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Prevalence of Bovine Cysticercosis in Cattle Slaughtered at Gimbi Municipal Abattoir West Wollega Zone of Oromia Regional State, Western Ethiopia

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Key words: Bovine, *Cysticercosis*, Gimbi municipal abattoir, prevalence

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Abstract: Bovine cysticercosis is an infection of cattle caused by the larval stage, *Cysticercus bovis* of the human intestinal cestode, *Taenia saginata*. It is an infection of public health significance as eating of raw or undercooked beef results in taeniasis in human population and an important cause of economic loss mainly due to condemnation and downgrading of infected carcasses. A cross-sectional study was conducted from November 2019 to April 2020 on bovine cysticercosis in cattle slaughtered at Gimbi Municipal Abattoir with the objectives of determining the prevalence of bovine cysticercosis, viability and organ distribution of the cyst. Out of 384 systematically selected slaughtered male cattle a total of 16 (4.16%) were infected with *Cysticercus bovis.* Among positive cases for *C. bovis* a total of 36 cysts were collected in which 15 (41.66%) were viable while the rest 21 (58.33%) were died cysts. The anatomical distribution of cysticerci shows highest proportion in triceps muscle 12 (33.33%), masseter muscle 9 (25%), heart 7 (19.44%), liver 4 (11.11%) while the lowest in lung and kidney 2 (5.55%). There was no statistical significant difference ($p>0.05$) in the prevalence of cysticerosis between the origin and body condition score of the animals but there was significant variation ($p<0.05$) between the age (higher prevalence in adult 2.8% than in old 1.3% age) and organ distribution of the cysts of the study animals. With respect to viable cysts, was show triceps muscle 7(46.66%), masseter muscle 4(26.66%), heart 2(13.33%), liver and kidney 1(6.66%) and none in lung 0(0%). In conclusion, the present study shows that the disease deserves special attention to safeguard the public health and promote beef industry in the country. Therefore, appropriate control and preventive measures should be taken in order to reduce the disease problem on public health and economic significance.

INTRODUCTION

Cestodes of the family Taeniidae infect dogs and humans as the definitive host and are transmitted to a wide range of intermediate host species where they cause coenurosis, hydatidosis and cysticercosis[1]. Tapeworm infection has been recorded in 1500 years ago and the earliest human parasite. *T. saginata* is a worldwide zoonotic cestode of socioeconomic and public health importance[2] and whose epidemiology is ethnically and culturally determined with estimation of 50-77 million annually. Both adult and larval forms hazardously affect health of their respective hosts, either directly or indirectly accompanied with several secondary infections, particularly in human. The occurrence of metacestode stage larvae *Cysticercus bovis* in cattle musculature causes *Bovine cysticercosis* while the adult worm in human small intestine is caused Taeniasis[3, 4].

It is transmitted by eating raw or undercooked meat infected with cyst stages of these parasites. *Taenia saginata* is a cosmopolitan parasitic disease found in industrialized countries as well as in developing countries. While in developed western countries much lower prevalence (0.01-10%) were recorded[5]. It is also more common in populations/age groups that consume raw or undercooked beef meats. Bovine cysticercosis, the source of infection for human beings, is highly prevalent in developing country like Ethiopia. In Eastern African countries like Ethiopia up to70% of the population reports to have been infected with a tapeworm[6]. In Ethiopia bush defecation, the habit of eating raw beef dishes such as kitfo and kourt and backyard slaughter might have contributed for the high prevalence of bovine cysticercosis[7]. Cysticercosis affects both the health of the consumer and country's economy which approaches 30% if allowance is made for the loss in the carcass weight and the cost of freezing of the infected meat[8]. Although, the life cycle cannot be maintained in regions that have adequate sanitation and good animal husbandry practices, these regions are still vulnerable, owing to immigration of people from highly endemic regions carrying infections of the adult stage (taeniasis). Such introduced infections account for an increased global distribution to non-endemic regions such as in the United States and Europe. These human carriers can contaminate the environment of others, leading to secondary infections[7, 9].

Differences in geographical isolates of the parasite and in the breed and age of cattle have been suggested as possible factors affecting the distribution of *Cysticercus bovis*. The problem of food borne parasitic zoonosis could be further complicated in Ethiopia by lack of efficient inspection at critical control points in abattoirs, lack of awareness and knowledge on the mode of transmission and public health hazard of these diseases as well as due to presence of widespread habit of raw meat consumption both in rural and urban communities. A number of reports in Ethiopia indicated that, certain groups who had easy access to raw meat and meat products and those people with low level of formal education were reported to be more infected with meat parasitic zoonosis than those who had low access to raw and those with better education[10]. The prevalence of bovine cysticercosis in Ethiopia reported so far varies from relatively lower prevalence of 3.1% in central Ethiopia[11]. To as high as 26.2% at Awassa[12], 13.3% at Wolaita Soddo's abattoir [13] and 4.4% at Jimma abattoir[14]. However, there is lack of information on prevalence status of bovine cysticercosis in Gimbi. Therefore, the objective of present study was:

- To determine the prevalence status of Bovine cysticercosis in slaughtered cattle at Gimbi municipal abattoir
- To determine viability and organ distribution of the cyst in slaughtered cattle

MATERIALS AND METHODS

Study area: The study was conducted from November 2019 to April 2020 at Gimbi Municipal Abattoir, West Wollega Zone of Oromia Regional State, Weastern Ethiopia. Gimbi town is located at about 441 km from Addis Ababa, the capital city of the country to the west. Geographically, the district is located 9°10°-9°17° North latitude and 35°44°-36°09° East longitudes; covering a land area of 100, 965 ha (1009.65 km). The area has one long rainy season extending from March to mid-October with annual rainfall ranging from 1400-1800 mL. The mean minimum and maximum annual temperature ranges between 10°C and 30°C and the elevation of the study area ranges from 1200 m-2222 m.a.s.l. Mixed crop-livestock agriculture is the main stay in the area. Like to many parts of Ethiopia, the study area is endowed with significant number of domestic animals; 93,640 cattle, 46,115 sheep, 7,207 goats, 131 mules and 80,370 poultry.

Study population: The study population was consisted of local zebu cattle breed presented to Gimbi Municipal Abattoir for slaughtering. The study population consists of 384 cattle at different age group, origin and body condition. Estimation of age was carried out by examination of the teeth eruption using the approach

forwarded by DeLahunta and Habel[15] and in this regard only two age groups were considered; adult (7-9 years) and old (≥10 years). Based on the body condition, animals were grouped as good and medium[16]. The origins of animals for the study were from different local markets of in and surrounding district (Gimbi, Nole, Arjo gudatu, Inango and Tole). The slaughtered animals in the abattoir were only male cattle.

Study design: Across-sectional study was conducted by using both ante-mortem and post-mortem inspection procedures to determine the prevalence of Bovine cysticercosis from November 2019 to April 2020 at Gimbi Municipal Abattoir.

Sampling method and sample size determination: Sampling was conducted using systematic sampling method employed in the lair age to select the required number of study population. The sample size was determined using a method recommended by Thursfield[17] by using 95% confidence interval at a desired absolute precession of 5%. In this study, 50% prevalence was considered as there was no similar previous study in the area. To calculate the sample size single proportion formula was utilized:

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

Where:

n = Required sample size
P_{exp} = Expected prevalence
d^2 = Desired absolute precision

Accordingly 384 cattle were examined to determine the prevalence of the *C. bovis* in the study area.

Study methods and data collection

Antemortem inspection: During antemortem inspection id, age, origin and body condition of the animals were recorded before slaughtering. During ante-mortem examination animals were clinically examined for any sign of illness while standing and moving according to[18]. Based on the body condition, animals were grouped as good and medium[16]. The age of each animal was estimated on the basis of dentitions[15] and in this regard only two age groups were considered; adult (7-9 years) and old (≥10 years). Young age group is excluded from the study due to reasons that most local farmers do not sell their cattle at young age but most commonly sell after many years of providing draft power. Moreover, the abattoir is not an export abattoir which mostly focuses on matured ages.

Postmortem inspection: After slaughtering visceral organs and carcass were thoroughly inspected by applying the routine meat inspection procedures; incisions and inspection was done following the methods described by Anosike[19]. During meat inspection, identified animals and their respective organs were strictly examined separately to avoid mixing up of organs. The various sites examined were liver, lung, heart, tongue, kidney, masseter muscle, triceps muscle and diaphragmatic muscle. Palpation and visualization of organs followed by incision of organs was made to examine for the presence of *Cysticercus bovis.* For masseter muscle, deep line incision were made parallel to the mandible, the heart were incised from base to apex to open the pericardium and incision were made for liver, shoulder muscle, diaphragm and longitudinal incision for tongue[20]. Cyst containing organs from infected animals and number of cysts per organ was recorded on the data collection format sheet prepared for this purpose. From all positive samples, the cysts were carefully dissected and transported to Wollega University, School of Veterinary Medicine, Veterinary Parasitology Laboratory for viability test.

Cyst viability test: The individual cysts from each of the infected organs were grossly examined for degeneration and then cysts were selected. The viability test of cysticerci was assessed to observe amoeboid like peristaltic movement. For clear vision, a drop of 0.1% aqueous eosin solution was added to cyst fluid on microscope slide and examined under Microscope for taking the dye. Live protoscolices do not take the dye whereas; the dead ones do[21].

Data management and analysis: The data collected in the municipal abattoir were entered and coded into on Microsoft Excel spread sheet. Further Statistical analysis was done using IBM SPSS 20.0 Versions. Categorical variable (area, body condition, age and predication site) were expressed in percentage. The prevalence proportion was calculated as the number of animals detected positive by inspection and incision, divided by the total number of animals examined during study period. For all analysis $p<0.05$ was taken as significant.

RESULTS

Prevalence of *Cysticercus bovis*: Out of the total 384 slaughtered animals inspected at Gimbi Municipal Abattoir, 16 animals were found positive for *C. bovis* at postmortem inspection with overall prevalence of (4.1%). There was no statistical significant difference ($p>0.05$)

Table 1: Prevalence of *C. bovis* among risk factors

Variables	No infected	Total	Prevalence	X2	p-values
Age (Years)					
Old (>10)	5	247	1.3	7.958	0.006
Adult (7-9)	11	137	2.8		
Origin of animal					
Gimbi	0	65	0	6.353	0.174
Inango	4	80	1.08		
Tolle	7	90	1.8		
Arjo Gudetu	3	73	0.78		
Nolle	2	76	0.05		
Body condition					
Good	7	230	1.8	1.812	0.139
Medium	9	154	2.3		
Total	16	384	4.16%		

Table 2: The anatomical distribution of *C. bovis* and viability of cysts among inspected organs

Organ inspected	Viable cyst (%)	Non-viable cyst (%)	Total (%)
Triceps	7(46.66)	5(23.8)	12(33.33)
Masseter	4(26.66)	5(23.8)	9(25)
Liver	1(6.66)	3(14.28)	4(11.11)
Heart	2(13.33)	5(23.8)	7(19.44)
Lung	0(0)	2(9.52)	2(5.55)
Kidney	1(6.66)	1(4.76)	2(5.55)
Total	15(41.66)	21(58.33)	36(100)

between body condition and origin of animals with the prevalence of *C. bovis* infection but there was statistical significant difference between age group of the animals ($p<0.05$) (Table 1).

The abattoir survey analysis clearly indicated that there was a significant variation with regard to the anatomical distribution of the cyst in the inspected organs of slaughtered animals. The highest intensity of infection was observed in triceps muscle 12 (33.33%) followed by masseter muscle 9 (25%), heart 7 (19.44%), liver4 (11.11%) and the lowest in lung and kidney 2 (5.55%). A total of 36 cysts were recovered from 16 cysticercosis positive animals during the study period. Out of the total of 36 cysts detected, 15(41.66%) were found to be alive (viable) while 21(58.33%) were died (degenerative) cysts (Table 2).

DISCUSSION

In this study, from a total of 384 animals inspected at Gimbi Municipal Abattoir, 16 (4.16%) animals were identified to be positive for *Cysticercus bovis*. The prevalence of the present finding was more or less comparable to the previous findingsreported in different agro-climatic zones of Ethiopia by Bekele, etc., (4.4%) in Jimma[6] (4.94%) in Kofale, Tamirat *et al*.[22] (4.2%) in Bahir Dar and Andualem and Belayneh (5.43%) in Debre Birhan. The current finding was relatively higher than previous findings of Bijiga and Temesgen[23] and Wabi and Girmay[24] (2.08 and 2.68%) in Nekemte, respectively. In the other hand, the present finding was lower than the previous finding of Bayou and Taddese[25] (6.5%) in Dale Wabera, Tegegne *et al*.[26] (8.97%) in Kombolcha, Hirpha *et al*.[27] (8.6%) in Halaba, Nigatu[28], (7.5%) in Addis Ababa, Abunna *et al*.[12] (26.25%) in Awassa and Hailu (17.5%) in Debre Zeit.

The above difference in prevalence of infection might be associated with many reasons including time of occurrence (higher in dry season than rainy season)[29, 28], sample size, type of re-infection, status of the people in the environment, the practical limitation to the number of incisions allowed in skeletal muscles, limit to the number and intensity of the incisions made during meat inspection (as this will reduce market price of the carcass) and the knowledge and ability of researchers[29]. Differences in the skills and motivation of meat inspectors, the speed of slaughter activity and the meat inspection facilities are among the many other contributory factors. Another possible reason for variation in prevalence may be due to difference in status of the people in the environment especially related to experience and appropriate use of toilet, habit of the community feeding raw and undercooked meat consumption. The number of viable *T. saginata* eggs ingested by cattle was also some of the reasons for variation of *C. bovis* prevalence indifferent localities[30].

In the current result statistically significant difference ($p<0.05$) in prevalence of bovine cysticercosis was observed between age group. Higher prevalence of 2.8% was estimated in adult age than in old age group. In agreement with this result previous researchers reported significantly higher prevalence of *C. bovis* in adult than old animals[29, 30]. This age related variation of *C. bovis* prevalence may be due to age dependent immunity of an animal. In this study, there was no statistical significant difference ($p>0.05$) in prevalence of cysticercosis between origin and body condition (Table 2). The reason for this may be due to the fact that most of slaughtered animals were brought from the same geographical location and have similar management (husbandry) system.

Distribution of *C. bovis* in various organs and tissues of the infected animal was observed with the more number of cysts in the triceps muscles 12 (33.33%), than other organs and tissues inspected during the study followed by masseter muscles 9(25%), heart 7(19.44%), liver 4(11.11%), lung 2(5.55%) and kidney 2(5.55%). The variations in anatomical distribution of the cyst depend on a number of factors such as blood kinetics (mostly found in muscles that have high blood supply due to animal's daily activities and frequently movement of the organs). Any geographical and environmental factors affecting the blood kinetics in the animal affect the distribution of onchospheres as well and hence the predilection sites

varies during meat inspection. Most of these organs, except the heart are consumed raw or under cooked and could be a potential public health hazard in contracting taeniasis. The observations showed that the masseter muscles, triceps muscle, lungs, liver, kidney and heart among others were the preferred organs (predilection site) for the cysts of *Bovine cysticercosis*. It appears that several factors such as activity of the muscles, age and the geographical area concerned determine largely the predilection sites in slaughtered cattle[4, 31].

Bovine cysticercosis usually does not cause much morbidity or mortality among cattle but it does cause serious economic problems in the endemic areas due to the condemnation of meat or down grading of carcasses contributing to constraint in food security and safety[32]. Out of 36 cysts examined for viability test, 15(41.66%) were found to be alive (viable), while 21(58.33%) were died (degenerative) cysts. Higher number of viable cysts were counted from triceps muscle 7(46.66%), followed by cyst from masseter muscle 4(26.66%), heart 2(13.33%), the lower number of cyst from liver and kidney 1(6.66%) while the cyst in the lung was found degenerated (dead) (Table 2).

CONCLUSION

Bovine cysticercosis caused by *C. bovis/T. saginata*, are one of the major zoonotic diseases that remain a major health problem of animals and humans causing serious socio-economic impact. This study demonstrated that *C. bovis/T. saginata* is highly prevalent parasitic disease in the city municipal abattoir. However, factors such as lack of public awareness about the disease, habit of eating raw meat, habit of feeding affected offal to pet animals, lack of infrastructures and services to carry out proper meat inspection at all levels and traditional animal husbandry systems have contributed to disease occurrence. The current finding indicates the presence of the parasite in the study area which needs high attention by the veterinarians of the study area. At the same time, there was variation of the prevalence of the disease in adult and old animals which were slaughtered in the municipal abattoir. Also, the rate of the disease in different organs also varies from one organ in other organs with high rate of the parasite in triceps muscle. Based on the above conclusion the following recommendations forwarded:

- Special attention must be given to routine meat inspection. Meat inspectors should be vigilant to detect *C. bovis* in beef carcasses by giving training for meat inspectors
- Public education should be given at all levels to increase public awareness (education of the people to use toilets/latrines, improving personal and environmental hygiene and bring cultural changes, so as to avoid the consumption of raw beef)
- Back yard slaughtering of cattle should be avoided
- Bovine cysticercosis as being the cause of economic losses and public health hazard, organizations such as health, agricultural and educational institutions should work with correlation in providing appropriate administrative, technical and financial support for the successful prevention and eradication of the diseases
- Further research on the prevalence of Cysticercosis and the economic importance of the parasite should be conducted

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ANNEXES

Annex 1; Meat inspection procedures: Meat inspection procedures vary with the parasite, i.e., zoonotic or not and the host involved, the tissue involved and the regulations within a country. Examinations tend to be more extensive with the zoonotic infections *T. saginata* and *T. solium*[20].

In general, meat inspection procedures consist of: Visual inspection of the carcass, its cut surfaces and the organs within it. This may reveal *T. saginata*, *T. solium* and *T. ovis* in the muscles, *T. hydatigena* on the liver, mesenteries or omentum, or *T. multiceps* in the brain.

The external and internal masseters and the pterygoid muscles are each examined and one or two incisions made into each, the cuts being parallel to the bone and right through the muscle.

The freed tongue is examined visually and palpated, particularly for *T. solium*. The pericardium and heart are examined visually. The heart usually is incised once lengthwise through the left ventricle and interventricular septum, so, exposing the interior and cut surfaces for

examination. Incisions may go from the base to the apex and regulations also may require additional, perhaps four, deep incisions into the left ventricle. Alternately, the heart may be examined externally and then internally after cutting through the interventricular septum and eversion.

The muscles of the diaphragm, after removal of the peritoneum, are examined visually and may be incised. The oesophagus is examined visually. In some countries, the triceps brachii muscle of cattle is incised deeply some 5 cm above the elbow. Additional cuts into it may be made. The gracilis muscle also may be incised parallel to the pubic symphisis. These cuts are usually undertaken for *T. solium* in pigs. Such incisions into the legs are made, particularly in African countries as it is suspected that more parasites lodge in these muscles in working or range animals walking long distances because of the exercise and consequent increased blood flow to these muscles. Other countries may also require such incisions into the legs. However, as this devalues the meat such incisions are made most commonly once one or more cysts have been found at the predilection sites so as to determine the extent of the infection.

Annex 2: Ante mortem examination

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