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

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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 (Gabaret 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.
in its intermediate hosts (cattle, shoat 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 taenidical drugs for human treatment were estimated (Tegegne et al., 2018) 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 taenidical 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 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 “Ganna” 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, heart 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 (Polydorous, 1981). Then the, 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 (Polydorous, 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. bovies were the sum of direct (DL) and indirect (IDL) losses.

\[
\begin{align*}
\text{Annual cost of offal condemned} &= (\text{CSR} \times \text{PHLu} \times \text{CPLu}) + (\text{CSR} \times \text{PHLi} \times \text{CPLi}) + (\text{CSR} \times \text{PHHe} \times \text{CPHe}) + (\text{CSR} \times \text{PHKi} \times \text{CPhKi}) \\
&+ (\text{CSR} \times \text{PHSp} \times \text{CPSp}) \\
\text{Annual cost of carcass weight losses} &= 5\% \times \text{CSR} \times \text{PH} \times \text{PC} \times \text{CP} \times 126 \text{ kg}.
\end{align*}
\]

Where: \( \text{CSR} \) = Average number of cattle slaughtered per year = 7300; \( \text{PHLu} \) = Percentage of lung condemned = 19.3%; \( \text{CPLu} \) = Mean cost of one bovine lung in Yabello = 80Birr; \( \text{PHLi} \) = Percentage of liver condemned = 19.3%; \( \text{CPLi} \) = Mean cost of one bovine liver in Yabello = 10bir; \( \text{PHHe} \) = Percentage of heart condemned = 3.64%; \( \text{CPHe} \) = Mean cost of one bovine heart in Yabello = 30Birr; \( \text{PHKi} \) = Percentage of kidney condemned = 4.4%; \( \text{CPhKi} \) = Mean cost of one bovine kidney in Yabello = 10bir; \( \text{PHSp} \) = Percentage of spleen condemned = 1.8%; \( \text{CPSp} \) = Mean cost of one bovine spleen in Yabello = 30 birr; \( \text{PC} \) = Price of carcass weight losses (ETB/kg) = 720 ETB/kg; \( \text{CP} \) = Percentage of direct (DL) losses = 5%.
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 ($\chi^2$) was calculated to assess significance of prevalence of both metacestodes in the studied risk factors. The difference in prevalence of hydatid cyst and C. bovis was 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 Stats 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% CI: 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 frequency (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 = 4.22, 95% CI: 1.26, 5.80) and poor body conditions (OR = 3.26, 95% CI: 1.57, 6.78) were observed. Significantly higher C. bovis in medium body conditions (0.001) and in poor body conditions (<0.001) than in good body condition 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 | Significances of CE over C. bovis |
|-----------------------|-------------|----------------------|----------------------|----------------------------------|
|                       |             | CE                   | C. bovis             | $\chi^2$ $p$-value OR 95% CI      |
| Origin of animal      | Yabello     | 87                   | 23 (26.4)            | 9 (10.3)                         | 7.5 $p$-value 0.006 3.11 1.4–7.2 |
|                       | El-Waye     | 95                   | 34 (35.8)            | 9 (9.5)                          | 18.8 $p$-value <0.001 5.3 4.2–11.9 |
|                       | Taitale     | 67                   | 25 (37.3)            | 6 (9.0)                          | 15.2 $p$-value <0.001 6.1 2.3–15.9 |
|                       | Dubuluk     | 62                   | 23 (37.1)            | 3 (4.8)                          | 19.5 $p$-value <0.001 11.6 3.3–40.9 |
|                       | Haro-bake   | 73                   | 23 (31.5)            | 6 (8.2)                          | 12.4 $p$-value <0.001 5.1 1.9–13.5 |
| $\chi^2$ p-value      |             |                      |                      | 2.8 1.57                         |                             |
| Age                   | 2–5 years   | 99                   | 27 (27.3)            | 7 (7.1)                          | 14.2 $p$-value <0.001 4.9 2.0–11.9 |
|                       | >5 years    | 285                  | 100 (35.1)           | 26 (9.1)                         | 55.8 $p$-value <0.001 5.4 3.4–8.6 |
| $\chi^2$ p-value      |             |                      |                      | 2.03 0.39                        |                             |
| Body condition        | Good        | 202                  | 60 (29.7)            | 6 (3.0)                          | 52.8 $p$-value <0.001 13.0 5.8–32.8 |
|                       | Medium      | 116                  | 35 (30.2)            | 15 (12.9)                        | 10.4 $p$-value 0.001 2.9 1.5–5.7 |
|                       | Poor        | 66                   | 32 (48.5)            | 12 (18.2)                        | 13.6 $p$-value <0.001 4.2 4.2–9.3 |
| $\chi^2$ p-value      |             |                      |                      | 8.56 18.6                        |                             |
| Total                 |             | 384                  | 128 (33.3)           | 33 (8.6)                         | 70.9 $p$-value <0.001 5.3 3.5–8.1 |

$^a$ The $\chi^2$ for the prevalence of a metacestodes within risk factor

$^b$ The $\chi^2$ for the association between CE and C. bovis in a studied category.
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 (Ashena, 2016).
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higher prevalence of
mance and growth, reduced quality and yield of meat and milk as well as live weight loss. The present animals. Polydorous (Polydorous, 1981) explained that in moderate to severe infections, the parasite may cause retarded perfor-

could be due to the causal effects of the diseases manifested by high cyst burden [84.4% for

fi

2017), in eastern Shoa (Hailu, 2005) and in central Ethiopia (Tembo, 2001). These indicated equal exposure of the animals to con-

fi

similar exposure risk under mixed grazing system in the area. Similar conditions were reported in Wolayta Soddo (Ataro and Tamirat,

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

in Bale Robe (Wubet, 1988) towns of Ethiopia. On the other hand, current study showed higher prevalence than the 8.4% in

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%

Mekelle (Kassahun, 2008), and 31.44% in Jimma (Getachew et al., 2017) towns of Ethiopia. However, it was lower than the

prevalance. 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%

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and diligence of meat inspector and other risk factors may have contributed for the change of bovine metacestodes

use of toilet the area), insuf

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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 vari-

ous 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 grezing management of animals, technical experi-

ence and diligence of meat inspector and other risk factors may have contributed for the change of bovine metacestodes

Prevalence of metacestodes among infected animals in different age groups and origins.

The wider organ and tissues distribution of the metacestodes in this finding indicates the diseases are affecting multiple phys-

iological system of infected susceptible host (Soulsby, 1982; 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 4
Organ and tissue distribution of metacestodes among infected animals at Yabello Municipal Abattoir.

| Organs          | Number (%) positive for metacestodes (n = 384) |
|-----------------|----------------------------------------------|
| Lungs           | 164 (42.7)                                   |
| Spleen          | 6 (1.6)                                      |
| Kidney          | 5 (1.3)                                      |
| Heart           | 8 (2.1)                                      |
| Liver           | 126 (32.8)                                   |
| Masseter muscle | 0 (0)                                        |
| Tongue          | 1 (0.3)                                      |
| Diaphragm muscle| 2 (0.5)                                      |
| Triceps muscles | 0 (0)                                        |
| Total           | 319 (83.1)                                   |

Table 5
Fertility 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) | 50 (17.0) | 80 (23.1) | 38 (10.9) | 52 (14.9) |
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 ([Arena, 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 theses 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 teaniais 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, theses metacestodes attributed meaningful finial 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.

| Condemned organ | No. (%) organ condemned | Average price ETB | Annual loss money (ETB)* |
|------------------|-------------------------|------------------|-------------------------|
| 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 (3.6)                | 30               | 7971.60                 |
| 1 kg of beef     | 34 (8.85)               | 200              | 129,210.00              |
| Total            | 230 (60.0)              | 385              | 301,139.60              |

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