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RESEARCH PAPER

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Prevalence and Economic Importance of Bovine Hydatidosis in Mekelle Municipal Abattoir

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ABSTRACT

A cross-sectional study was conducted from November 2015 to April 2016 to estimate the prevalence, organ distribution and economic losses associated with bovine hydatidosis in cattle slaughtered at Mekelle municipal abattoir. Out of the total 310 cattle examined, 78 (25.16%) were found harboring one or more hydatid cysts. Among the risk factors considered; only the body condition of the cattle was statistically associated with the prevalence of bovine hydatidosis (p< 0.05). Based on organ distribution, hydatid cyst was found 60 (77%) in lungs, 12 (15.4%) in liver, 1(1.28%) in heart, 3(3.8%) in kidney and 2 (2.56) in both lungs and liver. Size assessment made on 144 cysts indicated, 34.7% as small, 36.8% medium and 28.5% large sized cysts. 144, cysts were examined for viability, sterility, and calcifications thus, 19.4% were viable, 29.9% non viable, 30.55% sterile and 20.1% calcified. The rate of cyst calcification was higher in the liver while fertility rate was higher among the cysts of the lung. Considering the current result, the total annual economic loss from organ condemnation and carcass weight due to bovine hydatidosis at Mekelle municipal abattoir was estimated at 1,480,451.5 ETB (65,564.7 USD). The result of this study revealed that hydatidosis pose significant economic problems. Therefore, stray dog control and proper disposal of infected organs is necessary in order to alleviate its economic impact.

Key words: Abattoir, Cattle, Mekelle, Economic loss, Cross- sectional study, Hydatidosis.

INTRODUCTION

Ethiopia is known to have the largest livestock population in Africa and estimated to be 54 million cattle, 25.5 million sheep and 24.06 million goats. From the total cattle population 98.95% are local breeds and the remaining are hybrid and exotic breeds [CSA 2009]. Livestock plays vital roles in generating income to farmers, creating job opportunities, ensuring food security, providing services, contributing to asset, social, cultural and environmental values, and sustain livelihoods. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP [Metaferia et al., 2011]. However, Ethiopian livestock potential is not properly exploited, mainly due to prevailing traditional management, limited genetic potential and rampant diseases. Out of the diseases causing serious problems, parasitism represents a major drawback on livestock production in the tropics. Among parasitic diseases hydatidosis is the most important parasite which cause direct and indirect economic loss on livestock particularly in sheep and cattle [Okewole et al., 2000].

The disease in ruminants results in enormous economic damage due to condemnation of affected organs and decreasing of meat, milk and wool production. Hydatidosis in Ethiopia is the major cause of organ condemnation in most abattoirs and slaughter houses. The status of hydatidosis in animals studied in several regions of the country indicated that hydatidosis is widespread in Ethiopia with great economic and public health significance [Kebede et al., 2009 a]. Marketing and sales of meat require that animals should be inspected before and after slaughter, the meat hygiene service functions in such a way as to satisfy customers and safe guard public health and animal hygiene [Kebede, 2010]. Hydatidosis and Echinococcus are terms often used interchangeably; to describe the zoonotic infection caused by acestode of genus Echinococcus with species Echinococcus granulosus [Thompson and McManus, 2002].

It is characterized by long term growth of metacestode (hydatid cysts) in the intermediate hosts, mostly cattle [Zhang et al., 2003]. Hydatidosis is parasitic zoonoses that present major public health problems in lower income countries [Taylor et al., 2007].The asymptomatic (subclinical) nature of the disease both in the final and intermediate hosts makes the diagnosis difficult and increase the risk of transmission [Zhang et al., 2003] [Mandal, 2006]. Hydatidosis has worldwide distribution and variable geographical incidence [Craig et al., 2003]. It is highly distributed in under developed countries, especially in rural communities where humans maintain close contact with dogs, the definitive host and other domestic animals, that act as intermediate hosts [Mohammed and Nezhat, 2004]. It is one of the major causes of organ condemnation in most Ethiopian abattoirs and slaughter houses (Kebede et al., 2009 c) [Tolosa et al., 2009] [Getaw et al., 2010 Fromsa and Jobre, 2011] [Fromsa and Jobre, 2011] and leads to huge economic losses. Human cases of hydatidosis are frequently reported from different corner of the country [Kebede et al., 2009 c] [Biluts et al., 2006]. The pathogenecity of hydatidosis depends on the extent and severity of infection and the organ on which it is situated [White et al., 2004]. The wide variety of animal species both domestic and wild, which act as intermediate hosts, have made E. granulosus to be widely distributed across the globe [Thompson et al., 2002] [McManus and Thompson, 2003]. In humans, disease consequences may include poor quality of life, costs of medical treatment, lost opportunity for income generation, and mortality in some cases [Budke et al., 2006] while in animals there is reduced productivity and monetary losses due to abattoir condemnations of organs [Scala et al., 2006].

The objectives of this research paper were:

- To estimate the prevalence of hydatidosis in Mekelle municipal abattoir
- To estimate the annual economic loss from organ condemnation and carcass weight loss due to hydatidosis
- To determine organ distribution of hydatid cysts

MATERIALS AND METHODS

Study Area

The study was under taken from November 2015 to April 2016 at Mekelle municipal abattoir in Mekelle town, Tigray region, and it is located at 390 29, E and 130 30, N. The altitude of the area ranges from 2000-2200 Meters above sea level (m.a.s) and is situated 783 Km North of Addis Ababa. The mean annual rainfall of the study area is 579 -650 mm and the rainfall is bimodal with short rainy season occurring from middle of September to February. The annual minimum and maximum temperature is 11.8 and 24.9°C respectively [CSA, 2013].

Study animals

The study consisted of cattle brought from various localities to Mekelle municipal abattoir for slaughter. The age of the animals was estimated on the basis of the dentitions [De lahnta and Habel, 1986] and three age groups were considered. Young (4 to 6 years), adult (7 to 9 years) and old (>10 years). All the cattle presented for slaughter in the abattoir were male and infection rate regarding sex variation was not included. The origin of the animals was grouped into high land and lowlands. The body condition scoring was done according to [Nicolson and Butterworth, 1986] and was grouped as poor, medium and good.

Study design

A cross-sectional study was conducted from November 2015 to April 2016 to determine the prevalence of hydatidosis, organ distribution of hydatid cysts and to estimate annual financial loss due to organ condemnation and carcass weight loss in cattle slaughtered at Mekelle municipal abattoir.

Sampling and sample size

The required sample size for the study was calculated using the formula given by [Thrustfield, 2005]. Accordingly, the expected prevalence of hydatidosis in cattle slaughtered at Mekelle abattoir was 28.09% based on the previous study conducted by [Dawit et al., 2003].

$n = 1.962 \cdot Pexp (1-Pexp)/d2$

Where, n = required sample size,
Pexp = expected Prevalence,
d = desire absolute precision

Therefore, the required sample size calculated was 310 at 95% confidence interval and at 5% desired absolute precision. A systematic random sampling procedure was conducted to select individual animals for sampling in the abattoir.

Active abattoir survey and laboratory procedure

Ante mortem examination

Regular visits (3 days per week) were made to Mekelle municipal abattoir during the period from November 2015 to April 2016. Before the animals were slaughtered, ante mortem inspections were conducted on individual animals to determine any abnormalities and their age, body condition, breed, and origin.

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 visual inspection and palpation. The inspected organs were collected for close examination and then registered. Incision was also made when necessary to confirm doubtful cases.

Hydatid cyst distribution and characterization

Anatomical distribution of hydatid cyst and their status as active and calcified were determined by recording the organ affected. Single and multiple hydatid cyst distribution were recorded in different organs. Most of the hydatid cysts were found concentrated in great numbers in the lungs. Individual cyst was grossly examined for any evidence of degeneration and calcification. Cyst size measurement, cyst counting, cyst fertility and viability determination was also conducted. The size of the diameter of collected hydatid cysts was measured and classified as small (diameter less than 5 cm), medium (diameter between 5 and 10 cm) and large (diameter greater than 10 cm) [Oostburg et al., 2000]. The collected cysts were carefully incised and examined for protoscolices, which looks like white dots on the germinal epithelium, in hydatid fluid so as to classify cysts as fertile or infertile. Fertile cysts were further subjected to viability test. A segment containing protoscolices was placed on the microscope glass slide and covered with cover slip and observed for amoeboid like peristaltic movement with (40x) objective. For clear vision, a drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices in hydatid fluid on microscope slide with the principle that viable protoscolices should completely or partially exclude the dye while the dead ones take it up [Dalimi et al., 2002].

Economic loss assessment

Direct and indirect losses were used to determine the total economic loss. 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 [Torgerson et al., 2001]. The retail market price of average size offal (lung, liver, heart and kidney) and the cost of one kg beef were obtained from information gathered from butchers.

The loss from organ condemned was determined as described by using the following formula [Ogunrinade and Ogunrinade, 1980]:

LOC= (NASxPhxPluxcplu) + (NASxPhxPlixCpli) + (NASxPhxPhrxCphr) + (NASxPhxPkidxCpkid).

Where

LOC= Loss due to organ condemnation

NAS = mean number of cattle slaughtered annually

Ph = prevalence of hydatidosis

Plu =percent involvement of lung

Phr = percent involvement of heart

Cphr = current mean retail price of heart

Pkid = percent involvement of kidney

Cpkid = current mean retail price of kidney
Pli = percent involvement of liver
Cpli = current mean retail price of liver
Likewise, the following parameters were considered to estimate the economic loss encountered from carcass weight loss:

- Information on the mean retail market price of 1 kg beef at Mekelle town obtained from butchers
- The average annual slaughter rate of cattle from retrospective data of the last two years
- The average carcass weight loss of 5% due to hydatidosis [Getaw et al., 2010].

Thus, the economic loss due to denied carcass weight gain was determined using the following formula:
LCWC = NAS × Ph × CPB × 5% x 126 kg
Where
LCWC = loss from carcass weight loss
NAS = average number of cattle slaughtered annually;
Ph = prevalence of hydatidosis
CPB = current mean price of 1 kg of beef at Mekelle town
5% = estimated carcass weight loss due to hydatidosis
126 kg = is the dressed mean carcass weight of adult cattle [Regassa et al., 2010].

Data management and analysis
All the data collected from the slaughtered cattle was recorded on an A4 paper and then entered in to Microsoft excel sheet. The data was analyzed using SPSS version 16. Analyses were made at 95 % level of confidence and 5 % precision. The prevalence of cystic echinococcosis was computed with descriptive statistics (percentage). Chi-square statistical test was applied to determine the associations between the various potential risk factors and the prevalence of hydatid cyst in the examined animals. The economic loss from condemnation of organs and weight loss in the abattoir was made by taking the current selling price of organs and beef into consideration.

RESULT

Prevalence of Hydatidosis
In the current study, a total of 310 cattle at Mekelle municipal abattoir in Mekelle town were examined for the presence of hydatid cysts. Out of the total examined cattle, 78 (25.16%) were found to harbor hydatid cysts in one or more of their internal organs.
In this study, body condition, age, breed and origin were considered as potential risk factors for the occurrence of hydatidosis. Cattles with poor body condition scoring have the prevalence of hydatidosis (31.3%), followed by medium body condition scoring (30.08%) and the least prevalence were observed in good body scoring cattle (14.4%) and the difference was statistically significance($p< 0.05$).
Rate of infection of hydatidosis with respect to age group showed that higher prevalence was in cattle > 10 years and 7 to 9 years than in below 6 years, however it was not statistically significance($P >0.05$). No statistically significant difference ($p>0.05$) in hydatid cyst prevalence was observed between breeds of animals. However, higher prevalence was observed in local breeds (26.3 %) than cross breeds of cattle (18.2%). Analysis of the

occurrence of infection with regard to origin was also made and the prevalence was 26.7% and 20.5% for highlands and lowlands respectively, though it was not statistically significance (p> 0.05) (Table 1).

Table 1. Analysis of potential risk factors associated with the occurrence of hydatidosis.

Risk factors	No. of animals examined	Positive	Prevalence (%)	X^2	P- value
Body condition					
Poor	83	26	31.3	9.624	0.008
Medium	123	37	30.08		
Good	104	15	14.4		
Breed					
Local	266	70	26.3	1.327	0.249
Cross	44	8	18.2		
Age					
Young	42	7	16.66	2.001	0.368
Adult	208	54	25.96		
Old	60	17	28.33		
Origin					
Highland	232	62	26.7	1.196	0.274
Lowland	78	16	20.5		

Organ distribution of Hydatid Cyst and Cyst Characterization

Based on organ distribution, hydatid cyst was found to be 77% in lungs, 15.4% in liver, 1.28% in heart, 3.8% in kidney, 2.56% both in lungs and liver. The study revealed that in relation to other organs, lungs and liver were the most commonly affected and rejected from local market place and costing too much loss to the livestock industry of the area. The rejection rate of heart and kidney was however not as significant as that of lungs and liver (Table 2).

Table 2. Distribution of hydatid cysts in different visceral organs of infected Cattle.

Infected organs	No.	Percent (%)
Lung	60	77
Liver	12	15.38
Heart	1	1.28
Kidney	3	3.8
Lung and liver	2	2.56
Total	78	100

In the study, a total of 144 cysts were collected for size assessment, from infected organs and categorized into small, medium and large sized cysts. In general, 50(34.7%) cysts were small, 53(36.8% were medium and 41 (28.5%) were large sized cysts (Table 3).

Table 3. Number and size of hydatid cysts in different organs of cattle slaughtered at Mekelle municipal abattoir.

Organ	Small No (%)	Medium No (%)	Large No (%)
Lung	29 (26.36)	45 (40.9)	36 (32.73)
Liver	15 (53.57)	8 (28.57)	5 (17.86)
Heart	1(100)	0	0
Kidney	5 (100	0	0
Total	50(34.7)	53(36.8)	41(28.5)

From the total of 144 cysts examined, 26 (19.4%) cysts were viable, 43(29.9%) were non viable, 44(30.6%) were sterile and 29(20.1%) were calcified (Table 4).

Table 4: Hydatid cysts fertility and viability.

Organ affected	Viable No (%)	Non viable No (%)	Sterile No (%)	Calcified No (%)
Lung	26(23.63)	38(34.54)	32(29.1)	14(12.73)
Liver	2(7.1)	4(14.3)	7(25)	15(53.6)
Heart	0	0(0)	1(100)	0
Kidney	0	1(20)	4(80)	0
Total	28(19.4)	43(29.9)	44(30.6)	29(20.1)

Estimation of Economic Loss

From the total of 310 cattle examined, 78 (25.16%) were found harboring hydatid cysts. Besides, 62 (20%), 14 (4.52%), 1(0.32%) and 3(0.98%) of the hydatid cysts were located in the lungs, liver, heart and Kidneys respectively. The overall prevalence of hydatidosis and percentage involvement of lung, liver, heart and kidney were used as input to estimate the financial loss attributable to organs condemned in the present study.

Average market price of lung, liver, heart, kidney and a kilogram of beef was found to be 15, 150, 27, 25, and 120 Ethiopian Birr (ETB), respectively in Mekelle town. The mean annual numbers of cattle slaughtered at Mekelle municipal abattoir during the last two years was 7730, and the overall prevalence of hydatidosis was found 78 (25.16%) during the study period. By applying the formula described in the material and methods section, direct financial losses due to condemnation of organs and indirect financial losses due to carcass weight loss were calculated as follows on annual basis.

LOC=(NASxPhxPluxcplu)+(NASxPhxPlixCpli)+(NASxPhxPhrxCphr)+(NASxPhxPkidxCpkid). = (7730 x 0.25x0.2 x 15) + (7730 x 0.25 x 0.045 x 150) + (7730 x 0.25 x 0.003 x 27) + (7730 x 0.25 x 0.01 x 25).

LOC= 19,481.5 ETB

LCWL = NAS × Ph × CPB × 5% x 126 kg = 7730 × 0.25 × 120 x 0.05 × 126 = 1,460,970 ETB

Accordingly, the economic loss due to organ condemnation was calculated to be 19,481.5 ETB per annually. For calculating indirect loss due to carcass weight reduction, a 5% carcass weight loss brought by hydatidosis and 126 kg, average carcass weight of Ethiopian adult cattle was considered here to estimate the economic loss and computed result showed a loss of 1,460,970 ETB annually. The total economic loss can be evaluated by considering both loss of offal and carcass weight loss in cattle slaughtered at Mekelle municipal abattoir was estimated at 1,480,451.5 ETB (65,564.7 USD).
(1 USD= 22.58 ETB). Source=National Bank of Ethiopia.

DISCUSSION

In general terms, throughout the world, there had been different magnitude records of hydatidosis in cattle with low, medium and high rates of occurrences. The occurrence of bovine hydatidosis in the present study was found to be 25.16%. The present finding was slightly lower than that reported by [Dawit et al., 2013] at the same study area. The difference may be due to reduced backyard slaughter practice, control of dogs feeding offal and proper disposal of infected organs. The current study was in agreement with the findings of [Zewdu et al., 2010] [Getachew and Jelalu, 2014] [Solomon and Lechisa, 2015] with prevalence of 26.7%, 25.7% and 24.55% in Ambo, Kara-Alo Plc and Sebeta abattoirs respectively. Higher prevalence of hydatidosis than the present study were reported, research carried out by [Mohammed, 2011], research carried out by [Yetnayet, 2010], [Regassa, 2010] [Jobre et al., 1996] with 72.44%, 62.96%, 52.69% and 46.5% in Assela, Bale Robe, Hawassa and Debre Zeit respectively. Likewise, it was greater than some of the previous finding by [McManus, 2006] 16% in Wolaita Sodo municipal abattoir.
This variation in the prevalence of echinococcosis could be due to the difference in animal husbandry system, illegal slaughtering of animals and lack of proper disposal of infected carcass, and the presence of stray dogs and their relation with animals [Garippa et al., 2004]. Furthermore, [McManus, 2006] reported that the variation in different regions might be due to strain difference of E. granulosus that exists in different geographical situations.

In this study, assessment was made to establish relationship between body condition and prevalence of the disease. The result indicates that there is significant difference in rate of infection between body condition scores. Animals with poor body condition were found to have higher prevalence of hydatidosis and the poor body condition among animals is probably a reflection of the effect of relatively high cyst burden. This may be also due to a reduced immune response to hydatid disease. [Polydrous, 1981] Explained that in moderate to severe infection the parasite may cause retarded performance and growth, reduced quality of meat and milk as well as live weight loss.
Estimating the rate of infection of hydatidosis between breeds of cattle was done and higher prevalence was observed in local breeds (26.3 %) than cross breeds of cattle (18.2%). But no significant difference ($p>0.05$) was observed between the two breeds. This may be due to similarity in management systems. The prevalence of infection with regard to place of origin was analyzed and the prevalence of hydatidosis in animals originated from high

land (26.7%) which is higher than lowlands (20.5%). However, there was no significance difference between places of origin. This could be due to the similarity in the socio-economic status and animal husbandry practices of community in all areas from where animals were brought for slaughter. Analysis of age of animals had no significant association with the occurrence of the disease ($p > 0.05$) but the prevalence increases as the age increases, where age group 4-6 years had 16.66 %, 7-10 years old had 25.96 % and greater than 10 years had 28.33 %. As reported by [Regassa et al., 2010] animals above 5 years old had higher prevalence of infection than below 5 years age. This may be due to older animals may gain access more repeatedly on the field which will results the opportunity to be infected in their life time as compared to the younger ages, where they exposed shorter period than old age groups.

In the present study it was established that hydatid cysts occur predominantly in the lung and liver of infected animals. This could be justified by the fact that lungs and liver possess the first greater capillary sites encountered by the migrating Echinococcus onchospheres (hexcanth embryo), which adapt the portal vein route and primary negotiate hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved. This finding is in line with the previous works of [Jobre et al., 1996] who obtained similar results in Ethiopia. The rejection rate of heart and kidney was however not as significant as that of lungs and liver. This is in agreement with the findings of [Bekele and Butako, 2011] [Eckert and Deplazes, 2004], who showed that the lung and liver are the most common sites of hydatid cyst in domestic animals. The higher prevalence in lung associated with the fact that cattle are slaughtered at older ages. At this period the capillaries of liver are dilated and most cysts passed to the lungs. In addition to this, it is possible for the hexcanth embryo to enter the lymphatic circulation and be carried via the thoracic duct to the heart and lung in such case the lung will be infected before liver.

The proportion of medium and large sized cysts was higher in the lungs than in the liver. This may due to relatively softer consistency of the lung allows easier development of the pressure cyst, while the higher yield of small cysts in liver may be due to immunological response of the host which might preclude expansion of cyst size [Torgerson et al., 1998] [Larrieu et al., 2001]. The higher yield of calcified cyst in the liver could be attributed to relatively higher reticulo endothelial cells and abundant connective tissue reaction of the organ, which encapsulates the cyst with in a fibrous wall. In examining the condition of cyst fertility, the findings of 49.3% fertile, 30.6% sterile and 20.1% calcified cysts; indicates that cattle are an important IH for the perpetuation of the life cycle of the parasite in the study area. In comparison of the fertility rate among the organs, it was higher in lungs than in liver. This might be due to softer consistency of the lung tissue that allows easier development of the cyst. This finding is in agreement with that of [Kebede et al., 2009 b] who concludes that the fertility rates of hepatic cysts were lower than that of pulmonary ones.

In this study, hydatidosis was found to incur financial loss that was estimated to be 1, 480,451.5 ETB (65,564.7 USD) in cattle of the study area. Previous studies have also estimated the annual financial losses associated with bovine hydatidosis from different parts of the country. For instance, [Regassa et al., 2010] reported 1,791,625.89 ETB, [Zewdu et al., 2010] 160,032.23 ETB and [Torgerson et al., 1998] 410,755.90 ETB (30,202.64 US$) in Hawassa, Gondar, Ambo and Wolayita Sodo municipality abattoirs respectively. The difference in the calculated economic loss in the various abattoirs may be due to the

variations in the mean annual number of slaughtered cattle, prevalence of hydatidosis and variation in the retail market price of organs in different regions.

CONCLUSION AND RECOMMENDATIONS

In conclusion, hydatidosis is prevalent and causes considerable economic loss in cattle production of the study area. Bovine hydatidosis is not only a disease of animals; it is also a problem to the public since it has zoonotic implications. Lung and liver were the major organs condemned in the study site. Hydatidosis also causes substantial visible and invisible economic losses in cattle of the study area as a result of condemnation of edible offal and carcass weight loss. In terms of frequency, size and fertility of the cyst the lung was found to be the most preferred predilection site for larval stage of E. granulosus in cattle. Therefore, proper meat inspection and disposal of condemned organs are essential to reduce the financial losses and safeguard the public health.

Based on the above conclusion the following recommendations are forwarded:

- Public awareness and education programmes should be created on the transmission cycle of hydatidosis.
- The government should give attention towards building standard abattoirs with good facilities and control backyard slaughtering houses.
- Keeping dogs in close association with animals and humans should be supported with regular treatment.
- Feeding of infected offals to dogs and other canine species should be avoided and all infected visceral organs should be buried properly.
- Reduction of stray dogs' population should be conducted to reduce the risk of hydatidosis to animals and humans

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