MEDDOCS Open Access Publisher

ISSN: 2640-1223

Journal of Veterinary Medicine and Animal Sciences

Open Access | Research Article

A Study on Prevalence and Economic Significance of Bovine Hydatidosis in Haramaya Muncpial Abattior

Mohammed Abrahim Ahmed*; Chala Ahmed; Araya Mengistu

Gursum, Eastern Ethiopia.

***Corresponding Author(s): Mohammed Abrahim Ahmed**

Gursum, Eastern Ethiopia.

Tel: 251-922018046; Email: Lukiya2151@gmail.com

Received: Dec 28, 2023

Accepted: Jan 05, 2024

Published Online: Jan 12, 2024

Journal: Journal of Veterinary Medicine and Animal Sciences

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/

Keywords: Haramaya; Bovine; Economic significance; Hydatidosis; Prevalence.

Abstract

Cystic Echinococcosis (CE), which is caused by larval stages of *Echinococcus granulosus* is one of the most important and commonly found parasitic zoonoses in both humans and different animals. A cross sectional study was conducted on both local and cross breeds of animals from March 2021 to September 2021 to estimate the prevalence and economic impact of hydatidosis in cattle slaughtered at Haramaya muncipial Abattoir. A total of 384 cattle were included in the study. Simple random lottery method was conducted and breeds, age, sex, and body condition of study animals were taken during ante-mortem examination and post mortem examination was conducted to note the presence of hydatid cysts. The visceral organs of the study cattle were examined for hydatid cysts after slaughter. From the total 384 cattle examined, 41 (10.7%) were found positive for hydatid cyst infection in one or more of their organs. Organ based distribution of the cysts indicated that around 26 (63.41 %) were found in liver, 14 (34.1%) in lung and 6 (14.6%) in kidney. The statistical analysis showed that the prevalence of hydatidosis was found to be significantly associated with age, body condition and origin of the studied animals ($P< 0.05$). However, there was no significant association ($P> 0.05$) between the prevalence of bovine hydatidosis and other risk factors such as sex and breed of animals. In the present study, the total annual economic loss from organ condemnation and carcass weight loss due to hydatidosis was estimated as 556,331.52 Ethiopian birr per annum. As the disease have both economic and public health importance proper carcass condemnation/disposal, regular dog deworming and public awareness are recommended.

Introduction

Cystic Echinococcosis (CE) is one of the most important and commonly found parasitic zoonosis in both humans and different animals [1]. It is a zoonotic disease caused by larval stages of *Echinococcus granulosus*, associated with severe economic losses and great public health significance worldwide [2]. Ultimately being passed to animal or human food chains, incidence of zoonotic diseases and to estimate the financial losses incurred through condemnation of affected organs and carcasses [3]. In food animals, hydatidosis has an adverse effect on production causing decreased production of meat, milk, wool, reduction in grow the rate and predisposition to other diseases [4].

Cite this article: Ahmed MA, Ahmed C, Mengistu A. A Study on Prevalence and Economic Significance of Bovine Hydatidosis in Haramaya Muncpial Abattior. vet Med Animal Sci. 2024; 7(1): 1135.

The *genus Echinococcosis* has four species namely, *Echinococcus granulosus, Echinococcus multilocularis, Echinococcus vogeli and Echinococcus oligarthrus*, which are morphologically distinct both in their adult and larval stage [5]. World Health Organization (WHO) designated CE for the disease caused by *E.* Granulosus and Alveolar Echinococcosis (AE) for the disease caused by *E. multilocularis* Both *E. Granulosus* and *E. multilocularis* are the most important zoonotic and pathogenic species to humans and other domesticated animal [6]. Whereas the other form of hydatidosis caused by *E. Oligarthrus* and *E. Vogeli* is referred to as *Polycystic Echinococcosis* (PE) [7]. As to many other parasitic infections, the life cycle of Echinococcus infection is complex which requires two mammalian hosts (intermediate and definitive hosts) for the completion of its life cycle [8].

Dogs and foxes are the primary definitive hosts for the adult parasites while numerous herbivorous animals act as intermediate hosts for the larval stages [9]. Man becomes infected by an accidental injection of onchospheres from contaminated food, water and environments, whereas the Final Host (FH) becomes infected by ingestion of infected offal that contains metacestode larvae [9], Kedir *et al.*, 2018. In the intermediate hosts, the majority of the hydatid cysts develop in the liver and lungs and to a lesser extent in the spleen, kidneys and heart [10].

Hydatidosis seriously affects human health and imposes costs to the involved people due to the required medication, surgery, or both. Moreover, it is responsible for many economic losses in the livestock industry [11].

In Ethiopia, hydatidosis is one of the major endemic diseases, especially where sheep, goats, cattle, camel, and pigs are still slaughtered traditionally, and offal's are easily accessible to scavenging dogs and other wild carnivores. Accordingly, factors like absence of proper meat inspection procedures, poor management of food animals, lack of awareness about food borne diseases, and lack of adequate number of abattoirs compared to the fast growth rate of human population are all thought to contribute significantly to the high prevalence, persistence and emergency of *E. Granulosus* in the area [12]. Although a lot has been done in the country, there is no information regarding to the status of hydatidosis in bovine and the economic loss of the disease in Haramaya municipality abattoir in particular. Therefore, the aim of this study was to asses/estimate the prevalence, the economic losses and risk factors of hydatidosis in Haramaya Municipal Abattoir.

Therefore, general objectives of this study are:

➢ To estimate the prevalence of bovine hydatidosis and annual economic loss from organ condemnation due to hydatidosis at haramaya municipal abattoir.

Specific objectives of this study are:

➢ To estimate the prevalence of bovine hydatidosis slaughtered at Haramaya municipal abattoir.

➢ To estimate the annual economic loss from organ condemnation due to hydatidosis and

➢ To identify the associated risk factors for the occurrence of hydatidosis.

Literature review

Etiology

Echinococcus species is a cestode parasite that infects a wide range of vertebrates including humans. Classification of the causative agents of cystic Echinococcosis has been a big challenge for many years as a result of limited morphological description and lack of evidence for geographical or ecological segregation of the parasite as all were conventionally assigned to *E. Granulosus* [13].

They utilise a variety of ungulates as intermediate hosts and canids as definitive hosts. According to current information on cystic echinococcosis species, strains, and genotypes, Africa contains the most diversity of these parasites [14]. The most important species infecting humans and livestock in Africa include *E. Granulosus* (common sheep strain G1), *E. equines* (horse strain), *E. Ortleppi* (cattle strain), *E. Canadensis* (camel/pig strain) and *E. fidelis* (lion strain) [14]. In East Africa, the parasite presents a complex pattern of infectivity with more than one strain occurring sympatrically in different or the same livestock species [14].

Both humans and livestock suffer from cystic echinococcosis, which has a significant economic impact. When underreported cases are examined, the annual cost in terms of monetary losses and disability adjusted life years (Dalys) is around US$ 763,980,979. [15]. The disease is of major public health and veterinary importance. In livestock it results in death, decreased meat, and milk and fleece production. The disease also results in condemnation of infected organs in slaughter houses resulting in great economic losses [16,17].

Human hydatidosis has a number of significant economic consequences, including reduced or complete loss of income during illness, treatment costs, and the convalescent period. It's also important to consider the economic and societal costs of undetected and thus untreated cases. According to the majority of reports, between 1% and 2% of hydatidosis infections are fatal [15]. In Africa, the disease is widespread posing great challenges in most countries that practice large scale livestock economy [14,18].

Morphology of cyst

Echinococcus exhibits certain characteristics that differentiate it from the other major genus in the family Taenia. The adult Echinococcusis 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. Like all tape worms, Echinococcus has no gut and all metabolic interchange takes place across the synctial outer covering, the tegument [55]. The anterior end of the adult worm possess a specialized attachment organ, the scolex, which has four muscular suckers and two rows of hooks, one large and the other small on the rostellum (head). The body or strobila is segmented and consist of reproductive units (proglottids) which vary in number from two to six [20]. Echinococcus eggs contain an embryo that is called an oncosphere or hexcanth. The name of this embryo stems from the fact that these embryos have six hook lets [21].

Metacestode

The metacestode (second larval stage) basically consists of a bladder with an outer a cellular laminated layer and an inner nucleated germinal layer, which may give rise by asexual budding to brood capsules. The metacestode is also called Hydatid or Hydatid Cyst. Protoscoleces arise from the inner wall of the brood capsules. The structure and development of the metacestode differs between the four species of Echinococcus [22].

The hydatid cyst, after 3 weeks, measures 250 µm in diameter and has central cavity. Around fifth months, it measures approximately one- cm and it is apparent that its wall consist of two layers: An external cuticular, or laminar layer, formed by numerous thin lamina that resembles the cross section of an onion, and another, internal layer germinative or proligerous, which is delicate cellular syncytium. Larval form of *E. Granulosus* typically consists of single cavity (unilocular). The interior of a hydatid cyst is filled with fluid. During the same period, brood capsule buds off from the germinative layer, and forming an invaginated protoscolices [23].

Epidemiology

Geographic distribution

Echinococosis has a worldwide distribution, the reason is mainly due to ability of this tape worm to adapt to a wide variety of domestic and wild intermediate hosts [24], especially in the places where there is a contact between the herder and the final host (herbivorous) and highly endemic in North Africa and sub-Saharan Africa. Also found a high prevalence of CE in Middle East countries, Central Asia, China, India, and Japan. Mediterranean littoral, Southeastern countries Europe record an increase in the ratio of infection, while in the UK and central Europe show low in the infection ratio. Also in Australia report cases of infection since the end of 8th century, and the most cases were in sheep. South America is highly endemic more than North and Central America, while the infection there seems to be rare or not found [25].

Prevalence of hydatidosis in ethiopia

Several reports had indicated that hydatidosis is widely prevalent in livestock population of various regions of Ethiopia.

Table 1: Prevalence of Bovine hydatidosis and estimated annual economic loss in Ethiopia.

Author(s)	Study Area	Prevalence in Cattle	Annual Economic loss of Ethiopian birr
Terefe *et al*., 2012	Addis Ababa Abattoir	40.50%	19,847,704.00
Hussen *et al*.,2013	Assela	62.38%	-
Demissie and Kemal.,2014	Kara-Aloabattoir PLC	25.70%	22,010
Brhane and Abeba.,2015	Jimma	30.70%	94,485.00
Tadesse *et al*.,2014	Nekemte	17.10%	4,000,000.00
Lema *et al*.,2014	Harar	11.30%	96,315.00
Haftu and Kebede.,2014	Bako	11.88%	180,792.00
Gebreyohannes and Wondie.,2014	Dire-dawa	32.18%	362,617.39
Debas and Ibrahim.,2013	Gondar, ellfora	28.00%	674,093.04

Source: [69].

Risk factor

The most common production practices that increases the prevalence and the risk of exposure of domestic animals to cystic echinoccosis are traditional systems of raising animals (extensive or semi-extensive grazing). wide spread back yard slaughtering of animals, absence of rigorous meat inspection procedures, improper disposal of dead animals, keeping of high number of dogs, failure to treat dogs with anthelmintics, habit of feeding dogs with condemned offal and the subsequent contamination of pasture and grazing field where stray dogs have free acess [26]. The survival of the infective egg is influenced by environmental factors, such as humidity and temperature. While eggs may survive for several months under moist conditions and moderate temperatures. Desiccation is detrimental and they will only survive a short time when they exposed to direct sunlight and dry conditions [27].

Female animals were found to be more susceptible to the disease than male animals due to several reasons (i) female are kept for a longer period due to milk production and reproductive purposes than male [28]. Males are usually slaughtered at an early age [29], variation in the management of livestock usually females are managed near houses for milking purposes, which expose them more to come in contact with infected dogs [30].

The age of the animal is largely recognized as an infection determinant for many animal species. Several studies have recorded higher hydatidosis prevalence in old animals compared to young ones [31]. This could be mainly due to their longer exposure to *E. Granulosus* and to lower immunity against the infection. In addition, the reason for lower prevalence in cattle below five years might be early culling of the infected young cattle through slaughtering before they reach to adult and old age [10].

Prevalence of hydatidosis was also significantly influenced by body condition of affected animals. Those animals having poor body condition show higher prevalence (44%) of hydatidosis than animals with medium (26.5%) and good (8.1%) body condition score. This might be due to the fact that animals with poor body condition have low immunity to combat against the disease and poor body condition is probably a reflection of the effect of relatively high cyst burden [32].

Life cycle

Echinococcus species requires two mammalian hosts for completion of its life cycle [33]. Gravid proglottids or free eggs are passed along with the feces of the definitive host, a carnivore. The adult tapeworm is found in parts of small intestine of the definitive host, from where segments containing eggs are passed with the feaces. When the eggs are ingested by intermediate hosts like cattle, sheep, goats, pigs, and camel in which the metacestode develops, the onchospheres penetrates the wall of the small intestine [34].

A hormonal secretion from the onchospheres aids the penetration in to the intestine. Upon gaining access to a venue, the onchospheres is passively transported to the liver, where

some Public health importance of hydatidosis is retained, others reach the lungs, and a few may be transported further to the kidney, spleen, muscles, brain, and other visceral organs. Once the onchospheres has reached its final location, it develops into the metacestode stage (hydatid cyst). The hydatid cyst develops slowly over several months, forming an outer laminated membrane called the germinal layer. From the germinal membrane brood capsules develop, each containing one or several invaginatinated head (protoscolises) that can develop into the adult tapeworm upon ingestion by the definitive host [35].

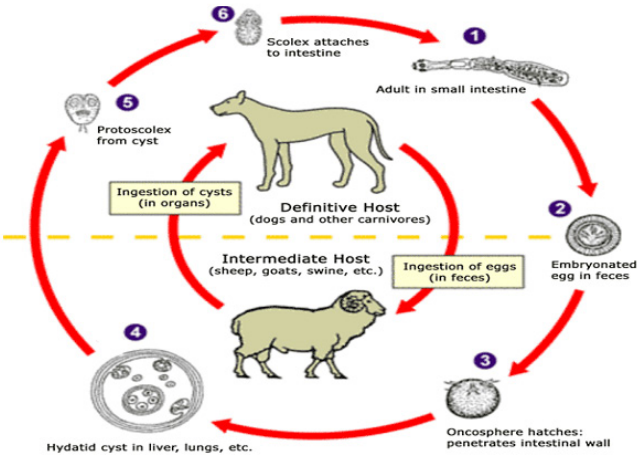


Figure 1: Life cycle of hydayidosis.
Source: Eckert and Thompson, 2017.

Transmission of hydatidosis to intermediate host

All disease causing species of Echinococcus are transmitted to intermediate hosts via the ingestion of eggs and are transmitted to definitive hosts by means of eating infected, cyst-containing organs. Cattle become infected when they swallow eggs from contaminated pasture and when hydatid eggs are swallowed by an intermediate host or cattle; they migrate through the stomach wall into the bloodstream [36]. The infection is transmitted to dogs when they feed on infected viscera of intermediate host during slaughter; dogs also get infected through scavenging. The disease is transmitted to humans through direct contact with dogs and consuming vegetables and water contaminated with dogs' feces. Humans are accidental intermediate host and are unable to transmit the disease [15].

Zoonotic importance

Hydatidosis caused by larval stages of *Echinococcus granulosus* is one of the most common zoonotic diseases associated with severe economic losses and great public health significance worldwide [19]. Echinococcus infections are estimated to affect approximately two to three million people worldwide, with Africa amongst the primarily endemic regions [37]. Humans are infected by ingesting eggs of *E. granulosus* through contaminated food, water and soil, or through direct contact with dogs [38]. In humans the cyst may reside and grow in liver, lung and other visceral organs. Occasional rupture of the cysts often leads to sudden death because of anaphylaxis, hemorrhage and metastasis [39].

Hydatidosis has the greatest public health impacts in rural communities of developing countries. Effective west disposal and prohibition of entrance of animals like dogs, cats, birds and other wild animals to abattoirs will play a crucial role in reducing the incidence of the disease [40].

Economic importance

Hydatidosis affects both human and livestock health and productivity, it is important to include both the human-associated and livestock-associated economic losses. Direct and indirect losses were the basis for the estimation of the annual economic losses. The human-associated economic losses are both direct and indirect costs. Direct costs include costs associated with diagnostics, treatment, and follow-up care. Indirect costs include costs associated with treatment related travel expenses, lost wages, and decreased productivity due to hydatidosis related morbidity and mortality (Glenda, *et al*., 2016). Similarly, in livestock-associated economic losses, Direct and indirect losses are the basis for the estimation of the annual economic losses. Direct losses were calculated on the basis of condemned organs, death and premature slaughter, whereas the indirect losses were estimated on the basis of live weight loss, decreased meat, milk and wool production caused by hydatidosis [24]. Abattoir data is an excellent option for detecting the direct economic importance of the hydatidosis in livestock (Aschalew *et al*., 2016).

In Ethiopia studies conducted in different abattoirs indicated that cystic hydatidosis is prevalent and considerable economic loss is associated with it. Different financial losses were reported from different part of the country. For example, significant financial loss was registered due to hydatidosis with an estimated loss of 19,847,704 birr per annum in Addis Ababa Abattoirs Enterprise (Dechasa *et al*., 2012). [41] reported 1,848,849.765 ETB in Kombolcha ELFORA Industrial Abattoir and [42] reported 148370 ETB losses per annum in Asella municipal abattoir. The difference in the amount of economic loss in different regions or localities could be due to the variation in the prevalence of the disease, retail market price of organs and mean annual slaughter rate in different abattoirs (Melak *et al*., 2012).

But these losses and infection prevalence do not show the real estimates because these estimates are made by meat inspection in abattoirs only and many animals slaughtered at backyard are not been included (Atsede and Abeba, 2015).

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 in Abattoir. 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 otherwise is of great relevance where economic realities often determine the type and scope of the control measures to be envisaged [42].

Clinical sign and diagnosis

The symptoms of echinococcosis depend on the size, number and the location of the metacestodes [43]. It can occur in any organ but is most commonly seen in the liver and lungs with respective frequencies of 60% and 20–30% of all cases [44]. Until the cysts become large enough to damage adjacent tissues and organs, they are usually asymptomatic. Large numbers of parasites may be able to cause enteritis, abdominal pain, abdominal distention, diarrhea, weight loss, weakness, nausea, jaundice vomiting, chronic cough, chest pain, and difficulty breathing [8]. The diagnosis of CE in individual patients is based on identification of cyst structures by imaging techniques, predominantly ultrasonography, computed tomography, X-ray examinations, and confirmation by detection of specific serum antibodies by

immunodiagnostic testes [45].

Treatment

Until the 1980s, surgery was the only treatment option for Hydatidosis, but chemotherapy with benzimidazole, praziquantel compounds, and more recently, cyst puncture, aspiration, chemical injection, and re aspiration have been introduced and, increasingly, have supplemented or even replaced surgery as the preferred treatment option for Hydatidosis [46].

Oxfendazole, like albendazole, is used in veterinary medicine to treat infections. Their ant parasitic spectra are comparable, but oxfendazole has a substantially longer half-life. Furthermore, unlike albendazole, oxfendazole is effective against the intestinal stage of E. granulosus as well as other gastrointestinal cestodes, and hence could be utilized to treat infection in dogs, which are the main reservoir for human infection. The finest agents available for treating human hydatid illness are benzimidazole and albendazole. Albendazole's efficacy, as evaluated by the removal of a cyst, is often less than 30% in ideal circumstances, according to most studies. In all, 60 percent of cysts respond to therapy in some way, such as shrinking in size or separation of cyst components from the wall. Albendazole should be taken every day for 4 to 6 weeks, and the treatment should be repeated two or three times more [47]. Surgery, percutaneous treatment, pharmacological medication, and monitoring are among approaches for treating CE in humans [48].

Prevention and control

Several E. granulosus control approaches have been thoroughly examined and are reported in detail elsewhere [49] One approach (type I) focuses on long-term public health education initiatives in conjunction with primary health care and veterinary public health activities, such as improving slaughter cleanliness and meat inspection, burning or burying condemned offal, dog registration, and sanitation measures [50].

In endemic areas, wild animals contact with dog and foxes should be avoided, although, it is impractical to eliminate the parasite from these wild animal hosts. Infection in dogs and cats prone to eat infected rodents can prevent by monthly treatment with praziquantel [19]. Vaccination of the intermediate host is also a burgeoning area that has moved forward considerably in recent years following the development of a recombinant vaccine against Taenia ovis infection in sheep [51].

Materials and Methods

Study area

The study was conducted at Haramaya municipal abattoir, in Haramaya town, which is found in East Hararghe administrative zone of Oromia Regional in Eastern Ethiopia. The study area has a latitude and longitude of 9°24'N 42°01'E and the area is found at an altitude of 1600-2100 m.a.s.l. with 64.5 relative humidity, is 510 Km far from Addis Ababa. The district experience rain fall with a short rainy season occurs usually in February and long rainy season extends from July to September. The annual rain fall of the areas ranges from 118-866 mm similarly the average monthly minimum and maximum temperature of the area is 9.4 and 24 co, respectively. Mixed crop livestock farming is the predominant production system in the rural area. The main livestock types kept in the area includes cattle, sheep, goat, camel, donkey and poultry. The total cattle population of Haramaya woreda is about, 98090, 120145 goat, 69950 sheep, 480 camel and 28250 Equine species [52].

Study population

The study animals were comprised of both cross and local breeds of both sexes brought for slaughter at the Haramaya municipal abattoir. But majority of the animals brought for slaughter were local breed and very few were cross breeds. In haramaya municipal abattoir average ten (10) cattle slaughtered daily. The sources for these animals were from nearby markets; namely, dawe, kersa, haramaya.

Study design

A cross-sectional study design was carried out to determine the prevalence of bovine hydatidosis and its associated economic loss in Haramaya Municipal abattoir from March 2021 to September, 2021.

Sample size determination and sampling methods

Simple random sampling technique was employed in the lairage to select the required number of study population. The sample size is determined according to the formula of [53] using 95% confidence interval and 0.05 absolute precision as follows:

$$N=\frac{1.96^2\ Pexp\ (1-Pexp)}{d^2}$$

Where N= required sample size, P exp = expected prevalence, D = desired absolute precision, 1.962 = z- value for 95% confidence interval. As a result, 384 animals will be sampled.

Study methods

Ante mortem examination

Simple random sampling technique was employed in the lairage to select the required number of study population. Each week, 20 animals were inspected. During the visit sex, age, breed, body condition and origin of animals were recorded. All the animals were identified on the basis of enumerated marks on their body surface using ink, and this marking was transferred to all visceral organs during postmortem inspections. The age of cattle was determined by dental examination according to [54] and animals age were classified as young (< 5 years), adult (5-8years) and old (> 8). The body condition scoring was also classified into three categories as lean (Score 1, 2 and 3), medium (Score 4-6) and fat (7-9) according to [56].

Postmortem examination

Important visceral organs (lung, liver, heart, spleen and kidney) of all study animals were inspected by visual inspection, digital palpation and systematic incision to detect presence of hydatid cysts.

Data analysis

Data obtained from ante mortem and postmortem findings in the abattoir were coded and loaded into Microsoft Excel 2010 spread sheet. Then, it was analyzed by using SPSS version 20.0 for windows software and description was made using descriptive statistics and the P-value less than 0.05 were considered as significant.

Economic loss estimation

Direct and indirect losses were the basis for the estimation of the annual economic losses due to hydatidosis. Direct loss was calculated on the basis of condemned organs, whereas indirect losses were estimated on the basis of live weight loss caused by hydatidosis. Accordingly, the economic values of the loss

from organ condemnations were evaluated by considering the following parameters. These includes information on the mean retail market price of the organs (Lungs, liver, spleen, heart and kidney) at Haramaya town obtained from butchers during the study period and the average annual slaughter rate of cattle at Haramaya municipal abattoir estimated from the retrospective data. And, the loss from organs condemned was calculated by using the formula (Negassa *et al*., 2010) as follows:

LOC= (NAS*ph*plu*Cplu) + (NAS*Ph*Phr*Cphr) + (NAS*Ph*pli*Cpli)+(NAS*Ph*Psp*Cpsp)+

(NAS*Ph*Pkid*Cpkid)

Where,

LOC: Loss Due To Organ Condemnation; NAS: Mean Number Of Cattle Slaughter Annually; Ph: Prevalence Of Hydatidosis; Plu: Persent Involvment Of Lung; Cplu = Current Mean Retail Price Of Lung; Phr: Persen Involvment Of Heart; Cphr: Current Mean Retail Price Of Heart; Pli: Present Involvement Of Liver; Cpli: Current Mean Retail Price Of Liver; Psp: Present Involvement Of Spleen; Cpsp: Current Mean Retail Price Of Spleen; Pkid: Present Involvement Of Kidney; Cpkid : Current Mean Retail Price Of Kidney.

Likewise, the following parameters were considered to estimate the economic loss due to carcass weight loss: Information on the mean market cost of 1 kg beef at Haramaya town obtained from restaurants during the study period. The average annual slaughter rate of cattle at the abattoir obtained from retrospective data. The average carcass weight loss of 5% due to hydatidosis thus, the economic loss due to carcass weight loss was determined as described by using the following formula.

LCWL=NAS*Ph*Cpb*5%*108 kg Where,

LCWL=Loss from Carcass Weight Loss

5%=estimated carcass weight loss due to hydatidosis

108 kg=Average carcass weight of Ethiopian local breed is estimated

NAS=average number of cattle slaughtered annually

Ph=prevalence of hydatidosis

Cpb=current average price of 1 kg beef at Haramaya town

Finally, the total economic loss was calculated by considering the losses from both organ condemnation and carcass weight loss (Nigatu *et al*., 2009). Thus,

Total loss=LOC+LCWL.

Result

Overall prevalence

In the current study, a total of 384 cattle at haramaya municipal abattoir in haramaya town were examined for the presence of hydatid cysts. Out of the total examined cattle, 41 (10.7%) were found to harbor hydatid cysts in one or more of their internal organs (**Table 2**). Cattle with poor body condition score had the prevalence of hydatidosis (28.3%), followed by medium body condition score (9.84%) and the least prevalence were observed in good body condition scoring cattle (5.41%) and the difference was statistically significance ($p< 0.05$). Infection of hydatidosis with respect to age group showed that higher prevalence seen in cattle > 8 years and 5 to 8 years than those under 5 years old and the difference was statistically insignificance ($P > 0.05$). Higher prevalence was observed in local breeds (10.9 %) than cross breeds of cattle (7.7%). The prevalence's were 4.4%, 9.7% and 14.4% for dawe, kersa and haramaya, respectively, (**Table 3**), where it was higher for haramaya.

Table 2: Total prevalence of affected animal at haramaya municipal abattoir in 2021.

Examined cattle	Frequency	Percent
Non Affected cattle	343	89.3%
Affected cattle	41	10.7%
Total	**384**	**100%**

In this study, body condition, age, breed, sex and origin were considered as potential risk factors for the occurrence of hydatidosis (**Table 3**).

Table 3: Analysis of potential risk factors associated with the occurrence of hydatidosis at haramaya municipal abattoir in 2021.

Risk factor	Number of examined	Number of infected	Percentage	prevalence	Prevalence of total examined animals	χ2	P-value
Sex							
Female	171	21	44.5	12.3	5.5	.831	0.362
Male	213	20	55.5	9.4	5.2		
Age							
Young	58	1	15.1%	1.7%	0.26%	12.881	0.002
Adult	279	29	72.7%	10.4%	7.55%		
Old	47	11	12.2%	23.4%	2.86%		
Breed							
Local	358	39	93.2	10.9	10.2	0.261	0.610
Cross	26	2	6.8	7.7	0.5		
Body condition							
Poor	53	15	13.8%	28.3%	3.9%	21.711	0.0001
Medium	183	18	47.7%	9.8%	4.7%		
Good	148	8	38.5%	5.4%	2.1%		

Origin							
Haramaya	180	26	46.9%	14.4%	6.8%	6.549	0.038
Kersa	113	11	29.4%	9.7%	2.9%		
Dawe	91	4	23.7$	4.4%	1%		

The postmortem examination revealed that the distribution of cysts involved liver, lung, and kidney. Among 384 cattle examined for hydatid cyst, the most affected organ was liver (63.1%) followed by lung (34.1%) and the least affected organ was the kidney, which accounts only (14.6%) (**Table 4)**.

Table 4: Number of infected organ with their prevalence's at haramaya municipal abattoir in 2021.

Organ	Number infected	Prevalence from infected animal	Prevalence from total examined animal
Liver	26	63.41%	6.8%
Lung	14	34.1%	3.6%
Kidney	6	14.6%	1.6%
Heart	0	0	0
Spleen	0	0	0
Total	46		12%

Number of infected organs and economic loss estimation

Post mortem examination revealed that out of 46 organ examined, 26 (63.1%) of liver were harboring one more hydatid cysts, 14(34.1%) of lung and 6 (1.6 %) of kidney, where harboring one or more hydatid cyst (**Table 4**). Estimation of economic loss: In the present study, a total of 26 livers, 14 lungs and 6 kidneys were condemned due to detection of hydatid cysts. The assessment of retail average market price of these organs in Haramaya town was 50.00, 30.00and 20.00 ETB, respectively. The mean number of animals slaughtered annually at abattoir was determined from the records of the last two years as 3200. The total annual Loss From Offal Condemnation (LOC) =1,643.52 and Loss From Carcass Weight Loss (LCWL) =554,688 in cattle slaughtered at haramaya municipal abattoir was estimated to be 556,331.52 ETB.

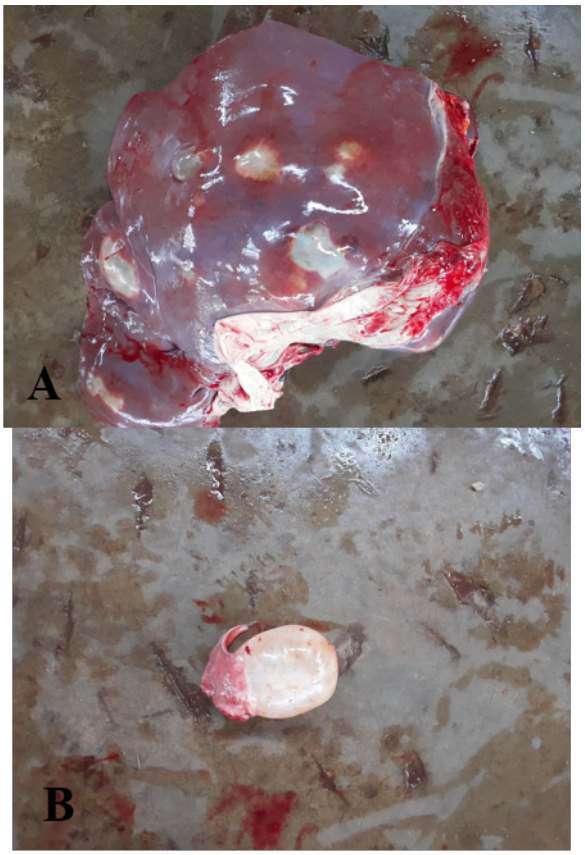


Figure 2: Hydatid cyst in liver **(A)** and lung **(B)**.

Table 5: Distribution of organs condemnation, total rejection rates, average current market price and money losses due to rejection of these organs at haramaya municipal abattoir in 2021.
The major organ condemned in the abattoir were liver (26) followed by lung (14) (Table 5).

Organs	Total organs rejected	Average current market price	Annual slaughter rates of cattle	Money losses in ETB
Liver	26	50	3200	1,164.16
Lung	14	30	3200	369.792
kidney	6	20	3200	109.568
Total	**46**			**1,643.52**

Discussion

In the present study the prevalence of bovine Hydatidosis in Haramaya municipal abattoir was found to be 10.7%. This finding was comparable with previous reports by different researchers in country, 9.4% at harar municipal abattoir by [57]. Higher prevalence rate on hydatidosis compared to this finding was reported, 20.1% by [] Miheret *et al*., (2013), 18.2% by [58] 11.88% by [59] at bako municipal abattoir and 11.30 by [60]. However the prevalence obtained in this study was much higher than the reports, 7.5% at shire by [61], 6.51 at Debra berhan municsipal abattoir by [10]. Generally variation among the prevalence of Hydatidosis at different geographical location was associated with the strain difference of *Echinococcus granulosus* that exist in different geographical locations Mc Manus, (2006). Additionally variation could be with age factors of the animals and other factors like difference in culture, socio economic activities and attitudes to dogs and their populations. Similar to the present findings, it was reported that cystic echinococcosis infection was higher in older animals as reported by Azlaf and Dakk (2006). Animals with more than Eighth 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 as the report of Himonas, (1987). Estimating the rate of infection of hydatidosis between breeds of cattle was done and higher prevalence was observed in local breeds (10.9 %) than cross breeds of cattle (7.7%). But no significant difference ($p> 0.05$) was observed between the two breeds. No significant

variation was noticed with regard to sex of animals. This may be explained by indiscriminate exposure to risk irrespective of sex in the management system of the area.

The prevalence of Hydatidosis by origin of slaughtered cattle was assessed and statistically significant difference of (P< 0.05) was found indicated that geographical region play an important role in the distribution of cyst according to this study. In this study, animals brought from haramaya area have high prevalence rates followed by Kersa area. This could be due to the difference in the socio-economic status and animal husbandry practices of the community and agro ecology of the areas from where the animals brought for slaughter. This finding was similar with the report of [62] and [63]. Statistically significant association (p<0.05) was recorded between body condition and occurrence of hydatidosis. Higher infection of hydatidosis was registered in animals that had poor body condition 53 (28.3%) followed by medium 18 (9.8%). This may be due to hydatidosis causes reduction in weight gain and growth. Symptoms can occur a long time after infection, sometimes months or years later and may not be symptoms at all [64]. This asymptomatic and chronic nature of the disease causes unexplained weight losses. The prevalence of hydatidosis among different organs involved in harboring of the cyst showed that liver was found to be the most commonly affected organ followed by lung. Similar findings were reported by [57]. In this study, it has been shown that hydatid cysts occurred most commonly in the liver (63.1%) followed by the lung (34.1%) and kidney (1.6%) (**Table 4**). This is in agreement with the findings of Njoroge *et al*., (2002) and [19], which show that the lung and liver are the most common sites of hydatid cyst in domestic animals. this is explained by the fact that liver and lung possess the first greater capillary sites encountered by the migrating E. granulosus oncosphere (hexacanth embryo) which adopt the portal vein route and primarily negotiate hepatic and pulmonary filtering system sequentially before any other peripheral 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 as reported by [65].

In the current study, an assessment was done on annual economic loss due to bovine hydatidosis at haramaya municipal abattoir. Losses from organ condemnation and carcass weight loss (meat production loss) in infected cattle were assessed and estimated at 556,331.52ETB. The current estimate is greater than estimates done by [61] (25,608 ETB) in Tigray region. However, it is lower than 1,791,625.89 ETB that estimated by Regassa et al., (2010) in Hawassa municipal abattoir. The difference in economic loss estimates in various abattoir or regions may be due to the variations in the prevalence of disease, mean annual number of cattle slaughtered in different abattoirs, and variation in the retail market price of organs.

Conclusion and recommendation

From the present study, it can be concluded that hydatidosis was one of the most important parasitic diseases in cattle slaughtered at Haramaya municipal abattoir where it is possible to say that, the observed overall prevalence was high. Liver and lung were the most frequently affected and condemned organs. Age of the animals and the origin were found to be risk factors for the occurrence of the disease. Hydatidosis also causes substantial visible and invisible economic losses in cattle in the study areas as a result of condemnation of edible offal and carcass weight loss. The financial loss estimated in the area due to the disease was also not minimal. Based on the above conclusion the following recommendations were forwarded.

- Proper condemnation of organs is suggested.
- A control program should be designed and implemented to reduce the number of stray dogs.
- Regular deworming of dogs should be practiced.
- Working on the public awareness should be given emphasis and
- Subspecies and strain identification of *E. granulosus*, followed by immunological study of infected animals should be carried out.

Declaration

I under signed, declare that the information presented here in my thesis is my original work, has not been presented for degree in any other university and that all source of materials used for the thesis have been dully acknowledged.

Name: CHALA AHMED

Signature: _____

Date of submission:

This thesis has been submitted for examination with my approval as university advisor

Name: Dr. ARAYA MENGISTU

Signature_____

References

1. Mandefro M, Tilahun B, Bayu Y, Zeryehun T. Prevalence of bovine hydatidosis and its economic importance in Adama Municipal Abattoir, Eastern Ethiopia. Ethiopian Veterinary Journal. 2019; 23: 24-41.
2. Abdeta D, Desissa F, Deresa B, Moje N, Assefa Z, et al. Epidemiology and Financial Loss of Bovine Hydatidosis in Cattle Slaughtered at Nekemte Municipal Abattoir, Ethiopia. 2014.
3. Alton GD, Pearl DL, Bateman KG, McNab WB, Berke O, et al. Factors associated with whole carcass condemnation rates in provincially-inspected abattoirs in Ontario 2001-2007: Implications for food animal syndromic surveillance. BMC veterinary research. 2010; 6: 1-11.
4. Nigatu K, Mekonnen H, Wossene A, Tilahun G. Hydatidosis of slaughtered cattle in Wolaita Sodo Abattoir, Southern, Ethiopia. Trop an Heal Prod. 2009; 41: 629-633.
5. Da Silva AM. Human echinococcosis: a neglected disease. Gastroenterology Research and Practice. 2010.
6. Magambo J, Njoroge E, Zeyhle. Epidemiology and control of echinococcosis in sub-Saharan Africa. Parasitology International. 2006; 55: 193-195.
7. Tappe KH, Mousavi SJ, Barazesh A. Prevalence and fertility of hydatid cyst in slaughtered livestock of Uramiacity , northwest Iran. Journal of parasitology and Vector Biology. 2008; 32: 29-32.
8. Paraja SC. Text book of medical parasitology: Protozology and helemintology symbol. 4th ed., All India Publishers & Distributors. 2013; 3: 93-94.
9. Hiko A, Ibrahim H, Agga GE. Journal of Veterinary Science & Technology. 2018.

10. Akeberegn D, Alemneh T, Kassa T. The prevalence of bovine hydatidosis among slaughtered cattle at DebreBerhan Municipal Abattoir, North Shewa Zone, Ethiopia. Journal of Veterinary Science and Medicine. 2017.

11. Ito A, Budke CM. The echinococcoses in Asia: the present situation. Actatropica. 2017; 176: 11-21.

12. Jafer M, Tase I, Abdurehman A, Mohammed M, Abiyi D, et al. Review on Socio-Economic Significance of Hydatidosis in Humans and Animals in Ethiopia. Journal Microb Biochem Technol. 2020; 12: 450.

13. Thompson RA. McManus DP. Towards a taxonomic revision of the genus Echinococcus. Trends in Parasitology. 2002; 18: 452-457.

14. Romig T, Omer RA, Zeyhle E, Huettner M, Dinkel A, et al. Echinococcosis in sub-Saharan Africa: Emerging complexity. Veterinary Parasitology. 2011; 181: 43-47.

15. Budke CM, Deplazes P, Torgerson PR. Global socioeconomic impact of cystic echinococcosis. Emerging infectious diseases. 2006; 12: 296.

16. Jenkins DJ, Romig T, Thompson RCA. Emergence/re-emergence of Echinococcus spp. A global update. International journal for parasitology. 2005; 35: 1205-1219.

17. Wahlers K, Menezes CN, Wong ML, Zeyhle E, Ahmed ME, et al. Cystic echinococcosis in sub-Saharan Africa. The Lancet infectious diseases. 2012; 12: 871-880.

18. Huttner M, Nakao M, Wassermann T, Siefert L, Boomker JDF, et al. Genetic characterization and phylogenetic position of EchinococcusfelidisOrtlepp, (Cestoda: Taeniidae) from the African Lion. Int. J. Parasitol. 1937: 38: 861-868.

19. Eckert J Deplazes P. Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern, symbol Clinical Microbiology Reviews. 2004; 17: 107-135.

20. Ahmadi N, Dalimi A. Characterization of Echinococcus granulosus isolates from human, sheep and camel in Iran. Infection Genetics and Evolution. 2006; 6: 85-90.

21. Endiras Z, Yechale T, Assefa M. Bovine Hydatidosis in Ambo Municipality Abattior, West Shoa, Ethiopia. Ethiopian Veterinary Journal. 2010; 14: 1-14.

22. Hama AA, Ali FM, Mero WMS, Biochemical markers and fertility rate of hydatid cyst isolated from human and animal in Sulaimani province. Kurdistan Journal of Applied Research. 2017; 2: 1-5.

23. Ali KMAA. Prevalence and Risk Factors of Ovine Hydatidosis in West Omdurman Locality (Doctoral dissertation, Sudan University of Science & Technology). 2015.

24. Torgerson P. Transmission dynamics of taeniid parasites in animal hosts: In: Craig P, Pawlowski Z (Eds), Cestodezoonoses: Echinoccosis and cysticercosis: An emergent and global problem. IOS Press Amsterdam, Netherlands. 2002; 1-395.

25. Cardona GA. Carmena D. A review of the global prevalence, molecular epidemiology and economics of cystic echinococcosis in production animals. Veterinary parasitology. 2013; 192: 10-32.

26. Garippa G, Varcasia A, Scala A. Cystic echinococcosis in Italy from the 1950s to present. Parassitologia. 2004; 46: 387-391.

27. Shiferaw F, Bekele W, Giro B, Mequanint Y. Epidemiology and Economic Importance of Hydatidosis in Domestic Animal and Human in Ethiopia-A Review, J Vet Sci Technol. 2018; 9: 563.

28. Ehsan M, Akhter N, Bhutto B, Arijo A, Gadahi JA, et al. Prevalence and genotypic characterization of bovine Echinococcusgranulosus isolates by using cytochrome oxidase 1 (Co1) gene in Hyderabad, Pakistan. Veterinary parasitology. 2017; 239: 80-85.

29. Khan MA, Tanveer A, Younus M, Shafiq M, Saeed K, et al. Prevalence, organ specificity and economic impact of hydatidosis in the cattle slaughtered in the Lahore Abattoir. IJAVMS. 2010; 4: 38-40.

30. Haleem S, Niaz S, Qureshi NA, Ullah R, Alsaid MS, et al. Incidence, risk factors, and epidemiology of cystic echinococcosis: A complex socioecological emerging infectious disease in Khyber Pakhtunkhwa, Province of Pakistan. Bio Med research international. 2018.

31. Lahmar S, Chéhida FB, Pétavy AF, Hammou A, Lahmar J, et al. Ultrasonographic screening for cystic echinococcosis in sheep in Tunisia. Veterinary Parasitology. 2007; 143: 42-49.

32. Tadesse A, Ayele B, Asefa A, Haile B. Prevalence and Economic Significance of Bovine Cystic Echinococcosis in Debra Tabor Municipal Abattoir, North West Ethiopia. Acta Parasitol. Globalis. 2016; 7: 114-120.

33. Hossein M, Ebrahim S, Dezaki F, Kheirandish B, Ezatpour S, et al. Scolicidal Effects of Black Cumin Seed (Nigella sativa) Essential Oil on Hydatid Cysts. Korean Journal. Parasitology. 2014; 52: 653-659.

34. Bourée P. Hydatidosis: Dynamics of transmission. World journal of surgery, 25.

35. Schantz PM. Progress in diagnosis, treatment and elimination of echinococcosis and cysticercosis. Parasitology International. 2006; 55: S7-S13.

36. Geda Sh, Birhanu A, Mengestie A, Genene G. Review on Bovine Hydatidosis. Biomedicine and Nursing. 2017; 3: 12-23.

37. Cummings H, Rodriguez SM, Satoskar AR. Symbol Hydatid disease symbol, in A.R. identification, serology and risk factors, Symbol PLoS Neglected Tropical. Satoskar G.L. Sim J. Hotez & M. Tsuji (eds.), Medical parasitology. 2009; 146-150.

38. Pednekar RP, Gatne ML, Thompson RCA, Traub RJ. Molecular and morphological characterization of Echinococcusfrom food producing animals in India, Veterinary Parasitology. 2009; 165: 58-65.

39. Getaw A, Beyena D, Ayana D, Megersa B, Abunna F, et al. Hydatidosis: Prevalence and its economic importance in ruminants slaughtered at Adama municipal abattoir, Central Oromia, Ethiopia, ActaTropica. 2010; 113: 221-225.

40. Abebe F, Jobre Y. Infection prevalence of hydatidosis (Echinococcusgranulosus, Batsch, 1786) in domestic animals in Ethiopia: A synthesis report of previous surveys. Ethiopian Veterinary Journal. 2011; 15: 11-33.

41. Wubshet N, Mahendra Pal. Prevalence, cyst viability, fertility and economic significance of bovine hydatidosis in an abattoir at Kombolcha, Ethiopia. Haryana Veterinarian. 2016; 55: 17-22.

42. Nuraddis I, Aman Y, Yosef D. Prevalence and Economic Importance of Bovine Hydatidosis at Asella Municipal Abattoir South Eastern Ethiopia. Global Veterinaria. 2017; 19: 491-499.

43. Getachew H, Guadu T, Fentahun T, Chanie M. Small ruminant Hydatidosis: Occurrence and economic importance in Addis Ababa abattoir. Global Veterinaria. 2012; 8: 160-167.

44. Gottstein B, Reichen J. Hydatid lung disease (echinococcosis/hydatidosis). Clinics in chest medicine. 2002; 23: 397-408.

45. Teggi A, Di Vico B. Echinococcosis (CE) by Imaging Methods. Cestode Zoonoses: Echinococcosis and Cysticercosis: An Emergent

and Global Problem. 2002; 341: 125.

46. Buttenschoen K, Buttenschoen DC, Gruener B, Kern P, Beger HG, et al. Long-term experience on surgical treatment of alveolar echinococcosis. Langenbeck's archives of surgery. 2009; 394: 689-698.

47. Song H, Shao Y, Aili T, Ahan A, Wen H, et al. Comparative evaluation of liposomal albendazole and tablet-albendazole against hepatic cystic echinococcosis: A non-randomized clinical trial. Medicine. 2016; 95.

48. Pawłowski ZS, Eckert J, Vuitton DA, Ammann RW, Kern P, et al. Echinococcosis in humans: Clinical aspects, diagnosis and treatment. WHO/OIE manual on echinococcosis in humans and animals: A public health problem of global concern. 2001; 20-66.

49. Beard TC, Bramble AJ, Middleton MJ. Eradication in our lifetime: Alog book of the Tasmanian hydatid control programs, 1962-1996. Department of Primary Industries, Water and Environment. 2001.

50. Gemmell MA, Roberts MG, Beard TC, Campano D, Lawson JR, et al. Control of echinococcosis. WHO/OIE manual on echinococcosis in humans and animals: A public health problem of global concern. 2001; 195-204.

51. Lightowlers MW, Flisser A, Gauci CG, Heath DD, Jensen O, et al. Vaccination against cysticercosis and hydatid disease. Parasitology Today. 2003; 16: 191-196.

52. Haru District Agricultural Office (HDAO), Haru District Livestock production and Productivity Report. 2011; 3-8.

53. Thrusfield M. Veterinary Epidemiology, 3rd ed. Singapore, Black well Science. 2005; 233-236.

54. De-Luata A, Habel RE. Teeth. Applied Veterinary .USA. W. B. Sounders company. 1986; 5-15.

55. Eckert J, Gemmell MA, Meslin FX, Pawlowski Z, et al. WHO / OIE Manual on Echinococcosis in humans and animals: A public health problem of global concern. Paris: Office International des. Epizooties. 2002; 202-225.

56. Nicolson M. Butterowrth M. A guide to condition scoring of Zebu cattle. International center for Africa, Addis Ababa, Ethiopia. 1986.

57. Belina D, Fekadu G, Zegaye E, Belina S, et al. Bovine hydatidosis: Prevalence, public health and its economic significance in and around Harar, Ethiopia. Journal of Veterinary Medicine and Animal Health. 2015; 7: 18-26.

58. Abdeta D, Desissa F, Deresa B, Moje N, Assefa Z, et al. Epidemiology and Financial Loss of Bovine Hydatidosis in Cattle Slaughtered at Nekemte Municipal Abattoir, Ethiopia. 2014.

59. Berihu H, Toffik K. Study on prevalence and economic significance of bovine hydatidosis in Bako municipal abattoir, West Shoa zone, Oromiya regional state. Journal of Veterinary Science and Technology. 2014; 5.

60. Lemma B, Abera T, Urga B, Niguse A, Agonafir A, et al. Prevalence of bovine hydatidosis and its economic significance in Harar municipality abattoir, eastern Ethiopia. American-Eurasian Journal of Scientific Research. 2014; 9: 143-149.

61. Kebede W, Hagos A, Girma Z, Lobago F. Echinococcosis/hydatidosis: Its prevalence, economic and public health significance in Tigray region, North Ethiopia. Tropical Animal Health and Production. 2009; 41: 865-871.

62. Mekuriyaw AG, Kebede T, Zenebe T, Kabeta, Ademssie. Prevalence of Bovine Hydatidosis and Its Cyst Characterization in Debre Zeit Elfora Export Abattoir, Oromia Regional State, Ethiopia Nat. Sci. 2016; 14: 87-98.

63. Nasr W, Pal M. Prevalence, cyst viability, fertility and economic significance of bovine hydatidosis in an abattoir at Kombolcha, Ethiopia. Haryana Veterinarian. 2016; 55: 7-22.

64. Mulatu M, Mekonnen B, Tassew H, Kumar A, et al. Bovine hydatidosis in eastern part of Ethiopia. Momona Ethiopian Journal of Science. 2013; 5: 107-114.

65. Alula A. Major Metacestodes in cattle slaughtered at Kombolcha Elfora abattoir, North Eastern Ethiopia: prevalence, cyst viability, organ distribution and socio-economic implications. DVM Thesis, Hawassa University, Department of Veterinary Medicine, Hawassa, Ethiopia. 2010.

66. Bingham GM, Larrieu E, Uchiumi L, Mercapide C, Mujica G, et al. The economic impact of cystic echinococcosis in Rio Negro Province, Argentina. The American journal of tropical medicine and hygiene. 2016; 94: 615-625.

67. Eckert J, Thompson RCA. Historical aspects of echinococcosis. Advances in parasitology. 2017: 1-64.

68. Hailu SB, Bishoftu E. Revew on prevalence and economic significance of bovine hydatidosis in ethiopia. 2018.

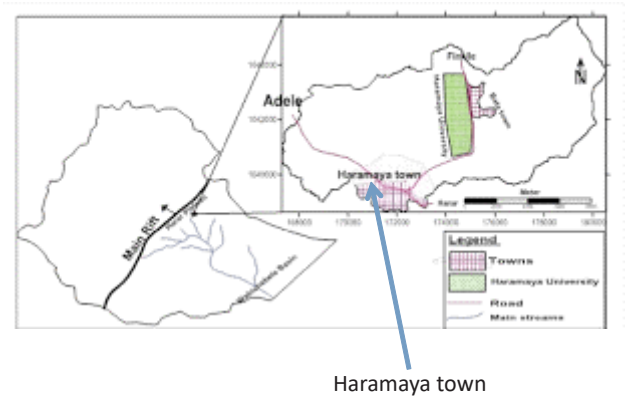
69. Mebrahtu B, Mesele T, Tekie T, Teklit Y. Echinococcosis: The Status of Cystic Hydatidosis in Ethiopia. 2019; 2: 2581-3226.

70. Terefe D, Kebede K, Beyene D, Wondimu A. Prevalence and financial loss estimation of hydatidosis of cattle slaughtered at Addis Ababa abattoirs enterprise. Journal of Veterinary Medicine and Animal Health. 2012; 4: 42-47.

Annex 1: Data collection format.

No	SEX		AGE			BREED		BCS			ORIGIN			RRSULT	EXAMINE ORGAN				
	M	F	Y	A	O	L	C	P	m1	G	H	K	D		liver	lung	heart	kidney	spleen
1																			
2																			
3																			

Remarks: M: Male; F: Female; Y: Young; A: Adult; O: Old; L: Local; C: Cross; P: Poor; M1: Medium; G: Good; H: Haramaya; K: Kersa; D: Dawe.



Haramaya town