



Zoonotic metacestodes and associated financial loss from cattle slaughtered at Yabello municipal abattoir, Borana-Oromia, Ethiopia

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ABSTRACT

Cross-sectional study was carried out to determine the prevalence and estimate financial losses associated with zoonotic metacestodes in cattle originated from Borana Pastoral Farming System and slaughtered at Yabello Municipal Abattoir, Ethiopia. A total of 384 cattle were randomly selected at the abattoir. Detailed postmortem examination, cyst count and fertile test were conducted. Significantly higher prevalence of *Cystic echinococcosis* (CE) (33.3%) with 5.3 times (OR 95% 3.5–8.1) than *Cysticercus bovis* (8.6%) was observed. Significant difference ($p < 0.05$) in prevalence of both CE and *C. bovis* were observed among the animal body condition, but not in other factors of the study. From total examined animals, 32.8%, 8.1% and 0.5% were infected by CE only, *C. bovis* only and both as concurrent infections, respectively. Significantly higher CE ($p < 0.05$) than *C. bovis* were observed within studied categories of risk factors. Tissue level cyst prevalence of 83.1% CE and 26.6% *C. bovis* were observed. High CE counts on the lungs (42.7%), liver (32.8%) and kidney (5.2%) but high *C. bovis* count in triceps muscle and masseter muscles (7.3% each) and heart (3.64%) were observed. Concurrent infections were observed in heart and liver. Out of the 347 counted CE cysts, fertile and viable were 34.0% and 23.1%, respectively. Of the counted *C. bovis*, 30.4% were both fertile and viable. A total of 301,139.6ETB (11,155.52USD) annual financial losses were calculated during the study period. The Borana Pastoral Farming System characterized by seasonal animal movement needs awareness creation on the elders and leaders regarding parasitic epidemiology and control strategies.

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1. Introduction

Metacestodes of taeniasis and echinococcosis are found public health and economic significance (Urguhart et al., 1996) often in developing countries, where the unhygienic conditions are coupled with poor cattle management practices and lack or absence of meat inspection (Eddi et al., 2003). Infection of different muscular tissues with *Cysticercus bovis* (*C. bovis*), the larvae of *Taenia saginata* (Nigatu, 2008; Tegegne et al., 2018) shows no symptoms. However, heavy infection may cause myocarditis or heart failure in animals (Cabaret et al., 2002). On the other hand, the adult stage of *C. bovis* (*Taenia saginata*) in human intestine causes gastrointestinal syndromes. *Cystic echinococcosis* (CE) is another frequently encountered metacestodes in developing countries

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in its intermediate hosts (cattle, goat and camels) where the adult stages are dog tapeworm (*Echinococcus granulosus*) (Urguhart et al., 1996; Abunna, 2013; Jobre et al., 1996; Hiko et al., 2018). The cyst is known by slowly growing parasitic condition most frequently occurs in the liver at 52–77% of cases. Organs such as the lungs, kidney, spleen and other soft tissues were also predilection sites from which the canine become infected up on ingesting the infected offal's (Urguhart et al., 1996; Cabaret et al., 2002; Budke et al., 2006).

In Ethiopia, abattoir based studies conducted on CE in various parts of the country showed that prevalence of hydatidosis ranging from 11.3% to 63% at Harar (Lemma et al., 2014) in bovine and 4.4% to 18.8% in sheep at Gondar (Tamene, 1986). The prevalence of 51% in cattle with area specific occurrences of 44% in Arsi, 30% in Borana, 85% in Jimma and 67% in Mi'eso were also reported by Hiko et al. (Hiko et al., 2018). Regarding *C. bovis*, several authors have reported the lower prevalence of 3.1% in Central Ethiopia (Tembo, 2001), 4.9% in Gondar (Dawit, 2004) and 7.5% in Addis Ababa (Nigatu, 2004). On the other hand, higher prevalence of 17.5% in East Shoa (Hailu, 2005), 21% in Nekemte (Issa, 1990) and 26.25% in Hawassa (Abunna et al., 2008) were reported.

Both metacestodes of the taeniasis and echinococcosis are downgrading and responsible for lowering the quantity and quality of animal commodities. They are responsible for decreasing of meat, milk and wool production (Hiko et al., 2018; Jibat et al., 2008). Economic losses associated with hydatidosis were estimated at various levels in different locations of Ethiopia. Annual losses of 25,608 ETB in Tigray (Kebede et al., 2009), 1,791,625.89 ETB at the Hawassa (Regassa et al., 2010), 473,173.75 ETB at Debre Markos (Nigatu et al., 2009), 52,828 ETB at Adama (Getaw et al., 2010) and 930,918.52 ETB at Mekelle (Getachew et al., 2017) abattoirs were reported due to CE and bovine cysticercosis. Average annual losses of 4,937,583.21 ETB or 225,036.97 USD due to taenicial drugs for human treatment were estimated (Abunna, 2012) in Ethiopia. Moreover, annual economic losses of 1,841,311.00 ETB (73,652.44 USD) consisting of 1,831,890.00 ETB due to *C. bovis* from organ condemnation and 19,421.00 ETB from taenicial drugs cost for human treatment were estimated (Tegegne et al., 2018) in Ethiopia.

Being metacestodes of echinococcosis and taeniasis have major public health impact and are responsible for economic losses, investigation on the prevalence and the levels of economic associated with metacestodes in cattle slaughtered at Yabello Municipal Abattoir, Borana-Oromia, Ethiopia were not yet assessed. This study was aimed to assess the prevalence, organs distribution and viability of cystic metacestodes of hydatidosis and bovine cysticercosis with associated economic losses at Yabello Municipal Abattoir, Borana-Oromia, Ethiopia.

2. Materials and methods

2.1. Description of the study area

The study was carried out at Yabello Municipal Abattoir. Yabello is the capital city of Borana Zone, Oromia Regional State located at 575 KM south of the capital city, Addis Ababa, Ethiopia. The zone has latitude ranges between 943 and 1800 m above sea level with average annual rainfall of 400 to 1100 mm exhibiting a bimodal rainfall (long and short rainy seasons). The area have long rainy season "Gamma" extends from March to May while short rainy season "Hagayya" extends from September to November. The annual temperature varies between (19–42 °C).

Borana Zone has an estimated human population of 962,489 (male 487,024 and female 475,465) with 91.2% of population living in Rural area (CSA, 2017). Historically, the area was occupied by Borana people characterized by nomadic residing in southern parts of Ethiopia and northern parts of Kenya keeping livestock as main livelihood strategies. The farming system was based on seasonal animal movement to search for animal feed and water, and to escape the risk of potential seasonal diseases (Coppock, 1994) and drought disaster under the umbrella of the Borana Oromo Gada System (Legesse, 1973).

2.2. Study design

A cross-sectional study was conducted from December 2017 to March 2018 to determine the prevalence and financial losses associated with zoonotic metacestodes (CE and *C. bovis*) in Yabello Municipal Abattoir, Borana Oromia, Ethiopia.

2.3. Study population

The study population were cattle presented for slaughters at Yabello Municipal Abattoir. Random sampling was applied at the abattoir. Using history of their origin, selected study animals were traced to their respective origin. Accordingly, studies animals were originated from Yabello, Taltalle, Haro-Bake, El-Waye and Dubuluk districts.

2.4. Sampling and sample size calculation

A simple random sampling method was employed at the abattoir on cattle brought for slaughter. Randomization was done from both the five slaughter working days of the abattoir and from the animals within the selected date of sampling. Hence, three of the five slaughtering days were selected. Five to six animals were sampled per selected sampling day. Sample size was calculated by considering 50% expected prevalence at 95% confidence level and 5% precision according to Thrusfield (Thrusfield, 2005). Thus, a total of 384 cattle were randomly selected at the abattoir.

2.5. Study methodology

2.5.1. Factors considered

Animal origins were categorized into Yabello, Taltalle, Haro-Bake, El-Waye and Dubuluk districts. Animal related risk factors such as age and body condition were considered. Thus, age were categorized into young (less than five) and adult (greater than five years) using the dental eruption. They were ranked as poor, medium and good body condition score (Nicholson and Butterworth, 1986). The organs and tissues to be examined during postmortem examination were considered. Heart, diaphragmatic mussel, tongue, liver, the lungs, kidneys, shoulder mussel, masseter muscles and others were included. Moreover, recording of condemned organs was done in order to assess the economic losses.

2.5.2. Antemortem examination

The study animals were selected during antemortem inspection. Specific identification number was given for each animal. Animal related risk factors (age and body condition), and their origins were recorded before slaughtering operation.

2.5.3. Postmortem inspection and sample collection

Animal identification number goes with each inspected organ and tissues. The factors of animal identification were also extended to the cyst fertility and viability test. During postmortem examination, thorough visual inspection and palpation of organs and tissues were made. Systematic incisions on each visceral organ, particularly on the liver, the lungs, kidneys, heart, masseter muscles, the tongue, diaphragmatic muscles, triceps and spleen, were carried out in accordance with the procedures of the Ethiopia Ministry of Agriculture Meat Inspection Regulation for the detection of hydatidosis and cysticercosis (Gracey and Collins, 1992; MOA, 1972). *CE* and *C. bovis* cyst count per infected organs and tissues were done immediately at the abattoir. All cysts from infected organs were collected and transported to the Yabello Regional Laboratory at +4 °C for cyst viability and fertility test (Macpherson et al., 1985). The whole ox bile was also collected at the abattoir and used while testing cyst fertility and viability.

2.5.4. Cyst fertility and viability test

The viability of *C. bovis* was assessed by incubating the cysts in a normal saline solution containing 30% ox bile at 37 °C for 2 h. The scolex was examined under microscope by pressing it between two glass slides. The cysts were recorded as viable if the scolex evaginate during the incubation period. The scolexes were checked to classify them as *Taenia saginata* metacestode based on absence of hook on the rostellum of the evaginated cyst (Macpherson et al., 1985).

With regards to the cysts of *CE*, the cyst wall was penetrated by a needle and opened with scalpel and blades under a great care. The contents were transferred into a sterile test tube. Based on the presence or absence of broad capsule containing protoscolices, which are similar to the appearance of white dots on the germinal epithelium, such cysts were characterized as fertile or infertile cysts in the hydatid fluid. Those fertile cysts were subjected to viability test. On the other hand, the infertile cysts were further classified as sterile (fluid filled cyst without any protoscolices) and calcified (cyst already calcified). To determine viability of protoscolices, a drop of the sediment consisting of the protoscolices was placed on a microscopic slide and equal amount of 0.1% aqueous eosin solution was added onto the sample on the slide. Then, it was covered with cover slip and observed under X40 microscope objective. The interpretation principle was, those viable protoscolices should completely or partially exclude the eosin solution dye while the dead one take it up (FAO/UNEP/WHO, 1982).

2.5.5. Financial losses assessment

Losses due to infected organs and tissue condemnation were calculated by considering information on the recent market price of the condemned organs and tissues (Ogunrinade and Ogunrinade, 1980) at butcher shops in Yabello town. Direct losses were calculated on the basis of the condemned organs and tissues (Polydorou, 1981). Then after, the direct and indirect financial losses were calculated on a yearly basis. Average market prices of the lungs, liver, spleen, kidneys, heart, tongue and a kilogram of beef were found to be 30, 80, 15, 10, 30, 20, 200 and 200 Ethiopian Birr (ETB), respectively. Average carcass weight of the Ethiopian Borana breed cattle is estimated as 126 kg. The indirect losses were estimated on the basis of live weight losses caused by hydatidosis and bovine cysticercosis (Polydorou, 1981). The total economic losses were calculated as the summation of cost of offal's condemned plus the cost of carcass weight losses (ILCA, 1993). The average carcass weight losses of 5% due to hydatidosis (Getaw et al., 2010) was used. The total cost (TC) of financial losses due to hydatidosis and *C. bovis* were the sum of direct (DL) and indirect (IDL) losses.

- Annual cost of offal condemned = (CSR * PHLu * CPLu) + (CSR * PHLi * CPLi) + (CSR * PHHe * CPHe) + (CSR * PHKi * CPKi) + (CSR * PHSp * CPSp)
- Annual cost of carcass weight losses = 5% * CSR * PH * PC * CPB * 126 kg.
- TC = IDL + DL

Where: CSR = Average number of cattle slaughtered per year = 7300; PHLu = Percentage of lung condemned = 19.3%; CPLu = Mean cost of one bovine lung in Yabello = 30 Birr; PHLi = Percentage of liver condemned = 19.3%; CPLi = Mean cost of one bovine liver in Yabello = 80Birr; PHHe = Percentage of heart condemned = 3.64%; CPHe = Mean cost of one bovine heart in Yabello = 30Birr; PHKi = Percentage of kidney condemned = 4.4%; CPHKi = Mean cost of one bovine kidney in Yabello = 10birr; PHSp = Percentage of spleen condemned = 1.8%; CPSp = Mean cost of one bovine spleen in Yabello =

15Birr; = Prevalence of hydatidosis in Yabello = 33.3%; PC = Prevalence of cysticercosis in Yabello = 8.6%, 5% = Carcass weight losses in individual animal due to metacestode, CPB = current mean price of 1 kg of beef at Yabello = 200Birr; TC = Total cost; IDL = Indirect loss; DL = Direct loss.

2.6. Inclusion and exclusion of the study

The study was aimed to assess the occurrence of zoonotic metacestodes and associated financial losses from the slaughtered cattle at Yabello Municipal Abattoir. Thus, all cattle on sampling date were included with equal probability of selection. The analysis of financial losses was also in terms market prices of organ and tissue condemned at Yabello during the study period. But, assessment of human cases and cost of human medication were excluded due to study time limitation.

2.7. Data management and analysis

Data generated from the study were registered Microsoft Excel 2013©. All considered risk factors, postmortem findings, laboratory cyst fertility and viability test results were register. The estimated financial losses were recorded and recalculated using annual loss. Data was analyzed using SPSS software version 20 BMI, STATA software version 11.0 (STATA Corp, 2009) and WinPE 5.3. Prevalence, organ distribution and fertility rate of hydatid cyst and *C. bovis* were expressed using percentage. Chi-square (χ^2) was calculated to assess significance of association of prevalence of both metacestodes in the studied risk factors. The difference in prevalence between hydatid cyst and *C. bovis* within in studied risk factors were also compared. Using univariate and multivariate logistic regression, odds ratio (OR) and OR 95% CI were also calculated. The finding was considered significant at p -values < 0.05. The sum of direct and indirect financial losses from animal organs and tissue contamination were calculated and expressed in Ethiopian Birr (ETB) and United States Dollar (USD).

3. Results

3.1. Prevalence of hydatidosis and bovine cysticercosis

Out of the 384 examined cattle, the prevalence of *CE* (33.3%) and *C. bovis* (8.6%) were observed. The prevalence of *CE* was 5.3 times (OR 95% 3.5–8.1) higher than that of *C. bovis* (Table 1). Except for animal body condition score, where the prevalence was significant difference ($p < 0.05$) both for *CE* and *C. bovis*, differences in prevalence were not observed among animal origins ($p > 0.05$) and between the age ($p > 0.05$). Comparing the prevalence of metacestodes within each category of studied variables, significantly higher *CE* than *C. bovis* were observed ($p < 0.05$).

The univariate and multivariate logistic regression analysis for the prevalence of metacestodes based on animal body condition was shown in Table 2. Using univariate logistic regression, the poor body condition animals harbors higher *CE* (OR = 2.22, 95%CI: 1.26, 3.94) than those with good and medium body condition animals. High occurrences of *C. bovis* in medium body conditions animal (OR = 4.85, 95%CI: 1.83, 12.88) and poor body conditions (OR = 7.26, 95%CI: 2.60, 20.23) were higher than in those with good body conditioned. Using multivariate logistic regression analysis, significantly high *CE* in poor body conditioned animals ($p = 0.006$) than in others were observed. Significantly higher *C. bovis* in medium body conditions (0.001) and in poor body conditions (<0.001) than in good body conditioned animals were observed.

Table 1

Prevalence of metacestodes (*CE* and *C. bovis*) in cattle slaughtered at Yabello Municipal Abattoir by studied risk factors.

Risk factors	Categories	No. of tested animal	No. (%) metacestodes ^a		Significances of <i>CE</i> over <i>C. bovis</i> ^b			
			<i>CE</i>	<i>C. bovis</i>	χ^2	p-value	OR	95% OR CI
Origin of animal	Yabello	87	23 (26.4)	9 (10.3)	7.5	0.006	3.11	1.4–7.2
	El-Waye	95	34 (35.8)	9 (9.5)	18.8	<0.001	5.3	4.2–11.9
	Taltale	67	25 (37.3)	6 (9.0)	15.2	<0.001	6.1	2.3–15.9
	Dubuluk	62	23 (37.1)	3 (4.8)	19.5	<0.001	11.6	3.3–40.9
	Haro-bake	73	23 (31.5)	6 (8.2)	12.4	<0.001	5.1	1.9–13.5
χ^2			2.8	1.57				
p-value			0.54	0.8				
Age	2–5 years	99	27 (27.3)	7 (7.1)	14.2	<0.001	4.9	2.0–11.9
	>5 years	285	100 (35.1)	26 (9.1)	55.8	<0.001	5.4	3.4–8.6
χ^2			2.03	0.39				
p-value			0.15	0.53				
Body condition	Good	202	60 (29.7)	6 (3.0)	52.8	<0.001	13.0	5.8–32.8
	Medium	116	35 (30.2)	15 (12.9)	10.4	0.001	2.9	1.5–5.7
	Poor	66	32 (48.5)	12 (18.2)	13.6	<0.001	4.2	4.2–9.3
χ^2			8.56	18.6				
p-value			0.014 ^a	<0.001				
Total		384	128 (33.3)	33 (8.6)	70.9	<0.001	5.3	3.5–8.1

^a The χ^2 for the prevalence of a metacestodes within risk factor

^b The χ^2 for the association between *CE* and *C. bovis* in a studied category.

Table 2Univariate and multivariate logistic regression analysis animal body condition associated with *metacestodes*.

<i>Metacestodes</i>	Animals body condition	No. of Examined animals	No. (%) positive	Univariate logistic regression analysis			Multivariate logistic regression analysis		
				OR	OR 95% CI	p-value	OR	OR 95% CI	p-value
EC	Good	202	60 (29.7)	1*			1*		
	Medium	116	35 (30.2)	1.02	0.62–1.68	0.93	0.99	0.60–1.65	0.987
	Poor	66	32 (48.5)	2.22	1.26–3.94	< 0.001	2.25	1.25–4.02	0.006
<i>C. bovis</i>	Good	202	6 (3.0)	1*			1*		
	Medium	116	15 (12.9)	4.85	1.83–12.88	0.002	4.92	1.84–13.14	0.001
	Poor	66	12 (18.2)	7.26	2.60–20.23	< 0.001	8.35	2.93–23.75	< 0.001

Note: OR = Odds Ratio; CI = Confidence Interval; 1* is Reference.

Out of 384 examined cattle, 32.8% were infected only by *CE* but 8.1% were infected only by *C. bovis*. Concurrent infections were observed in 2 (0.5%) of the infected animals (Table 3). The concurrent infections were observed in poor body conditioned animals (3.03%).

3.2. Organs and tissue distribution of metacestodes

Anatomical based organs and tissue distributions of cystic metacestodes were shown in Table 4. Of the total 384 examined animals, organs and tissue level cyst prevalence of 319 (83.1%) *CE* and 102 (26.6%) *C. bovis* were observed. The highest proportions of *CE* were observed on the lungs (42.7%) followed by liver (32.8%) and kidneys (5.2%). Regarding *C. bovis*, the highest and equal proportions [28 (7.3%)] were observed in each of the triceps muscle and the masseter muscle followed by heart 14 (3.64%), diaphragm muscles (3.4%), tongue (3.1%) and liver (1.8%) during the study period. Concurrent infections were observed in heart and liver.

3.3. Fertility and viability of metacestodes

In total, 347 *CE* cysts were counted in the positive animals. The majorities of *CE* [118 (34.0%)] were fertile and 80 (23.1%) were viable. Few, 59 (17.0%) and 52 (14.9%) were sterile and calcified respectively (Table 5).

A total of 102 *C. bovis* cysts were counted in infected animals. Of the total, 31 (30.4%) viable, 60 (58.8%) non-viable and 11 (10.78%) calcified cysts were observed (Table 6).

3.4. Financial losses due to organs and tissue condemnation

Financial losses from condemned organs and tissue due to metacestodes during the study period were 301,139.6 ETB (11,155.52 USD) (Table 7). The beef losses accounted for the most (129,210.00 ETB) followed by liver condemnation loss (112,712.00 ETB).

4. Discussion

Bovine metacestodes have impacts on livestock and also have a zoonotic and socio-economic significance. It has been reported to be wide spread and a common disease in Africa (FAO, 2005). Ethiopia also shares the problem of parasitism on livestock production systems in the tropics. The present 8.6% bovine cysticercosis prevalence was similar with the 8.6% at Halaba Kulito Town, South Ethiopia (Hirpha et al., 2016), 8.8% in Addis Ababa (Nigatu et al., 2008), 7.5% in Wolaita Soddo Municipal Abattoir (Ashenafi,

Table 3Proportion of animal with single or mixed infection by metacestodes (*CE* and *C. bovis*) at Yabello Municipal Abattoir.

Risk factory	Categories	No. of examined animal	Positive for <i>CE</i> only	Positive for <i>C. bovis</i> only	Positive for <i>CE</i> and <i>C. bovis</i>
			No. (%)	No. (%)	No. (%)
Animal origin	Yabello	87	23 (26.44)	9 (10.3)	0 (0.0)
	El-Waye	95	33 (34.7)	8 (8.4)	1 (1.05)
	Taltale	67	25 (37.3)	6 (9.0)	0 (0.0)
	Dubuluk	62	23 (37.1)	3 (4.8)	0 (0.0)
	Haro-bake	73	22 (30.1)	5 (6.9)	1 (1.4)
Age	2–5 years	99	27 (27.3)	7 (7.07)	0 (0.0)
	>5 years	285	98 (34.4)	24 (8.42)	2 (0.7)
Body condition	Good	202	60 (29.7)	6 (3.0)	0 (0.0)
	Medium	116	35 (30.2)	15 (12.9)	0 (0.0)
	Poor	66	30 (45.45)	10 (15.15)	2 (3.03)
Total		384	126 (32.8)	31 (8.1)	2 (0.5)

Table 4

Organ and tissue distribution of metacestodes among infected animals at Yabello Municipal Abattoir.

Organs	Number (%) positive for metacestodes (n = 384)	
	CE	<i>Cysticercus bovis</i>
Lungs	164 (42.7)	0
Spleen	6 (1.6)	0
Kidney	5 (1.3)	0
Heart	8 (2.1)	14 (3.6)
Liver	126 (32.8)	7 (1.8)
Masseter muscle	0	28 (7.3)
Tongue	0	12 (3.1)
Diaphragm muscle	0	13 (3.4)
Triceps muscles	0	28 (7.3)
Total	319 (83.1)	102 (26.6)

2013), 6.7% in Wolaita Sodo (Endris and Negussie, 2011) and 11.3% in Kombolcha (Regassa et al., 2009). The present finding was slightly greater than the 2.6% (Addisu and Wondimu, 2015), 3.6% (Tolosa et al., 2009) and 2.93% (Gomol et al., 2011), 2.59% (Dawit et al., 2012) and 3.6% (Nuradis and Frew, 2012), 3.2% (Tembo, 2001) reports from different parts of Ethiopia. Conversely current finding was lower than the 26.25% (Abunna et al., 2008), 18.49% (Nigatu, 2008) and 17.5% (Hailu, 2005) reports from various parts of Ethiopia. Such wide distributed prevalence might be due to poor personal and environmental hygiene (inappropriate use of toilet the area), insufficient method and quality of meat inspection, free grazing management of animals, technical experience and diligence of meat inspector and other risk factors may have contributed for the change of bovine metacestodes prevalence. Like wises, the current 33.3% bovine hydatidosis was similar with the 32.12% in Bahir Dar (Gesses, 1991), 33.6% at Mekelle (Kassahun, 2008), and 31.44% in Jimma (Getachew et al., 2017) towns of Ethiopia. However, it was lower than the 36.6% in Bahir Dar (Tigist, 2009), 54.8% in Assela (Regassa, 1990) and 48.9% in Debre Markos (Nigatu et al., 2009) and 62.96% in Bale Robe (Wubet, 1988) towns of Ethiopia. On the other hand, current study showed higher prevalence than the 8.4% in Shashemene town (Moje et al., 2014). This occurrence of bovine hydatidosis in pastoral community whose are under movement with their dogs, the improper disposal of infected offal's in none-sedentary area and possible involvement of wild carnivores could leads to wide spread of the diseases in the area.

Observing similar prevalence of the *C. bovis* as well as *CE* within age groups and origins of the positive animals indicated similar exposure risk under mixed grazing system in the area. Similar conditions were reported in Wolayta Sodd (Ataro and Tamirat, 2017), in eastern Shoa (Hailu, 2005) and in central Ethiopia (Tembo, 2001). These indicated equal exposure of the animals to contaminated field and the wide spread of the diseases in free range grazing areas of Ethiopia. With regards to animal body condition score, the prevalence of metacestodes were high in poor [48.5% for *CE* and 18.2% for *C. bovis*] than in other risk factors. Theses could be due to the causal effects of the diseases manifested by high cyst burden [84.4% for *CE* and 26.6% for *C. bovis*] in infected animals. Polydorous (Polydorous, 1981) explained that in moderate to severe infections, the parasite may cause retarded performance and growth, reduced quality and yield of meat and milk as well as live weight loss. The present finding indicts significantly higher prevalence of *CE* than *C. bovis* ($p < 0.05$) showing the ubiquitous and cosmopolitan properties of *CE* in the area. This could be due to biological multiple protoscolices per cyst of a *CE* which increases probability of survival and infections of both the intermediate and definitive hosts. But, biological presence of single protoscolice per a cyst of *C. bovis* might account to the lower occurrences in the area than *CE*.

The wider organ and tissues distribution of the metacestodes in this finding indicates the diseases are affecting multiple physiological system of infected animals resulted in hindering anabolic (tissue building) mechanism with the outcome of poor performance. This suggestion is concomitant with the higher prevalence of *CE* and *C. bovis* in poor body conditioned animals. Similar suggestions were given (Gracey and Collins, 1992; Scandrett et al., 2009; Paniker, 2002). Dissemination of the oncosphere (hexacanth embryo) of echinococcosis and *Teania saginata* via circulatory systems of infected susceptible host (Soulsby, 1982; Taylor et al., 2007) resulted in the attachment in the respective organs and tissue. The presence of high fertility *CE* (51.5%) and *C. bovis* (30.4%) in infected organs and tissues in this study indicates high chances of maintained the lifecycle of the diseases in the area. The nomadic pastoral farming system characterized by free animal movement with improper disposal of infected organs

Table 5Fertility and viability of *CE* obtained from different organs at Yabello Municipal Abattoir.

Organs	No. of cyst collected and tested	No. (%) of Hydatid cyst by type				
		Fertile	Sterile	Viable	Non-viable	Calcified
Liver	137	38 (27.7)	28 (20.4)	22 (11.1)	16 (11.7)	33 (24.1)
Lungs	189	71 (37.6)	28 (14.8)	51 (26.9)	20 (10.6)	19 (10.1)
Kidney	5	2 (40.0)	1 (20.0)	2 (40.0)	0	0
Heart	8	4 (50.0)	0	3 (37.5)	1 (12.5)	0
Spleen	8	3 (37.5)	2 (25.0)	2 (25.0)	1 (12.5)	0
Total	347	118 (34.0)	59 (17.0)	80 (23.1)	38 (10.9)	52 (14.9)

Table 6Viability of *C. bovis* cyst obtained from different organs and tissues of the study animals.

Organs	No of cyst examined	No. (%)		
		Viable ^a	Non-viable	Calcified
Tongue	12	3 (25.0)	9 (75.0)	0
Masseter muscle	28	8 (28.6)	18 (64.3)	2 (7.1)
Heart	14	3 (21.4)	8 (57.14)	3 (21.4)
Triceps	28	10 (35.7)	15 (53.5)	3 (10.7)
Diaphragm muscles	13	3 (23.0)	8 (61.5)	2 (15.4)
Liver	7	4 (57.0)	2 (28.57)	1 (14.3)
Total	102	31 (30.4)	60 (58.8)	11 (10.8)

^a All fertile cysts were found viable.

and tissue followed by the chance of consumption of such tissue by definitive host (canine for *CE*) could maintain the diseases in the area. Poor environmental hygiene with free area defecation could attribute to the risk of circulation of *C. bovis*. Arene (Arene, 1985) suggested the variation in fertility, sterility and calcification of the strain of zoonotic metacestodes.

The current 301,139.6ETB (11,155.52USD) estimated financial losses from these zoonotic metacestodes at Yabello Municipal Abattoir during the study period indicates the significance of the diseases in the area. Financial losses from *CE*, *C. bovis* and *Taenia saginata* contributed to serious economic problems in the endemic areas due to meat and organ condemnation, down grading of carcasses (Wanzala et al., 2003; Fan, 1997), cost of human treatment and hampering food of security and safety (Tegegne et al., 2018; Abunna, 2013; Tolossa et al., 2015). At Kombolcha, a total of 1,841,311.00ETB (73,652.44 USD) economic losses from *C. bovis* and teaniasis treatment (Tegegne et al., 2018) were reported in Ethiopia.

5. Conclusions and recommendations

The present finding indicated the occurrence zoonotic metacestodes (*CE* and bovine cysticercosis) in cattle with also possible presence of co-infection in positive animals originated from different locations in Borana. The occurrences of significantly higher *CE* than *C. bovis* were observed within studied categories of risk factors. Besides their animal health risk, these metacestodes attributed meaningful financial losses from organ and carcass condemnation in connection with public health risk. Following the Borana community Oromo Gada System (Legesse, 1973), leaders and elders focused awareness creation program on the parasitic epidemiology and control strategies should be launched in the area. Butchers, abattoir workers, meat sellers and dog owners in the area shall also implement parasitic lifecycle breaking the control and prevention methods.

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Conflict of interest

Authors declare that they have no conflict of interest.

Human and animal rights, and informed consent.

This article does not contain any studies with human. But, ethical clearance was issued from College of Veterinary Medicine, Haramaya University research ethical committee for study performed on animal subjects.

Table 7

Percentage of organ and tissue condemned and the concomitant with financial losses at Yabello Municipal Abattoir.

Condemned organ	No. (%) organ condemned	Average price ETB	Annual loss money (ETB) ^a
Tongue	10 (2.6)	20	3796.00
Lungs	74 (19.3)	30	42,267.00
Liver	74 (19.3)	80	112,712.00
Kidney	17 (4.4)	10	3212.00
Spleen	7 (1.8)	15	1971.00
Heart	14 (3.64)	30	7971.60
1 kg of beef	34 (8.85)	200	129,210.00
Total	230 (60.0)	385	301,139.60

^a 1USD = 27 Ethiopian Birr (ETB) in average during the study period.

References

- Abunna, F., 2012. Study on the Prevalence of Bovine Cysticercosis in Hawassa Municipal Abattoir and *T. Saginata* in Hawassa Town and its surrounding South Ethiopia. M.Sc Thesis, FVM, AAU, Debre Zeit, Ethiopia.
- Abunna, F., 2013. Prevalence, organ distribution, viability and socioeconomic implication of bovine cysticercosis/taeniasis, Ethiopia. Rev. Médecin Vétér. Tropicaux 66 (1), 25–30.
- Abunna, F., Tilahun, G., Megerssa, B., Regassa, A., Kumsa, B., 2008. Bovine cysticercosis in cattle slaughtered at Hawassa municipal abattoir Ethiopia: prevalence, cyst viability and distribution and public health implication. Zoonoses Public Health 55, 82–88. <https://doi.org/10.1111/j.1863-2378.2007.01091.x>.
- Addisu, D., Wondimu, D., 2015. Prevalence of *Taenia Saginata*/Cysticercosis and Community Knowledge about Zoonotic Cestodes in and around Batu. DVM Thesis, College of Veterinary Medicine and Agriculture, Department of Microbiology, AAU, Debre Zeit, Ethiopia.
- Arena, F., 1985. Prevalence of hydatidosis in domestic livestock in Nigeria. Delta Tropical Animal Health Production 17 (1), 3–4.
- Ashenafi, M., 2013. Prevalence of Bovine Cysticercosis and Hydatidosis in Wolaita Soddo Municipal Abattoir. Southern Ethiopia. M.Sc Thesis, AAU.
- Ataro, A., Tamirat, T., 2017. Study on prevalence and cyst characterization of Hydatidosis in cattle slaughtered at Wolaita Soddo municipal abattoir. Int. J. Res.-Granthaalayah 5 (7), 60–78. <https://doi.org/10.5281/zenodo.827202>.
- Budke, C.M., Deplazes, P., Torgerson, P.R., 2006. Global socioeconomic impact of cystic echinococcosis. Emerg. Infect. Dis. 12, 296–303. <https://doi.org/10.3201/eid1202.050499>.
- Cabaret, J., Geerts, S., Madeline, M., Ballandonne, C., Barbier, D., 2002. The use of urban sewage sludge on pastures: the Cysticercosis threat. Vet. Res. 33, 575–597. <https://doi.org/10.1051/vetres:2002040>.
- Coppock, D., 1994. The Borana Plateau of Southern Ethiopia: Synthesis of Pastoral Research, Development and Changes 1980–1990. International Livestock Center for Africa, Addis Ababa, Ethiopia.
- CSA. Federal Democratic Republic of Ethiopia Central statistical Agency (CSA). Livestock and livestock characteristics, 2017; Vol. 2.
- Dawit, S., 2004. Epidemiology of *Taenia Saginata* Taeniasis and Cysticercosis in North Gondar Zone, Northwestern Ethiopia. DVM Thesis. Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia.
- Dawit, T., Tewodros, S., Tilaye, D., 2012. Public health and economic significance of bovine cysticercosis in Wolaita Soddo, Southern Ethiopia. Glob. Vet. 9, 557–563. <https://doi.org/10.5829/idosi.gv.2012.9.5.6547>.
- Eddi, C., Nari, A., Amanfu, W., 2003. *Taenia solium* cysticercosis/taeniosis: potential linkage with FAO activities; FAO support possibilities. Acta Trop. 87, 145–148. [https://doi.org/10.1016/S0001-706X\(03\)00037-8](https://doi.org/10.1016/S0001-706X(03)00037-8).
- Endris, J., Negussie, H., 2011. Bovine cysticercosis: prevalence, cyst viability and distribution in cattle slaughtered at Kombolcha ELFORA meat factory, Ethiopia. Am. Eurasian J. Agric. Environ. Sci. 11, 173–176.
- Fan, P.C., 1997. Annual economic loss caused by *T. Saginata* taeniasis in East Asia. Parasitol. Today 13, 194–195.
- FAO. Food and Agriculture Organization of United nations, Government of Democratic republic of Ethiopia: support to partnership for African Development and comprehensive African Agriculture Program. Food and Agriculture Organization (FAO), 2005.
- FAO/UNEP/WHO. Guidelines for echinococcosis or hydatidosis surveillance, prevention and control. FAO. Rome, 1982; 29: 147.
- Gesses, N., 1991. Study of Hydatidosis or Echinococcosis in Cattle Slaughtered at Bahir Dar Municipality Abattoir. DVM thesis, FVM, AAU, Debre Zeit, Ethiopia.
- Getachew, T., Olani, W., Sadia, H., 2017. Prevalence and economic significance of bovine hydatidosis and cysticercosis in Mekelle municipality abattoir, northern Ethiopia. Open Access J. Vet. Sci. Res Inst. 2 (3), 2474–9222.
- Getaw A, Beyene D, Ayana D, Megersa B, Abunna F. Hydatidosis: Prevalence and its economic importance in ruminants slaughtered at Adama Municipal Abattoir, Central Oromia, of Ethiopia. Acta Tropica, 2010; 113: 221–225. <https://doi.org/10.1016/j.actatropica.2009.10.019>.
- Gomol, T., Achnef, M., Basazenuw, B., Mersha, C., 2011. Cyst viability, body site distribution and public health 414 significance of bovine cysticercosis at Jimma, South West Ethiopia. Glob. Vet. 7, 164–168.
- Gracey FJ, Collins SD. Meat Hygiene: 5th Edn. Billiere. Tindal, 24–28 Oval Road, London, 1992; p. 413–420.
- Hailu D. Prevalence and Risk Factors for *T. Saginata* Cysticercosis in three selected areas of Eastern Shoa. M.Sc Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia; 2005.
- Hiko, A., Ibrahim, H., Agga, G.E., 2018. Abattoir based survey of bovine cystic echinococcosis in selected commercial abattoir in Ethiopia. J. Vet. Sci. Technol. 9, 527. <https://doi.org/10.4172/2157-7579.1000527>.
- Hirpha, A., Bekele, T., Melaku, 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 J. Agri. Sci. 12 (4), 299–307. <https://doi.org/10.5829/idosi.wjas.2016.12.4.23762>.
- ILCA, 1993. A Handbook of African Livestock Statistics. Addis Ababa, Ethiopia.
- Issa, A., 1990. Bovine Cysticercosis in Animals Slaughtered at Nekemte Abattoir. Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia, DVM Thesis.
- Jibat, T., Ejeta, G., Asfaw, Y., Wudie, A., 2008. Cause of abattoir condemnation in apparently healthy slaughtered sheep and goat at Helmex Abattoir Debre Zeit, Ethiopia. Revue Medicine Veterinaire. 5, 305–311.
- Jobre, Y., Lobago, L., Tiruneh, R., Abebe, G., Dorchie, P., 1996. Hydatidosis in three selected regions in Ethiopia an assessment trial on its prevalence, economic and public health importance. Rev. Med. Vet. 143, 797–804.
- Kassahun B. Prevalence and economic significance of cystic hydatidosis in cattle slaughtered at Mekelle Municipality abattoir. DVM, thesis. FVM, MU, Mekelle, Ethiopia, 2008.
- Kebede, W., Hagos, A., Girma, Z., Lobago, F., 2009. Echinococcosis/hydatidosis: its prevalence, economic and public health significance in Tigray region, North Ethiopia. Trop. Anim. Health Prod. 41, 865–871. <https://doi.org/10.1007/s11250-008-9264-9>.
- Legesse, A., 1973. Gada: Three Approaches to the Study of African Society. Free Press, New York.
- Lemma, B., Abera, T., Urga, B., Niguse, N., Agonafir, A., 2014. Prevalence of bovine hydatidosis and its economic significance in Harar municipality abattoir, eastern Ethiopia. Emerg. J. Sci. Res. 9, 143–149. <https://doi.org/10.5829/idosi.ajejr.2014.9.5.9144>.
- Macpherson, C., Zihale, E., Roaming, T., 1985. An echinococcosis plot control program for Northwest Turkana, Kenya. Ann. Trop. Med. Parasitol. 78, 188–192.
- MOA. Meat Inspection Regulations. Legal notice No. 428 Negarit Gazeta. Minister of Agriculture (MOA), Addis Ababa, Ethiopia, 1972.
- Moje, N., Zewde, Z., Bacha, Z., Regassa, A., 2014. Metacestodes in cattle slaughtered at Shashemene municipal abattoir, southern Ethiopia: prevalence, cyst viability, organ distribution and financial losses. Glob. Vet. 12 (1), 129–139. <https://doi.org/10.5829/idosi.gv.2014.12.01.8119>.
- Nicholson M, Butterworth M. A guide to condition scoring of zebu cattle. International livestock Centre for Africa. Addis Ababa, 1986; p. 1–50.
- Nigatu K. *C. bovis*: Development and evaluation of serological tests and prevalence at Addis Ababa Abattoir. M.Sc Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia; 2004.
- Nigatu K. Cysticercosis of slaughtered cattle in northwestern Ethiopia. Research Veterinaria Science, 2008; 85: 522–526. <https://doi.org/10.1016/j.rvsc.2008.01.009>.
- Nigatu, K., Tilahun, G., Hailu, A., 2008. Current status of bovine cysticercosis of slaughtered cattle in Addis Ababa abattoir, Ethiopia. Trop. Anim. Health Prod. 41, 291–294. <https://doi.org/10.1007/s11250-008-9188-4>.
- Nigatu, K., Abuhay, A., Tilahun, G., Wossene, A., 2009. Financial loss estimation, prevalence and characterization of hydatidosis of cattle slaughtered at Debre Markos municipality abattoir, Ethiopia. Trop. Anim. Health Prod. 41, 1787–1789.
- Nuradis, I., Frew, Z., 2012. Prevalence of *Taenia Saginata* Cysticercosis in cattle slaughtered in Addis Ababa municipal abattoir, Ethiopia. Glob. Vet. 8, 467–471.
- Ogunrinade, A., Ogunrinade, B.I., 1980. Economic importance of bovine fasciolosis in Nigeria. Trop. Anim. Health Prod. 12, 155–160.
- Paniker CKJ. Cyclophyllidean Tapeworm: Text books of medical parasitology, 5th Edn, tape the Brothers Medical Publisher, 2002; p. 133–136.
- Polydorous, K., 1981. Animal health and economics case study: echinococcosis with reference to Cyprus. Bull. Int. Epiz. 93 (5), 981–992.
- Regassa, A., 1990. The Prevalence of Hydatidosis in Cattle, Sheep, Goats and *Echinococcus granulosus* in Dogs in Arsi Administrative Region. Addis Ababa University, Debre Zeit, Ethiopia, DVM thesis.

- Regassa, A., Abunna, F., Mulugeta, A., Megersa, B., 2009. Major metacestodes in cattle slaughtered at Wolaita Soddo municipal abattoir, southern Ethiopia: prevalence, cyst viability, organ distribution and socioeconomic implications. *Trop. Anim. Health Prod.* 41, 1495–1502. <https://doi.org/10.1007/s11250-009-9338-3>.
- Regassa, F., Molla, A., Bekele, J., 2010. Study on the prevalence of cystic hydatidosis and its economic significance in cattle slaughtered at Hawassa municipal abattoir. *Trop. Anim. Health Prod.* 42, 977–984. <https://doi.org/10.1007/s11250-009-9517-2>.
- Scandrett, B., Parker, S., Forbes, L., Gajadhar, A., Dekumyoy, P., Weikagul, J., Haines, D., 2009. Distribution of *Taenia saginata* cysticerci in tissues of experimentally infected cattle. *Vet. Parasitol.* 164, 223–231. <https://doi.org/10.1016/j.vetpar.2009.05.015>.
- Soulsby E.J.L. Helminths, arthropods and protozoa of domesticated Animals, 7th Edn., Lea and Tebiger, Philadelphia, PA, 1982; p. 119–127.
- Tamene M. A Preliminary study on Echinococcosis/Hydatidosis of livestock (Cattle, sheep and goats) in Gondar Administrative Region. DVM. Thesis, Faculty of Veterinary Medicine, Addis Ababa University, 1986; p. 286.
- Taylor, M.A., Coop, R.L., Wall, R.L., 2007. *Veterinary Parasitology*. 3rd edn. Blackwell publishing Ltd, Oxford, UK.
- Tegegne A, Hiko A, Elemo KK. Bovine cysticercosis and human taeniasis: Animal–human health and economic approach with treatment trends in Kombolcha Town, Wollo, Ethiopia. *Int J One Health*, 2018; 4: 15–21. doi: 10.14202/IJOH.2018.15-21.
- Tembo A. Epidemiology of *T. saginata* taeniasis/cysticercosis in three selected agro-climatic zones in central highland of Ethiopia (Unpublished MSc. Thesis), Addis Ababa University, Debre Zeit, Ethiopia; 2001.
- Thrusfield M. *Veterinary Epidemiology*. Blackwell Science, Singapore/3rd Edn. 2005; p. 233.
- Tigist, N., 2009. *Prevalence and Economic Importance of Bovine Hydatidosis in Bahir Dar Municipal Abattoir*. School of Veterinary Medicine, Jimma University, Jimma, Ethiopia, DVM thesis.
- Tolosa, T., Tigre, W., Teku, G., Dorny, P., 2009. *Prevalence of bovine cysticercosis and Hydatidosis in Jimma municipal abattoir, Southwest Ethiopia*. *Onderstepoort J. Vet. Res.* 76, 323–326.
- Tolossa, Y.H., Taha, A., Terefe, G., Jibat, T., 2015. Bovine cysticercosis and human taeniasis in Adama town, Oromia region, Ethiopia. *J. Vet. Sci. Technol.* S10, 003. <https://doi.org/10.4172/2157-7579.S10-003>.
- Urguhart GM, Armour J, Duncan JL, Dunn AM, Jenning FW. *Veterinary parasitology* 2nd Edn. London, Blackwell Science, 1996; p. 120–137.
- Wanzala W, Onyango-Abuje JA, Kang'ethe EK, Zessin KH, Kyule NM, Baumann MPO, Ochanda H, Harrison LJS. Analysis of postmortem diagnosis of Bovine cysticercosis in Kenyan cattle. *Onl. Journal. Veterinary Research*, 2003; 1(1–9): 28–31. URI:<http://hdl.handle.net/123456789/6439>.
- Wubet, S., 1988. *Prevalence of Cattle Hydatidosis and its Economic Significance in Bale Robe Municipal Abattoir*. Faculty of Veterinary Medicine Addis Ababa University, Debre Zeit, Ethiopia, DVM thesis.