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Prevalence and Financial Loss of Cystic Echinoccosis in Cattle Slaughtered at Butajira Municipal Abattoir, South Ethiopia

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Abstract: A cross-sectional study was carried out to determine the prevalence, organ distribution and condition of cysts and assess the financial losses associated with cystic Echinococcosis in cattle slaughtered at Butjira municipal abattoir. Out of 400 slaughtered cattle examined for the presence of hydatid cysts, 128 animals harbored hydatid cysts with an overall prevalence of 32% cystic Echinococcosis. Identification of risk factors depicted that age and body condition of cattle were significantly associated with the occurrence of hydatidosis ($x^2 = 33.4$; $P < 0.001$). The prevalence of cystic Echinococcosis was higher in cattle greater than 5 years of age (39.41%) than those less than 5 years (7.53%). In addition, the proportion of hydatid cyst harbouhring far exceeds in medium body condition cattle (44.83%) than those of cattle with good body condition (26.76%) ($x^2 = 12.4$; $P < 0.001$). Thorough inspection of visceral organs showed that a total of 146 livers and lungs bore ≥ 1 hydatid cysts. Out of positive cattle, 85.9% had infection on single organ while the remaining 14.1% found with multiple organ infection. The respective proportion of lungs and livers studded with hydatid cysts were 22% and 14.5%. Of the total 545 hydatid cysts collected and examined in the laboratory, 463 (84.96%), 56 (10.27%) and 26 (4.77%) were found to be small, medium and large size in that order. Examination of condition of hydatid cysts revealed that 335 (61.47%), 5 (0.92%) and 205 (37.61%) were sterile, fertile and calcified cysts, respectively. The annual financial losses from organ condemnation and carcass weight loss due to bovine cystic Echinococcosis at Butajira municipality slaughterhouse was estimated at 438,968.2 ETB. In conclusion, prevention of cystic Echinococcosis through avoidance of backyard slaughter of animals, instigation of strict meat inspection procedures, destruction of infected offal's, regular deworming of dogs and creation of public awareness is recommended.

Key words: Butajira · Cattle · Cystic Echinococcosis · Economic Loss · Prevalence · Slaughterhouse

INTRODUCTION

Parasitism represents a major drawback on livestock production in the tropics [1]. Echinococcosis/hydatidosis is a zoonotic infection caused by the adult or larval (Metacestode stage of the cestode belonging to the genus *Echinococcus* [2]. It is one of the most important of the helminth zoonoses and remains a significant problem worldwide. *Echinococcus* has a global distribution and continues to exert an unacceptable burden on human health, livestock production and wildlife ecology and in several regions; the aetiological agents of cystic Echinococcosis (CE) and alveolar Echinococcosis (AE) hydiatid disease/Echinococcosis are extending their range [3]. The genus *Echinococcus* contains four generally accepted species. Namely: *Echinococcus granulosus*, *E. multilocularis*, *E. vogeli* and *E. oligorthus*: the first two species have veterinary and public health significance [4]. A fifth species, *E. shiquicus*, has been described in China [5].

An adult *Echinococcus* is of only a few millimeters long (Rarely more than 7 mm) and usually has no more than six segments whereas species of *Taenia* can grow to several meters in length and consist of several thousand segments [6]. Anteriorly and adult *Echinococcus* possesses a specialized attachment organ, the scolex that

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has four muscular suckers and two rows of hooks, one large and one small on the rostellum. The body or strobila is segmented and consists of a number of reproductive units (Proglottids), which may vary, in number from two to six [7]. The adult worm is hermaphrodite with reproductive ducts opening at a common, lateral, genital pore, the position of which may vary depending on species and strain [8].

The eggs of *Echinococcus* are morphologically indistinguishable from those of other tapeworms of the genus *Taenia* [9]. They are ovoid (30 µm-40 µm diameter) consisting of hexacanth embryo (Oncosphere first larval stage) surrounded by several envelops, a the most noticeable one being the highly resistant keratinized empryophose, which gives the egg a dark striated appearance. The outer capsule quickly disappears once the eggs are liberated from the host.

The metacestode (Second larval stage) of *Echinococccus* consists of a bladder with an outer acellular laminated layer and an inner nucleated germinal layer, which may give rise by a sexual budding to brood capsules. Protoscoleces arise from the inner wall of the brood capsules. The structure and development of the metacestode differs between the four species of *Echinococcus* [9].

The dog is the definitive host of *E. granulosus* and harbors the adult tapeworms and excretes eggs along with their feces while livestock and humans are the main intermediate hosts [10]. In human and animal infection causes hydatid cysts in lung liver or other organs [11].

Echinococcosis is a zoonotic parasitic infection caused by the larval stage of several species belonging to the genus *Echinococcus*. Human echinococcosis results following the direct or indirect infection from canid hosts, which are themselves infected by various domestic and wild mammals. *Echinococcus* species arefound throughout the world, although some species have restrictive distributions. Cystic echinococcosis is a major public health concern, particularly in developing regions with limited economic resources. Furthermore, there are indications of an increasing number of cases in certain areas so it is becoming an emerging or re-emerging disease [12].

Cystic echinococcosis is one of the most important parasitic diseases of ruminants responsible for huge economic losses due to reduction in weight gain and condemnation of organs and causes serious public health hazards [13]. The main hydatid-induced losses in ruminants are productivity losses (Reduction in carcass weight, milk production and fleece value), losses of offal (Liver, lung, kidney and heart) and fertility losses [14, 15].

In Ethiopia, the status of hydatidsis in animals is not well documented and explored nation-wide. In some regions Jobre *et al*.[16] prevalence of 46.5%, 25.7% and 24.3 % in cattle and 2.45% and 0% in sheep slaughtered in Butajira, South Omo and Gondar slaughter houses respectively were reported. Many studies reported an annual losses of 1,791,625.89 Ethiopian birr (ETB) and (131,737.19 USD) in cattle slaughtered at the Hawassa municipal abattoir [17] 410,755.90 ETB (30,202.64 USD) in cattle slaughtered at Wolayita Sodo abattoirs [18] and 45,532.9 ETB (5059.2 USD) in cattle slaughtered at the Adama abattoir [19].

The absence of proper meat inspection procedures, the lack of regular deworming of dogs and the presence of large population of stray dogs contribute significantly to the high prevalence of cystic echinococcosis in Ethiopia. Therefore, it is justifiable to find reliable data for monitoring epidemiological aspects of a disease and to prepare baseline data for future comparison [20]. In Butajira, there is no enough information on the prevalence of hydatidosis that can be traced back to the source origin of animals. This makes this study necessary to identify gaps whether or not the prevalence of hydatidosis is similar in different parts of the country for the development and implementation of control strategies, future improvement options and research focus. Therefore, the present study was conducted with the objectives to determine the prevalence of the cystic echinococcosis on cattle slaughtered at Butajira municipality slaughterhouse, to study the localization and condition of hydatid cysts such as fertility and sterility and to assess the economic loss due to condemnation of organs harboring hydatid cysts and carcass weight loss.

MATERIALS AND METHODS

Study Area: The study was conducted at Butajira municipal slaughterhouse, which is found in the State of the South Nations and Nationalities Peoples (SSNNP), South Ethiopia at about 134 km South of Addis Ababa which is capital of Meskan District ("*Woreda*") of Gurage Zone. Topographically Butajira is within the central highland of the SSNNP, which is the extension of the central Ethiopia high lands at an altitude of 1750-3200 m.a.s.l., with mean annual rain fall of 900-1400 mm and a maximum of 24°C and minimum 10.3°C mean annual temperatures. The area has three climatic conditions; *Kola* (Lowland), *Woyena Dega* (Middle altitude) and *Dega* (Highland) and has a small irrigation from the *Woyena Dega* and *Dega* parts of the area [21].

Study Animals: The study animals were 400 cattle brought from various localities to Butajira municipality slaughterhouse and slaughtered there. They were all local zebu breeds that were raised under the traditional livestock management system. Tracing back all slaughtered animals to their geographical origins and relate the findings to a particular locality was difficult. Nonetheless, some of them were brought from Batu (The former Zeway) Enseno, Sility, Tora, Bulbula and Adami Tulu areas.

Study Design and Sample Size: A cross-sectional survey was conducted on 400 heads of cattle during the study period from November 2013 to June 2014 to estimate the prevalence of bovine cystic echinococcosis in Butajira municipality slaughterhouse through meat inspection. The sample units were selected using systematic random sampling technique. The slaughterhouse was visited for 7 months, 3 days/week i.e., on Monday, Wednesday and Friday due to the relative high number of slaughtered animals. The sample size was determined according the formula described by Thrusfield [22] for simple random sampling.

$$n = \frac{1.96^2 \, p_{exp} \, (1-p_{exp})}{d^2}$$

where,
n = sample size
P_{exp} = Expected prevalence
d = Desired absolute precision

Thus, considering 95% of confidence interval at a desired accuracy level of 5% and with expected prevalence of 50%, the required sample size (n) is determined as 384. However, 400 animals were selected using random sampling method.

Data Collection

Postmortem Examination: A total of 400 randomly selected cattle presented for slaughter at Butajira municipality slaughter house were examined ante-mortem and post-mortem. During ante-mortem examination, each study animal was given an identification number. Then this temporary identification number and origin of animals as well as animal data such as age, sex, breed and were recorded. However, 90% of cattle presented to the slaughterhouse were males, local breeds (Zebu) and above 3 years of age. The age was determined based on dentition in accordance with Ensminger [23]. The body condition score was assessed as per Nicholson and Butterworth [24].

All animals recruited as sample units were examined for the presence of hydatid cysts following the routine meat inspection procedures. The inspection procedure used during the postmortem examination consisted of primary examination followed by a thorough secondary examination upon evidence of metacestode presence. Primary examination involved usually inspection and palpation of organs and viscera. The secondary detailed examination involved further incisions into each organ whenever single or multiple cysts were found in the liver, lungs spleen, kidney, muscle, mesentery and omentum of each grossly examined animal. Each organ was incised once or twice with knife in order to detect small hydatid cysts where necessary. Whenever, the cysts were present, they were removed, put in polyethylene bags separately, labeled and taken to the laboratory for further characterization of their conditions. During the study detailed information on the number, size and location of the cysts were collected. The infected organs from each positive animal were collected and recorded. The total numbers of hydatid cysts were counted and recorded per infected organ. The size of the diameter of collected hydatid cysts was measured and classified as small (Diameter less than 5 cm), medium (Diameter between 5 cm and 10 cm) and large (Diameter greater than 10 cm) [25].

Cyst Characterization: Identification of cysts was done at Wolaita Sodo Reginal Laboratory (WSRL). Each collected hydatid cyst was carefully incised and examined for protoscollice, which look like white dots on the germinal epithelium; characterized as fertile cysts. Fertile cysts were subjected to viability test. A drop of the sediment containing the protoscollices were placed on a microscope glass slide, covered with cover slip and observed for amoeboid like peristaltic movements with 40 × objectives. For clear vision a drop of 0.1% aqueous eosin solution was added to equal volume protoscollices in hydatid fluid on microscope slide with the principle that viable protoscollices should completely or partially exclude the dye while the dead ones taken it up [26]. Furthermore, infertile cysts were further classified as sterile or calcified. Sterile hydatid cysts were characterized by their smooth inner lining usually with slightly turbid fluid in its content. Typical calcified cysts produce a gritty sound feeling up on incision [6].

Financial Loss Estimation: Direct and indirect losses were the basis for the estimation of the annual economic losses due to hydatidosis. Direct losses were calculated based on condemned organs whereas the indirect loss was estimated based on live weight loss caused by cystic echinococcosis [27, 28].

Direct Loss (DL): In order to evaluate the financial loss, the following parameters were taken in to consideration: the mean retail market price of liver, lung, kidney, spleen and heart and cost 1kg beef was estimated based on information gathered from butchers in the area. Average annuals slaughter rate of animals at Butajira slaughter house was estimated based on observation during the study period. Average carcass weight (dressing percentage of Ethiopian Zebu cattle breed estimated by ILRI [29]. Average carcass weight loss due to hydatidosis was taken in to account. A 55 kg carcass weight loss due to hydatidosis was described by Polydrous [27]. The loss from lung and liver condemnation due to cystic echoinococcosis is calculated as follows [30].

DL = (NAS x Ph x Plu x Clu) + (NAS x Ph x Pli x Cli)

where

NAS = Average number of cattle slaughtered annually (4000)
Ph = Prevalence rate of hydatidosis.
Plu = Percent involvement of the lung
Clu = Mean retail price of the lung
Pli = Percent involvement of the liver
Cli = Mean retail price of the liver

Indirect loss (IL) – IL = 5% NAS x Ph x CPB x 126 kg

where

IL = Indirect loss; 5% = estimated carcass weight loss due to hydatidosis
NAS = Average number of cattle slaughtered annually
Ph = Prevalence rate of hydatidosis
CPB = Current average price of 1kg of beef at Butajira
126kg = Average carcass weight of an adult Zebu cattle

Total Economic Loss (IL): The total economic loss can be evaluated by considering other direct loss (DL) and indirect loss (IL), TL = DL + IL

Data Analysis: Data collected from postmortem and laboratory findings were entered in to Microsoft Excel Spreadsheet. Then, the data was edited, coded and transferred into SPSS (Version 20) statistical package that was employed to analyze the results. Prevalence and other percentages were calculated by dividing the number of positives by the total number of animals examined multiplied by 100. Chi-square (x^2) test was used to compare the prevalence of cystic echinococcosis among cattle of different age and body conditions scores. A statistically significant association among the varies values of the variables was considered to exist if *P*-value was less than 0.05 ($P < 0.05$).

RESULTS

A total of 400 cattle examined for the presence of hydatid cysts at Butajira municipality slaughter house, 128 were found harboring one or more hydatid cysts. Therefore, the overall prevalence of cystic echinococcosis was 32%. Analysis of the occurrence of hydatidosis and the considered risk factors showed a significant association (Table 2). The prevalence of cystic echinococcosis was higher in cattle ≥5 years of age (39.41%) than those <5 years (7.53%). This variation is statistically significant ($P<0.05$). In addition, the proportion of hydatid cyst harbouring Medium body condition cattle (44.83%) far exceeds those with good body condition (26.76%). This discrepancy was also statistically significant ($P<0.05$) (Table 1).

The liver and lung were affected with hydatid cyst. The total number, prevalence and number of cysts harbored in each individual affected organ is shown (Table 2). Single and multiple infections of organs were recorded. Out of a total of 128 cattle harboring hydatid cysts 110 (85.9%) were found involving only a single organ and the remaining 18 (14.1%) showed a multiple organ involvement (Table 3).

The sizes of all 545 cysts encountered in the lungs and liver were measured. Out of the measured cysts 84.9%, 10.3% and 4.8% were small, medium and large cysts, respectively. The proportion of small cysts was higher in liver (93.2%) as compared to lung (79.4%). In contrast, the percentage of large cysts was greater in lung (6.5%) than in liver (2.3%) (Table 4).

The fertility and sterility of hydatid cysts were also studied. The fertility percentage of protoscolices was higher in lungs (1.5%) while the percentage of calcified cyst was (71.4%) highest in the liver (Table 5).

Financial Loss Assessment: Due to cattle cystic echinococcosis as direct loss 88 lungs and 58 livers were condemned within the study with an economic loss 1,760

Table 1: Association between prevalence and risk factors of hydatid cysts in cattle slaughtered at Butajira Municipal slaughterhouse.

	Number of Cattle			
Organs	Examined	Positive (%)	x^2	*P*-Value
Age				
< 5 Years	93	7(7.53)	33.35	0.001
≥5 Years	307	121 (39.41)		
Over all	400	128 (32.0)		
Body condition				
Medium	116	52(44.83)	12.35	0.001
Good	284	76(26.76)		
Over all	400	128 (32.0)		

Table 2: Prevalence and number of cysts harbored in organs of the slaughtered cattle

	Number of organs			
Organs	Examined	Affected	Percentage (%)	Total no of cysts
Lungs	400	88	22.0	325
Liver	400	58	14.5	220
Total	800	146	18.25	545

Table 3: Distribution of hydatid cysts in organs of cattle slaughtered at Butajira Municipality slaughterhouse.

Organ	Number of cases	Percentage (%)
Lung only	70	54.7
Liver only	40	31.2
Both Lung and liver	18	14.1
Single organ infection	110	85.9
Multiple organ infection	18	14.1
Total	128	100

Table 4: Cysts size and intensity in cattle slaughtered at Butajira Municipality slaughterhouse

	Small cyst		Medium cyst		Large cyst		
Organ	Number	Percentage	Number	Percentage	Number	Percentage	Total
Lung	258	79.4	46	14.1	21	6.5	325
Liver	205	93.2	10	4.5	5	2.3	220
Total	463	84.9	56	10.3	26	4.8	545

Table 5: Cyst condition of hydatid cyst in organs of cattle slaughtered at Butajira Municipality slaughterhouse

	Sterile		Fertile		Calcified		
Organ	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	Total
Lung	272	83.7	5	1.5	48	14.8	325
Liver	63	28.6	0	0.0	157	71.4	220
Total	335	61.5	5	0.92	205	37.6	545

Table 6: Economic significance of hydatid cyst in cattle slaughtered at Butajira Municipality slaughterhouse

Organ	Number of organs condemned	Price per organ	Total price (ETB)
Lung	88	20	1760
Liver	58	60	3480
Total	146	80	5240

ETB and 3448 ETB respectively (Table 6). This was assessed from the mean retail market price of each organs and the total number of organs condemned during the study period. Annual economic loss on the other hand was estimated considering annual slaughter rate of cattle and prevalence of cystic echinococcosis per each organ and was calculated to be 35,763.2 ETB per annum. The estimated annual economic loss from carcass weight as an indirect cause of economic loss due to cystic echincoccosis is estimated to be 403,200 ETB. Therefore, the total estimated annual economic loss in cattle Butajira municipality slaughterhouse due to cystic echinococcosis was 438,963.2 ETB, which is equivalent to 21948.15 USD.

DISCUSSION

In the present study, the prevalence of hydatid cyst in cattle was found to be 32%. Globally, there have been different magnitude records of hydatidosis in cattle with low, medium and high rate of occurrence. The prevalence of cystic echinococcosis determined in the present study is in agreement with the findings of others such as Getachew [31] Awassa (34.3%), Berhe [32] in Mekelle (32.11%), Zewdu *et al.* [33] in Ambo (29.69%) and Tolosa *et al*. [34] in Jimma (31.44%). Higher registered prevalence's include 72.44% in Assela [35] 52.69% in Hawassa [17] and 49.5% in Shashemanne [36] and yet, a relatively low recorded prevalence's were 7.2% in Debre Berhan [37] 16% in Wolayita Sodo [38] 17.4% in Kombolcha ELFORA [39] 3.0% in Zeway (The present Batu) [40] and 13.4% in Assela [41].

Generally, the variation in prevalence among different geographical locations could be ascribed to the strain different of *E. granulosus* that exists in different geographical location [42]. Additionally variability could be related with age factors. Other factors like different in culture, social activities and attitudes to dogs in different region may contribute to variation [26, 43]. Most of the slaughtered animals at Butajira municipality slaughterhouse were above 4 years of age and hence they were exposed to the disease over long period with an increasing possibility of acquiring the infection.

The higher prevalence recorded in the present study as compared to others is probably attributed to beliefs of the society that allow the presence of large population of dogs as a guard for their home. Therefore, the high prevalence of the cystic echinococcosis in the present study as compared to some of the previous studies in different area of the country could be due to higher dog population and absence of control strategy of stray dogs and wild carnivores and also the wide spread tradition of offering uncooked infected offals to pet animals around home stead, poor public awareness about the disease, the absence of proper fencing (Where dogs and other carnivores get an easy access) and the habit of disposing dead wild or domestic animals unburied and left open for scavenging carnivores creates favorable condition for environmental contamination by maintaining the life cycle of *E. granulosus* in stray dogs and wild carnivores.

In identifying the risk factors influencing the occurrence of cystic echinococcosis, age and body condition of cattle were significantly associated with the prevalence of hydatidosis. The present data showed that adult cattle (≥5years) were more frequently affected than young animals (<5 years) (P>0.05). Negash *et al*. [36], Abebe *et al*. [39] and Umur [44] have reported a similar observation. The age-wise variation in infection rate could be mainly due to longer exposure time to *E. granulosus* [32]. In contrast, Melaku *et al*. [45] and Abunna *et al*. [46] demonstrated statistically insignificant variation between the two age groups.

Furthermore, a significant variation was observed in the rates of infection as per body condition (P< 0.05) where medium body conditioned animals were more infected than Good body condition animals. This is in agreement with Bekele *et al*. [18]. Polydorous [27] explained that in moderate to severe infections, the parasite might cause retarded performance and growth, reduced quality and yield of meat and milk as well as live weight loss.

In the current study, hydatid cysts were found predominantly in lungs and liver representing 60.3% and 39.7% respectively. This finding supports the previous observations that showed hydatid cyst are most commonly found in the lungs and liver of ungulates [13, 45, 47, 48]. This could be justified by the fact that lungs and liver process greater capillary fields, which allow these organs to efficiency filter the ingested oncosphers from the blood. Liver and lungs undergo sequential filtration of blood. Liver undergoes primary filtration of blood from portal veins, which is followed by pulmonary filtering actions before other organs are invaded. Only those onchospheres that travels to them will reach the systemic circulation and other tissues [13, 49].

Higher number of small, medium and large sized cyst was found in the lungs than in the liver while the liver harbored higher number of calcified cyst. The reason for higher percentage of medium and large cysts in the lungs is due to softer consistency of the lungs while the higher

yield of calcified cyst in liver could be attributed to relatively higher reticuloendothelial cells and abundant connective tissue reaction of the organ. The higher proportion of small cysts may be due to immunological response of the host that might preclude expansion of cyst size [28, 50]. In the current study examination of condition of hydatid cyst revealed 61.47% sterile, 0.92% fertile and 37.62% calcified cysts. Kebede *et al*. [25] in Bahir Dar and Terefe *et al*. [51] in Addis Ababa have also reported similar observations. This may imply the general thought that most of hydatid cysts in cattle are sterile.

In this study, cystic echinococcosis was found to incur a financial loss that is estimated to be 438,963.2 ETB to Butajira slaughterhouse per year (Which is more than 21948.15 USD). Several authorss have also estimated the annual financial loses associated to bovine hydatidosis. To mention some of them, the financial loss attributable to hydatidosis was estimated to be 641,422 ETB in Kombolcha ELFORA slaughter house [52] 813,526.40 ETB in Debre Zeit slaughter house [53] 90,647.95 ETB in Gonder [54] 131,190.45 ETB in Jimma [55,] 587.02 ETB in Nekemte slaughter house [29] 681,333.87 ETB [45] and 19,847,704.5 ETB in Addis Ababa [51] The difference in the calculated financiao losses from various slaughter houses is either due to the variation in the number of slaughtered animals or variation in the prevalence of cystic echinococcosis or due to variation in the retail market price of organs. Based on our results we suggest that cystic echinococcosis in cattle is one of the major disease of the livestock prevailing in the country incurring enormous direct and indirect losses to the cattle industry in Ethiopia.

CONCLUSION AND RECOMMENDATIONS

Cystic echinococcosis is common in cattle slaughtered at Butajira municipality slaughterhouse. In cattle, lungs and liver are the most commonly affected organs harboring cysts of various sizes and numbers, majority of the hydatid cysts of cattle slaughtered at Butajira are sterile. It is one of the major diseases of cattle prevailing in the area incurring economic direct and indirect losses warranting serious attention for its prevention and control in the area. It seems that there are favorable socio-economic conditions for transmission of the disease. Establishment of policy on dog keeping and handling including registration, treatment and elimination of stray dogs. Promoting construction of slaughterhouse with their appropriate disposal pits particularly in rural areas and conducting an obligatory meat inspection services. Further detailed investigation on epidemiological factors governing the spread of hydatidosis in the region establishes regional control start.

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