

Original Research

Prevalence and Economic Significance of Hydatidosis on Cattle Slaughtered at Nekemte Municipal Abattoir, Western Ethiopia

Tuge Temesgen, DVM*

Wolaita Sodo University, School Of Veterinary Medicine, SNNP Region, Ethiopia

*Corresponding author

Tuge Temesgen, DVM

Wolaita Sodo University, School of Veterinary Medicine, SNNP Region, Ethiopia; E-mail: kassahunayana@gmail.com

Article information

Received: September 18th, 2020; Revised: October 1st, 2020; Accepted: October 27th, 2020; Published: November 18th, 2020

Cite this article

Temesgen T. Prevalence and economic significance of hydatidosis on cattle slaughtered at Nekemte municipal abattoir, Western Ethiopia. *Vet Med Open J.* 2020; 5(3): 57-63. doi: [10.17140/VMOJ-5-150](https://doi.org/10.17140/VMOJ-5-150)

ABSTRACT

Aim

The study was conducted to determine the prevalence of hydatidosis, to identify the association between expected risk factors and occurrence of the disease, to investigate economic importance and to evaluate fertility and viability of the hydatid cyst in cattle slaughtered at the abattoir.

Materials and Methods

A cross-sectional study, which involves both ante-mortem and post-mortem examination, was conducted at Nekemte municipal abattoir from November 2015 to March 2016.

Results

A total of 355 local cattle breed was randomly sampled and examined for the presence of hydatid cysts in the organs of the animals using the standard meat inspection procedures, 66 (18.6%) animals were found harboring hydatid cysts. Statistical analysis showed that there was a significant difference ($p < 0.05$) between the prevalence of bovine hydatidosis in all risk factors with exception of sex of the animals. Among 207 hydatid cysts recorded, 93 (44.92%) were from lungs, 65 (31.40%) from livers, 4 (1.93%) from heart, 3 (1.44%) from kidney, 1 (0.48%) from spleen and 41 (19.8%) were in two organs from lung and liver. Fifty-seven (57) of these 207 cysts were randomly selected and subjected to fertility and viability test which revealed 19 (33.33%) as fertile, 25 (43.86 %) sterile and 13 (22.81%) calcified. Viability test proved 7 (12.28%) of 19 fertile cysts as viable and 12 (21.05%) of 19 fertile cysts as non-viable. Viability of cysts in different organs revealed that 5 (16.1%) and 2 (10%) of cysts from lungs and liver, respectively. The estimated financial loss during the study period both due to condemnation of organs and an in direct carcass weight loss from hydatidosis was 2,190,143.52 ETB.

Conclusion

The results of this study revealed that bovine hydatidosis was an economically important disease of cattle which need serious attention for prevention and control actions in and around Nekemte. Hence, establishment of well-equipped standardized abattoirs, prohibition of backyard slaughter, creation of public awareness, deworming and control of stray dogs are of paramount importance.

Keywords

Abattoir; Cattle; Economic loss; Hydatidosis; Nekemte; Prevalence.

INTRODUCTION

Ethiopia have an estimated livestock population of approximately 49.3 million cattle, 25.02 million sheep, 27.88 million goats, 8.41 million equines, 1.06 million camels, 20,000 pigs, and 58 million chickens, which stands first in Africa and tenth in the

world.¹ In the country, cattle are important source of income for rural communities and are one of the nation's major sources of foreign currency from export. However, this great potential is not properly exploited. This is because of endemic disease burdens, traditional management system, inferior genetic makeup coupled with malnutrition and absence of well-developed market infra-

structure.² Among the many prevalent livestock diseases, parasitic disease represent a major constraint to livestock development in the tropics in general and hydatidosis is among the major parasitic diseases contributing to low productivity of meat production due to carcass or organ condemnation, in particular.³

Hydatidosis is caused by several species of Echinococcus, cestodes parasites in the family Taenidae, genus Echinococcus. Currently recognized species include *E. granulosus*, *E. multilocularis*, *E. vogeli*, *E. oligarthrus* and possibly *E. shiquicus*. The two type hydatidosis includes unilocular echinococcosis and multilocular echinococcosis.⁴ The life cycle of this parasite involves two mammalian hosts. The definitive hosts are carnivores, which harbor adult tapeworm in the small intestine and excrete the parasite eggs along with their feces into the environment, while livestock and humans are the main intermediate host.⁵

Diagnosis of the disease relies on epidemiologic and clinical findings; on detection of the hydatid cyst by imaging techniques and serology. There are several major options for treatment of cystic Echinococcosis, including surgery, puncture aspiration injection respiration (PAIR) and chemotherapy.⁶ Control of *E. granulosus* based on the regular treatment and exclusion of dogs from their diet of animal material containing hydatid cysts. This is achieved by preventing dogs access to abattoirs, and where possible by proper disposal of carcasses on farms. Educating rural population about hydatidosis and its control, centralizing the slaughtering of animals for food in veterinary control units and ensuring sanitary condition for slaughtering done on ranches are also conventional control measures.⁷

Echinococcus granulosus remains as a cause of a persistent and reemerging problem in low income countries where resources for an intensive control program are not available. Future control programmes for human echinococcosis are also likely to depend on the reduction of transmission of the parasite from animals to humans.⁸ In Africa *E. granulosus* has been recognized from most countries including Ethiopia. Previous and recent report has described the endemic occurrence of *E. granulosus* in dogs and livestock.⁹

The information existing from different authors confirms that the disease is prevalent in various parts of the Ethiopia, 22.1%,¹⁰ and 32.1%¹¹ are some of the researches conducted in different parts of the country to determine the prevalence and economic impact of the disease and from these data's it can be deduced that it is most commonly observed in bovine species.

Despite the above studies, in Ethiopia, the disease has not been investigated sufficiently and information related to its prevalence, economic impact and associated risk factors are still inadequate especially in and around Nekemte. Moreover, to establish appropriate strategy for prevention and controls, it is very important to have sufficient information about the prevalence, economic impact and associated risk factors of the disease at the study area.

Therefore, depending on above hypothesis the study was undertaken:

- To determine the prevalence of hydatidosis in the study area.
- To identify the association between expected risk factors and occurrence of the disease.
- To investigate economic importance of hydatidosis in cattle slaughtered at abattoir.
- To evaluate fertility and viability of the cysts.

MATERIALS AND METHODS

Study Area

The study was conducted at Nekemte municipal abattoir found at Nekemte town, East Wollega Zone, Oromia Region located at 331 Km West of Addis Ababa. It is situated at latitude of 9°4' 9571N and longitude of 36°32'9281E and at an altitude of 2124 meters above sea level. The mean annual rainfall and average temperature range from 1800-2200 mm and 20-25 °C, respectively. The area receives bimodal rainfalls that were long rainy season and short rainy season. The long rainy season occurs during the months of June to September while the short rainy season observed during the months of March, April and May.²

Study Animals

The study animals were local Zebu cattle's presented to the Nekemte municipal abattoir from November, 2015 to March, 2016 for slaughtering from different localities and the study animals were taken randomly and routinely inspected for cystic Echinococcosis. Animals were grouped for simplicity in to two categories as animals with age less than six (<6) years as young and greater than and equal to six years as adult.^{11,12}

Study Design

A cross-sectional study designs was employed to generate the desired data. The cross-sectional study of active abattoir survey was made according to the standard procedures recommended for ante-mortem and post-mortem inspection by Food and Agriculture Organization (FAO).¹³

Study Methodology

Sample size determination and sampling method: The sample size was calculated according to (Thrusfield, 2005) by considering 17.1% expected prevalence¹⁴ and 95% confidence level with a 5% desired absolute precision. Thus,

$$N = \frac{1.962 * P_{exp} (1 - P_{exp})}{d^2}$$

Where, N=required sample; P_{exp}=expected prevalence; d=desired absolute precision

Even though the minimum required sample size was 218, 137 animals were added to increase the precision. Thus, a total of 355 animals were included in the study. During the study period animals were selected by simple random sampling technique.

Ante-mortem examination: During ante-mortem inspection, each of the study animals was given an identification number by using a permanent marker. Age, sex, origin and body condition scoring of the study animals were also recorded.¹² Estimation of age was carried out by examination of the teeth eruption using the approach forwarded by Nicholson et al.¹⁵ Two age groups were considered; less than 6-years as young and above 6-years an adult and body condition scoring was classified into three categories as poor (score 1, 2 and 3), medium (score 4, 5 and 6) and good (7, 8 and 9).^{12,16}

Post-mortem inspection: A post-mortem examination was carried out through visual inspection, palpation and incision of visceral organs (lung, liver, heart, spleen and kidney) and the presence of hydatid cysts and their organ distribution were recorded. Each organ Hydatid cysts were carefully removed and separately collected (in organ basis) in clean containers for further cyst characterization. Hydatid cyst characterization was made to assess the status of the cysts.¹³

Cyst characterization: Anatomical distribution of hydatid cyst and their status as active and calcified were determined by recording the organ affected. Individual cyst was grossly examined for any evidence of generation and calcification. Cyst fertility and viability determination was also studied.¹⁰ The collected hydatid cysts were subjected to cyst fertility and viability studies. The pressure of the cyst fluid was reduced by using a sterile hypodermic needle. Then cyst was incised with a sterile scalpel blade and the content was poured into vial and allows to settle for 20-30-minutes and examined under microscope (X40) for the presence of protoscolices. If protoscolices were present, seen as white dots on germinal epithelium or brood capsule or hydatid sands within the suspension, the cyst was categorized as fertile. Fertile cysts were subjected to viability test. A drop of fluid from cyst containing the protoscolices were placed on the microscope glass slide and covered with cover slip and observed for amoeboid like peristaltic movements, with X40 objective. For clear vision, a drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices in hydatid fluid on microscope slide with the principle that viable protoscolices should completely or partially exclude the dye, while the non viable protoscolices absorb the stain.¹⁷ Furthermore, infertile cysts were classified as sterile or calcified. Sterile hydatid cysts were characterized by their smooth inner lining usually with slightly turbid fluid in its content. Typical calcified cysts produce a gritty sound feeling up on incision.¹⁰

Economic loss evaluation: Financial losses due to hydatidosis means due to condemnation of liver, lung, heart and other organs and cost due to carcass weight reduction. Economic loss due to organ condemnation was determined by considering annual slaughter rate of cattle and prevalence of hydatidosis per organ and an estimated 5% carcass weight loss was considered.^{18,19} Average carcass weight of Ethiopian local breed is estimated as 108 kg. The total economic losses were calculated as the summation of cost of offal condemned plus the cost of carcass weight loss. The loss from organs condemned was calculated by using the formula described by Regassa et al²⁰ as follows:

$$LOC = (NAS * ph * plu * Cplu) + (NAS * Ph * Phr * Cphr) + (NAS * Ph * pli * Cpli) + (NAS * Ph * Psp * Csp) + (NAS * Ph * Pkid * Cpkid)$$

Where, LOC=loss due to organ condemnation

NAS=mean number of cattle slaughter annually

Ph=prevalence of hydatidosis

Pli=per cent involvement of liver

Plu=per cent involvement of lung

Cplu=current mean price of lung

Phh=per cent involvement of heart

Cphr=current mean price of heart

Cpli=current mean price of liver

Psp=per cent involvement of spleen

Csp=current mean price of spleen

Pkid=per cent involvement of kidney

Cpkid=current mean 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 Nekemte 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 by¹⁶ using the following formula.

$$LCWL = NAS * Ph * Cpb * 5\% * 108 \text{ kg}$$

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 Nekemte town

Finally, the total economic loss was calculated by considering the losses from both organ condemnation and carcass weight loss.¹⁰ Thus,

$$\text{Total loss} = LOC + LCWL$$

RESULTS

A total of the 355 slaughtered local breed cattle were examined

during the study period with routine meat inspection procedures at Nekemte municipal abattoir. The overall prevalence of hydatidosis in the study area was 18.6% (66/355).

Association of Major Risk Factors with Occurrence of the Cyst

The study revealed that the number of male and female animals slaughtered during the present study were 287 and 68, respectively, with higher prevalence recorded in males 47 (71.2%) than females 12 (18.2%). The prevalence of bovine hydatidosis in older animals were significantly higher ($p < 0.05$), than that of young animals with 71.2% (47/284) and 28.8% (19/71), respectively as indicated in (Table 1). Highest prevalence of bovine hydatidosis (45.5%) was found in medium body condition followed by (27.3%) and (27.3%) in good and poor body condition scores, respectively. Based on the origin of the animals, higher prevalence was recorded at Bandira (33.3%), Sasiga (22.7%), Arjo (15.2%), Uke (12.1%), Digga (10.6%) and Getema (6.1%) (Table 1). The statistical analysis showed that there was a significant difference ($p < 0.05$) between the prevalence of bovine hydatidosis in all risk factors with exception of sex of the animals (Table 1).

Risk Factors	Category	No Inspected Animals	No Positive Animals	χ^2	p value
Sex	Male	68	12(18.2%)	0.011	0.824
	Female	287	54(81.8%)		
Age	Young	71	19(28.8%)	3.913 ^a	0.048
	Adult	284	47(71.2%)		
Bcs	Good	99	18(27.3%)	9.632 ^a	0.008
	Medium	202	30(45.5%)		
	Poor	54	18(27.3%)		
Origin	Arjo	54	10(15.2%)	14.785 ^a	0.011
	Bandira	67	22(33.33%)		
	Digga	39	7(10.6%)		
	Getema	21	4(6.1%)		
	Sasiga	83	15(22.7%)		
	Uke	91	8(12.1%)		

Distribution and Number of Cysts in Different Organs

Among 207 hydatid cysts (Table 2), 93(44.92%) were from lungs,

65 (31.40%) from livers, 4 (1.93%) from heart, 3 (1.44%) from kidney, 1 (0.48%) from spleen and 41 (19.8%) from lung and liver.

Organs	No Positive Organs	No Cysts
Lung only	31(41%)	93(44.92%)
Liver only	20(26.7%)	65(31.4%)
Heart only	3(4.0%)	4(1.93%)
Kidney only	2(2.7%)	3(1.44%)
Spleen only	1(1.3%)	1(0.48%)
Lung and liver	18(24%)	41(19.8%)
Total	75	207

Characterization of Hydatid Cysts

Fifty-seven (57) of these 207 cysts were randomly selected and subjected to fertility and viability test which revealed 19 (33.33%) as fertile, 25 (43.86%) sterile and 13 (22.81%) calcified. Viability test proved 7 (12.28%) of 19 fertile cysts as viable and 12 (21.05%) of 19 fertile cysts as non-viable. With respect to organ distribution viability was 5 (16.1%) of cysts from the lungs and 2 (10%) from livers as indicated in Table 3.

Estimation of Economic Loss

Economic loss due to organ condemnation and carcass weight loss was estimated to 76216.32 ETB and 213927.2 ETB, respectively. The total economic loss encountered due to hydatidosis in cattle slaughtered at Nekemte municipal abattoir during the study period was revealed 2,190,143.52 ETB.

DISCUSSION

Prevalence of hydatidosis varies from country to country or even within the country and has been reported by various researchers from developing countries under extensive production system.²¹ The overall prevalence (18.6%) in the present study was roughly similar to several previous studies conducted in the same study abattoir 17.1% by Birhanu et al,¹⁴ 18.2% by Abdata et al,²² and other studies in Wolaita Sodo town 16% by Nigatu et al,¹⁰ 17.95% in south Wollo by Degefu,²³ 17% in Kombolcha ELFORA abattoir

Organs	No. of Cysts Examined	Cyst Characterization				
		Fertile	Viable	Non Viable	Sterile	Calcified
Lung	31	12(38%)	5(16.1%)	7(22.58%)	16(51.16%)	3(9.67%)
Liver	20	7(35%)	2(10%)	5(25%)	4(20%)	9(45%)
Heart	3	0(0.00%)	0(0.00%)	0(0.00%)	2(66.66%)	1(33.33%)
Kidney	2	0(0%)	0(0%)	0(0%)	2(100%)	0(0%)
Spleen	1	0(0%)	0(0%)	0(0%)	1(100%)	0(0%)
Total	57	19(33.3)	7(12.28%)	12(21.05%)	25(43.85%)	13(22.81%)

by Fufa et al,²⁴ 18.61% at Adigrat Municipal abattoir by Assefa et al.²⁵ However, it was lower than the prevalence of 28% at Gondar ELFORA abattoir by Adane et al²⁶ and 31.44% in Jimma municipal abattoir by Tariku et al.²⁷

Unlikely the current prevalence was higher than the prevalence reported by Buzuayehu et al²⁸ at Harar Municipal abattoir 11.3%,¹⁰ in Shire 7.5%,²⁹ in Debre Birhan 7.2%. This variation might be attributed to the strain difference of *E. granulosus* that exist in different geographical situations and other factors like difference in culture, social activity and attitude to dog in different regions.³⁰ However, the variability in prevalence demonstrated in areas having similarity with the present study area may mainly due to different stages of infection in the population at the time of examination and sampling strategy that was employed.

Association of Major Risk Factors with Occurrence of the Cyst

No significant variation was noticed with regard to sex of animals ($p>0.05$). This is in line with the findings reported by Birhanu et al¹⁴ in the same abattoir and by Eckert et al⁵ at Bako municipal abattoir. This may be due to indiscriminate exposure to risk regardless of sex in the management system of the area. In this study, there was a significant difference ($p<0.05$) in prevalence of bovine hydatidosis among young (<6-years) and adult (6-years) animals. Adult animals having a higher prevalence may be due to their longer exposure to infection and lower immunity to combat infection. In addition most of the slaughtered animals were culled animals due to less productiveness and hence were exposed to the diseases (parasitic ova) over long period with an increased possibility of acquiring the infections and this result is in agreement with very earlier studies in Ethiopia, at Konso by Fikre.³²

The study also revealed that there was significant difference in prevalence of the disease between origins of animals ($p<0.05$). Higher prevalence was reported at Bandira (33.3%), Sasiga (22.7%), Arjo (15.2%), Uke (12.1%), Digga (10.6%) and Getema (6.1%). This finding was in line with the finding at the same study area by Morar et al.¹⁹ This might be due to difference in culture, social activity, animal husbandry systems, lack of proper removal of condemned organs/carcass and control measures and attitude to dogs.³⁴

There was a significant association between hydatid cyst infection and body condition of animals ($p<0.05$). The prevalence of hydatid cysts as related to body condition showed was 27.3%, in poor body condition, 45.5% in medium body condition and 27.3% in good body condition. High prevalence of the diseases was found on medium body condition. This variation in relation to body condition might be due to the little tendency of excluding emaciated animals from being slaughtered and majority of animals slaughtered in the abattoir were medium body conditioned. The present research has the same result with studies reported at Adama municipal abattoir by Birhanu et al.¹⁴

Distribution and Number of Cysts in Different Organs

The result obtained from this study indicated that lungs and liver

were found to be the most predominantly affected organs (44.92% and (21.25%), respectively). The heart, kidney and spleen are the less affected organs in the study animals. This could be justified by the fact that lungs and liver possess the first great capillary sites encountered by the migrating *Echinococcus oncosphere* (hexacanth), which adopt the portal vein route and primarily negotiate hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved.⁵ Furthermore, lungs were the most frequently infected organs than any other organ. This is justified by the fact that cattle are slaughtered at older age, during which period the liver capillaries are dilated and most cysts directly pass to the lungs. Also during this period, 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 the liver or instead of the liver.³⁰

Characterization of Hydatid Cysts

Prevalence and fertility of hydatid cysts in various organs of cattle are important indicators of potential sources of infection to perpetuate the disease in dogs. In this study, the percentage of fertile cysts recovered was 33.33%. Fertility rate among the organs was higher in the lungs (16.1%) than in livers (10%), which is in agreement with, 21% reported by Tariku et al.²⁷ This variation might be due to the difference between tissue resistances of organs. The percentage of calcified cysts is found to be higher in the liver than in the lungs. This may be associated with the relatively higher reticulo-endothelial cells and abundant connective tissue reaction of the organ.³⁵

Economic Loss as a Result of Cysts

In the present study, the economic loss during the study period as a result of bovine hydatidosis at Nekemte municipal abattoir from direct and indirect losses was estimated to about 2,190,143.52 ETB which was lower than from previous report by (Birhanu et al¹⁴) 3,996,000 ETB, but higher than 674, 093 ETB reported at Jimma municipal abattoir by Debas et al.³⁶ As it was suggested by several authors the difference in economic loss analysis in various abattoirs\regions is considered to be 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.

CONCLUSION AND RECOMMENDATIONS

The present investigation showed that hydatidosis is prevalent in cattle population of Nekemte and its surroundings. Hydatidosis causes economic losses due to condemnation of the organs and carcass weight loss in the study area. This reflects that, there is no proper meat inspection and disposal of condemned organs. In addition to this, there was no construction of well-equipped abattoirs and no awareness of people about economic and public importance of the disease. Therefore, it is necessary to establish appropriate strategy for prevention and controls of the disease.

Based on the above conclusion the following recommendations are forwarded:

- Modify the construction of slaughter houses with adequate facilities and implementation of proper meat inspection services.
- Public awareness should be created about the situation to break the life cycle of the parasite and possibly prohibition of backyard slaughter.
- There should be proper disposal of condemned organs and preventing dogs from free access to raw viscera to mitigate the life cycle of the parasite.
- Furthermore, researches should be conducted on proper methods for reducing stray dogs and wild carnivores particularly to find out best drug for deworming pet dogs.
- Prevention of the disease in the intermediate host by conduct extensive research programs to find a suitable drug to destroy or render the hydatid cyst.

ETHICAL STATEMENT

My deepest heartfelt thanks goes to the Department of Animal Health Awi Zone, Livestock Resource Development and Promotion Office, Amhara region, Ethiopia.

STATUTORY DECLARATION

I declare that this thesis presents the work carried out by myself and does not incorporate without the acknowledgement of any material previously submitted for a degree or diploma in any university; and to the best of my understanding, it does not contain any materials previously published or written by another person except where due reference is made in the text; all substantive contributions by others to the work presented including jointly authored publications, is clearly acknowledged.

REFERENCES

1. Central Statistical Authority (CSA). Federal Democratic Of Ethiopia. Agricultural Sample Survey. Report on Livestock and Livestock Characteristics. 2008. Web site. <https://searchworks.stanford.edu/view/6509594>. Accessed September 17, 2020.
2. Ministry of Agriculture and Rural Development. Agriculture and Rural Development Bulletin (Amharic version), 1997; 2nd year.
3. Parija C. Text Book Of Medical Parasitology. In: *Protozoology and Helmenthology*. 2nd ed. New Delhi, India: India Publishers and Distributors; 2004: 473-477.
4. Taylor A, Coop L, Wall L. *Veterinary Parasitology*. 3rd ed. Singapore: Black Well; 2007: 374-379.
5. Eckert J, Deplazes P. Biological, epidemiological and clinical aspects of echinococcosis a zoonosis of increasing concern. *Clin. Microbio Rev.* 2004; 17: 107-135. doi: 10.1128/cmr.17.1.107-135.2004
6. Eckert J, Schantz P, Gasser R. Manual on echinococcosis in humans, animals, geographic distribution and prevalence. *WHO. Org. anim. Heal Paris*. 2002; 101-143.
7. Oku Y, Malgor R, Benavidez U, Carmona C, Kamiya H. Control program against hydatidosis and the decrease prevalence in uruguay. *Intr Congre Ser.* 2004; 12: 98-104. doi: 10.1016/j.ics.2004.01.087
8. Robinson W, Dalton P. Zoonotic helminth infections with particular emphasis on fasciolosis and other trematodiasis. *Phil Trans R Soc B.* 2009; 64: 763-776. doi: 10.1098/rstb.2009.0089
9. World Health Organization (WHO). Manual on echinococcosis on humans and animals: A public health problem of global concern; 2001; Web site. <https://apps.who.int/iris/handle/10665/42427>. Accessed September 17, 2020.
10. 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. doi: 10.1007/s11250-008-9234-2
11. Berhe G. Abattoir survey on cattle hydatidosis in tigray region of Ethiopia. *Trop Anim Heal Prod.* 2009; 41: 347-352. doi: 10.1007/s11250-009-9320-0
12. Achenef M, Lukas B, Bogale B. Cyst viability, organ distribution and financial losses due to epidemiological and clinical aspects of hydatidosis in cattle slaughtered at dessie municipal Abattoir, North Eastern Ethiopia. *Vet World.* 2012; 5(4): 107-135. doi: 10.5455/vetworld.2012.213-218
13. Food and Agriculture Organization (FAO). Meat inspection manual for developing officials and all the workers for their willingness and countries; Rome, Italy; 1994.
14. Birhanu T, Abda S. Prevalence, economic impact and public perception of hydatid cyst and cysticercus bovis on cattle slaughtered at adama municipal Abattoir, South Eastern Ethiopia. *Amer-Euras J Sci Res.* 2014; 9: 87-97. doi: 10.5829/idosi.ajejr.2014.9.4.86128
15. Nicholson M, Butterworth H. A Guide Condition Scoring Of Zebu Cattle. 1986; Web site. <https://agris.fao.org/agris-search/search.do?recordID=XF2016010547>. Accessed July 17, 2020.
16. Polydrous K. Animal health and economic case study: Echinococcus with reference to cyprus. *Bull Int Epiz.* 1981; 9: 981-992.
17. Dalimi A, Motamedi G, Hosseini M, Mohammadian B, Malaki H, Ghamari Z, et al. Echinococcosis/hydatidosis in western Iraq. *Vet Parasitol.* 2002; 10: 161-171. doi: 10.1016/s0304-4017(02)00005-5
18. Budke M, Deplazes P, Torgerson P. Global socioeconomic impact of cystic echinococcosis. *Emer Inf Dis.* 2005; 12(2): 296-303. doi: 10.3201/eid1202.050499
19. Morar R, Feldman K. Pulmonary echinococcosis. *Eu Resp J.* 2003; 21: 106-1017. doi: 10.1183/09031936.03.00108403
20. Regassa F, Abunna F, Mulugeta A, Megersa B. Major meta-cestode in cattle slaughtered at Wolayita Sodo Municipal Abattoir,

- Southern Ethiopia: Prevalence, cyst viability, organ distribution and socioeconomic implications. *Trop Anim Heal Prod.* 2009; 41: 1495-1550. doi: [10.1007/s11250-009-9338-3](https://doi.org/10.1007/s11250-009-9338-3)
21. Gracey J, Collins D, Huey R. *Meat Hygiene*. 10+ ed. London, UK: W. B. Saunders Company; 1999: 660-665.
22. Abdata D, Desissa F, Deresa B, Moje N, Assefa Z. Epidemiology and financial loss of bovine hydatidosis in cattle slaughtered at Nekemte Municipal Abattoir, Ethiopia. *Acta Para Global.* 2014; 5: 133-138. doi: [10.5829/idosi.apg.2014.5.2.84177](https://doi.org/10.5829/idosi.apg.2014.5.2.84177)
23. Degefu H, Damet T. Hydatidosis of cattle and sheep, its economic importance and echinococcus granulosus among stray dogs in South Wollo, Ethiopia. *Ethio Vet J.* 2013; 17: 101-119. doi: [10.4314/evj.v17i2.8](https://doi.org/10.4314/evj.v17i2.8)
24. Fufa A, Sisay F, Bekele M, Regassa A. Prevalence of bovine hydatidosis in Kombolcha ELFORA Abattoir, North Eastern Ethiopia. *Open Journal of Animal Sciences.* 2012; 2: 281-286. doi: [10.4236/ojas.2012.24038](https://doi.org/10.4236/ojas.2012.24038)
25. Assefa A, Tesfaye H. Hydatidosis in cattle slaughtered at Adigrat Municipal Abattoir, Ethiopia. *Inter J Trop Dis Heal.* 2014; 4: 52-61. doi: [10.9734/IJTDPH/2014/4514](https://doi.org/10.9734/IJTDPH/2014/4514)
26. Adane M, Guadu T. Bovine hydatidosis: Occurrence, economic and public health importance in Gondar ELFORA Abattoir. *Eu J Appl Sci.* 2014; 6: 11-19. doi: [10.5829/idosi.ejas.2014.6.2.8585](https://doi.org/10.5829/idosi.ejas.2014.6.2.8585)
27. Tariku T, Tigre W, Teka G, Dorny P. Prevalence of bovine cysticercosis and hydatidosis in Jimma Municipal Abattoir, South West Ethiopia. *J Vet Res.* 2009; 76: 23-32. doi: [10.4102/ojvr.v76i3.37](https://doi.org/10.4102/ojvr.v76i3.37)
28. Buzuayehu L, Tsegalem A, Befikadu U, Ayalew N, Abebe A. Prevalence of bovine hydatidosis and its economic significance in Harar Municipal Abattoir, Eastern Ethiopia. *Eu J Sci Res.* 2014; 9: 143-149. doi: [10.5829/idosi.aejsr.2014.9.5.9144](https://doi.org/10.5829/idosi.aejsr.2014.9.5.9144)
29. Tesfamichael T. *Epidemiology of Bovine Fasciolosis and Hydatidosis in Debre-Brahan*. [dissertation]. FVM, AAU, DZ; Ethiopia; 1995.
30. Arene F. Prevalence of hydatidosis in domestic livestock in the Niger Delta. *Trop Anim Heal Prod.* 1995; 17: 3-5. doi: [10.1007/BF02356125](https://doi.org/10.1007/BF02356125)
31. Haftu B, Kebede T. Study on prevalence and economic significance of Bovine hydatidosis in Bako Municipal Abattoir, West Shoa Zone, Oromiya Regional State. *J Vet Sci Techno.* 2014; 5: 5-30. doi: [10.4172/2157-7579.1000197](https://doi.org/10.4172/2157-7579.1000197)
32. Fikre L. *Echinococcosis/Hydatidosis in Konso/Southern Ethiopia: Assessment Trail of Its Prevalence, Economic and Public Health Importance*. [dissertation]. Debre-Zeit, Ethiopia: Addis Ababa University; 1994.
33. Efreem L, Biresaw S, Berhanu S, Eyob H. Causes of organ condemnation, its public health and financial significance in Nekemte Municipal Abattoir, Wollega, Western Ethiopia. *Journal of Veterinary Medicine and Animal Health.* 2013; 7: 105-114. doi: [10.5897/JVMAH2014.0355](https://doi.org/10.5897/JVMAH2014.0355)
34. Mulatu M, Mekonnen B, Tassew H, Kumar A. Bovine hydatidosis in Eastern part of Ethiopia. *Momona Ethiopian Journal of Science.* 2013; 5: 107-114. doi: [10.4314/mejs.v5i1.85334](https://doi.org/10.4314/mejs.v5i1.85334)
35. Gemmell A, Roberts G, Beard C, Diaz S, Lawson R, Nonnemaker J. Control of echinococcus granulosus. *World Organization for Animal Health France.* 2001; 195-203.
36. Debas E, Ibrahim, N. Prevalence and economic importance of hydatidosis in cattle slaughtered at North Gonder ELFORA Abattoir. *Trop Anim Eu J Appl Sci.* 2013; 5: 29-35. doi: [10.5829/idosi.ejas.2013.5.1.6564](https://doi.org/10.5829/idosi.ejas.2013.5.1.6564)