Study on Prevalence and Economic Importance of Cysticercus Bovis in Cattle Slaughtered at Kombolcha ELFORA Abattoir, South Wollo Zone, Amhara Region, North Eastern Ethiopia.

[1] Mulugeta Alebachew, Dejen Tsehayeneh [2*], Birhanu Eticha[2*] and Haile Worku[2*]

[1] Amhara Regional State, East Gojam, Dejen Woreda Agriculture office, Dejen, Ethiopia
[*2] Benishngul Gumuz Regional State, Livestock and Fisheries Resource Development Agency, P.O.Box:30, Assosa, Ethiopia;
E-mail: workuhaile29@gmail.com, brihanueticha12@gmail.com and drdejen@gmail.com

Abstract: This cross-sectional study was conducted from October 2011 to April 2012 to determine the prevalence, associated risk factors and economic importance of bovine cysticercosis in cattle slaughtered at Kombolcha ELFORA abattoir, North Eastern Ethiopia. A total of 1201 cattle slaughtered were examined during the study period and an overall (61/1201, 5.07%) prevalence was recorded. A retrospective study was also conducted to evaluate the significance of cysticercosis in the study area. A four year (2007 to 2010) abattoir data analysis in the study area showed that the prevalence of Cysticercus bovis range varied from 6.2% to 13.2%. Sex and ecological origins of cattle did not show significant association (P>0.05) with presence of cysts. Liver was found to be the most affected organ of cysticercosis 32(52.45%) followed by masseter muscle 9(14.75%), tongue 8(13.11%), thigh muscles 6(9.88%), heart 6(9.83%), shoulder 3(4.91%) and diaphragm 2(3.27%). Out of 218 cysts collected from different organs and tested for viability, 100 (45.87%) were found to be viable and out of this liver was harbor a proportionally higher (26.60%) rate of viable cysts. Considering the current study Cysticercus bovis infection is a widespread occurrence in cattle slaughtered at Kombolcha ELFORA abattoir. To conclude, the impact of cysticercosis necessitates serious attention in order to safeguard the public health and economy of the country; to reduce the transmission of Cysticercus bovis, strategic actions aiming at public education to avoid consumption of raw meat, improved standards of human hygiene and strict routine meat inspection should be considered.
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1. Introduction

Taenia saginata, taeniasis occurs throughout the world with variable degree of prevalence (Harrison and Sewell, 1991). In the world there are 77 million bovine taeniasis patient of which 32 million are in Africa, 11 million in Asia and about 3 million in the new world (Kebede, 2004). The disease is relatively common in Africa, some parts of Eastern Europe, the Philippines and Latin America (Wikipedia, 2012). Cattle become infected with bovine cysticercosis by ingesting materials contaminated with tapeworm eggs originating from human feces. Bovine cysticercosis is not transmitted directly from cattle-to-cattle nor is *Taenia saginata* (the human tapeworm species) transmitted directly from person-to-person. In a typical cattle barn climate, tapeworm eggs are estimated to survive about 18 months. Tapeworm eggs are also resistant to a number of common disinfectants. They can, however, be destroyed by drought, since they do not survive in a very dry environment (CFIA, 2012).

Bovine cysticercosis, refers to the infection of cattle with metacestodes of the human tapeworm (*T. saginata*) (Radostits *et al.*, 1994; Oladele *et al.*, 2004). Cysticercus bovis is the larval stage of the human tapeworm *Taenia saginata* and is manifested by presence of cysts (cysticerci) in the striated muscles of cattle (McAnich, 1974). Cysticercus bovis is a two host parasite with the encysted larva which is found in cattle and the adult tapeworm, *Taenia saginata*, is found in man (CCDR, 2002). Mature tapeworm proglottids, typically containing thousands of eggs, are commonly passed in the feces of infected individuals and under unsanitary conditions can lead to pasture or water contamination and the infection of cattle. Ingested eggs develop into cysticerci, which can be detected during meat inspection at the routinely inspected localization sites of the parasite, including heart, skeletal muscle, diaphragm, and esophagus (Oladele *et al.*, 2004).

Cysticercus bovis is found worldwide, but most often in rural developing countries, where unhygienic conditions are coupled with poor cattle management practices and lack or absence of meat inspection (Shikongo-Kuvare, 2007). The cestode *Taenia saginata*, while causing public health problems due to human taeniasis is mainly of veterinary and economic importance since the intermediate stage, the Cysticercus or metacestode, is found in the

musculature of cattle. Infected meat is either downgraded in value or condemned as unfit for human consumption resulting in production losses at the point of slaughter (Ferrer *et al*., 2003).

The World Health Organization (WHO, 1983) has classified the prevalence of *Taenia saginata* in three different groups: highly endemic countries or regions with their presence in human population above 10%; moderate prevalence with infection rate between 0.1 and 10%; low prevalence with infection rate below 0.1% or the total absence of the endemic organism. According to WHO classification, South American countries are included among the moderate prevalence of *Taenia saginata.* It has a worldwide distribution and the prevalence is low in developed countries, being less than 1% in carcasses inspected (Bedu *et al*., 2011) and very common in Africa reaching a level of 30-36% in Kenya, 20% in Guinea, 18% in Sierra Leone and 20% in Cameroon (Bedu *et al*., 2011).

Taeniasis caused by *T. saginata* is a well-known disease in Ethiopia with prevalence ranging from 10% to 70% (Mamo, 1988). The prevalence reports of cysticercosis in Ethiopia showed variable results with localities. Relatively lower prevalence of 3.1% in Central Ethiopia (Tembo, 2001), 4.9% at Gonder (Dawit, 2004) and 7.5% in Addis Ababa (Nigatu, 2004) were reported, while others reported as high as 17.5% in East Shoa (Hailu, 2005), 21% at Nekemt (Ahmed, 1990), 26.25% at Awassa (Abunna *et al.,* 2007) and 30% (Hailemariam, 1980) from different abattoirs in the country. Hence, bovine Cysticercosis is an important public health and economic problems caused by its consequence on public health, nutrition and economy of countries (Wanzala e*t al.,* 2003).

The epidemiology of bovine cysticercosis/human taeniasis varies from one area to another so control measures appropriate in one area are not necessarily of value in another. Hence, it is essential to have adequate knowledge of the epidemiology of the disease before contemplating control strategies. Therefore, the present study was designed to determine the prevalence of bovine cysticercosis in cattle slaughtered at Kombolcha ELFORA abattoir, to investigate associated risk factors involved in the occurrence of infection and to forward possible control measures.

2. Material and Methods

2.1. Study Area

The study was conducted from November 2011 to March 2012 in Kombolcha town, found in South Wollo administrative zone of Amhara National Regional State in North Eastern Ethiopia, which is located 376 km North of Addis Ababa with $11^{0}084`49``^{0}$N latitude and $0.39^{0}737`46``^{0}$E longitude. The altitude ranges from 1500-1840 meter above sea level. The topography of the zone is generally marked by the presence of numerous mountain, plateaus, hilly, and sloppy area, rivers and lakes with three topography category including 14% of high altitude (Dega), 34% mid altitude (Woyna dega) and 52% low altitude (Kola). The study area experiences a bimodal rainfall receiving rainfall amount that ranges from 750 to 900 mm of which 67% fall in the long rainy season which extends from June to September. The recorded temperature in the area is 23.9^{o}_{c} during short rain fall and 11.7^{o}_{c} during long rain fall and the relative humidity of the area varies from 23.9% to 79% (Trade and Investment Guide of Kombolcha, 2008).

The vegetation of the area changes with an altitude ranging from scattered tree bushes to dens shrub. The soil is vertisol, which is deep clay soil. The major crops grown in the area include sorghum, maize, teff, wheat, barley, oats and others. The farming system is mixed type (crop-live stock production). According to current document of South Wollo Zone and Kalu Wereda Agriculture and rural development office (2008), the livestock population of the area comprises 100,381 cattle, 12,975 sheep, 31,043 goat, 1,254 horses, 908 mule, 7,758 donkey, 1,865 camel and 119,347 poultry. The grazing land includes water logged areas, forest margins, hilltops, mountainsides, stony land, and roadsides. In the area extensive management system dominants, while semi-intensive system of production is almost non-extensive (South Wollo zone and Kalu woreda agriculture and rural development office, 2008).

2.2. Study population

Animals which were presented to Kombolcha ELFORA abattoir for routine meat inspection were mainly from low land (Kemisse, Bati, West Afar, Harbu, Kobo and Ancharo), mid land area (woreylu, East Gojjam, hike, Jama, Borena and Shiwarobit) and high land area (Dessie and Dalanta,). Accordingly, the cattle presented to the ELFORA abattoir for slaughtering were used as a study population for active abattoir survey and retrospective study were carried out at the abattoir for the case of bovine cysticercosis from compiled data from the year 2007 to 2010.

2.3. Study design

Cross-sectional and retrospective studies were used to determine the prevalence and economic impact of bovine cysticercosis at Kombolcha ELFORA abattoir.

2.4. Sample size and sampling method

The total number of cattle required for the study was calculated based on the formula given by Thrusfield (2005) for random sampling method. By the rule of thumb where there is no information for an area, it is possible to take 20% or 50% prevalence. In this study, we took 50% expected prevalence to calculate the sample size using the following formula.

$n = 1.96^2 (P_{exp}) (1-P_{exp})/ d^2$

Where, n = required sample size

P_{exp} = expected prevalence

d = desired level of precision (5%)

1.96^2 = the value of Z at 95% confidence interval

Therefore, $n = 1.96^2(0.5) (1-0.5)/ 0.0025=384$ cattle

But 1201 cattle were sampled in the study to increase the level of precision and randomness of detecting Cysticercus bovis in slaughtered cattle.

2.5. Study Methodology

2.5.1. Retrospective Study

A retrospective study was carried out on data recorded by ELFORA abattoir for the last four years at Kombolcha, North Eastern Ethiopia. The data used in this evaluation were obtained from meat inspection reports compiled at the abattoir for the last four years (2007 to 2010) involved a total of 18429 cattle slaughtered. Assessment of organ distribution and prevalence of Cysticercus bovis were made simultaneously at the abattoir. In addition, the annual prevalence of these parasitic infections was estimated for the past four years.

2.5.2. Cross- sectional Study

The cross-sectional survey which was based on the active abattoir survey to estimate the prevalence of bovine cysticercosis was conducted during routine meat inspection on randomly selected 1201 cattle slaughtered at Kombolcha ELFORA abattoir. During ante-mortem inspection, each study animal was given an identification number and the possible risk factors for the occurrence of this disease; sex, age and origins of animals were recorded. It was difficult to precisely track back the geographical origins of all animals slaughtered and relate the findings to particular locality. Nevertheless, the market origin of animals was recorded from merchants that supply to ELFORA abattoir. They were brought from Dessie, Bati, Kemissie, Dalanta, Woreylu, Haik, Harbu, East Gojjam, West Afar, Shewarobit and Kobo. In the abattoir, meat inspection was carried out on different organs of each slaughtered animals, such as heart, shoulder muscle, thigh muscle, masseter muscle, tongue, diaphragm and liver.

Meat inspection was made in accordance with the procedures of Ethiopian Ministry of Agriculture Meat Inspection Regulation (1979) for the detection of *T. saginata*, cysticercosis. Visual inspection followed by multi-incisions of 0.5 cm in each organ (heart, diaphragm, shoulder, tongue, liver, kidney, lung and masseter muscle) were made to examine the cysts of *T. saginata*. Lesions consisting of cysticerci are 5–8 mm by 3–5 mm, translucid and filled with brownish fluid. For masseter muscle deep linear incisions were made parallel to the mandible; the tongue was examined from base to top; the heart were incised from base to apex to open the pericardium and incision was also made into cardiac muscle for detail examination. Deep adjacent and parallel incisions were made above the point elbow in the shoulder muscles. Examination of the liver, kidney and lung was also conducted accordingly. Randomly selected positive samples from each organ were transported to the parasitology department of Kombolcha Regional Veterinary Diagnostic Laboratory for confirmation of cyst viability. The cysts were incubated at 37^{o}C for 1-2 hours using 40% ox bile solution diluted in saline solution. After this, the scolex was examined under microscope. The cysts were regarded as viable if the scolex evaginate during the incubation period (WHO, 1983). Data on cyst findings and organ distribution in each animal slaughtered were recorded.

2.6. Data Management and Analysis

All collected data were recorded carefully and entered in to Microsoft Excel spread sheet. The outcome variables for the abattoir study were cases of *T. saginata* cysticercosis detected during routine postmortem inspection at Kombolcha ELFORA abattoir. Sex and origin of the animals were regarded as the explanatory variables. The prevalence of the disease was determined and various potential risk factors for cysticercosis in animals were analyzed by general linear model logistic regression using Stata 11 statistical software.

3. Result

3.1. Retrospective Study

Records of Kombolcha ELFORA abattoir revealed that detection of Cysticercus bovis is common in cattle slaughtered at the abattoir from 2007- 2010. This study has also indicated that liver is the most common organ harboring cysts at a high frequency throughout the period (Table 1).

3.2. Cross-sectional Study

3.2.1. Prevalence and Risk Factors

Out of a total 1201 cattle slaughtered and examined during the study period, 61(5.07%) were found to be infected by Cysticercus bovis. In this study sex and origin of slaughtered cattle were considered as risk factors to have effect on the occurrence of cysts. Accordingly, no significant difference ($P>0.05$) was observed between the carcasses of male and female animals in cyst detection considering sex as associated risk factor (Table 2).

Table 1: Occurrence of Cysticercus bovis infection in cattle slaughtered at Kombolcha ELFORA abattoir (2007 – 2010).

Year	Number of carcasses		Organ distribution of cysts			
	Examined	Infected (%)	Musseter muscle	Heart	Liver	Tongue
2007	5116	677 (13.2)	49 (7.2)	192 (28.4)	342 (50.5)	94 (13.9)
2008	4491	277 (6.2)	14 (5.1)	49 (17.7)	189 (68.2)	25 (9.0)
2009	4791	413 (8.6)	11 (2.7)	90 (21.8)	252 (61.0)	60 (14.5)
2010	4031	255 (6.3)	5 (1.96)	41 (16.1)	125 (49.0)	84 (32.9)
Total	**18429**	**1622(8.8)**	**79(4.9)**	**372(22.9)**	**908(55.9)**	**263(16.2)**

Table 2: Prevalence of Cysticercus bovis in cattle slaughtered at ELFORA abattoir, Kombolcha based on sex category.

	Number of animals					
Sex	**Examined**	**Positive**	**Prevalence (%)**	**95% CI**	χ^2	**P –value**
Female	111	7	6.13	1.71- 10.89	0.3821	0.537
Male	1090	54	4.95	3.66- 6.24		
Total	**1201**	**61**	**5.07**	**3.8 – 6.3**		

Analysis of the result considering the effect of agro-ecological origin of cattle on cyst detection did not show any significant association (P>0.05) (Table 3).

Table 3: Prevalence of Cysticercus bovis in cattle slaughtered at ELFORA abattoir, Kombolcha based on origin of animals.

Origin	**Number of animals**				
	Examined	**Positive**	**95% CI**	χ^2	**P-value**
Lowland	386	16(4.15%)	2.1-6.1	3.5847	0.167
Midland	470	21(4.47%)	2.5-6.3		
Highland	345	24(6.69%)	4.2-9.6		
Total	**1201**	**61(5.07%)**	**3.8-6.3**		

3.2.2. Organ distribution of cysts

Out of the total 1201 cattle carcasses examined, the prevalence of Cysticercosis was found to be 61(5.07%). Organ distribution of cysts was checked and revealed that high prevalence of cysts was recorded in liver 32 (52.45%), followed by masseter muscle 9 (14.75%), tongue 8 (13.11%), thigh muscles 6 (9.83%), heart 6 (9.83%), shoulder muscles 3 (4.91%), and diaphragm 2 (3.27%) respectively.

3.2.3. Cyst viability

Out of the total 218 cysts collected from different organs and tested for viability, 100 (45.87%) were found to be viable; of which liver was found to harbor a proportionally higher prevalence (26.60%) rate of viable cysts (Table 4).

Table 4: Organ distribution of Cysticercus bovis in cattle slaughtered at ELFORA abattoir, Kombolcha based origin of animals.

Number of animals		**Organ distribution of cysts**						
Examined	Positive	Liver	Masseter muscle	Tongue	Thigh muscles	Heart	Shoulder muscles	Diaphragm
1201	61	32(52.45)	9(14.75)	8(13.11)	6(9.83)	6(9.83)	3(4.91)	2(3.27)

Table 5: Viability of cysts originating from different organs

Infected organs	**No of cysts examined**	**No of viable cysts**	**% of viable cyst**
Tongue	13	6	2.75
Masseter muscle	10	7	3.21
Shoulder muscle	9	7	3.21
Thigh muscle	6	4	1.83
Heart	38	16	7.34
Liver	139	58	26.60
Diaphragm	3	2	0.92
Total	**218**	**100**	**45.87**

4. Discussion

The current study revealed 5.07% prevalence of cysticercosis in cattle slaughtered at Kombolcha ELFORA abattoir. This result is lower when compared to earlier findings of 26.3% (Abunna *et al*. 2008) in Hawassa, 21.17% (Ahmed, 1990) in Nekemte, 18.49% (Kebede, 2008) in northwestern Ethiopia, 17.5% (Hailu, 2005) in East Shoa. This could be due to the practical limitations to the number of incisions allowed and many infections could be undetected. Usually lower number of incisions is allowed at the predilection sites by the owners as gross incision lower marketability of carcasses and introduces contamination. This may in turn lead to missing of infected animals as the sensitivity of detecting the parasite will decline with limited number of incisions (Wanzala *et al.*, 2003). Experimental studies showed a 5-50 times higher prevalence by complete slicing of the predilection sites (Minozzo *et al.,* 2002). However, the present finding is in agreement with the findings of 7.5% (Kebede *et al*., 2008) in Addis Ababa, 9.7% (Amsalu, 1989) in Debre Zeit, 4.9% (Dawit, 2004) in Gondor and 3.1% (Tembo, 2001) in central Ethiopia.

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 condemnation of meat or downgrading of carcass in light infections (Onyango-Abuje *et al*., 1996) contributing to constrain in food security and safety. The economic losses as a result of the condemned and downgraded carcasses due to treatment or processing of carcasses for human consumption are substantial (Fan, 1997; Walther and Koske, 1980). In East Africa, cysticercosis has been reported as a widespread and extremely common (Urquhart *et al*, 1996). This idea is reflective of the conditions in the current study area.

Moreover, retrospective data obtained from Kombolcha ELFORA abattoir involving records of routine meat inspection for four years period (2007-2010) showed that the prevalence of cysticercosis ranges from 6.2% to 13.2% with an average of 8.8%. It is generally anticipated that the number of cysts detected in routine meat inspection activities are most likely underestimates. This is due to the inefficiency and characteristics of the conventional method of inspection. Cysticerci are easily missed, as they may not be present on routine cuts considering that most cases of cysticercosis are light infections (Dorny *et al*., 2000). Moreover, live cysts are translucent and often pinkish in color and may therefore be less conspicuous in the meat than dead cysts that usually form white and fibrotic lesions (Onyang *et al*., 1996). Differences in the skills and motivation of meat inspectors, the speed of the slaughter activity, and the meat inspection facilities, are among the many other contributory factors. Therefore, palpation and incision techniques of routine meat inspection cannot detect the true picture of Cysticercus bovis. For that reason, the actual prevalence of Cysticercus bovis in the current study area is likely to be higher than the current result.

Analysis of hypothesized risk factors showed that there was no significant association between Cysticercus bovis infections and geographical areas the slaughtered cattle. This agrees with the finding of Alula (2010) in the same study area and Abunna *et al*. (2008) in Hawassa who reported insignificant association to the same factor. This might be due to a more or less similar level of environmental contamination, with the eggs of *Taenia saginata* among the different animal origins. Moreover, raw meat consumption in Ethiopia is one of the habits that are shared by various social groups which probably contributed for the absence of significant variation in Cysticercus bovis infection in different areas. The prevalence of bovine cysticercosis did not show statistically significant difference between the sex of animals which was in line with reports of Abunna *et al*. (2007), Hailu (2005), Tembo (2001), Alemseged (2008) and Alula (2010).

Regarding to the anatomical distribution of cysts, Cysticercus bovis was recorded at various sites in the carcasses examined; cysts were detected in the liver, tongue, heart, masseter muscle, shoulder muscle, thigh muscle and diaphragm. However, contrary to past studies conducted by different researchers, high proportion of cysts was detected in the liver, followed by masseter muscle and tongue. The finding of such a high frequency of cysts in the liver in this study might be due to thorough examinations usually made on liver for Cysticercus bovis at Kombolcha ELFORA abattoir. This has also been supported by the finding of consistently greater frequency of cysts in the liver during the study period covered in the retrospective study. Likewise, the proportion of viable cysts was also found to be higher in the liver 58(26.6%) than other predilection sites in this study. This could be related to the large number of cysts found so frequently and assessed.

5. Conclusion

The finding of this work suggests that Cysticercus bovis infection is a usual phenomenon in cattle slaughtered at Kombolicha ELFORA abattoir. The widespread distribution of *Taenia saginata*/ Cysticercus bovis is associated with several factors including; consumption of raw and undercooked meat, bush defecation and poor waste disposal practice, poor sludge and sewage treatment systems, low level of public awareness and presence of backyard (village) slaughtering practices. Conventional meat inspection technique is less sensitive and time consuming, lightly

infected carcasses can be easily missed and passed for human consumption thus the infection transmission is maintained between humans and cattle. Thus taeniasis/ cysicercosis remains a wide spread zoonosis that affects human health and economy through condemnation, quality degradation of frozen beef, cost of refrigeration, cost of human therapy, lowering productivity of infected workers who may be absent from work or reduced working efficiency by creating uneasiness. Hence, the impact of cysticercosis necessitates serious attention in order to safeguard the public health and economy of the country; to reduce the transmission of Cysticercus bovis, strategic actions aiming at public education to avoid consumption of raw meat, improved standards of human hygiene and strict routine meat inspection should be considered.

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Corresponding authors:

Dr. Haile Worku, Dr. Birhanu Eticha, and Dr. Dejen Tsehayeneh, Benishngul -Gumuz Regional State, Livestock and Fisheries Resource Development Agency, Assosa, Ethiopia
Emails: workuhaile29@gmail.com, brihanueticha12@gmail.com and drdejen@gmail.com.

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