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Prevalence and Economic Importance of Bovine Hydatidosis at Asella Municipal Abattoir South Eastern Ethiopia

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Abstract: A cross-sectional study was conducted from November, 2014 to April, 2015 to assess the status of cystic hydatidosis in cattle slaughtered at Asella municipal abattoir. Out of the total 430 cattle examined visually and manually (palpation and incision), 274 (63.7%) were found harboring hydatid cysts. From the total of 430 cattle examined during postmortem inspection, 426 different visceral organs were found to be affected by hydatid cyst and from these organs, 855 cysts were obtained. In line with their distribution among the infected visceral organs, 413 (48.3%), 405 (47.4%), 22 (2.57%), 6 (0.701%) and 9 (1.05 %) cysts were obtained from lung, liver, spleen, kidney and heart, respectively. Among risk factors age and origin of the animals shown significant difference with prevalence of the disease ($P<0.05$). Out of 75 cysts tested for fertility, observation indicated that 24 (57.1%) cysts of lung, 8 (40 %) cysts of liver and 1(33.3%) of spleen origins had protoscolices detected and hence, fertile. The rest were either sterile or calcified. A total of 37 fertile cysts originating from lung, liver and spleen were tested for viability. The examination indicated that 16 cysts from lung and 3 cysts from liver origin had viable protoscolices. Considering the current result, the total annual economic loss from organ condemnation due to bovine hydatidosis at Asella municipal abattoir was estimated at 148370ETB ($7065USD). Regular testing and treatment of dogs should be practiced throughout the country to prevent the risk of hydatidosis to farm animals.

Key words: Cross Sectional · Economic Loss · Fertile Cyst · Postmortem · Viable · Visceral Organs,

INTRODUCTION

Parasitic diseases are distributed throughout the world and affect animal health resulting into a low working potential and reduced productivity. Amongst these parasitic diseases, hydatidosis is one of the most important parasitic diseases, which affects the efficiency of both animals and Human being [1, 2]. The disease occurs throughout the world and causes considerable economic losses and public health problems in many countries. Hydatidosis causes condemnation of offal containing hydatid cysts in slaughter houses [3].

Hydatidosis caused by the larval stage (metacestode) of *Echinococcus granulosus* is the most widespread parasitic zoonoses [4, 5]. Dogs are the usual definitive hosts while a large number of mammalian species are intermediate hosts, including domestic ungulates and man. It is a cosmopolitan zoonotic infection [6].

Despite the large efforts that have been put into the research and control of echinococcosis, it still remains a disease of worldwide significance. In some areas of the world, Cystic echinococcosis caused by *E. granulosus* is a re-emerging disease in places where it was previously at low levels, Urquhart *et al.* and Kebede *et al.* [7, 8].

Echinococcus granulosus infection is endemic in East and South Africa, Central and South America, South Eastern and Central Europe, Middle East, Russia and China. The highest incidence is reported mainly from sheep and cattle rearing areas [9]. The disease is most important in livestock production which is based mainly on extensive grazing system. Several reports from different parts of Ethiopia indicate that hydatid cyst is prevalent in livestock population of the country [10, 11]. According to 13 Abebe and Yilma [12] a prevalence of 72.4%, 37.72%, 33.78% and 13.7% in cattle slaughtered in Asella, Adama, Gonder and Dire Dawa was documented

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respectively indicating its high importance in the livestock industry. Its distribution is higher in developing countries especially in rural communities where there is close contact between dogs (definitive host) and various domestic animals intermediate hosts [13]. By affecting many animal species, intermediate animal hosts and humans, hydatid cyst causes tremendous economic losses worldwide and specially in those areas where the parasite is endemic [7].

Knowledge about the prevalence of the diseases together with associated risk factors as part of the epidemiology of the disease is crucial for any attempt of prevention and control of the disease in question. Moreover, determination of the economic significance of the disease is important for decision making, planning, development and implementation of local control strategies. Therefore, the objectives of this study were to assess the prevalence of hydatidosis, to determine associated risk factors in cattle and to estimate the economic significance of the disease at Asella municipal abattoir.

MATERIALS AND METHODS

Description of the Study Area: This study was conducted from November, 2014 to April, 2015 in Asella town, the capital city of Arsi zone, in Oromia Regional State 175 km to the South east of Addis Ababa. Asella town geographically located at an elevation of 1650-3000 meters above sea level (m.a.s.l). The area has highland escarpment, midland and lowland climatic zones. About 37% of the total area is highland (>2400m), 52% mid-land (1800-2400m) and 11% is lowland (<1800m). Asella is within $6^0$59'and $8^0$49'N latitude and $40^0$44'East longitude while the climatic condition of the area is "weynadega" (mid land). The area receives an annual range of rain fall from 700-1658 mm and annual average humidity ranging from 43-60%. The area has a biomodal rainfall occurring from March to April (a short rainy season) and from July to October (long rainy season). The annual temperature range is 10-22.6°C. It has a daily maximum temperature that can reach up to 28°C and minimum temperature of 10°C.The area is known to have three different soil types:

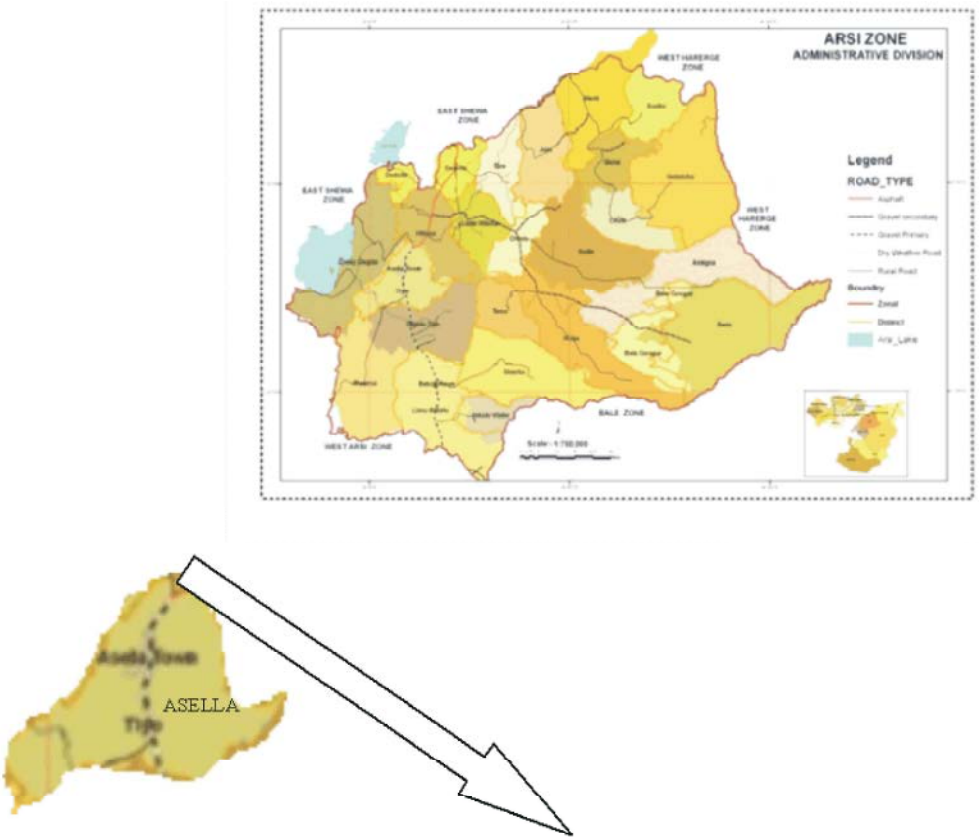

Fig. 1: Map indicating Arsi zone Asella town (indicated by arrow)
Source: Oromia National Regional State, Office of the President, [15]

black soil, clay soil and sandy soil. Asella town and the surrounding farming community, has a total area of 300.21sq.km. This, about 208.43sq.km (69.4%) of the total area is agricultural land, 40.61sq.km (13.5%) pastoral land, 6.74sq.km (2.3%) forest, 39.34sq.km (13.5%) land for construction and 5.08sq.km (1.69%) non-fertile land. There is mixed farming of crop production and animal breeding. The breeds of cattle in the area are largely local zebu with significant number of cross-breed and few exotic breeds located especially in Asella town. Except for few indoor and intensive animal production systems, which are located especially in Asella town, extensive type of production system is the dominant type of husbandry practice [14].

Study Animals and Population: The study animals were indigenous zebu cattle presented to the Asella municipal abattoir those randomly selected and included in the study. Animals slaughtered at the Asella abattoir were cattle brought from different areas namely: Hetosa, Lemu-bilbilo, Tiyo and Digalu-tijo. In the study 430 cattle were taken randomly from the slaughtered animals in the abattoir in the days of abattoir visit.

Sample Size Determination: As previous study has not been conducted on bovine hydatidosis in the study area, the expected prevalence was assumed to be 50%. Therefore, the sample size calculated at 50% expected prevalence rate with a desired precision of 5% and 95% confidence interval was determined by using the formula given by Thrusfield [16].

$$n = \frac{1.962 \times Pexp\ (1\text{-}Pexp)}{d^2}$$

Where n = required sample size, Pexp = expected prevalence, d^2 = desired absolute precision. Therefore based on the above formula a total of 384 cattle were to be examined but to increase its accuracy and precision a total of 430 cattle were included in the study.

Study Design: A cross sectional study was conducted to study the prevalence of bovine hydatidosis in Asella municipality abattoir. In this cattle were categorized into three age groups (< or = 5, 5 – 8 and > 8 years). Age estimation done based on eruption of one or more incisor teeth according to De Lahunta and Habel [17]. Body condition score was made by the scoring system described by Tennant *et al*. [18] in cattle. The body condition score was classified into lean, medium and good (fat) categories [19]. The body condition was scored as 0 to 5 (0 = very thin; 1 = thin, 2 = fair, 3 = good, 4 = fat and 5 = very fat). However, for the purpose of data analysis, body condition 0 to 5 was assigned to three distinct groups: Categories 0, 1 and 2 was grouped as "thin or lean", category 3 was defined as "medium" and body condition scores 4 and 5 was categorized as "good".

To study the prevalence of bovine hydatidosis in Asella municipality abattoir a cross-sectional study type was conducted and 430 study cattle were simple randomly selected and included in the study from cattle which were presented for slaughter on the days of abattoir visit.

Study Methodology

Antemortem Inspections: During antemortem inspection, each of the study animals was given an identification number (with a paint mark on their body). Age, sex and body condition scoring of the study animals were also recorded.

Postmortem Inspection: During postmortem examination organs especially liver, lung, spleen, kidney and heart as a whole were systematically inspected for the presence of hydatid cyst by applying the routine meat inspection procedure of primary examination followed by secondary examination. The primary examination involves visualizations of the organs, were as secondary examination involves further incision of each organs into pieces and whenever evidence of hydatid cyst was found, it was classified as live or calcified and the cyst distribution into organs was recorded [20].

Examination of Cysts for Fertility and Viability: Based on the presence or absence of brood capsules containing protoscolices in hydatid fluid, cysts were identified and classified as fertile and infertile according to the method described by Macpherson *et al.* [21]. Individual hydatid cysts were carefully incised and examined for protoscolices, which resembled white dots on the germinal epithelium; such cysts were characterized as fertile cysts. Fertile cysts were subjected to viability test. A drop of the sediment containing the protoscolices were placed on the microscope glass slide and covered with cover slip and observed for amoeboid like peristaltic movements 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 exude the dye while the dead ones absorb it Macpherson, Zeyhele and Roming [21]. 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 their content. Typical calcified cysts produce a gritty-sound heard at incision [22].

Economic Analysis: To study the economic losses due to hydatidosis in cattle, both direct and indirect losses were considered. The calculation of the direct losses is based on condemned organs (lung, liver, heart, spleen and kidney) and the indirect losses were assessed on the basis of live weight reduction due to hydatidosis. In calculating cost of condemned edible organs and carcass weight loss, ten different meat sellers were interrogated randomly to establish the price per unit organ and the collective price of lung, liver, heart, spleen and kidney was determined. Average price was drawn out from that data and this price index was later used to calculate the meat loss in terms of Ethiopian birr (ETB). Average market price of lung, liver, spleen, kidney, heart and a kilo gram of beef were find to be 20 ETB, 50 ETB, 10 ETB, 30 ETB, 30 ETB and 130 ETB, respectively during the study period in the study area.

Average annual slaughter rate of cattle in Asella municipality abattoir was estimated based on retrospective analysis of data recorded from three years. A 5% estimated carcass weight loss due to bovine hydatidosis described by Polydorous [23] was taken into account to determine the carcass weight loss. Average carcass weight of an Ethiopian zebu was taken as 126 kg, as estimated by International Livestock Center for Africa [24]. Accordingly, the loss from liver, heart, kidney, lung, spleen condemnation was calculated as follows [25]:

LOC= (NAS x ph x plu x cplu) + (NAS x ph x phr x cphr) + (NAS x ph x pli x cpli) + (NAS x ph x psp x cpsp) + (NAS x ph x pkid x cpkid);

Where
NAS = Average number of cattle slaughtered annually
Ph = Prevalence rate of hydatidosis
Plu = Percent involvement of lung
Cplu = Current mean retail price of lung
Phr = Percent involvement of heart
Cphr = Current mean retail price of heart
Pli = Percent involvement of liver
Cpli = Current mean retail price of liver
Psp = Percent involvement of spleen
Cpsp = Current mean retail price of spleen.
Pkid = Percent involvement of kidney
Cpkid = Current mean retail price of kidney
N.B.: All prices are determined from the price at Asella town.

Data Analysis: The data obtained was coded in Microsoft excel and subjected to descriptive statistics and chi-square in order to assess the magnitude of the difference of comparable variables using SPSS version 20.0 software. Statistically significant association between variables is considered to exist if the P-value is less than 0.05.

RESULTS

Out of the total 430 heads of cattle slaughtered and examined, 274 (63.7%) were infected with hydatid cyst, harboring one or more cysts involving different visceral organs (lung, liver, heart, spleen and kidney).

Prevalence of Hydatid Cyst on the Basis of Age: Rate of infection in different age groups (<5, 5-8 and >8 years) was assessed and described (Table 1). Age prevalence has shown a statistically significant variation ($P<0.05$) with >8years group having higher infections.

Prevalence of Hydatid Cyst on the Basis of Body Condition: Prevalence was also assessed in terms of body condition score (Table 1). It was found that cattle having medium body condition had the highest prevalence (66.8%) followed by good (60.55%). The difference in prevalence rate among the body condition scores was statistically insignificant ($P>0.05$).

Prevalence of Hydatid Cyst in relation to origin of the animal: Origin of the animal was also assessed as risk factor in this study. The present study result indicated that the prevalence of hydatidosis in relation to origin of the animal was statistically significant in the study area ($P<0.05$). Although, the prevalence of hydatidosis in Digalu tijo village was highest (71.95%) as compared to least prevalence in Hetosa village (36.4%) (Table 1).

Prevalence of Hydatid Cyst on the Basis of Sex: The highest and lowest prevalence of cryptosporidiosis within sex groups were 64.5% and 43.75% in male and female, respectively. There was no statistical variation ($P>0.05$) within sex groups (Table 1).

Table 1: Prevalence of hydatidosis in relation to risk factors (n = 430)

Variable	No examined	Prevalence (%)	*x*2	P-value
Age				
=5	45	16 (35.55)	56.8	=0.001
5-8	186	95 (51.07)		
8>	199	163 (81.9)		
Total	430	274 (63.7)		
Sex				
Male	414	267 (64.5)	2.9	0.09
Female	16	7 (43.75)		
Total	430	274 (63.7)		
BCS				
Medium	217	145 (66.8)	1.82	0.177
Good	213	129 (60.55)		
Total	430	274 (63.7)		
Origin				
Digalutijo	246	177(71.95)	21.6	=0.001
Hetosa	33	12(36.4)		
Tiyo	43	25(58.1)		
Lemubilbilo	108	60(55.55)		
Total	430	274 (63.7)		

Table 2: Distribution of hydatid cysts by organs affected (N = 855)

Organs	No obtained (%)
Lung	413 (48.3)
Liver	405 (47.4)
Spleen	22 (2.57)
Heart	9 (1.05)
Kidney	6 (0.701)
Total	855

Table 3: Distribution of hydatid cysts within infected single and/or multiple organs (n = 274)

Organs affected	Prevalence (%)
Lung only	78 (18.1)
Liver only	49 (11.4)
Spleen only	4 (0.9)
Lung and liver	122 (28.4)
Lung and spleen	3 (0.7)
Liver and spleen	5 (1.2)
Lung+liver+spleen	8 (1.9)
Lung and heart	3 (0.7)
Liver and kidney	1 (0.2)
Lung+spleen+kidney	1 (0.2)
Total	274 (100)

Table 4: Relative distribution of cysts among risk factors

Variable	No of cysts	No of calcified cysts (%)	No of non-calcified cysts (%)
Age			
=5	133	68(51.1)	65(48.9)
5-8	287	183(63.8)	104(36.2)
> 8	435	327(75.2)	108(24.8)
Sex			
Male	760	503(66.2)	257(33.8)
Female	95	63(66.3)	32(33.7)
Organs			
Lung	413	283(69.5)	130(31.5)
Liver	405	119(29.4)	286(70.6)
Spleen	22	11(50)	11(50)
Kidney	6	2 (33.3)	4(66.7)
Heart	9	5(55.6)	4(44.4)

Table 5: Fertility/sterility of cysts and Viability statuses of fertile cysts collected from organs of Cattle

Organ affected	No cyst examined	Fertile cyst (%)	No of fertile cyst examined	Viable cyst (%)
Lung	42	24 (57.1)	24	16 (66.6)
Liver	30	8 (40)	8	3 (37.5)
Spleen	3	1 (33.3)	1	0
Total	75	37 (49.3)	37	24 (64.9)

Organ Involvement and Distribution of Cysts: From the total of 430 cattle examined during post-mortem inspection, 426 different visceral organs were found to be affected by hydatid cyst and from these organs, 855 cysts were obtained. In line with their distribution among the infected visceral organs, 413(48.3%), 405(47.4%), 22(2.57%), 6(0.701%) and 9(1.05 %) cysts were obtained from lung, liver, spleen, kidney and heart, respectively (Table 2).

Out of the total 274 infected animals 78, 49 and 4 of them had hydatid cysts on their lung, liver and spleen alone, respectively. While other animals had hydatid cyst in two and more than two organs (Table 3).

All cysts that were distributed in age, sex groups and in different organs of cattle slaughtered at Asella municipal abattoir were identified in to calcified and non-calcified cysts (Table 4). Out of 855 cysts examined 578 were calcified and 277 were noncalcified cysts.

Cyst Characterization: A total of 42 cysts of lung, 30 cysts of liver and 3 cysts of spleen origins were taken and subjected to cyst characterization (Table 5).

Cyst Fertility: Out of 75 cysts tested for fertility, observation indicated that 24 (57.1%) cysts of lung, 8 (40 %) cysts of liver and 1(33.3%) of spleen origins had protoscolices detected and hence, fertile. The rest were either sterile or calcified (Table 5).

Cyst Viability: A total of 37 fertile cysts originating from lung, liver and spleen were tested for viability. The examination indicated that 16 cysts from lung and 3 cysts from liver origin had viable protoscolices showing the amoeboid like peristaltic movement (flame cell motility) and up on staining with 0.1% aqueous eosin solution, the viable protoscolices partially/totally excluded the dye while the dead ones take it up (Table 5).

Economic Loss Estimation: Due to asthetic value and to break the life cycle of the Echinococcus parasites infected organs are condemned. A total of lung, liver, spleen, kidney and heart were condemned due to hydatidosis

with an economic loss of 45864 ETB, 98608 ETB, 2247.0 ETB, 963.0 ETB and 688 ETB, respectively. The direct economic loss was about 148370.04 ETB ($7065USD).

DISCUSSIONS

In the present study the prevalence of bovine hydatidosis in Asella Municipal abattoir was found to be 63.7% which is comparable with the results of 54.84% [26]. The present study was much higher compared to the prevalence of reported of 28% at Gonder ELFORA abattoir [27], 31.44% [28]2009) and 22.4% [29] at Jimma municipal abattoir, 17.5% at Axum and 20.3% reported at Adigrat abattoir [11]. Much lower prevalence was also reported by Kebede [30] (7.5%) in Shire. Generally, variation among the prevalence of hydatidosis at different geographical location could be associated with the strain difference of *Echinococcus granulosus* that exist in different geographical locations [31]. Additionally variation could be with age factors of the animals and other factors like difference in culture, socio-economical activities and attitudes to dogs and their population. Similar to the present finding, it was reported that cystic Echinococcosis infection was higher for older animals [6]. Animals with more than five years of age were found to be highly infected that statistically significant ($P<0.05$). This could be mainly due to the fact that aged animals have longer exposure time to *E. granulosus* eggs. In addition, older animals might have weaker immunity to combat against infection [32].

The prevalence of hydatidosis by origin of slaughtered cattle was assessed and statistically significant difference ($P<0.05$) was found indicating that geographical regions play an important role in distribution of the cysts. This could be due to the difference in the socio-economic status and animal husbandry practices of community in all areas from where animals were brought for slaughter.

The prevalence of hydatidosis among different organs involved in harboring of the cyst showed that lung was found to be the most commonly affected organ followed by liver. Number of cysts collected from lung is also at greater proportion 413(48.3%) than liver 405(47.4%) and others 37(4.32%). Similar findings were reported by Haftay [33] and Yechale [34]. But this result contradicts with Solusby [22]. This might be due to the fact that cattle are slaughtered at older age, during which period the liver capillaries are dilated and most oncospheres directly pass to the lung; additionally, it is possible for the hexacanth embryo to enter the lymphatic circulation and be carried via the thoracic duct to the heart and lungs in such a way that the lungs may be infected before or instead of liver [35]. The finding that lung and liver are the most commonly infected organs could be due to the fact that lungs and livers possess the first great capillaries of sites encountered by migrating Echinocooccus onchosphere (hexacanth embryo) which adopt the portal vein route the first large capillaries encountered by migrating blood borne onchospheres and primarily negotiate pulmonary and hepatic filtering system sequentially before any other organ is involved. However, development of hydatid cysts occur occasionally in other organs like spleen, kidney and heart and other organs and tissues when onchosphers escaped into general systemic circulation [7].

Liver harbored highest number of calcified cysts and this could be attributed to relatively high reticulo-endothelial cells and abundant connective tissue reaction of the liver [36]. This finding is in agreement with finding of Yechale [34] (2008) and Haftay [33]. This can be due to the host defense mechanisms of killing more efficiently the parasitic larvae at the early stage of development [32].

The percentage of fertile cysts in this study was 57.1% that was higher than the report of 24.4% recorded by Solomon [37]. But the present is quite lower compared to the 70%, 96.9% and 95% reported from Great Britain, South Africa and Belgium respectively [35]. Yet much lower fertility report such as 1.76% was recorded in cattle from Wolayita Soddo [38]. The variation in fertility rates among different species and in different geographical zones could be due to difference in strain of *E. granulosus* [31]. Strain of the parasite and the host can modify the infective pattern of the parasite [36].

Comparison of the fertility of the cyst from different organs, was found to be significantly higher for lung than liver and others organ. This may be due to the softer consistency of the lung tissue that allows the easier development of the cyst hence providing good environment for the fertility of hydatid cysts [32]. The variation between tissue resistances of the affected organs may also influence the fertility rate of cysts, in the liver hosts reaction may limit fertility rate of hydatid cysts [35].

In this study prevalence of viable protoscolices was 66.6% and this finding is in agreement with the 64.9% viability rates reported by Debas and Ibrahim [27]. Significantly greater number of viable protoscolices (66.6%) were found in lung and followed by liver (37.5%).

These indicate that cattle are an important intermediate host for the perpetuation of the life cycle of the parasite in Asella and its surroundings.

The annual direct economic loss incurred by hydatidosis was calculated to be 148370 ETB ($7065USD). The result was relatively lower than the report of 674,093.038 ETB at Gonder ELFORA abattoir [27], 19,847,704.5ETB at Addis Ababa abattoir enterprise [39], Belina *et al.* [40] and Zewdu *et al*. [41] with annual economic loss of 841,419.3 and 160,032.23, respectively. The economic losses was different from the reports of others studies in the country which may be due to the variation in prevalence of the disease and mean annual number of cattle slaughtered in different Abattoirs and variation in retail market price of organs [23].

CONCLUSION

The overall prevalence in the present study was relatively high and it is an important zoonotic disease in the area and this could be due to several factors of which keeping dogs in close association with cattle. 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. The most preferred predilection sites of hydatid cyst in cattle like liver, kidney, heart and lungs and condemnations of these important organs having a single or multiple hydatid foci is really a huge loss. Regular testing and treatment of dogs should be practiced throughout the country to prevent the risk of hydatidosis to farm animals.

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