

Original Research

Prevalence and Public Health importance of Bovine Cysticercosis in Haramaya Municipal Abattoir, East Hararghe Zone of Oromia Regional State, Eastern Ethiopia

Mohammed Abdella, DVM¹; Mohammedkernal M.Ame, BVSc²

¹Department of Veterinary Medicine, Haramaya Municipal Abattoir, East Hararghe, Ethiopia

²Department of Veterinary Public Health, College of Veterinary Medicine, Haramaya University, P. O. Box. 138, Dire Dawa, Ethiopia

*Corresponding author

Mohammed Abdella, DVM

Department of Veterinary Medicine, Haramaya Municipal Abattoir, East Hararghe, Ethiopia; Tel +251921171393; E-mail: mameabdella53@gmail.com

Article information

Received: January 13th, 2022; Revised: February 15th, 2022; Accepted: March 10th, 2022; Published: March 19th, 2022

Cite this article

Abdella M, Ame MM. Prevalence and public health importance of bovine cysticercosis in Haramaya Municipal Abattoir, East Hararghe Zone of Oromia Regional State, Eastern Ethiopia. *Vet Med Open J.* 2022; 7(1): 5-11. doi: [10.17140/VMOJ-7-161](https://doi.org/10.17140/VMOJ-7-161)

ABSTRACT

Aim

This study was conducted by using the protocols of post-mortem examinations of meat (visual inspection) to determine the prevalence of bovine cysticercosis in the cattle slaughtered at Haramaya Municipal Abattoir, Eastern Hararghe, Ethiopia and to determine zoonotic significance of taeniasis.

Method

A cross-section study design was conducted from November 2020 to March 2021, based on routine meat inspection on simple randomly selected cattle slaughtered at the abattoir. Visual inspection of all exposed surface was made in all active organs. They are shoulder muscles, hearts, masseters (cheek muscle), diaphragms, tongues and livers. This is followed by incision of all those organs to be examined for *Cysticercus bovis* cysts.

Results

Twenty-one (21) of the 384 cattle examined utilizing the post-mortem examinations meat inspection methodology were positive for *C. bovis*, resulting in a prevalence of 5.5%. The masseter muscle (11.5%) had the highest prevalence of cysts, followed by the triceps (8.3%), heart (5.8%), liver (4.8%), and tongue (2.9%). The sex-based prevalence rates were 10 (3.4%) and 11 (12.1%), respectively. The predominance of bodily condition was found to be good (1.3%), medium (11.1%), and bad (50%). The prevalence male and female differed substantially by organ, sex, and bodily condition ($p > 0.05$), but not statistically significant by age of the animals (young 2.8% vs. adult 6.1%) ($p > 0.05$). Eight (20%) of the total 40 interviewees had contracted *Taenia saginata* infection at least once in their lives. Religion showed a significant difference ($p > 0.05$) (Christian 66.7% and Muslim 6.5%). However, there was no statistically significant difference in meat consumption habits (raw 31.6% vs. cooked 9.5%), sex (male 26.5% vs. female 11.8%), age (young 33.3% vs. adult 17.7%), educational status (illiterate 22.2% vs. elementary 14.3% vs. high school 27.3% vs. college 16.7%) or latrine use (proper users 19.4% and non-proper users 25%).

Conclusion

This study to increasing public awareness of the disease, as well as strict routine meat inspections, should be prioritized in order to decrease the parasite's impact.

Keywords

Bovine, *Cysticercus bovis*; Haramaya Municipal Abattoir; Prevalence; Public health.

INTRODUCTION

In all parts of the world, animal illnesses are one of the most significant limitations of increasing the productivity of food animals. Among the various parasitic diseases that impair cattle output around the world, parasitism is one of the most serious. Tape-

worms are commercially important intestinal parasites that have infected humans for thousands of years all throughout the world.¹ Besides *Taenia saginata* causes one type of taeniasis, while *Taenia solium* causes the other. Both infections are acquired indirectly, with humans swallowing parasite-infected beef or pork. Humans are the definitive hosts, while cows and pigs serve as intermediate hosts.²

Tapeworm infection has been recorded in 1500-years ago and the occurrence of metacestode stage larvae (*C. bovis*) in cattle musculature causes bovine cysticercosis while the adult worm in human small intestine is the cause of taeniasis. Both adult and larval forms have hazardously affect health of their respective hosts, either directly or indirectly accompanied with several secondary infections, particularly in human.³

T. saginata is a worldwide zoonotic cestode whose epidemiology is ethnically and culturally determined by estimation of 50-77 million annually.⁴ The parasite is very common in Africa and endemic in central and East African countries like Ethiopia, Kenya and Zaire. The custom of eating raw or undercooked beef dishes such as kourt, lebleb, kiteffo and the habit of defecating in open fields coupled with cattle to graze in such fields which are cause of cysticercosis for cattle and taeniasis for human.⁵ A high-prevalence of human infection in different agro-climatic zones of Ethiopia has been reported and estimates made by different investigators on the prevalence is vary widely from 2-16% to over 70%.⁶

Transmission to animals occurs by the ingestion of food or water contaminated with the feces of infected humans. Bovine cysticercosis is asymptomatic after development in infected animals. However, it produces irreversibly effects to the beef cattle industry, when the disease is diagnosed at slaughterhouses by visual inspection of specific sectioned tissues.^{7,8}

Humans become infected by eating raw or undercooked meat containing the viable cysticerci. The tapeworm develops within the small intestine and becomes sexually mature in about three months, producing gravid proglottids, which are mobile and either migrate from the anus of the infected host spontaneously or shed in feces.⁹ Cysts of *C. bovis* can be found anywhere in the carcass and viscera, but its illustrated sites are predilection like masseter, tongue, heart, triceps, intercostals muscle and the diaphragm which organs are consumed at raw level and causes of public health hazardous.¹⁰

Haramaya district had, large head of cattle but production is low which may be due to parasitic diseases; among which bovine cysticercosis is the most important disease, causing direct and indirect economic loss on livestock production, particularly of cattle and the parasite has public health importance.¹ However, there was no study indicating the disease in Haramaya district which may vary epidemiologically from one area to another.

Therefore, the objectives of this study were:

- To determine the prevalence of bovine cysticercosis at the Haramaya municipal abattoir.
- To determine zoonotic significance of Cysticercosis in the study area.

MATERIALS AND METHODS

Study Area

The research was carried out in the Haramaya Municipal Abattoir,

which is located in the Oromiya region's Eastern Hararghe Zone. Harar is 14 kilometers away, and Finfinne is 508 kilometers away. According to agricultural statistics from the Haramaya district, the district contains 63,723 cattle, 13,612 sheep, 20,350 goats, 15,978 donkeys, 530 camels, and 42,035 chickens. The district's production system is a hybrid. It is located at a height of 1600-2100 meters above sea-level, with an average yearly temperature of 18 °C and a relative humidity of 65%. The area receives roughly 900 mm of rain per year on average, with a bimodal distribution pattern peaking in mid-April and mid-August. It is situated at 41° 59' 58" north latitude and 9° 24' 10" south longitude.¹¹

Study Population

The study was conducted on the local breed of cattle coming to the Haramaya municipal abattoir which were reared under semi-intensive and extensive farming system. Different risk factors were considered like sex, age, body condition and organ affected. Examination and evaluation of body condition were accomplished during ante-mortem examination. They were classified as poor, medium and good by observing the body condition of the animals in the field according to the method described by Nicholson et al.¹² The ages of animals were also estimated by the dentition method.¹³

Study Design and Sampling Strategy

Cross-sectional study was used to know the prevalence of bovine cysticercosis. The study was based on routine meat inspection on simple randomly selected cattle slaughtered at the abattoir. Visual inspection of all exposed surface was made in all active organs. They are shoulder muscles, hearts, masseters (cheek muscle), diaphragms, tongues and livers. This is followed by incision of all those organs to be examined for *C. bovis* cysts.

Moreover, a cross-sectional study was conducted by a structured questionnaire survey to assess the prevalence of *T. saginata* and associated risk factors.

Sample Size Determination

The number of animals required for the study was determined using the formula given by Thrusfield¹⁴ for simple random sampling, by using 95% level of confidence, 50% expected prevalence and 0.05 desired absolute precision.

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

Were as: n=numbers of individuals to be sampled.
Pexp=expected prevalence
d²=desired absolute precision
1.96=95% confidence level

There was no previously obtained data on the prevalence of *C. bovis* in extensive cattle production system in the study area. Therefore, an overall mean expected prevalence of 50% (0.5) was used with desired absolute precision of ±5%. Accordingly, 384

heads of cattle were sampled in the study.

Study Methodology

Active abattoir survey: The explanatory variables considered are age, sex, body condition and species of animal. The animals were examined before slaughter (ante-mortem inspection) and after slaughter (post-mortem inspection). During ante-mortem examination each animal was marked for identification by writing a code on its head by using un-washable ink and the tagged number of each animal was recorded. Ante-mortem examination on individual animal was done for the assessment of body condition, age, sex and species. During post-mortem inspection, examination of muscles and different organs for the presence of cysts was undertaken by incisions. Each individual was examined based on routine meat inspection on randomly selected cattle slaughtered at the abattoir for the presence of *C. bovis* in organs like Masseter, tongue, heart, triceps, intercostals muscle and the diaphragm. Post-mortem inspection is the most common method in use to detect bovine cysticercosis.

Questionnaire surveys on taeniasis: Questionary survey was used to collect data regarding human taeniasis by visiting hospital 40 patient in Haramaya town by using questionnaire survey. The potential risk factors of taeniasis such as habit of raw meat consumption, age, sex, religion, occupation, educational levels, presence and usage of sanitary facilities especially toilet and knowledge of *T. saginata* was assessed.

Data Analysis

Abattoir data and questionnaire collected were entered to Microsoft Excel spreadsheet and analyzed by using statistical package for the social sciences (SPSS) version 20 software. Associations between each factor were determined by using Chi square test (χ^2). A statically significant association between variables exists when $p < 0.05$ and at 95% confidence level (CI).

RESULTS

Out of the total 384 cattle examined, 21 were found positive for the presence of *C. bovis* with overall prevalence of 5.5%. There is no statistically significant difference ($p > 0.05$) in the prevalence of cysticercosis between the age groups. Analysis of the active abattoir survey proved that there is statistically significant difference between sex groups ($p < 0.05$) as well as between body condition (Table 1).

An association with regard to the anatomical distribution of *Cysticercus* cysts in the inspected organs showed statistical significance. Out of single organ, the maximum intensity of infection was observed in masseter muscle followed by tongue and liver, 11.3%, 1.6% and 1.3% respectively. The cyst found in more than one organ, the maximum intensity were found in liver and masseter muscle (37.5%) followed by triceps muscle and tongue (8.3%), head and heart (5.8%) (Table 2).

Table 1. Prevalence of Bovine Cysticercosis on the Basis of Sex, Age and Body Condition

Variable	Animals Examined	Positive	Prevalence (%)	χ^2	p-value
Sex					
Male	293	10	3.4	10.1	0.002
Female	91	11	12.1		
Total	384	21	5.5		
Age					
Young	71	2	2.8	1.2	0.15
Adult	313	19	6.1		
Total	384	21	5.5		
Body Condition					
Good	229	3	1.3	24.8	0.00
Medium	153	17	11.1		
Poor	2	1	50		
Total	384	21	5.5		

Table 2. Frequency Distribution of *C. bovis* in Different Organs and Tissues of Affected Animals

Organ infected	No. of Infection	Percent (%)	χ^2	p-value
Liver	1	1.3	30.6	0.00
Tongue	2	1.6		
Masseter muscle	12	11.3		
Liver and masseter	3	37.5		
Triceps and tongue	1	8.3		
Head and heart	2	5.8		
Total	21	5.5		

Questionnaire Survey on Taeniasis

Of the total 40 interviewed respondents who participated in this study, 20% (8/40) had contracted *T. saginata* infection at least once in their life time, of which, 17.5% and 2.5% reported using modern drugs and traditional drugs, respectively. The majority of the respondent had an experience of raw meat consumption as a result of traditional and cultural practice.

The analysis of the risk factors showed a significant difference ($p < 0.05$) in the prevalence of taeniasis with religion, but there was no significance difference between age, sex, educational status, address, habit of eating meat and latrine using behavior of the respondents ($p > 0.05$) (Table 3).

DISCUSSION

In the current study, the overall prevalence of bovine cysticercosis was 5.5%. This is comparable with finding of Gomol et al,¹⁵ (3.6%) and Megersa et al,¹⁶ (4.4%) in Jimma Municipal Abattoir as well as result by Dawit¹⁷ (4.9%) at Gondar. However, this was lower than findings reported by Abunna et al,¹⁸ (26.3%) in Awassa, Hailu¹⁹ (17.5%) in East Shoa, Getachew²⁰ (13.8%) in Debre Zeit, Regassa et al,²¹ (13.3%) in Ahmed²² (21%) in Nekemte abattoirs. This difference might be because most of the animals slaughtered

Table 3. Association between Prevalence of Human Taeniasis with Risk Factors in Haramaya Town

Variable	Interviewed People	No. of Infected	Prevalence (%)	χ^2	p-value
Sex					
Male	23	6	26.1	1.25	0.18
Female	17	2	11.8		
Total	40	8	20		
Age					
Young(1-20)	6	2	33.3	0.78	0.26
Adult(>20)	34	6	17.7		
Total	40	8	20		
Education Status					
Illiterate	9	2	22.2	0.72	0.87
Elementary	14	2	14.3		
High school	11	3	27.3		
College	6	1	16.7		
Total	40	8	20		
Address					
Rural	12	1	8.3	1.46	0.19
Urban	28	7	25		
Total	40	8	20		
Religion					
Christian	9	6	66.7	15.8	0.001
Muslim	31	2	6.5		
Total	40	8	20		
Meat Eating Habit					
Raw	19	6	31.6	3.03	0.07
Cooked	21	2	9.5		
Total	40	8	20		
Use of Latrine					
Proper User	36	7	19.4	0.69	0.43
Non proper user	4	1	25		
Total	40	8	20		

in the abattoir were brought from fattening systems flourishing in different district of east Hararghe zone in which animals from such are less exposed for eggs of *C. bovis* as they graze on relatively clean pasture and restricted indoor husbandary system used by Hararghe farmers.²³

The prevalence of this study is also lower than to some reports from African countries, such as 20% in Senegal, 27% in Tanzania and 38-62% in Kenya Opera et al.²⁴ Similarly, Opara et al,²⁴ had reported prevalence of 26.2% from slaughter animals in Nigeria. Conversely, lower prevalence was reported from developing countries, such as 0.26% in Croatia (Zivkovic et al,²⁵ 0.48-1.08% in Germany Abuseir et al,²⁶ and 0.9% in Suarez et al).²⁷

The different prevalence reported in these studies might be due to diagnosis of bovine cysticercosis by meat inspection underestimates the true prevalence, especially when infection is light Dorny et al.⁹ The higher prevalence of cysticercosis in developing countries might indicate poor sanitary infrastructure, low awareness and improper disposal of sewage, which also

pertains to Ethiopia, where the widespread habit of eating raw meat is an additional important risk factor.

In Ethiopia, available literature reveals different percentages of cattle positive for *C. bovis*. Tembo²⁸ found 70(3.11%) out of 2250 randomly selected adult of bovine carcasses in the central highlands (Akaki, Debrezeit, Nazereth) positive for cysticercosis. Similarly, in Gondar area, the prevalence of *C. bovis* was reported to be 9.7% and 4.9% by Demissie²⁹ and Hailu¹⁹ respectively. In contrast to low prevalence reported above, such studies in export abattoirs like Mojo, ELFORA, Dukem and Luna revealed a comparatively higher prevalence was reported as 17.9%, 13.6%, 19.2% and 27.6% respectively.³⁰ In Amhara regional state, Kebede³¹ reported (18.49%). These reports indicate variation in the prevalence within Ethiopia. Difference in the prevalence of cysticercosis within a country probably reflects the difference in the expertise/or diligence of meat inspectors. The high prevalence reported in modern and export abattoirs may be due to a thorough meat inspection by incising all organs and muscles and also inspectors in such abattoirs are more experienced and

also have awareness to the economic importance of *C. bovis* in the exportation Gracey et al.³²

In the present study there is statistically significant difference ($p < 0.05$) between both sexes (male 3.4%, female 12.1%) and this is in contrary with report of Gomol et al,¹⁵ Kebede,³¹ Jemal et al³³ and of Garedaghi et al.³⁴ The possible reason is that, the sample size of female cattle is not comparable to that of male cattle slaughtered at Haramaya municipal abattoir. Prevalence based on body condition were (1.3%), (11.1%) and (50%) in good, medium and poor, respectively which has significant difference ($p < 0.05$). This is contrary with report by Abunna et al.¹⁸ The reason might be due to sample size of medium body condition slaughtered is greater and/or immune system of poor body condition animal is weak and easily exposed to infection.

In current study there is no statistically significant difference ($p > 0.05$) between age group (young 2.8% and adult 6.1%). It agrees with observation by Hailu¹⁹ and Tembo²⁸ but not in agreement with report of Gomol et al,¹⁵ and Jemal et al³³ The possible explanation for this might be that young animals have close susceptibility due to poor immunity. Animals brought to the abattoir are in the same age group that means nearly adult and also the sample size is a factor for its insignificance.

The study also revealed that the highest prevalence of cysts was found in the masseter muscle (11.5) followed by triceps (8.3), heart (5.8), liver (4.8) and tongue (2.9) as observed on Table 2. This finding is in agreement with the reports of Amsalu,³⁵ Dawit¹⁷ and Opara et al.²⁴ Report by Wanzala et al,⁸ indicates *C. bovis* are commonly found in muscles of mastication, particularly masseter muscles, shoulder muscles, heart, tongue, and occasionally in liver, lungs and lymph nodes. The variations in anatomical distribution depend on a number of factors, such as blood kinetics and animals' daily activities.

Human taeniasis was a health problem in the study area with prevalence of 20%. The occurrence of the disease had significant association ($p < 0.05$) taeniasis, prevalence was higher among the Christian community than Muslims. This might be because of raw meat consumption is not common in Muslims as in Christians and Christians also celebrate several annual festivals with the tradition of raw meat consumption, which was in agree with reports by Abunna et al,¹⁸ and Hailu.¹⁹

Non-statistical variation between people and different risk factors were as follows; Prevalence with educational backgrounds was 22.2%, 14.3%, 27.3% and 16.7 in illiterate, elementary, high school and college, respectively. This might be because of the deeply rooted tradition of raw and undercooked meat consumption regardless of the educational level status. Association between human taeniasis and sex was 26.5% in male and 11.8% in female. The higher prevalence of taeniasis among male could be due to economic reasons and cultural practices in that male do not prepare their dish at home, rather consume at restaurants and butcheries. This study also indicate higher prevalence of Taeniasis among individuals who often consume raw meat than those with less frequent raw meat consumers (31.6% and 9.5% raw and

cooked meat consumers, respectively) and use of latrine (proper users 19.4% and non-proper users 25%) indicate being higher in non-proper latrine users similar with Magarsa et al.¹⁶ But disagree with Magarsa et al,¹⁶ Age wise prevalence was 33.3% in young and 17.7% in adult, the reason associated with children play outdoor with in contaminated soil and pasture and feed most of the time without washing their hand unless their families control them. Bovine cysticercosis/teniasis is a serious illness in both bovine and human populations, according to the current study. The disease causes financial losses due to the rejection of infected organs and the degradation of carcasses, as well as the high costs of human treatment. As a result, regular meat inspections should be done to ensure that contaminated carcasses and organs are rejected appropriately.

CONCLUSION AND RECOMMENDATION

Both the active abattoir and the questionnaire survey concluded that bovine cysticercosis caused by *C. bovis/T. saginata* is a major livestock disease that causes human health problems in Haramaya and the surrounding district areas. This is linked to risk factors such as raw meat consumption, incorrect bathroom usage, and a lack of other hygienic measures. According to the findings, the condition mostly affects the mastication muscle, resulting in significant production losses.

The following recommendations were made based on the aforesaid conclusion.

- Strengthening training should raise public understanding about the disease's importance and impact on health.
- Lessen the disease's impact on humans and animals, there should be strong and tight collaboration between medical and veterinary professionals.
- Sewage disposal and latrines should be well-designed.
- Strict routine meat inspection is required, as well as a comprehensive examination of all organs for cyst.

ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude to my advisor, Dr. Geremew Haile, for his invaluable support, dedication of time in editing this manuscript, unwavering and consistent advice, encouragement, painstaking correction to give the paper its form, and brotherly approach in all aspects.

My special gratitude go to my co-advisor, Dr. Natenael Tamiret, who assisted me in all facets of my work during my externship program.

Finally, I'd want to express my gratitude to Haramaya University, the College of Veterinary Medicine, and the Haramaya Municipal Abattoir inspector for their assistance during this project, as well as my family for their financial and moral support.

REASON FOR NOT HAVING THE APPROVAL FROM ETHICAL COMMITTEE AND THE INSTITUTIONAL REVIEW BOARD

Keeping in view the public health significance of bovine

cysticercosis, the present study was proposed to find the occurrence of bovine cysticercosis in some parts of Eastern Ethiopia and its implication on public health. The current study was proposed in light of the public health significance of bovine cysticercosis. Its goal was to determine the prevalence of bovine cysticercosis in specific sections of eastern Ethiopia, as well as its implications for public health.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

- Radostits MO, Gay CC, Hinchcliff KW, Constable PD. *Veterinary Medicine. Text Book of the Disease of Cattle, Sheep, Goats, Pigs and Horses*. 10th ed. Philadelphia, Pennsylvania: Saunders; 2007: 1581-1583.
- Marquardt WC, Demaree RS, Grieve RB. *Parasitology and Vector Biology*. 2nd ed. San Diego, nd London, UK: Accademic Press; 2000: 327-334.
- Minozzo JC, Gusso RLF, DeCastro EA, Lago O, Soccoi VT. Experimental bovine infection with *T. saginata* eggs: Recovery rates and cysticerci location. *Braz Arch Biol*. 2002; 45. doi: 10.1590/S1516-89132002000600008
- Carlos E, Armando N, William A. *Taenia solium* cysticercosis/taeniosis: Potential linkage with FAO activities; FAO support possibilities. *Acta Trop*. 2003; 87(1): 145-148. doi: 10.1016/s0001-706x(03)00037-8
- Kumar A, Tadesse G. Bovine cysticercosis in Ethiopia: A review. *Ethiop. Vet J*. 2011; 15: 15-35. doi: 10.4314/evj.v15i1.67681
- Mohammed AA, Waqtole C. Medical Parasitology for Medical laboratory Technology students. Ethiopia Public Health Training Initiative. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_tech_students/ln_parasitology_final.pdf. 2006: 339-341. Accessed January 11, 2022.
- Geysen D, Kanobana K, Victor B, et al. Validation of meat inspection results for *Taenia saginata* cysticercosis by PCR restriction fragment length polymorphism. *J Food Prot*. 2007; 70(1): 236-240. doi: 10.4315/0362-028x-70.1.236
- Wanzala W, Onyango AG, Kang KE, Zessin HK, Kyule MN. Control of *Taenia saginata* by post-mortem examination of carcasses. *Afr Health Sci*. 2003; 3: 68-76.
- Dorny P, Praet N. *Taenia saginata* in Europe. *Vet Parasitol*. 2007; 149: 22-24. doi: 10.1016/j.vetpar.2007.07.004
- Gyles CL, Prescott JF, Songer JG, Thoen CO. *Pathogenesis of Bacterial Infection in Animals and its Product Hygiene*. 3rd ed. NY, USA: Blackwell Science; 2004: 122-119.
- Haramaya woreda agricultural development bureau (HBD). 2009: Haramaya, Ethiopia.
- Nicholson M, Butterworth T. *A Guide to Condition Scoring of Zebu Cattle*. Addis Ababa, Ethiopia. 1986:
- Gatenby R. *The Tropical Agriculture, London and Beijing Stock Mc Millan Education Ltd*. Washington, D.C., USA: ACCT; 1991: 6-10.
- Thrusfield M. *Veterinary Epidemiology*. 2nd ed. Oxford, USA: Black Well Science tropics; 2005:
- Gomol T, Achnef M, Basazenuw B, Mersha C. Cyst viability, body site distribution and public health significance of bovine cysticercosis at Jimma, South West. Ethiopia. *Global Veterinaria*. 2011; 7(2): 164-168.
- Megersa B, Tesfaye E, Regassa A, Abebe R, Abunna F. Bovine cysticercosis in cattle slaughtered at Jimma municipal abattoir, South Western Ethiopia: Prevalence, cyst viability and its socio-economic importance. *Vet World*. 2011; 3: 257-262. doi: 10.5455/vetworld.2010.257-262
- Dawit S. *Epidemiology of Taenia Saginata Taeniosis and Cysticercoids in North Gondar Zone, North Western Ethiopia*. [dissertation]. Debre zeit, Ethiopia; Addis Ababa University; 2004.
- Abunna F, Tilahun G, Megersa B, Regassa A, Kumsa B. Bovine cysticercosis in cattle slaughtered at Hawassa Municipal Abattoir, Ethiopia: Prevalence, Cyst Viability, Distribution and its public health implication. *Zoonoses Public Health*. 2008; 55(2): 82-88. doi: 10.1111/j.1863-2378.2007.01091.x
- Hailu D. *Prevalence and Risk Factor for T. saginata Cysticercosis in Three Selected Areas of Eastern Shoa*. [master's thesis]. Debre zeit, Ethiopia; Addis Ababa University; 2005.
- Getachew B. *Prevalence and Significance of Cysticercus Bovis among Cattle Slaughtered at Debre Zeit Abattoir*. Debre zeit, Ethiopia; Addis Ababa University; 1990.
- Regassa A, Abunna F, Mulugeta A, Megersa B. Major meta-cestodes in Wolaita Soddo municipal abattoir, Southern Ethiopia: Prevalence, cyst viability, organ distribution and socio-economic implication. *Trop Anim Health Prod*. 2009; 41: 1495-1502. doi: 10.1007/s11250-009-9338-3
- Ahmed I. *Bovine Cysticercosis in Animals Slaughtered at Nekemte Abattoir*. [dissertation]. Addis Ababa University; Debre Zeit, Ethiopia; 1990.
- Over HJ, Jansen J, van Olm PW. *Distribution and Impact of Helminth Diseases of Livestock in Developing Countries (No 96) (FAO Animal Production and Health Paper S.)*. Rome, Lazio, Italy: Food & Agriculture Organization of the United Nations; 1992.
- Opara M, Ukpong I, Okoli C, Anosike J. Cysticercosis of slaughter cattle in southeastern Nigeria. *Ann N Y Acad Sci*. 2006;

1081: 339-346. doi: [10.1196/annals.1373.048](https://doi.org/10.1196/annals.1373.048)

25. Zivkovic J, Velimirovic D, Dzaja P, Grabarevic Z. Prevalence of *C. bovis* in measles with particular reference to histopathological changes in meat. *Arch Lebensmittelhyg.* 1996; 47: 66-68.

26. Abuseir SC, Epe T, Schnieder G, Klein M. Visual diagnosis of *Taenia saginata* cysticercosis during meat inspection: Is it unequivocal? *Parasitol Res.* 2006; 99: 405-409. doi: [10.1007/s00436-006-0158-3](https://doi.org/10.1007/s00436-006-0158-3)

27. Suarez HM, Santizo RM. Epidemiology of the *Taenia saginata* complex and *C. bovis* in Ciego de Avila, province of Cuba. *Rev Patol Trop.* 2005; 34: 43-52.

28. Tembo A. *Epidemiology of Taenia saginata, Taeniasis/Cysticercosis in Three Selected Agro Climatic Zones.* [master's thesis]. Debre zeit, Ethiopia; Addis Ababa University; 2001.

29. Demissie A. *Prevalence and Significance of Cysticercus Bovis Among Slaughtered Cattle at Gondar Meat Factory.* [dissertation]. Debre zeit, Ethiopia; Addis Ababa University; 1989.

30. Degefu H. *Prevalence and Risk Factors for Taenia Saginata Taeniasis/*

Cysticercosis in Three Selected Areas of Eastern Shoa. [master's thesis]. Debrezeit, Ethiopia; Addis Ababa University; 2005.

31. Kebede N. Cysticercosis of slaughtered cattle in north western Ethiopia. *Res Vet Sci.* 2008; 85: 523-526. doi: [10.1016/j.rvsc.2008.01.009](https://doi.org/10.1016/j.rvsc.2008.01.009)

32. Gracey J, Collins DS, Huey R. Diseases caused by helminthes and arthropod parasites. In: *Meat Hygiene.* 10th ed. London, UK: W. B. Saunders Company Ltd.; 1999: 673.

33. Jemal E, Haileleul N. Bovine cysticercosis: Prevalence, Cyst viability and distribution in cattle slaughtered at Kombolcha Elfora meat factory, Ethiopia. *American Eurasian Journal of Agriculture and Environmental Science.* 2011; 11: 173-176.

34. Garedaghi Y, Saber P, Khosroshahi MS, Prevalence of bovine cysticercosis of slaughtered cattle in meshkinshahr abattoir. *American Journal of Animal and Veterinary Sciences.* 2011; 6(3): 121-124. doi: [10.3923/javaa.2012.785.788](https://doi.org/10.3923/javaa.2012.785.788)

35. Amsalu D. *Prevalence and Significance of Cysticercus bovis Among Slaughtered Cattle at Debrezeit Abattoir.* [dissertation]. Debrezeit, Ethiopia; Addis Ababa University; 1989.