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Bovine Cysticercosis: Prevalence and Viability in Cattle Slaughtered at Shone Municipal Abattoir, Southern Ethiopia

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Abstract

In order to ascertain the presence and survivability of Cysticercus bovis in cattle butchered at Shone Municipal Abattoir from August 2020 to May 2021, a cross-sectional study, a straightforward random sample approach was carried out. 28 (7.29%) of the 384 carefully chosen killed cattle tested positive for Cysticercus bovis. There were 126 cysts removed in all, of which 76 (or 60.32%) were still alive and the other 50 (or 39.68%) were degenerated. The anatomical distribution of cysticercosis was found to be in the liver, heart, shoulder muscle, tongue, masseter muscle, and lung in sequence, arranged in the order of the host of the cyst. The statistical analysis of infection rates based on animal source and sex did not show any significant difference ($p > 0.05$), but there was a significant age difference (p 0.05). In conclusion, bovine cysticercosis requires attention to safeguard public health and promote beef in the country. Therefore, effective control measures are necessary to prevent the spread of bovine cysticercosis and protect both animal and human health.

Keywords: abattoir, cattle, Cysticercus bovis, prevalence, shone, viability

1. Introduction

Bovine cysticercosis is a parasitic disease caused by the larval stage of the tapeworm *Taenia saginata*. The disease affects cattle and is a major public health concern in many parts of the world, particularly in developing countries where meat inspection and control measures are inadequate. Bovine cysticercosis can have significant economic impacts on the livestock industry, as infected animals may be condemned at slaughter or have reduced meat and milk production. In addition, the disease poses a risk to human health, as consumption of infected beef can lead to human cysticercosis, a serious and potentially fatal condition (Lightowlers, M. W., 2019).

The mature cysticercus C. bovis in bovines is typically around 1cm in diameter, greyish-white in colour, and filled with fluid that often reveals a visible scolex. Upon incision, the cyst may either be viable, containing a thin fibrinous capsule, or degenerate, displaying cream- or green-coloured calcification. It takes approximately three to four months for the cysticerci to form after the ingestion of the egg and can remain viable in the hos for the host's entire life (Gracey, J., Collins, D. & Huey, R., 1999).

Bovine cysticercosis is a disease that is found worldwide, but it is most prevalent in Africa due to poorly educated populations and limited access to safe tapeworms, which facilitate the spread of Taenia saginata. In some countries, such as Kenya, up to 80% of cattle are believed to be infected. Although the disease has little impact on animal health, it is socially and economically significant as it can infect both humans and animals. The meat is often condemned, and costly extermination measures are required. Young cattle are particularly susceptible to *T. saginata* cysticerci, as older animals are more resistant to infection. Livestock can serve as an intermediate host for tapeworms in humans and other animals. The metacestodes, or larval tapeworms, develop

into fluid-filled cysts that are typically located in specific areas of the body and can lead to condemnation during meat inspections. Cysticercosis bovis, also known as the human tapeworm, or *Taenia saginata*, can be carried by cattle around the world in their striated musculature (Radostits, O.M., Gay, C.C., Hinchcliff, K.W & Constable, P.D., 2006; Smyth, J.D., 1994; Urquhart, G.M., Armour, J., Duncan, J.L., Dunn, A.M. & Jennings, F.W., 1996).

Taenia saginata is a parasitic tapeworm that infects humans through the consumption of undercooked or raw beef. The epidemiology of Taenia saginata infection varies depending on the region, with higher prevalence rates reported in areas where beef consumption is common and sanitation and hygiene practises are poor. Consumption of raw or undercooked beef was a significant risk factor for infection, highlighting the importance of food safety measures in preventing transmission of the parasite. The epidemiology of Taenia saginata infection underscores the need for improved sanitation and hygiene practises as well as increased awareness of the risks associated with consuming raw or undercooked beef (Mekonnen, G. B., & Ameni, G., 2019).

Bovine cysticercosis typically occurs without any clinical signs under natural conditions. However, experimentally infected calves have been known to develop problems associated with the development of cardiac cysticercosis. In humans, adult parasites can cause diarrhea and hunger, but the infection is usually asymptomatic. In developed countries, controlling bovine cysticercosis involves maintaining high standards of human hygiene, cooking meat thoroughly, mandatory meat inspection, and freezing any affected carcasses. Freezing the meat at -10°C for 11 days is a common practice that is sufficient to kill cysticerci, although it does reduce the economy the beef. In agricultural practise, only arable land or areas where cattle won't graze for at least two years should utilise human sewage as fertiliser. The most helpful action now available appears to be teaching populations about cleanliness and thoroughly preparing meat in impoverished nations, where equivalent actions may not always be economically possible. (Taylor, M., Coop, R. & Wall, R., 2007; Urquhart, G.M., Armour, J., Duncan, J.L., Dunn, A.M. & Jennings, F.W., 1996). Therefore, the objective of this study was to determine the prevalence and characterize the viability of cysticercus bovis in cattle at Shone Municipal abattoir.

2. Materials and Methods

2.1 Study Area Description

Shone is located in the Hadiya Zone of Southern Ethiopia, 345 kilometers from Addis Ababa. In terms of terrain, the altitude is 1650-2050 meters above mean sea level, the annual average temperature is 18%, and the relative humidity is 65%. The average temperature is 11 to 27°C, with few climatic fluctuations. There are two ecological zones in the entire district, 100 of which are the central line. According to Shone Town administrative agricultural statistics, there are 93,040 cattle, 15,457 sheep, 19,123 goats, 8,340 donkeys, 428 mules, 52 chickens, and 76,747 chickens in stock in the county. The production system throughout the region is of a mixed type. Geographically, the map of the study area was shown below.

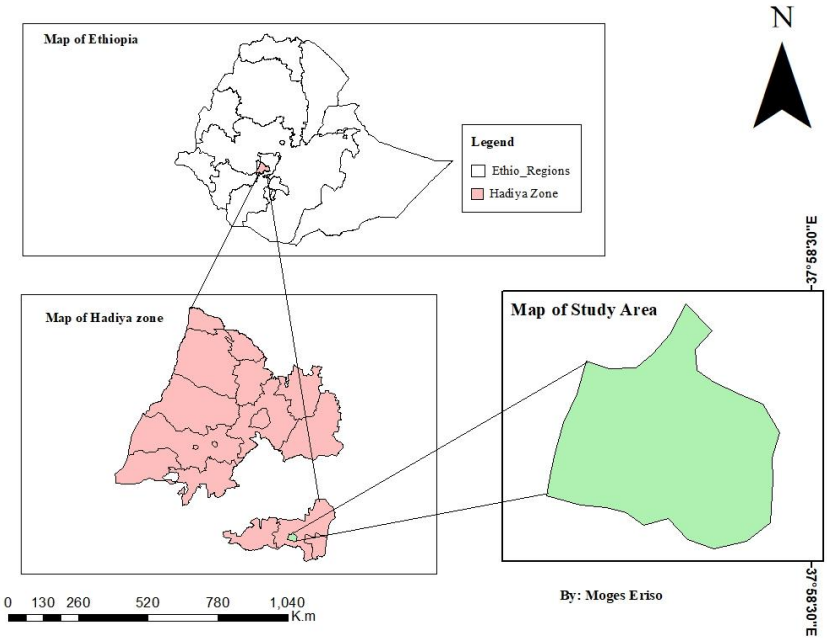

Figure 1. Map of the study area (Moges, 2021).

2.2 Study Animals

Cattle that had been randomly chosen from Shone municipal abattoir were brought from regional cattle markets to slaughter are selected as the study animals. Almost exclusively local breeds, some of which were cross-breed, were employed in this study.

2.3 Study Design and Research Methods

Between November 2020 and April 2021, a cross-sectional study was carried out on bovine cysticercosis in cattle slaughtered at Shone Municipal Abattoir. The study utilized an active slaughter house survey and laboratory work, and the systematic random selection method was employed. Since the approximate previous prevalence value was unknown, the required sample size was determined using the formula provided by Thrusfield (2005). An expected prevalence of 50% was assumed, and a desired absolute precision (d) of 5% (0.05) with a 95% confidence level was used for the study. Finally, one sample was added, and the calculated sample size was 384.

2.4 Ante-Mortem Inspection and Post-Mortem Inspection

When conducting an antemortem inspection of animals, various details are recorded, including the species, breed, sex, age, and origin of the animal. Age is estimated based on tooth type and is categorized as young (<2 years), adult (2-5 years), or elderly (≥5 years). During post-mortem examination, the organs are systematically examined, including the shoulder, masseter muscle, tongue, heart, liver, and lungs, using routine meat examination procedures. This involves visualizing and palpating organs and muscles to check for the presence of Cysticercus bovis cysts. If single or multiple cysts are found, further incisions are made in each organ, and the number of cysts per organ per animal is recorded.

2.5 Cyst Viability Testing

All positive samples were transported to the Shone veterinary Parasitology Laboratory to confirm cyst viability. Incubated cysts in ox bile at 37°C for one to two hours using 40% ox bile solution diluted in saline. After that, examine the scolex under a stereomicroscope, if the scolex is evaginated during the latent period, the cyst is considered viable and also checked for the absence of hooks on the rostellum of the evaginated cyst (WHO (World Health Organization), 1983; Gracey, J., Collins, D. & Huey, R., 1999).

2.6 Data Management and Analysis

Post-mortem meat inspection data collected were recorded and entered into a Microsoft Excel 2007 spreadsheet and statistically analyzed using STATA version 11.0 (Stata Corp, 2001). The results of the analyzes were evaluated using Pearson's chi-square (x^2) to look for significant difference of variables on the occurrence of Bovine cysticercosis.

3. Results

3.1 Prevalence Study

Out of the 384 animals inspected at the municipal slaughterhouse in Shone, 28 were found to be infected with bovine cysticercosis, resulting in an overall prevalence of 7.29%. The incidence of the disease did not differ significantly between animals based on sex, breed, or origin ($p > 0.05$). The highest prevalence was observed in cattle from Shone (8.24%), followed by East Badawacho (7.95%), Lenda (7.23%), Jarso (5.56%), and Korga (0.00%) (Table 1). The analysis also revealed significant variation in the distribution of cystic cysts among the organs examined. The liver had the highest proportion of C. bovis cysts, followed by the heart, shoulder muscles, tongue, and masseter muscles (Table 3). Out of the 126 C. bovis cysts collected during the study, 76 (60.31%) were viable, while the remaining 50 (39.68%) were degenerative cysts (Table 6).

Table 1. Prevalence of Bovine cysticercosis in the origin of the animals

Origin	No. of animals examined	No. of animals infected	Prevalence	95% CI
Shone	85	7	8.24%	33.75-16.23
EastBadawacho	175	14	7.95%	4.42-12.98
Jarso	18	1	5.56%	0.14-0.27
Lenda	83	6	7.23%	2.70-15.07
Korga	23	0	0.00%	-
Total	384	28	7.29%	

Note: $\chi 2 = 2.1210$, pr = 0.714

Table 2. Prevalence of *C.bovis* based on the sex of animals examined

Sex	No. of animals examined	No. of animals infected	Prevalence	95% CI
Male	328	22	6.69%	4.24-9.95
Female	56	6	10.71%	4.03-21.87
Total	384	28	7.29%	

Note: $\chi 2 = 1.1510$, pr = 0.283

Table 3. Frequency and anatomical distribution of cysts among inspected organs

Organs	No. of animals examined	No. of animals infected	Prevalence
Liver	384	7	1.82%
Heart	384	5	1.29%
Tongue	384	4	1.04%
Masseter	384	2	0.5%
Shoulder	384	4	1.08%
Heart& Liver	384	3	0.78%
Lung & Liver	384	1	0.26%
Tongue & Masseter	384	1	0.26%
Heart & Shoulder	384	1	0.26%
Total	384	28	7.29%

Most of the infected animals (22 or 78.57%) had cysts in only one organ or tissue, while the remaining 6 (21.43%) had cysts in multiple organs. The distribution of cysticercus bovis among the infected organs and muscles was highest in the liver, followed by the heart and tongue. The lungs had the lowest proportion of cysts (Table 3).

Table 4. Prevalence of bovine cysticercosis age wise

Age group	No. of animals examined	No. of animals infected	Prevalence	95% CI
Young	13	3	23.08%	5.03-53.81
Adult	286	17	5.92%	3.49-9.31
Old	85	8	9.41%	4.5-17.70
Total	384	28	7.29%	

Note: $\chi 2 = 6.1665$, pr = 0.046

Among the 287 adult animals examined, 17 were found to be infected with cysticercus bovis cysts, resulting in a prevalence of 5.92%. For the 85 old animals, 8 were infected, resulting in a prevalence of 9.41%. Out of the 13 young animals examined, 3 (23.08%) were infected with C. bovis. The analysis revealed a significant association ($p<0.05$) between age and the rate of infection (Table 4).

Table 5. Prevalence of bovine cysticercosis in terms of breed

Breed	No. of animals examined	No. of animals infected	Prevalence	95% CI
Local	378	27	7.09%	4.72-10.14
Cross	6	1	25.00%	0.6-80.59

Total	384	28	7.29%

Note: $\chi 2 = 1.8835$, Pr = 0.170

Among the 378 local breed animals examined, 27 were found to be infected, resulting in a prevalence of 7.09%. Only 1 out of the 6 cross-breed animals examined was infected, resulting in a prevalence of 25.00% (Table 5).

3.2 Viability Test

Table 6. Viability of *C. bovis* in affected organs

Affected organs	**Cyst status**		**Total No. of cysts**	**Prevalence**
	No. of Viable cysts	**No. of calcified cysts**		
Shoulder	6 (42.85%)	8 (57.15%)	14	11.11%
Masseter	1 (33.33%)	2 (66.67%)	3	2.40 %
Tongue	2 (20%)	8 (80%)	10	7.90%
Heart	7 (58.33%)	5 (41.67%)	12	9.52%
Liver	44 (73.33%)	16 (26.67%)	60	47.6%
Liver and Heart	10 (66.67%)	5 (33.33%)	15	11.90%
Liver and Lung	4 (66.67%)	2 (33.33%)	6	4.76%
Masseter and Tongue	0 (0.00%)	3 (100%)	3	2.38%
Shoulder and Heart	2 (66.67%)	1 (33.33%)	3	2.38%
Total	76 (60.32%)	50 (39.68%)	126	7.29%

Throughout the study period, 126 cysts were gathered from 28 animals at Shone municipal abattoir. Out of the total cysts collected, 76 (60.32%) were viable, while 50 (39.68%) were degenerated cysts (Table 6).

4. Discussion

During the course of this study, 28 out of 384 animals that were examined at Shone Municipal Abattoir were found to be positive for bovine cysticercosis, resulting in an overall prevalence rate of 7.29%. The prevalence rate of this finding is consistent with those of other studies, such as 7.5% in Addis Ababa (Nigatu, K., 2004) and 7.01% in Mekele (Getachew, M., 2008). However, it is higher than the prevalence rates reported in other works, such as 3.11% in central Ethiopia (Tembo, A., 2001), 4.9% in Gondar, and 26.25% in Awassa (Abunna, F., Tilahun, G., Megersa, B., Regassa, A & Kumsa, B., 2008; Hailemariam, S., 1980). It is important to note that the sample size and practical limitations in the number of incisions allowed per organ during examination can result in many infections going undetected. Additionally, the owner did not permit multiple incisions for detailed examination due to concerns about mutilation reducing the marketability of the corpse and introducing contamination.

There was no correlation in this study ($P > 0.05$), the relationship between sex, origin, breed, and prevalence of cysticercosis. Analysis based on sex was not statistically significant, with a prevalence of 22 males (6.7%) and 6 females (10.7%). This is because both sexes graze on the same pastures and therefore face similar challenges to *T.saginated* eggs. In terms of origin, the majority of animals destined for slaughter at the study abattoirs came from stock breeders' associations in Shone, East Badawacho, Lenda, Korga, and Jarso.

The prevalence of cysticercus bovis was found to be higher in young animals (23.08%) compared to adults (5.92%) and the old age group (9.41%), with a statistically significant difference between the age groups ($P<0.05$). This difference in prevalence may be attributed to age-related immunity, where the animal's immunity is re-stimulated after a persistent invasion by onchospheres, leading to the development of more cysticerci from invading onchospheres (Wanzala, W., Onyango Abuje, J., Kang, A., Ethe, E., Zessin, K., Kyule, N., Baumann, M., Ochanda, H. & Harrison, L., 2003). The organs most affected by cysticerci in this study were the muscles of the liver, heart, tongue, and shoulders, with the highest number of cysts, while the lungs had the least number of cysts. The liver was found to be the most affected organ with the highest number of cysts, which is consistent with a previous report (Umer. A., 2009) indicating that the liver was the most severely infected organ. However, another study (Tembo, A., 2001) has shown that the heart is the most seriously infected organ.

Cyst viability tests revealed that the liver had the highest number of viable cysts, followed by the heart, tongue, and shoulder muscles. The changes in anatomical distribution of cysts can be influenced by various factors, including hemodynamics and the daily activity of the animal. The distribution of onchospheres and their preferred location during meat inspection can be affected by geographic and environmental factors that impact the animal's hemodynamics (Gracey, J., Collins, D. & Huey, R., 1999).

5. Conclusions and Recommendations

The survey conducted in the slaughterhouse revealed that the prevalence of bovine cysticercosis is 7.29%. Although the prevalence rate is not very high, it can still cause economic losses in livestock due to organ/tissue discard, while taeniasis can lead to public health problems and economic losses due to drug costs. The risk factors associated with bovine cysticercosis and its impact on public health are attributed to inadequate meat inspection, traditional practices of consuming raw or undercooked meat, lack of awareness among the public regarding pasture contamination by human excreta, and poor sanitation and sanitation infrastructure. These factors often result in the contamination of the environment, particularly pastures, by Taenia bovis eggs. The aforementioned conclusions lead to the following recommendations:

- Prioritize routine meat inspection and conduct further investigations to determine the incidence and public health implications of bovine cysticercosis,
- Raise awareness among the public about the risks associated with consuming raw or undercooked meat and the potential for bovine cysticercosis,
- Promote education on proper toilet use and improve personal and environmental hygiene,
- Recognize that bovine cysts can cause economic losses and pose a threat to public health, and engage health, agricultural, and educational institutions to provide appropriate administrative, technical, and financial support for successful control and eradication,
- Ensure that meat is cooked thoroughly to eliminate larval cysts if present, and practice good hygiene, such as washing hands after using the toilet, to prevent the spread of tiny eggs and other contaminants.

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