Journal of Science and Sustainable Development (JSSD), 2017, 5(1), 57-71

ISSN: 2304-2702 (print); 2414-4479 (online)
DOI: https://doi.org/10.20372/au.jssd.5.1.2017.067

Prevalence, Organ Distribution, Cyst Viability and Financial Losses of Bovine Hydatidosis in Shashemene Municipal Abattoir, Ethiopia

Awol Hussen[1], Jelalu Kemal[1], and Alemayehu Regassa[2]
[1]Haramaya University College of Veterinary medicine, P. O. Box 138, Dire Dawa, Ethiopia
E- Mail: jelaluk@gmail.com; awolhussein@gmail.com
[2]Hawassa University school of Veterinary Medicine, P. O. Box 05, Hawassa, Ethiopia.
E-mail: alemregassa@yahoo.com respectively

Abstract

A cross-sectional study was conducted from November 2015 to May 2016, to estimate the prevalence, organ distribution, cyst viability and financial losses of bovine hydatidosis in Shashemene municipal abattoir. A total of 405 samples were collected from cattle slaughtered at the abattoir using simple random sampling method. The cattle were examined clinically both at rest and in motion during ante mortem examination. For the post-mortem examination visceral organs were inspected for the presence of hydatid cysts by applying meat inspection procedure. Individual cysts were grossly examined for any evidence of degeneration and calcification. The viability of protoscoleces was assessed by the motility of flame cells. Out of the total examined cattle, 191 (47.2%) were harboring hydatid cyst from one or more of their visceral organs. There was statistically significant association (P <0.05) between age and body condition of the cattle slaughtered with the occurrence of hydatidosis. The prevalence of hydatidosis was higher among animals with advanced age and, animals with medium and poor body condition. The proportion of organs infected by hydatidosis was found to be 68.13% in lungs, 29.30% in liver and 2.56% in spleen. In this study, the estimated financial loss due to organ condemnation was 12,590.00 ETB. The study indicated that hydatidosis is economically important parasitic disease of cattle with implication of public health importance. Application of detail meat inspection, proper disposal of infected organs and control of stray dogs are of paramount importance to control the disease.

Keywords: Cattle, hydatid cyst, financial losses, liver, lung, prevalence

Introduction

Ethiopia has the largest livestock population in Africa (CSA, 2015). This livestock sector has been contributing considerable portion to the economy of the country, and still promising to bring together the economic development of the country. It is eminent that livestock products and by-products in the form of meat, milk, honey, eggs, cheese, and butter supply etc. provide the needed animal protein that contributes to the improvement of the nutritional status of the people. Livestock also plays an important role in providing export commodities, such as live animals, hides, and skins to earn foreign exchanges to the country (Abunna *et al*., 2009). Ethiopia has an estimate of about 56.71 millions of cattle, 29.33 millions of sheep, 29.11 millions of goats, 1.16 million of camels, 9.86 millions of equines and 56.87 millions of chickens (CSA, 2014).

However, the contribution from these huge livestock resources to the national income is disproportionately small, owing to several factors. Among them, parasitic diseases are considered as a major problem in health and product performance of livestock. Hydatidosis is one of the most important parasitic diseases, which affects the efficiency of both animals and Human being (Cringoli *et al*., 2007). The disease occurs throughout the world and causes considerable economic losses due to condemnation of offal containing hydatid cysts in slaughter houses, decreased livestock production and public health problems in many countries (Ernest *et al*., 2008).

Echinococcosis occurs in four forms: cystic echinococcosis, also known as hydatid disease or hydatidosis, caused by infection with *Echinococcus granulosus*; alveolar echinococcosis, caused by infection with *Echinococcus multilocularis*; polycystic echinococcosis, caused by infection with *E. vogeli*; and unicystic echinococcosis, caused by infection with *Echinococcus oligarthrus*. The two most important forms, which are of medical and public health relevance in humans, are cystic echinococcosis and alveolar echinococcosis (WHO, 2016). The adult *E. granulosus* inhabits small intestine of dogs and wild canids. *Echinococcus* adult worms develop from protoscolices and are typically 6 mm or less in length and have head (scolex), neck and the body (strobilla) (Thompson and McManus, 2002; John *et al*., 2006).

This multi host parasite is prevalent all over the world and annual economic loss in livestock due to this parasite is highly significant. In Africa, hydatid disease is reported more common in cattle those are communally owned or raised of free range and which associated more intimately with domestic dogs. Hydatidosis in domestic ruminants inflicts enormous economic loss via decreasing livestock production and condemnation of red and green offals in slaughterhouses (Tavakoli *et al*., 2008).

In Ethiopia, hydatidosis has been known and documented as early as 1970's and is the major cause of organ condemnation in most Ethiopian abattoirs and slaughterhouses causing huge economic losses to the livestock industry (Hagos, 1997). In the country, studies conducted in different abattoirs indicated that, cystic hydatidosis is prevalent and considerable economic losses are associated with it. Previously, hydatid cyst prevalence ranges of 9.4% to 61% were reported at Harar (Belina *et al*., 2015) and Asela (Koskei, 1998) municipal abattoirs in the country, respectively. Some traditional activities could be commonly described as factors substantiating the spread and high prevalence of the disease in many areas of the country. These may include the widespread backyard animal slaughtering practice, the corresponding absence of rigorous meat inspection procedures and long-standing habit of the most Ethiopian people to feed their dogs

with condemned offal. Such conditions can effect facilitate the maintenance of the perfect life cycle of *E. granulosus* and consequently high rate of infection of susceptible hosts (Kebede, 2010). Even though some studies were conducted on the prevalence of bovine hydatidosis, till there is limited information on the current status of the disease in the study area which necessitated further study. Therefore, the objectives of this study were to estimate the occurrence of bovine hydatidosis and its financial loss, and determine the proportion and different characteristics of the cysts and its organ distribution in Shashemene municipal abattoir, Ethiopia.

Materials and Methods

Description of the study area

The study was conducted at Shashemene municipal abattoir, west Arsi zone, Oromia regional state, which lies within the rift valley of Ethiopia and located at 250 km south of Addis Ababa. Geographically, the town is located at 7^{o} North Latitude and 38^{o} East Longitude. The urban land of Shashemene stretches over 1,858 hectares of land. Climatically, Shashemene district falls into three climatic zones known as *Dega, Woinadega* and *Kolla.* Its altitude ranges from 1,672 to 2,722 meters above sea level. The temperature ranges from 12-28 °C and yearly rainfall varies from 1,500-2,000 mm (Abraham *et al.*, 2006). This Zone has a total human population of 1,964,038, of whom 973,743 are men and 990,295 women (CSA, 2014).

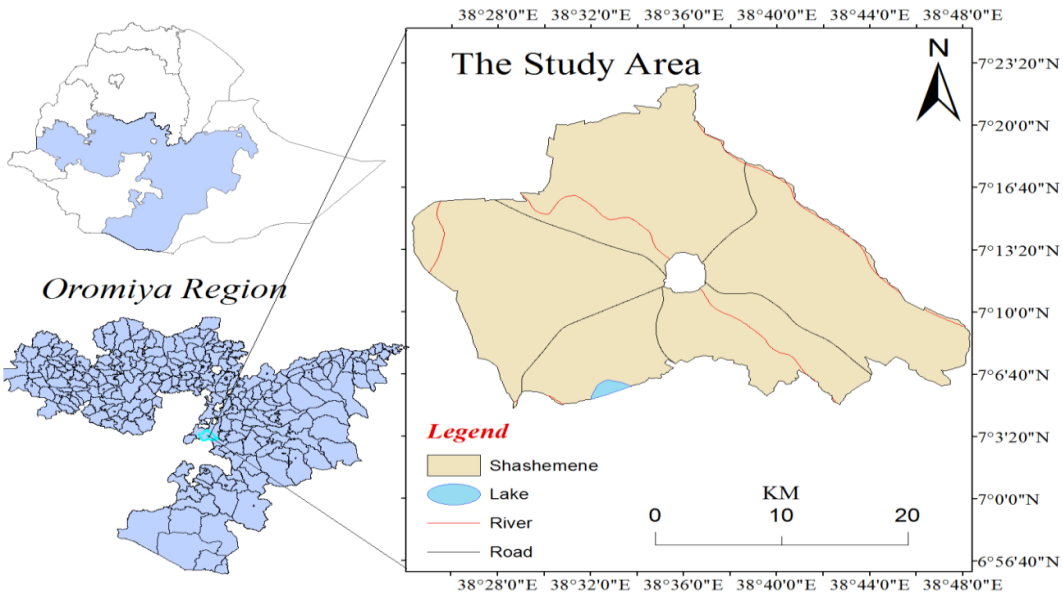

Figure 1. Illustrative representation of Shashemene, west Arsi zone, Oromiya region Ethiopia.

Study population

Study population was cattle that were brought mainly from Arsi Nagelle, Kofale and Shashemene district for slaughter at Shashemene municipal abattoir. On average, 50 cattle were slaughtered at the abattoir three days per week in which local and cross breeds were included. All the slaughtered animals in the abattoir were male. Extensive system is dominant farming system of the study area in which animals are allowed to graze in free range land.

Study design

A cross sectional study was conducted from November, 2015 to May, 2016 in Shashemene abattoir, west Arsi zone. A total of 405 cattle were selected using simple random sampling method and slaughtered at the abattoir. Both ante mortem and postmortem inspection procedures were carried out during the study periods. Information like origin, body conditions, age, sex and lesion distribution as well as nature of the cyst was recorded using standard format. Age estimation was also done based on observation of animals and dentition. Cattle were grouped into young (1 to 2 year), adult (3 to 7 years) and old (>8 years). Age and body condition of the slaughtered animals was determined based on De Lahunta and Habel (1986) and Nicholson and Butter Worth (1986) respectively.

Sample size determination

The required sample size of the study was determined as described by Thrusfield (2005) with the expected prevalence of 50.1% (Regassa, 2014) using 95% confidence interval and 5% desired precision.

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

Where N = required sample size; P_{exp} = expected prevalence and d = desired absolute precision (usually 0.05)

Based on this formula 383 animals were selected and due to need for precision, the sample size was increased by about 5% to 405 cattles for the study.

Study methodology

Ante-mortem and post-mortem examination

Ante-mortem and post-mortem examinations were conducted by visiting the abattoir three days per week. The cattle were examined clinically both at rest and in motion during ante mortem examination. They were coded with an identification number, and the animals were recorded. For the post-mortem examination the lungs, liver, spleen, kidneys and heart were inspected for the presence of hydatid cysts by applying meat inspection procedure. During the first stage, visualization and palpation of organs were carried out. After that, further incisions were done in each case for the study of the cysts. Identified cysts were removed and collected in polyethylene bags and/or Petri-dishes. Each polyethylene bag or Petri-dish was used for hydatid cysts obtained from one animal and was labelled appropriately. The cysts were transported to the Hawassa University parasitology and pathology laboratory and examined within one hour.

Cyst fertility and viability test

Individual cysts were grossly examined for any evidence of degeneration and calcification. Cysts were selected for fertility studies and to reduce intra-cystic pressure, the cyst wall was penetrated with a needle and opened up with a scalpel and scissors. The contents was then transferred into a sterile container and examined microscopically (40×) for the amoeboid-like peristaltic movements of protoscoleces according to the standard procedure (Smyth and Barrett, 1980). Cysts, which were not containing any protoscoleces as well as heavily suppurative or calcified, were considered unfertile. The viability of protoscoleces was assessed by the motility of flame cells together with staining with a 0.1% aqueous eosin solution for equal volume of protoscolices on a microscope slide (Sarae *et al*., 2013). Living protoscoleces did not take up the stain, unlike the dead ones (Macpherson *et al*, 1989).

Financial losses

Direct economic loss was estimated by recording the total number of organs condemned and the current market prices per condemned organs. Then, the economic loss was computed by the summation of number of condemned organs multiplied by the current retail market price per organ according to Erneo (2015) as follows.

$$EL=\sum \{NLu*PLu+NLi*PLi+NHrt*PHrt+NKi*PKi\}$$

Where, EL = Economic Losses, NLu = Number of lungs, PLu = Price of

lungs, NLi = Number of liver, PLi = Price of liver, NHrt = Number of heart, PHrt = Price of heart, NSp = Number of spleen, PSp = Price of spleen, NKi = Number of kidneys, PKi = Price of kidneys.

Data management and statistical analysis

Data for this study was collected using pre-designed ante-mortem and post mortem format as per the set objectives of explanatory variables such as age, origin and body condition of the animals. The data obtained was entered and coded in Microsoft excel database system and subjected to descriptive statistics in order to assess the magnitude of the difference of comparable variables using SPSS software version 20 computer program. Chi-square test was applied to compare the infection status with regard to the hypothesized risk factors. Statistically significant association between variables was considered to exist if the p-value is less than 0.05.

Results

Prevalence of bovine hydatidosis

From a total of 405 cattle slaughtered and examined at Shashemene municipal abattoir, 191(47.2%) of them were harboring hydatid cysts in one or more of their visceral organs. The prevalence according to the origin of the animals slaughtered was 43.0%, 52.6% and 44.5% for Kofale, Arsi Nagelle and Shashemene, respectively. The difference in the prevalence of the disease among animals of different origin was not statistically significant ($P>0.05$) (Table 1). The prevalence of bovine hydatidosis according to different age group of animals slaughtered was 13.6%, 40.2% and 64.7% in young (<5 years), adult (5-10 years) and old (>10 years) animals, respectively. The infection was proportionally higher in cattle of age above 5 years and the age specific prevalence among age groups were statistically significant ($P<0.05$) (Table 1). The prevalence of bovine hydatidosis based on body condition score was, 55.0%, 62.9% and 34.40% in poor, medium and good body condition scores of animals slaughtered, respectively. The prevalence among them were statistically significant ($P<0.05$) (Table 1).

Table 1. Prevalence of bovine hydatidosis at Shashemene municipal abattoir

Categories	Total Cattle Examined	Hydatid Cyst		χ^2	P-value
		Positive	%		
Origin					
Kofale	130	56	43.0	3.02	0.220
Arsi Nagelle	156	82	52.6		
Shashemene	119	53	44.5		
Age					
Young	22	3	13.6	31.96	0.000
Adult	244	98	40.2		
Old	139	90	64.7		
BCS*					
Poor	20	11	55.0	31.28	0.000
Medium	167	105	62.9		
Good	218	75	34.4		
Total	**405**	**191**	**47.2**		

*** Body condition scores**

Organ distribution of hydatid cysts

From the total of 405 cattle examined during post-mortem inspection, 273 different visceral organs were found to be affected by hydatid cyst. From these 186 (68.1%) lungs, 80 (29.3%) livers and 7 (2.5%) spleen were affected by hydatid cyst. Liver and lung alone harbored 97.4% of the total cysts obtained during this study period (Table 2).

Table 2. Distribution of hydatid cyst within the affected organs at the abattoir

Organ	Infected	Percent
Lung	186	68.1
Liver	80	29.3
Spleen	7	2.5
Total	**273**	

Fertility and viability of cysts

In this study a total of 180 cysts were collected for laboratory examination from 27 lungs, 8 livers and 1 spleen, in which larger proportion of fertile cysts were obtained from lungs compared to those obtained from liver and spleen. From the total examined cysts, 31 (17.2%) cysts were fertile; and 149 (82.8%) cysts were sterile. From the total 31 fertile cysts, 5 (16.1%) were viable of which 4 cysts from lung and 1 from liver (Table 3).

Table 3. Fertility/sterility of hydatid cysts and association between number of viable cysts and organ involvement

Organs Infected	No of cysts (n=180)	No and fertility status			
		Fertile (%)			Sterile (%)
		Viable (%)	Non-viable (%)	Total	
Lung	124	4 (16)	21 (84)	25 (20.2)	99 (79.8)
Liver	52	1 (20)	4 (80)	5 (9.6)	47 (90.4)
Spleen	4	0	1 (100)	1 (25)	3 (75.0)
Total	**180**	**5 (16.1)**	**26 (83.9)**	**31 (17.2)**	**149 (82.8)**

Financial losses

The direct financial loss from total condemnation of organs infected by hydatidosis at the abattoir was due to the aesthetic value, zoonotic importance and to break the life cycle of the *Echinococcus* parasites. Average market price of lung, liver, spleen, kidney and heart were 20, 110, 10, 45, and 25 Ethiopian Birr (ETB), respectively. Annual direct monetary loss was estimated considering annual slaughter rate of cattle and prevalence of hydatidosis per organ and was calculated to be 12,590.00 ETB (576.20 USD), which was calculated based on current market price (Table 4).

Table 4. Total number of organs infected by hydatid cysts and its financial losses

Organs	Condemned	Price (ETB)	Total Loss (ETB)
Lung	186	20	3720.00
Liver	80	110	8800.00
Spleen	7	10	70.00
Total	**273**	**75**	**12,590.00**

Discussion

In Ethiopia echinococcosis/ hydatidosis is a very common parasitic disease with high prevalence in most area of the country as reported by Koskei (1998). In this study the prevalence of bovine hydatidosis in cattles slaughtered at Shashemene municipal abattoir was 47.2%. Recent study conducted in the study area by Regassa *et al.* (2014) revealed a 50.1% prevalence of hydatid cyst, which is slightly higher than the one reported in this present study. High prevalence has been reported in other areas of the country; 61% in Assela (Koskei, 1998), 52.69% in Hawassa (Regassa *et al.,* 2010), 48.9% in Debre Markos (Kebede *et al*., 2009a), and 46.5% in Debre Zeit (Jobre *et al*., 1996). A lower prevalence rate of the disease compared to this current finding was reported in Bahir Dar (34.05%) (Kebede *et al*., 2009b), Mekelle (32.1%) (Berhe, 2009), Jimma municipal abattoir (31.44 %) (Tolosa *et al.,* 2009) and North Gonder Elfora abattoir (28%) (Endalew *et al*., 2013). Demissie and Kemal (2014) reported 25.7% at Kara-Alo Abattoir PLC, Addis Ababa, 22% in Tigray (Kebede *et al*., 2009c), 20.50% at Arbaminch municipality abattoir (Tilahun *et al.* 2013), 20.05% at Dire Dawa municipality abattoir (Miheret *et al.,* 2013), 17.34% at Nekemte municipal abattoir (Nebyou *et al*, 2014), 11.88% at Bako municipal abattoir (Berihu *et al*, 2015) and 9.4% in around Harar (Belina *et al*., 2015).

In other countries the prevalence of the disease reported was 48.7% in Ngorongoro district of Arusha region, Tanzania (Ernest, 2008), 19.4% in Kenya (Njoroge *et al*., 2002), and 3.99% in Juba, South Sudan (Erneo *et al*, 2015).

The prevalence of hydatidosis is likely to be high in Ethiopia owing to several factors favoring its transmission, among which are, keeping of dogs in close association with ruminants, low public awareness on the role of offal in transmitting hydatid cysts, feeding of dogs with hydatid infected organs and backyard slaughtering practices (Tolosa *et al*., 2009). In this current active abattoir survey the prevalence is slightly lower than the previous one; this may be due to decrease in illegal slaughter, length of study period and reduction in infection rate in dogs. However, in the study abattoir even if the affected organs were condemned the dogs were not restricted to access the condemned organs; because, dogs were considered as waste cleaner.

In general terms, throughout the world, there had been different magnitude records of hydatidosis in cattle. The variation in the prevalence of hydatidosis among different researchers could be associated with the strain difference of *E. granulosus* that exist in different geographical locations, the source of cattle, dog population, management and deworming practices, offal disposal habits, body condition score of slaughtered animals, age of the animals and other factors in socio-economic activities in different region of the country (McManus, 2006).

The prevalence of bovine hydatidosis according to different age group and body condition were statistically significant (P<0.05), indicating that there was an association between the occurrence of the disease and the variables in this study. The prevalence of hydatidosis was found to increase in this study as the animal advances in age. The rate of infection among age groups above 5 years was high. This was in agreement with the findings of various researchers (Azlaf *et al*., 2006; Regassa *et al*., 2010; Endrias *et al*., 2010; Moje *et al*., 2014) who all reported a higher prevalence in older animals. This could be due to the longer exposure time of aged animals to to *E. granulosus* eggs and weaker immunity to resist the infection (Tolosa *et al*., 2009; Alembante, 2009).

The prevalence of bovine hydatidosis by the origin of slaughtered cattle was not statistically significant (P >0.05). This could be due to the socio-economic status and animal husbandry practices of the community, agro-ecology and attitude of people to dogs in different regions (Ibrahim, 2010).

In line with body condition score, the current study showed that, there was a significant (P<0.05) prevalence differences among the two body condition (poor and medium) scores. Animals with poor body condition have been reported to have high risk of infection with hydatid cyst due to low immunity (Melaku *et al.,* 2012; Miheret *et al*., 2013).

In this cross sectional study, organ distribution of hydatid cyst was 68.13% in lungs, 29.30% in liver and 2.56% in spleen. Lungs and liver alone harbored 97.43% of the total cysts

obtained during this study period. In the previous study the greatest proportions of cysts were recorded in the lungs (71.6%) and liver (24.1%) (Negash *et al*., 2013). The findings of highest prevalence in lungs followed by livers in the present study is in agreement with several earlier reports (Tolosa *et al*., 2009; Zewdu *et al*., 2010; Omer *et al*., 2010; Bekele *et al*., 2011; Bizuwork *et al*., 2013; Moje *et al*., 2014; Abebe *et al*. 2014). This might be due to the fact that, if cattle are slaughtered at older age, during which the liver capillaries are dilated, most oncospheres pass directly to the lungs and damage it. Furthermore, 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 lung may be infected before or instead of liver (Arene, 1985). Liver undergoes primary filtration of the blood from portal veins, which is followed by pulmonary filtration before other organs are invaded. However, development of hydatid cysts occurs occasionally in other organs like spleen, kidney and heart and other organs and tissues when onchospherers escaped into general systemic circulation (Eckert and Deplazes, 2004).

Out of the 180 cysts collected for laboratory examination, 48.3% cysts were calcified and 51.7% were non-calcified, in which 2.8% (5/180) of cysts were viable among total examined cysts or 16.1% (5/31) from fertile cysts were viable. Nearly similar percentage of sterile cyst finding was registered in Dessie municipal abattoir (Woubet, 1988). Demissie and Kemal (2014) reported 35.5%, 27.3% and 37.8% of calcified, fertile and viable cysts, respectively in Kara-alo PLC abattoir. Fertility of cysts could be affected by differences in strain of *E. granulosus* (Njoroge *et al*., 2002; Romig *et al*., 2011). Cysts, depending on the geographical situation, host, site, size and type of cyst may have different rates of fertility (Ibrahim, 2010).

The direct economic losses of the condemned organs appeared to be considerable. In this study, an estimated financial loss from examined animals due to condemnation of affected organs was 12,590.00 ETB (576.20 USD) which is relatively higher than the finding of an estimated financial loss of 1379.65 ETB (79.3USD) in Shashemene municipal abattoir due to organs condemnation by the effect of bovine hydatidosis reported by Regassa *et al*. (2014). Getaw *et al*. (2010) reported annual economic losses in animal due to hydatidosis estimated to be 5,869.8 USD, which is higher compared with the current value. Moreover, assessment of annual economic loss due to bovine hydatidosis at Bako municipal abattoir from offal condemnation and carcass weight loss was estimated at 180,792 ETB (Berihu *et al*., 2015). The difference in economic loss analysis in various abattoir or regions may be due to the variations in the prevalence of the disease, mean annual number of cattle slaughtered in different abattoirs and

variations in the retail market price of organs (Alula, 2010).

Conclusions

This study showed a higher prevalence of hydatidosis among cattle slaughtered at Shashemene municipal abattoir. The study also confirmed that hydatidosis was found to be important disease causing considerable loss of revenue at the abattoir due to organs condemnation. Among the study variables considered, age and body condition were identified as important risk factors for the occurrence of hydatidosis in cattle. Thus, routine meat inspection, proper disposal of affected offals, reduction of stray dog population and creating awareness of the community about the public health importance are suggested to alleviate the spread and reduce the financial loss associated with hydatidosis.

References

Abebe, A., Beyene, D. and Kumsa, B. 2014. Cystic echinococcosis in cattle slaughtered at Gondar Elfora export Abattoir, northwest Ethiopia. *Journal of Parasitic Dis*eases 38(4):404-409.

Abraham, A., Tekola, B., Gudissa, D., Demille, H., Tesfu, M., and Musie, R. 2006. Ethiopia urban study, Arada Area (Kebele 08/09), Shashemene, University of Bath: WeD-Ethiopia.

Abunna, F., Kasasa, D., Shelima, B., Megersa, B., Regassa, A. and Amenu, K. 2009. Survey of tick infestation in small ruminants of Miesso district, West Hararghe, Oromia Region, Ethiopia. *Tropical Animal Health and Production* 41:969–972.

Alembante, M. 2009. Study on Prevalence and Economic Significant of Hydatidosis in Cattle Slaughtered at Hawassa Abattoir. DVM Thesis, Jimma Univ. Ethiopia.

Alula, A. 2010. 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.

Arene, F. 1985. Prevalence of hydatidosis in domestic livestock in the Niger Delta. *Tropical Animal Health and Production* 85**:**69-73.

Azlaf, R. and Dakkak, A. 2006. Epidemiology of Cystic Echinococcosis in Morocco. *Veterinary Parasitology* 131:83-93.

Bekele, J. and Butako, B. 2011. Occurrence and financial loss assessment of cyst echinococcosis (hydatidosis) in cattle slaughtered at Wolayita Sodo municipal abattoir South Ethiopia. *Tropical Animal Health and Production* 43(1):221-228.

Belina, D., Fekadu, G., Zegaye, E. and Belina, S. 2015. Bovine hydatidosis: prevalence, public health and its economic significance in and around Harar, Ethiopia. *Journal of Veterinary*

Medicine and Animal Health 7(1):18-26.

Berhe, G. 2009. Abattoir survey on cattle hydatidosis in Tigray Region of Ethiopia. *Tropical Animal Health and Production* 41:1347-1352.

Berihu, H. and Toffik, K. 2015. Study on Prevalence Economic Significance of Bovine Hydatidosis in Bako Muncipal Abattoir, West Shoa zone, Oromiya Regional State, Ethiopia. *Global Journal of Animal Scientific Research* 3(1):109-118.

Bizuwork, A., Nigatu, K., Tariku, T., Getachew, T. and Tesfu, K. 2013. Occurrence and financial significance of bovine cystic echinococcosis in Southern Wollo, Northeastern Ethiopia. *Journal of Veterinary Medicine and Animal Health* 5 (2):51-56.

Cringoli, G., Rinaldi, L., Musella, V., Veneziano, V., Maurelli, M.P., F., Frisiello, M. and Di Pietro, S. 2007. Geo-referencing livestock farms as tool for studying cystic echinococcosis epidemiology in cattle and water buffaloes from southern Italy. *Geospat Health* 2(1):105-111.

Central Statistical Authority (CSA). 2014. Report on livestock and livestock characteristics; Volume II, Ethiopia, Addis Ababa.

Central Statistical Agency (CSA). 2015. Agricultural sample survey. Report on livestock and livestock characteristics (private peasant holdings), Addis Ababa, Ethiopia, vol. 1I, pp. 181.

Demissie, G. and Kemal J. 2014. Bovine Hydatidosis and its Economic Importance at Kara-Alo Abattoir PLC, Addis Ababa, Ethiopia. *Journal of Veterinary Science and Technology* 5:206.

De Lahunta, A. and Habel, R.E. 1986. Teeth Applied veterinary anatomy, W.B. Saunders Company, Pp 4-6

Eckert, J. and Deplazes, P. 2004. "Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern". *Clinical Microbiology Review* 17(1):107–35. PMC 321468. PMID 14726458.

Endalew, D. and Nuradddis I. 2013. Prevalence and Economic Importance of Hydatidosis in Cattle Slaughtered at North Gonder Elfora Abattoir. *European Journal of Applied Sciences* 5(1):29-35.

Endrias , A., Yechale, T. and Assefa, M. 2010. Bovine hydatidosis in the Ambo municipal abattoir, West Shoa, Ethiopia. *Ethiopian Veterinary Journal* 14(1):1-14.

Erneo, B. O. 2015. Prevalence and Economic Loss due to Hydatidosis in Slaughtered Animals in Juba South Sudan. *International Journal of Research Studies in Biosciences* 3(3):177-182

Ernest, E., Nonga, H. E, Kassuku, A. A. and Kazwala, R. R. 2008. Hydatidosis of slaughtered animals in Ngorongoro district of Arusha region, Tanzania. *Tropical Animal Health and Production.* doi 10.1007/s11250-008-9298-z.

Getaw, A., Beyene, D., Ayana, D., Megersa B. and Abunna F. 2010. Hydatidosis: Prevalence and its

economic importance in ruminants slaughtered at Adama municipal abattoir, Central Oromia, Ethiopia. *Acta Tropica* 113:221-225. doi:10.1016/j. actatropica. 2009.10.019.

Hagos, Y. 1997. Hydatidosis/echinococcosis: prevalence and economic impact in bovine at Mekele Municipal abattoir, zoonosis and infection in dogs (Mekele Tigray), DVM Thesis, AAU, FVM, DZ, Ethiopia, Pp 35.

Ibrahim, M.M. 2010. Study of cystic echinococcosis in slaughtered animals in Al BahaRegion, Saudi Arabia, Interaction between some biotic and abiotic factors. *Acta Tropica* 113:26–33.

Jobre, Y., Labag ,F., Tirone, R., Abebe, G. and Dorchines, P. 1996. Hydatidosis in three selected regions in Ethiopia: an assessment trial on its prevalence, economic and public health importance. *Revue de Medicine Veterinare*147:797-804.

John, David, T., William Petri., William, A., Markell., Edward, K. and Marietta,V. 2006. The Cestodes: *E. granulosus*, *E. multiloularis* and *E. vogeli* (Hyatid Disease)". *Markell and Voge's Medical Parasitology* (9th ed.). *Elsevier Health Sciences*. Pp. 224.

Kebede, N. 2010. A retrospective survey of bovine hydatidosis in three abattoirs of Amhara National Regional State, northwestern Ethiopia. *Tropical Animal Health and Production* 42(3):323-325.

Kebede, N., Mokonnen, H., Wossene,A. and Tilahun, G. 2009a. Hydatidosis of slaughtered cattle in Wolayita Sodo abattoir southern Ethiopia. *Tropical Animal Health and Production* 41:629–633.

Kebede, N., Mitiku, A., and Tilahun, G. 2009b. Hydatidosis of slaughtered animals in Bahir Dar abattoir, northwestern Ethiopia. *Tropical Animal Health and Production*. 41:43–50.

Kebede W., Hagos A. Girma Z. and Lobago F. 2009c. Echinococcosis/hydatidosis: its prevalence, economic and public health significance in Tigray region, North Ethiopia. *Tropical Animal Health and Production* 41, 865-871. doi: 10.1007/s11250-008-9264-9.

Koskei PK. 1998. Prevalence and strain differentiation of *E. granulosus* in some selected sites of Ethiopia. Berlin and Ethiopia: Ferie Universitat and Addis Ababa University, M.Sc. thesis.

Macpherson, J.M, Horak, F.B, Dunbar, D.C, Dow, R.S. 1989. Stance dependence of automatic postural adjustments in humans. Exp Brain Res 78:557-566.

McManus, D.P. 2006. Molecular discrimination of Hydatid cestodes. *Parasitology International* 55:531-532.

Melaku A, Lukas B. and Bogale B. 2012. Cyst Viability, Organ Distribution and Financial Losses due to Hydatidosis in Cattle Slaughtered At Dessie Municipal Abattoir, North-eastern Ethiopia, *Veterinary World* 5(4):213-218.

Miheret, M., Biruk, M., Habtamu, T and Ashwani, K. 2013. Bovine Hydatidosis in Eastern part of Ethiopia. *Medical Eastern Journal Science* 5(1):107-114.

Moje, N., and Degefa, A. 2014. Prevalence, cyst viability, organ distribution and financial losses due to hydatidosis in cattle slaughtered at Nekemte municipal abattoir, Western Ethiopia. *Journal Veterinary Medicine and Animal Health*. 6(11):280-288.

Nebyou, M., Debela, A., Solomon, K., Tesema, T., Fanta, D. and Alemayehu, R. 2014. Major Causes of Organs and Carcass Condemnation in Cattle Slaughtered at Nekemte Municipality Abattoir, East Wollega, Ethiopia. *Global Veterinaria* 13 (3):278-284.

Negash, K., Beyene, D. and Kumsa, B. 2013. Cystic echinococcosis in cattle slaughtered at Shashemanne Municipal Abattoir, south central Oromia, Ethiopia: prevalence, cyst distribution and fertility. *Transaction of the Royal Society of the Tropical Medicine Hygiene* 107(4):229-34.

Nicholson, M. and Butterworth, M.H. 1986. A Guide to Body condition scoring of Zebu cattle. International livestock center for Africa, Addis Ababa, Ethiopia.

Njoroge, E.M., Mbithi, P.M., Gathuma, J.M., Wachira, T.M., Magambo, J.K. and Zeyhle, E. 2002. A study of cystic echinococcosis in slaughter animals in three selected areas of northern Turkana, Kenya. *Veterinary Parasitology* 104:85–91.

Omer, R.A., Dinkel, A., Romig, T., Mackenstedt, U., Elnahas, A.A., Aradaib, I.E., Ahmed, M.E, Elmalik, K.H., and Adam, A. 2010. A molecular survey of cystic echinococcosis in Sudan. *Veterinary Parasitology* 169:340–346.

Regassa, A., Nebyou, M., Demeke, Z., and Belachew, B. 2014. Metacestodes in Cattle Slaughtered at Shashemene Municipal Abattoir, Southern Ethiopia: Prevalence, Cyst Viability, Organ Distribution and Financial Losses. *Global Veterinaria* 12 (1):129-139.

Regassa, F., Molla, A. and Bekele, J. 2010. Study on the prevalence of cystic hydatidosis and its economic significance in cattle slaughtered at Hawassa Municipal abattoir, Ethiopia. *Tropical Animal Health and Production* 42:977–984.

Romig, T., Omer, R.A, Zeyhle, E., Hüttner, M., Dinkel, A., Siefert, L., Elmahdi, I.E., Magambo, J., Ocaido, M., Menezes, C.N., Ahmed, M.E., Mbae, C., Grobusch, M.P. and Kern, P. 2011. Echinococcosis in sub-Saharan Africa: emerging complexity. *Veterinary Parasitology* 181:43–47

Sarae, M., Shahnazi, M., Jafari, A. and Javadi, M. 2013. Fertility of Hydatid Cysts and Viability of Protoscoleces in Slaughtered Animals in Qazvin, Iran. *Journal of Agricultural Science* 5(1):141-146.

Smyth, J.D and Barrett, N.J. 1980. Procedure of testing the viability of human hydatid cyst following surgical removal, especially after chemotherapy. *Transactions of the*

Royal Society of Tropical Medicine and Hygiene 74:649-652.

Tavakoli, H., Bayat, M. and Kousha, A. 2008. Hydatidosis Infection Study in Human and Livestock Populations during 2002-2007. *American-Eurasian Journal of Agriculture and Environmental Sciences* 4(4):473-477.

Thompson, R.C.A. and McManus, D.P. 2002. Towards a taxonomic revision of the genus Echinococcs. *Trends Parasitology* 18:452-457.

Thrusfield, M. 2005. Veterinary Epidemiology. 3rd ed., Singapore, Uk. Blackwell sciences. Pp. 233.

Tilahun, A., and Yitagele, T. 2013. Hydatidosis: Prevalence, Cyst Distribution and Economic Significance in Cattle Slaughtered at Arbaminch Municipality Abattoir, Southern Ethiopia. *Global Veterinaria*. 11(3):329-334.

Tolosa, T., Tigre, W., Teka, G. and Dorny, P. 2009. Prevalence of bovine cysticercosis and hydatidosis in Jimma municipal abattoir, South West Ethiopia. *Onderstepoort Journal of Veterinary Research* 76:323–326

World Health Organization (WHO). 2016. Echinococcosis Fact sheets, Updated April 2016, Accessed on June 14/16, www.who.int/mediacentre/factsheets/fs377/en/

Woubet, S. 1988. Prevalence of hydatidosis and its economic significance in Dire Dawa abattoir. DVM thesis, FVM, AAU, Debre Zeit Ethiopia. 12.

Zewdu, E., Teshome, Y. and Makwoya, A. 2010. Bovine hydatidosis in Ambo Municipal Abattoir, Ethiopia. *Ethiopian Veterinary Journal* 14(1):1–14.