Research Article

IJCRCPS

Bovine cysticercosis and human teniosis in urban and peri-urban community of Debre-Berhan, Amhara region, Ethiopia

Teklemariam Shewandagn, Abdi Feyisa, Jiratashiferaw, Berhane Wakjira and Yacob Hailu Tolossa*

Addis Ababa University, College of Veterinary Medicine and Agriculture
P.O Box: 34, Bishoftu, Ethiopia. Correspondence: yacob.hailu@aau.edu.et

Abstract

A cross sectional study was conducted from November 2021 to April 2022 on 384 zebu cattle slaughtered at Debreberhan municipal abattoir to determinethe current prevalence of bovine cysticercosis and associated risk factors. In addition 100 residents in Debre Berhane town were randomly selected for questionnaire survey to assess the public health significance of *Taenia saginata*. From the total of 384 cattle inspected, eight of them were found to be positive for *Cysticercus bovis* with an overall prevalence of 2.08%.The occurrence of the cystsin different organ showed that numerous cysts were observed in tongue 3/384, (0.78%) followed by heart, 2/384, (0.52%), liver, 2/384, (0.52%) and thigh muscle 1/384, (0.26%).There was no significant association between the prevalence of Cysticercus bovis based on age, sex, breed and body condition of the animals (P>0.05).Out of100 interviewed individuals, 25 (25%) respondents had infected by *T. saginata* at least once in their entire life. Human taeniosis prevalence showed that there was statistically significant association in the prevalence of taeniosis based on education level and raw meat consumption habit among interviewed (p<0.05), but there was no statistically significant association (p>0.05) observed in the prevalence of taeniosis among different age, sex, occupation and religion. In the current study, even though lower prevalence of bovine cysticercosis observed in inspected animals, in the contrary in human relatively higher prevalence of taeniosis was observed. Therefore, due attention should be given to public education on the route of transmission and prevention methods.

Introduction

Ethiopia is one of the countries in Africa with huge livestock resources that play a crucial role in the livelihoods of the majority of Ethiopians. The cattle population for the country is estimated at 65 million. Despite the huge resources, Ethiopia livestock productivity remains below being adequate. Among biological constraints contributing to low productivity includes the low genetic potential of the animals, poor nutrition and prevailing disease like parasitosis(CSA, 2020).Out of many prevalent livestock diseases parasitism is a major limit to livestock development in the tropic in general and *Cysticercus bovis*, which is the larvae stage of the human tapeworm, *Taenia saginata* causes significant economic losses to the beef industry and public health hazard (Pal, 2007).

Despite the fact that food-borne parasite diseases are underestimated, they cause death and serious disease in humans and animals around the world, and have public health and socioeconomic importance (Zhou *et al.*, 2008). Cysticercosis is one of the parasitic zoonosis. Cysticercus, the larval stage of the Cestoda Family Taeniidae, causing an infection in cattle. These parasites have evolved in two different hosts, with humans as the primary host and animals as intermediate hosts (Minozzo *et al.,*2002). *Taenia saginata* is the causative agent of bovine cysticercosis, a zoonotic parasitic disease with universal distribution (Rubiola, 2021:Cabaret *et al.*, 2002). Its life cycle is dependent on the link between humans and cattle, and any disturbance of his link can result in the parasite's complete eradication. Tapeworm infections have been recorded since 1500 BC and are considered as one of the earliest human parasites (Urquhart *et al.*, 2013).

Ingestion of live cysticerci with in raw or undercooked meat causes infection of the final host (human) with *T.saginata.* The mature tape worm, *T. saginata*, is located in the small intestine of the definitive host, man, while the metacestode (*C.bovis*), which serves as the principal intermediate host, is found in cattle (Endiras, 2011).The diseases epidemiology is linked to the cattle rearing system, the age of the cattle, meat inspection practices, and the habit of eating raw or undercooked meat. In rural regions, low awareness, poor cleanliness, and sanitary infrastructure may be favorable to disease transmission between animals and humans. The adult worm stage in the intestine averages 4–12 meters in length, and humans could be infected for years. Daily, approximately 6–9 proglottids are shed, either through feces or active migration. 50,000–80,000 eggs are contained in each proglottid (Dorny and Praet,2007).

Bovine cysticercosis has public health impact, after ingestion by humans, the cysts mature into the adult parasite T. saginata, which causes anorexia, weight loss, abdominal pain, digestive problems, and insomnia. Adult parasites movable gravid segments can sometimes find their way to unusual places like the appendix, uterus, or biliary tract, causing serious problems (Abay and Kumar, 2013).In countries like Ethiopia, the prevalence of *C. bovis*/*T.saginata*is higher because of the traditional habit of raw beef consumption in the form of kourt, lebleb and kitffo and the use of open field toilets coupled with the tradition of allowing cattle to graze on fields contaminated by the taenia on chosphers (Teka, 1997). Since in recent years, urbanization is so rapid with high population mobility (for jobs opportunity, tourism, workshops and trainings) in big towns like Debre-Berhan with numerous newly opened butcheries and increased raw beef consumption habits, it deems necessary to see the current status of *C.bovis*/*T.saginata* at slaughter houses and among public.

The objectives of the current study were [1] To determine the current abattoir prevalence of bovinecysticercosis and its organ distribution [2] To estimate human taeniosis among community in the urban and per-urban areas of Debre-Berhan [3] Identifying major risk factors associated with bovine cysticercosis and human taeniosis [4] To assess community knowledge, attitude and perception on human taeniosis.

Materials and Methods

Study Area

The study was conducted at Debre Berhane which is located about 130km north east of Addis Ababa situated at the central highland plateau. The town is the administrative center of north show a zone of the Amhara regional state located at 9°41'N latitude and 39°32'E longitude at about 130 km North-east of Addis Ababa. The altitude of the area is 2840 meter above sea level. The mean annual temperature of the study area is 11.4°C. The area is also characterized by two seasons, the wet season from June to September, and the dry season from October to May. The study area receives mean annual rainfall of (927.10mm) and characterized by bi-modal rainfall pattern with maximum and minimum peaks in August and December respectively. The study area's farming system is classified as a mixed crop-livestock production system. The extensive management system was the most common, whereas the semi-intensive husbandry approach with cross breed dairy cattle was rarely practiced.

Study Population

The study animals for the abattoir survey were the indigenous zebu cattle and cross breeds of zebu with Holstein Friesian cattle brought at Debre-Berhan municipal abattoir in Debre-Berhan town for slaughtering from different localities such as Debre Berhan, Jiru, Chacha, Shewarobit, Ankober and Kotu districts of north Shewa zone. Most of the slaughtered animals were male cattle. During sampling of the study animals its origin, sex, breed, ages and body conditions of all was recorded. For human study population, residents of Debreberhan town and peri-urban farmers were subjected to questionnaire surveys.

Study Design

Across-sectional study was conducted to determine the current prevalence using routine meat inspection technique in municipality abattoir for the presence of *Cysticercus bovis* in cattle slaughtered at Debreberhan municipal abattoir.

Meat inspection was done in accordance with the procedures of Ethiopian Ministry of Agriculture Meat inspection Regulation (1972) for the detection of *cysticercus bovis.* In addition across-sectional study was applied to randomly selected individuals from 9 kebele to assess community awareness, exposure risk, and treatment trends for taeniasis by a structured questionnaire survey to assess the prevalence of *T.saginata*/taeniosis, associated potential risk factors and its public health importance.

Sample Size Determination

The sample size for abattoir and questionnaire survey was determined using the formula described by (Thrusfield,2005) and Arsham (2002) respectively, at 95% confidence interval and 5% absolute precision. Expected prevalence was taken as 50% (4.6% by Kifle and Shiret, 2015). So, 384 animals were expected to be inspected.

$$N = \frac{1.96^2 \times p\,(1-p)}{d^2}$$

Where N = required sample size, P = expected prevalence, d = desired absolute precision (usually 0.05), and 1.96 = Z-value for 95% confidence level.
 Using the formula given by Arsham(2002) $N=(0.25/SE^2$, where N = sample size and SE (standard error)) = 5%.
The questionnaire survey was supposed to have a sample size of 100 people.

Study methods

Abattoir Survey

Active abattoir survey was conducted at Debreberhan town municipal abattoir. On slaughterhouse visiting days, a random sample of cattle was inspected. Each animal was given an identification code before being sampled. Before slaughtering, the animal's breed, age, sex, and body condition scores were all recorded. There were three categories for body condition scores:

good, medium, and poor. An animal was considered good if it had fat covering all of its ribs, whereas exposed ribs with an emaciated body were considered as poor. Medium-body condition animals were in between the two classes. The age of the animals was categorized as young <4 years old, adult 4–8 years and old >8 years(Abera *et al.,* 2022).Postmortem examination was made as per the procedures of Ethiopian ministry of agriculture meat inspection regulation (1972) for the detection of *C.bovis.* Visualization, palpation, and systematic incision of visceral organs such as the liver, lung, heart, and tongue, as well as muscles such as the masseters, diaphragm, and triceps, were used to check for the presence of parasites. The presence or absence as well as the organ distribution of the cysts were registered. To avoid organ mixing during meat inspection, each organ of an animal was checked carefully and separately.

Questionnaire Survey

To determine related risk factors of taeniosis, 100 Volunteer respondents are selected based on their convenience and were asked about taeniosis and major risk factors. The interview was conducted face to face after each participant had a thorough discussion of the study objectives. Questionnaire survey respondents for this study were asked about their raw meat consumption habits, taeniosis infection, and the discovery of proglottids in their feces, underwear. Religion (Christian and Muslim), educational status, age, knowledge of *T. saginata* and toilet availability of respondents were registered as possible risk factors. Occupation was subdivided in to farmer, merchants, Butchersand abattoir workers, civil servants and students. Data will also classified according to education levels of the respondents as illiterate (without formal education),literate (elementary up to high school) and graduates (colleges and universities)

Data analysis

STATA version -19 was used to analyze the data collected from the active abattoir surveys. Cases of *C. bovis* detected during routine postmortem inspection were the outcome variables for the abattoir survey. Pearson's Chi square test was used to test the relationship between the variables and bovine taeniosis. SPSS version -26 was used to summarize the results of the questionnaire survey data. At a 5% alpha level of significance, descriptive analysis and important factors were tested for their association with the occurrence of taeniosis in humans using the chi-square test.

Results

From the whole of 384 cattle examined, 8 were found positive for the presence of *C. bovis* giving a prevalence of 2.08%.The prevalence of *C. bovis* in the tongue is 3/384, (0.78%) was higher than in heart 2/384, (0.52%),liver 2/384(0.52%)and thigh muscle 1/384, (0.26%) in table 2. There was no statistical difference for the age groups body condition score, sex and breed with the occurrence of *C. bovis* (p>0.05).From the total 384 cattle, 313/384 were male out of those 5(1.6%)of them are positive, while 71/384cattle were female out of which 3(4.23%) are positive. According to age studied animals 319/384 were adult animals from them 8(2.5%) are infected and 65/384 as old cattle none of those are infected.

Table 1: Prevalence of Bovine cysticercosis based on sex, age, breed and body condition of the animals (N=384)

Risk factor	Categories	No. of Examined	No.of Infected(%)	X^2	P-value
Sex	male	313	5(1.6%)		
	female	71	3(4.23%)	1.952	0.162
Age	adult	319	8(2.5%)		
	old	65	0(0%)	1.6648	0.197
Breed	local	340	7(2.05%)		
	cross	44	1(2.27%)	0.0087	0.926
Body condition	good	219	4(1.83%)	0.3442	0.842
	medium	159	4(2.5%)		
	poor	6	0(0%)		

Table 2: Prevalence of *C. bovis* in different organs of the study animals (N=384)

Organ infected	No of positive(frequency)	prevalence(100%)
Heart	2	0.52
Liver	2	0.52
Thigh muscle	1	0.26
Tongue	3	0.78
triceps muscle	0	0
masseter muscle	0	0
Diaphragm	0	0

Results of questionnaire survey

Sixty-one percent of the 100 voluntary individuals interviewed were aware of the possible risk factors for taeniasis infections (*T. saginata*) and 25% of them had history of taeniasis infection previously. In a survey of 100 volunteers, 61 said they were aware that raw or undercooked meat is the source of infection. The prevalence was 27.9% in male but 18.8% in female. The most commonly used traditional drug used in the area is koso followed by Metere and Enkoko. From associated risk factors only education level and raw meat consumption becomes significantly associated with taeniasis (p<0.05).Out of 100 respondents, 48 of them stated that they would not stop eating raw beef because of human taeniasis.

28

Table 3: History of human taeniosis infection on the basis of sex, age, occupation, religion and level of education N=100

Risk factor	Respondents	Interviewed	Suffered(%)	X^2	P-value
Age	Adult	55	10(18.18%)		
	Old	45	15(33.33%)	1.923	0.166
Sex	Male	68	19(27.9%)		
	Female	32	6(18.8%)	0.980	0.322
Religion	Christian	95	25(26.3%)		
	Muslim	5	0(%)	1.754	0.185
Occupation	Farmer	20	8(40%)		
	Student	18	2(11.1%)		
	Civil servant	15	2(13.30%)	7.360	0.195
	Butcher	15	3(20%)		
	Merchant	17	4(23.5%)		
	Abattoir worker	15	6(40%)		
Education level	Illiterate	31	14(45.2%)		
	Literate	53	8(15.1%)	9.827	0.007
	Graduate	16	3(18.8%)		

Table 4: Frequency of raw beef meat consumption and its associated risk to taeniosis

Meat consumption habit	Frequency	Taenia infected(%)	X^2	P-value
Never taste raw beef	39	3(7.7%)	4.436	0.035
Stop but restarted	12	2(16.67%)		
Never dared to stop	49	20(40.8%)		

Table 5: Community awareness/knowledge on anthelmintic used risks of *Taenia saginata* contraction

factors studied	Response	Frequency
	Mebendazole	4
	Praziquantel	3
Modern drug used	Dichlorophene	1
	I didn't know which I taken	12
	I didn't take ever	80
Do you know the cause of tape worm?	Yes	61
	No	39
Can you identify tape worm infective form?	Yes	2
	No	98
Do you intend to stop eating raw beef because of human taeniasis	Yes	48

Discussion

In the present study, the prevalence of cysticercosis in Debreberhan city was found as 2.08%.Out of 384 bovines inspected, 8 of them were found to be positive for *C. bovis* at postmortem inspection with over all prevalence of 2.08%. The percent positivity is smaller than the report from Ethiopia's other places. This could be due to the fact that the prevalence of *C. bovis* varies depending on meat inspectors experiences, and the commonly used meat inspection procedure has practical limitations on the number and degree of incisions allowed, as gross mutilation lowers the carcass market value, so many infestations go undetected (Abay, and Kumar., 2013).On the other hand variation in prevalence of bovine cysticercosis from place to place might be due to the changes in the environmental and epidemiological factors, this could affect the rate of *Taenia saginata*/bovine cysticercosis transmission. Intensive keeping of the animals, farm sanitation, farmer's knowledge about the disease are the other factors that make the difference in prevalence percent of bovine cysticercosis (Yimer and Gebrmedehan, 2019). This study result is around the findings of previous study conducted such as, in central Ethiopia with prevalence of 3.1% (Tembo, 2001), 2% at Gondar ELFORA Abattoir(Adem, E. and Alemneh, T., 2016), Nekemte 2% (Ahmed,1990), Addis Ababa, Ethiopia 2.2%-3.3% (Alemu, 1997),Holata, Addis Alem and Ginchi districts west Shewa Zone 2.5%(Abate,Worku.,2014), in Addis Ababa 3.6% (Ibrahim and Zerihun, 2012), in Jimma 2.93 (Tolosa *et al*.,2009).

When we compare the lower prevalence reported in the current study (2.08%) with reports of export abattoirs like Mojo, ELFORA, Dukem, Luna, relatively higher prevalence of bovine cysticercosis were reported. These reports were 17.9%, 13.6%, 19.2%, and 27.6% respectively (HailuDegefu, 2005). In Amhara National regional state (Nigatu, 2008)reported that presence of *C. bovis* in 824 (18.49%) of 4456 cattle. Meanwhile, in more recent study in DebreBerhan, Kifle and Shiret (2015) reported 4.6% of abattoir prevalence which was much

higher compared with our result. This might be due to the result obtained from field extension workers (Das) in the study area where the urban and peri-urban community is well educated about environmental hygiene and the use of public toilets. From these results, it is possible to conclude that there is a great variation in the prevalence of *C. bovis* in cattle in Ethiopia. (Gracey*et al*., 1999) reported that the difference in the prevalence of cysticercosis within a country shows the variation in the experience and carefulness of meat inspectors and socioeconomic activities such as, personal and environmental hygiene. May be due to the variation in sample size, status of the people in the environment especially related to experience and appropriate use of toilet, habit of the community on raw and undercooked meat consumption. In addition to this, percentage prevalence of bovine cysticercosis is reported high in export abattoirs than municipal abattoir which might be due to better meat inspection by incising all organs/muscles and also inspectors in such abattoirs are trained (experienced) and also they recognize economic importance of C. bovis in the exportation. The possible reason for relatively lower prevalence *C.bovis* in this area may be due to lack of better lighting, cleanness of the abattoirs and facilities.

Because most cases of cysticercosis are light infec tions, cysticerci are easily missed because they m ay not be seen on routine cutting. Furthermore, observations revealed that, except for the dead, degenerate, or calcified cysticerci that usually form white and fibrotic lesions, a careless meat inspector could miss a large number of viable cysticerci that resemble the pinkish-red color of the meat and be passed on for human consumption. Among the many other contributing factors are differences in meat inspectors' skills and motivation, the speed of the slaughter process, and the meat inspection facilities.

According to our study result, breed, sex, age and body condition of slaughtered cattle were not significantly associated (p>0.05) with *C. bovis* infection(Table 1). Distribution of *bovine cysticercosis* with related to sex of the slaughtered cattle in this study showed that sex of the animals

and infections were not associated. The possible reason for this variation might be that sample size of male (313) was not comparable to that of female (71)cattle slaughtered at Debreberhan municipal abattoir not sex. Since the animals slaughtered were more of adults it was not possible to compare the relationship of prevalence with the ages of the animal. The breed and body condition also is not normally distributed.

The variation of occurrences at different altitudes could be due to the parasite's egg (tape worm ova) having less resistance to live in the cold grazing environment of the highlands for extended periods of time. (Adem and Alemneh, 2016).

The current abattoir survey also revealed that the most affected organs in order of *C. bovis*cysts occurrence and selected as a predilection sites were tongue, heart, liver and thigh muscle was found affected. Similarly higher number of cyst was seen in tongue (0.78%), in heart (0.52%) followed by 0.52% in liver and 0.26% thigh muscles agree with the result of(Abunna, 2013) and (Tamirat *et al.*, 2018), (Bedu H, *et al* 2011).The cyst's anatomical distribution is affected by a number of factors, including blood kinetics, which is mostly located in muscles with a rich blood supply due to the animal's daily activities and frequent organ movement (Yimer and Gebrmedehan, 2019).

Twenty-five percent of the 100 voluntary respondents interviewed said that they had seen proglottids in their feces and had been infected with T. saginata at least once in their lives. The prevalence of human taeniasis (25%) illustrates the importance of taeniasis in Debre Berhan and its surrounding areas. The most of the respondents consume raw meat as a result of traditional or cultural habits. This finding is slightly higher than

the result of Abdulaziz *et al.*, (2016) in Halaba Kulito (19.0%) and Birhanu and Abda (2014) in Adama (18%). But the current result was lower than the results of Abunna *et al.* (2008) in Awassa town (64.2%), Terefe et a l(2014) in Harari (60.7%), Tegegne *et al.*(2018) in Kombolcha (33.8%), 70% in Yirgalem (Abunna,

2013), 79.5% in east shewa (Hailu, 2005), 69.2% in north Gonder (Dawit, 2004). The reasons for this lower result of this study as compared to the above result could be the respondents who were asked in this study may be disclosed findings of proglottids in their feces (some people are not willing to tell that they had contracted taeniosis) may be related to habit or culture of raw meat consumption with these different areas, extension works in the area, availability of toilet in the area from 100 respondents all had toilet in their house, lower habit of defecation in the field.

The survey also indicated significant association among peoples of different educational backgrounds ($p < 0.05$) in which illiterates are more vulnerable to the risk of experiencing the disease due to low awareness agrees with findings of (Birhanu and Abda, 2014).Because those with low level of education do not consider taeniosis as a disease, the prevalence of the taeniosis was higher in this group than in those with a higher level of education. Individuals who consume raw meat have a significantly higher prevalence of Taeniasis than those who do not consume raw meat, according to this study. This is similar to the finding of (Abunna*et al.*, 2008) and (Megersa *et al.,* 2010) who reported higher prevalence of taeniosis in those of raw meat consumer. The majority of the findings in most part of Ethiopia showthat those who eat raw or undercooked meat had higherchance to easily be contracted by*Taenia saginata*.

31

Fig. 1a: *C.bovis* in the skeletal muscle Fig. 1b: Calcified cyst Fig. 1c: *C.bovis* in the liver

Conclusion and Recommendations

Bovine cysticercosis is an important zoonotic disease. Those of the abattoir and the questionnaire surveys revealed that bovine cysticercosis was important parasitic disease in Debreberhan and surrounding areas in terms of its economic and public health implications. In the current study, even though lower prevalence of bovine cysticercosis observed in inspected animals, in the contrary in human relatively higher prevalence of taeniosis was observed indicating the need of public education on the route of transmission and prevention methods. Different level of knowledge and awareness observed among community in the study area on the associated risk factors with the occurrence of this parasitic disease.

The following is a list of recommendations based on the above conclusion:

➤ Awareness should be created in the public with regard to the zoonotic importance of bovine cysticercosis and the risk of raw beef meat consumption.

➤ Strict routine meat inspection of slaughtered animals should be carried out.

➤ The community should be intensively encouraged for construction of a toilet to minimize contamination of pasture with human stool, so that the cycle of *T. Saginata* interrupted.

➤ Moreover, close collaborative works are recommended among medical and veterinary services to reduce the occurrence of the taeniosis in both human and cattle population in the study area.

Acknowledgments

References

Abate, W.(2014). *Cysticercusbovis and taeniasaginata:* prevalence, public health significance and community perception about meat borne zoonosis in three select districts of west shewa zone of Oromia region, Ethiopia (doctoral dissertation, Addis ababa university).

Abay, G. and Kumar, A. (2013).Cysticercosis in cattle and its public health implications in Mekelle City and surrounding areas, Ethiopia. *Ethiopian Veterinary Journal*, **17**(1):31-40.

Abdulaziz, H., Tilahun, B. and Moa, M. (2016). Study on Bovine Cysticercosis with Special Attention to its Prevalence, Economic Losses and Public Health Significance in and Around Halaba Kulito Town, South Ethiopia. *World Journal of Agricultural Sciences*, **12** (4): 299-307

Abera, A., Sibhat, B. and Assefa, A. (2022). Epidemiological status of bovine cysticercosis and human taeniasis in Eastern Ethiopia. *Parasite Epidemiology and Control*, 17:248.

Abunna F., Tilahun g. MegersaB., Regassa A. (2007). Taeniasis and its socio-economic implication in Awassa town and its surroundings, Southern Ethiopia. *East African Journal Public Health*, **4**:73-79.

Abunna, F. (2013).Prevalence, organ distribution, viability and socioeconomic implication of bovine cysticercosis/taeniosis, Ethiopia. *Revue d'élevageet de médecinevétérinaire des pays tropicaux*, **66**:25-30.

Abunna, F., Tilahun, G., Megerssa, B., Regassa, A. and B, Kumsa, B. (2008).Bovine cysticercosis in cattle slaughtered at Awassa municipal abattoir Ethiopia: prevalence, cyst viability and distribution and public health implication. *Zoonoses and Public Health*, **55**(2): 82-88.

Adem, E. and Alemneh, T. (2016).The occurrence of *Cysticercus bovis* at Gondar ELFORA abattoir, northwest of Ethiopia. *Journal of Cell and Animal Biology*, **10**(3):16-21.

Alemu, M. (1997). Bovine cysticercosis: prevalence, economic and public health importance (Unpublished DVM thesis, Addis Ababa University, Faculty of Veterinary Medicine, DebreZeit, Ethiopia

Arsham H. (2002). Questionnaire Design and Surveys Sampling Error! Hyperlink Reference not Valid.

Bedu H, Tafess K, Shelima B, Woldeyohannes D, Amare B, Kassu A. (2011). Bovine cysticercosis in cattle slaughtered at Zeway municipal abattoir: Prevalence and its public health importance. J Vet Sci Technol.**2**:2157-7579.

Birhanu, T. and Abda, S. (2014). Prevalence, economic impact and public perception of hydatid cyst and cysticercusbovis on cattle slaughtered at Adama municipal abattoir, south-eastern Ethiopia. American-Eurasian Journal of Scientific Research, 9:87-97.

Cabaret, J., Geerts, S., Madeline, M., Ballandonne, C. and Barbier, D. (2002). The use of urban sewage sludge on pastures: The cysticercosis threat. Veterinary Research, **33**:575–597

CSA (2020).Federal Democratic Republic of Ethiopia. Central Statistical Agency, Agricultural Sample Survey Report on Livestock and Livestock Characteristics, Addis Ababa, Ethiopia.

Dawit S. (2004). Epidemiology of *T. saginata*taeniasis and cysticercosis in north Gonder zone.DVM thesis, Faculty of Veterinary Medicine, DebreZeite, Northwest Ethiopia.

Degefu, H. (2005). Prevalence and risk factors for *Taenia saginata* Taeniasis/cysticercosis in three selected areas of eastern Shoa.MSc thesis, Addis Ababa University, Debrezeit, Ethiopia.

Dorny P, Praet N. (2007). *Taenia saginata* in Europe. *Veterinary Parasitology*.**149**:22–4.

Gracey, J., Collins, D.S. and Huey, R. (1999). Diseases caused by helminthes and arthropod parasites. In: Meat Hygiene. 10th edition, W.B.Saunders Company Ltd., London.673.

Hailu D. (2005). Prevalence and risk factor for *T. saginata* cysticercosis in three selected areas of Eastern Shoa. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Ibrahim, A.(1990). Bovine cysticercosis in animals slaughtered in Nekemte Municipality slaughter house (Unpublished DVM thesis, Addis Ababa University, Debrezeit, Ethiopia).

Kebede, N., (2008). Cysticercosis of slaughtered cattle in northwestern Ethiopia. *Research of Veterinary Science.***85**:522-526.

Kifle, W. and Shiret, B. (2015).Prevalence and Public Health Significance of *Cysticercus bovis* in and Around Debreberhan City. European Journal of Applied Sciences, 7 (5): 199- 208.

Megersa, B., Tesfaye, E., Regassa, A., Abebe, R. and Abunna, F. (2010). Bovine cysticercosis in Cattle Slaughtered at Jimma Municipal Abattoir, South western Ethiopia: Prevalence, Cyst viability and Its Socio-economic importance. *Veterinary world*, **3**(6).

Minozzo, J.C., Gusso, R.L.F., Castro, E.A.D., Lago, O. and Soccol, V.T. (2002). Experimental bovine infection with Taeniasaginata eggs: recovery rates and cysticerci location. *Brazilian Archives of Biology and Technology*, **45**:451-455.

Pal M. (2007).Zoonosis.2nd ed. Satyam publishers, Jaipur, 241-242.

Rubiola, S., Moroni, B., Carisio, L., Rossi, L., Chiesa, F., Martano, G., Cavallo, E. and Rambozzi, L.(2021). Risk Factors for Bovine Cysticercosis in North-West Italy: A Multi-Year Case-Control Study. Animals.**11**(11):3049.

Tamirat, B., Tamirat, H. and Gebru, M.U. (2018).Prevalence, financial impact and public health significance of *Cysticercus bovis* at Bahir Dar Municipal Abattoir, Ethiopia. *Journal of Veterinary Medicine and Animal Health*, **10**(1):14-20.

Tegegne, A., Hiko, A. and Elemo, K.K. (2018). Bovine cysticercosis and human taeniasis: animal–human health and economic approach with treatment trends in Kombolcha town, Wollo, Ethiopia. *International Journal of One Health*, **4**:15-21.

Tembo, A. (2001). Epidemiology of *T. Saginata* Taeniasis and Cysticercosis in Three Selected Agro Climatic Zones in Central Ethiopia. Msc Thesis, Faculty Of Veterinary Medicine, Addis Ababa University & Free University Of Berlin, Debrezeit.

Terefe, Y., Redwan, F. and Zewdu, E. (2014).Bovine cysticercosis and its food safety implications in Harari People's National Regional State, eastern Ethiopia. *Onderstepoort Journal of Veterinary Research*, **81**(1):1-6.

Thrusfield M. (2005).Sampling in Veterinary Epidemiology.Second Edition London: Black Well Science. University of Pennsylvania.

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

Urquhart GMJ, Armour JL, Duncan AM, Dunn FW, Jennings, (2013).Veterinary Parasitology. 2nd edition.Black well science, London.120-137.

Yimer, A. and Gebrmedehan, B.M. (2019). Bovine cysticercosis and hospital based retrospective survey of human taeniasis in and around Debre Berhan city, central Ethiopia. *Experimental Biology and Medicine,* **11**(2):455.

Zhou, P., Chen, N., Zhang, R.L., Lin, R.Q. and Zhu, X.Q. (2008). Food-borne parasitic zoonoses in China: perspective for control. Trends in parasitology, **24**(4):190-196.