the Hydatid cysts were carried out and the result were registered.

Laboratory examination

Laboratory examinations were carried out on all collected specimens to determine the fertility and sterility of the cysts. The contents of the cyst was aspirated with a syringe to decrease its pressure and collected in a graduated beaker and the rest of the fluid was then added to it and measure its volume and it was allowed to stay on incubator for 30 min at 36°C to settle the content and then about 10 ml of these sediment was poured to the test tube and centrifuged at 1000 rpm for 3 min to separate the contents clearly from the liquid part and the supernatant was discarded, but the sediment with some fluid was left in test tube examination was done under objectives of 40X magnification for the presence or absence of protoscolex (Gupta and Singla, 2012). The protoscolex which preset as white dots on the germinal epithelium or brood capsules for hydatid sands with in the suspension cysts was categorized as fertile and where its absence categorize the cysts as sterile or non fertile (McPherson, 1985).

Economic loss assessment

The total economic loss due to hydatidosis in cattle slaughtered at Adama municipality abattoir was estimated from the summation of annual organ condemnation cost (direct loss) and cost due to carcass weight reduction (indirect loss).

Direct loss

All organs namely liver, lung, heart, spleen and kidney which are positive for hydatidosis were totally condemned and conditions leading to partial condemnations were poorly recorded. The economic losses due to total/partial condemnation of organs due to bovine hydatidosis was then assessed using the following formula set by Ogunrinade and Ogunrinade (1980).

$ACL_1L_2HKC = P (CSR \times PL_1c \times L1c) + P (CSR \times PL_2C \times L_2C) + P (CSR \times PHC \times HC) + P (CSR \times PKC \times KC) P (CSR \times PSC \times SC)$.

Where ACL_1L_2HKSC = Annual cost of live, lung, heart, kidney and spleen condemned; CSR – average number of cattle slaughtered per year at a abattoir; P – prevalence of hydatidosis at Adama municipal abattoir; PL_1C – percentage of lungs condemned; L_1C – mean cost of one lung in Adama town; PL_2C – percentage of liver condemned; L_2C – mean cost of one lung in Adama town; PHC – percentage of heart condemned; HC – mean cost of one heart in Adama town; PKC – percentage of kidney condemned; KC – mean cost of one kidney in Adama town; PSC – percentage of spleen condemned; SC – mean cost of spleen in Adama town.

Indirect loss

A 5% carcass weight loss, due to hydatidosis in cattle, has been described by Polydrous (1992). So, the annual economic loss due to carcass weight reduction as a result of bovine hydatidosis was calculated as.

ACW = CSR x P x BC x CL x 126 kg

Where, ACW = annual loss from carcass weight loss due to hydatidosis; CSR = average number of cattle slaughtered per annum in Adama; CL = carcass weight loss in individual cattle due to hydatidosis; BC = average market price of 1 kg beef in Adama town; P = prevalence rate of hydatidosis at Adama abattoir.

Data analysis

Basic data entry and handling was done using MS-Excel. From row data collected, total number of cases showing hydatid cyst were determined.

Prevalence of hydatidosis was calculated as the number of cattle found to be infected with hydatid cysts expressed as the percentage of the total number slaughtered (Thrusfield, 2007), economic loss assessed by formula set by Ogunrinade and Ogunrinade (1980) and variation between origin were evaluated by Pearson's Chi-square (χ^2) and differences were regarded statistically significant if $P < 0.05$ using STATA 7.0

RESULTS

Prevalence

Regular visit to Adama slaughter house during study period (November 2008 to May 2009) allowed examination of 500 cattle, of these 191 (38.9%) were found infected with hydatid cyst.

Observation during this period revealed that 166 (65.6%) lungs, 73 (28.9%) liver, 3 (1.16%) spleen, 9 (3.56%) kidney and 2 (0.79%) hearts were harbored with hydrated cyst representing a total 253 organs all together (Table 1).

Out of the total infected organs, the involvement of lung and liver accounted for 94.5%. In addition, pulmonary infection out weighted involvements of liver and other organs (Table 1). The frequency of distribution (infection rate) can also vary among different origin of animals in superiority of Arsi followed by Bale, Borena and Harar, respectively, even though the result was statistically insignificant (Table 2).

The total number of cysts found on each organ was in the order of 322 (72.9 %) in lungs, 105 (23.8%) in liver, 4 (0.9%) in heart in total cyst count being 442 (Table 1).

Table 1. Prevalence of bovine hydatidosis and organ involvement rate.

Organs involved	No. examined	No. Involved	Relative Prevalence (%)	Cyst count	
				Max. no of cyst/organ	Total
Lung	500	166	65.61	20	322
Liver	500	73	28.85	6	105
Spleen	500	3	1.16	2	4
Kidney	500	9	3.56	1	9
Heart	500	9	0.79	1	2
Total	500	253	100	20	442

Table 2. Prevalence of hydatidosis based on origin in the study area.

Results	Origin									
	Arsi		Bale		Borana		Harar		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Positive animals	65	34.03	49	25.65	39	20.42	38	19.90	191	100.00
Negative animals	112	36.25	78	25.24	67	21.68	52	16.83	309	100.00
Total	117	35.40	127	25.40	106	21.20	90	18.00	500	100.00

Pearson chi^2 (χ^2) =0.8771, P=0.831.

Cyst characterization

Cyst size

An exceptionally large cyst was found measuring 15 cm in diameter and containing about 1.5 L of fluid. A considerable number of hydatid sands were recovered from it, which up on microscopic examination was classified as fertile and viable cyst. The remaining cysts were by far smaller than the above described one and were classified as: 153 (34.62%) small, 92 (20.81%) medium, 39 (8.82%) large and 158 (35.75%) calcified cyst (Table 3). The result revealed that small cysts represent the highest proportion, while large cysts are the least in terms of their prevalence (Table 3).

Fertility and sterility of cyst

Out of the total hydatid cysts recovered in this survey, 204 (46.15%) were found sterile, 80 (18.10%) fertile and 158 (35.74%) are calcified (Table 4).

Economic losses assessment

Assessment of the retail market prices of organs from averaged sized zebu in the study area revealed that the cost for lungs, liver, kidney, heart and spleen were indicated below (Table 5). The price of a kilo of beef is about 55 Ethiopian Birr in average. Therefore, the calculated annual economic loss due to bovine hydatidosis at Adama slaughter house from organ condemnation are 3,069.71 Ethiopian Birr and from carcass weight loss is 168365.74 Birr mounting to a total loss of 171,436.36 Birr.

DISCUSSION

It was noted that *E. granulosus* recovered from geographic regions have shown considerable variation which may have important epidemiological implication. In addition, other factors such as difference in culture, social activities and attitudes to dogs in different regions may contribute to the variations in its prevalence (Arene, 1986).

In this study, a prevalence of 38.2% was seen which is very close (37.7%) to a finding by Yamane (1990) and slightly lower (48.7%) than that of Ahmed et al. (2016) in East Shoa. Barsisa (1994) in Nekemte reported a prevalence of 36.66%, Abduljewad (1988) reported 36.66% in Jima , Tamene (1986) 33.78% and Belina et al. (2012) in Bahir Dar. Still high prevalence values were also registered in other places: 63% of prevalence in Robe (Wubet, 1988), 54.8% in Arsi (Alemayehu, 1990), 55.71% in Debrezeit (Abera, 2007), 54.9% in BahirDar (Nebiyou, 1990) and 46.5% in Debrezeit (Yilma, 1984).

The high prevalence may be related to the presence of favorable factors for the propagation and maintenance of

Table 3. Cyst size and organ involvement frequency distribution.

Organs involved	Small		Medium		Large		Calcified		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Lung	128	39.75	78	24.22	27	8.39	89	27.64	322	72.85
Liver	22	20.95	12	11.43	11	10.48	60	57.14	105	23.76
Spleen	0	-	2	50.00	1	25.00	1	25.00	4	0.9
Kidney	3	33.33	0	-	0	-	6	66.67	9	2.04
Heart	0	-	0	-	0	-	2	100.00	2	0.45
Total	153	34.62	92	20.81	39	8.82	158	35.75	442	100

Table 4. Distribution of cyst condition versus predilection site in affected animals.

Organs involved	Sterile		Fertile		Calcified		Total	
	No.	%	No.	%	No.	%	No.	%
Lung	163	50.62	70	21.74	89	27.64	322	72.85
Liver	35	33.33	10	9.52	60	57.14	105	23.76
Spleen	3	75.00	0	-	1	25.00	4	0.9
Kidney	3	33.3	0	-	6	66.7	9	2.04
Heart	0	-	0	-	2	100.00	2	0.45
Total	204	46.15	80	18.10	158	35.75	442	100

Table 5. Number of organs affected, % involvement and their current value in Adama market of cattle organs.

Type of organs	No. of condemned organs	Percentage	Price of each organ (Birr)	Total cost (Birr)
Lung	166	33.2	5.00	830
Liver	73	14.6	11.00	803
Spleen	3	0.6	1.00	3
Kidney	9	1.8	2.00	18
Heart	2	0.4	3.00	6

high level infection in the area. Moreover, the age of slaughtered animals is also anticipated as one of the reason contributing to the high prevalence of the disease in the area most of the slaughtered animals were old probably culled from productivity and, hence they were exposed over a longer period of time with an increased possibility of acquiring the infection. Studies conducted in New Zealand (1958) also strongly suggested that prevalence is heavily influenced by age. The result from this study later indicated that 9% of affected cattle were 1-2 years old. While 74% were 5yrs older. Another study reported a prevalence in calves as 7%, in cows 52.2%, in fattening bullocks 69.7%, in bulls and bullocks as 81.2% (Abebe and Yilma, 2011; Gracy, 1994).

A maximum of 20 cysts were recovered from a single lung in this study. This finding is nearly close to the findings of Fikre (1994) and Nebiyou (1990). A much higher and lower result was also found previously by Tamene (1986), Wubet (1988), Feyissa (1987) and Barsisa (1994) who found 132, 5, 99 and 63 cysts per organ, respectively. Such variation in cyst abundances in an organ is explained as probably to the special distribution and infectivity of *Echinococcus* eggs (Gemmel, 1987).

In the present study, it was found that about 94% of the case hydatid disease involves the lungs and liver, although lung infection was relatively higher. This finding concord with the observations of other workers: Barsisa (1994), Nebiyou (1990), Abera (2007), Tamene (1986) Wubet (1988), Fufa and Debele (2013) and Lati et al (2015) for this reason, the explanation shows that these organs are the first capillary sites encountered by the migrating *Echinococcus* oncosphere.

In addition as to why lungs are organs much more affected than the liver is related to the slaughtered subject, as most animals were slaughtered with the age

of above 5 years liver capillaries are dilated at older age that most oncospheres are easily pass directly to the lungs. This also facilitate the condition, then to the thoracic ducts and heart and finally to be trapped in the lungs.

In the present trial, higher number of medium and large sized cyst was found in lungs than in liver and most calcified cyst in liver. Similar observations were also described by other workers: Fikre (1994), Tamene (1986), Alemayehu (1990), Abera (2007) and Hagos (2007). The reason given for the occurrence of higher percentage of calcified cysts in the liver is associated with the relatively higher reticulo-endothelial cells and abundant connective tissue reaction of the organ (Gemmel, 1987); hence larger numbers of oncosphere are killed in this organs.

The study carried out to evaluate the condition of hydatid cyst revealed that rates of sterility and fertility vary among different organs. The finding of 46.25% sterile, 18.09% fertile and 35.74 calcified cysts may generally imply that most of the cysts in cattle are infertile. This finding is consistent with the observation of Fikre (1994), Barsisa (1994), Nebiyou (1990) and Wubet (1988). Conversely in Britain, up to 90% of the total cysts from cattle are said to be sterile. On the other hand, in some countries like South Africa, Belgium and Rhodesia, 96.9, 94.2 and 86.5%, respectively, of the uncalcified cysts were fertile (Arene, 1986). The variation in fertility rates in different geographic zone of the globe could be allocated to strain differences of *E. granulosus* (Arene, 1986) also strain of parasites and host can modify infectivity of parasite (Gemmel, 1987).

The economic loss due to bovine hydatidosis at Adama slaughter house from offal condemnations and carcass weight loss was estimated to be about 171, 436.36 Ethiopian birr per annum. These figures correspond to loss of 134.77 birr per head of slaughtered cattle. Interpretation of this result must be made with a very serious precaution particularly in light of the fact that in the study area, only few animals were brought to slaughter house for prevailing tradition in back-yard slaughtered. The calculated loss present is generally considered as by far lower than the real losses brought about by bovine hydatidosis.

Conclusions

Cystic echinococcosis/ hydatidosis is a disease of considerable importance both from public health and economic point of view. The prevalence of the disease and estimated corresponding economic losses in Adama municipal abattoir from offal condemnation and carcass weight loss were 38.2% and 171,436.36 ETB, respectively. Therefore, it is concluded that owing to the presence of socio- economic conditions that favors the propagation and maintenances of high level infection, and considering the incalculable indirect loss, hydatidosis is one of the most economically important disease in Adama and its surrounding, warranting serious attention for its control and prevention.

Based on the results obtained and socio-economic realities in Adama town and its surrounding, the authors forwarded the following recommendations; public education of zoonotic importance, life cycle and economic importance of the disease through teaching at school for students, extension workers for farmer and other possible mass media (Radio, TV, etc); construction of abattoirs and provision of facilities such as well educated meat inspectors, construction of dog proof fence and construction of ideal disposal pits; imposing legislative measures that will put an end to back yard and road side slaughter activities and create favorable conditions for people to bring their animals to slaughter houses; control of dog population through killing of stray dogs in collaboration with rabies control campaign and detailed investigations for basic epidemiological factors governing the dissemination of hydatidosis/echinococcosis must be carried out.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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