Major parasitic causes of edible offal condemnation and financial loss estimation in slaughtered cattle at Butajira municipal abattoir, Southern Ethiopia

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Abstract: A cross-sectional study was conducted in Butajira municipal abattoir from November 2013 to April 2014 to determine the major parasitic causes of edible offal condemnation and estimate the associated annual economic losses. A total of 1120 randomly selected male cattle were subjected to standard antemortem and postmortem examination. Chi-square statistic and comparison of proportions were used to analyse the data. From the total organs inspected, 426 (38.04%) livers, 268 (23.93%) lungs, 31 (2.77%) hearts and 13 (1.16%) kidneys were infected by one or more parasites and totally condemned as unfit for human consumption. Of the major parasitic diseases, fasciolosis alone caused 228 (20.36%) livers rejection, and together with hydatidosis, it was responsible for the rejection of 44 (3.93%) livers. Hydatidosis caused the rejection of 258 (23.04%) lungs. Cysticercosis was also responsible for the condemnation of a significant proportion of liver (6.16%), and a few hearts (1.34%) and lungs (0.89%) were also rejected due to cysticercosis. The association between the age of the animals and the frequency of organ condemnation was statistically significant (p = 0.002). However, organ condemnation rates did not show any statistically significant difference (p > 0.05) between origins and among body condition score of slaughtered animals. The total annual direct financial loss due to edible organ condemnation was estimated to be 99,182.47 ETB per year. In conclusion, the results of the current study revealed that the main causes of organ condemnation that lead to huge economic losses were fasciolosis and hydatidosis. Therefore, appropriate control and preventive measures should be taken so as to minimize the public health and financial impacts of the diseases.

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PUBLIC INTEREST STATEMENT

Parasitic diseases are responsible for huge economic losses across the developing world. They lead to death of animals, reduction in carcass weight and condemnation of carcass and other edible organs. Parasites are also responsible for human illness. Therefore, studying the status of parasitic diseases is of paramount importance for designing and implementing appropriate control and prevention strategies.
1. Introduction
Meat provides the needed animal proteins to the population. Therefore, it should be free from diseases particularly of zoonotic importance such as, among others, tuberculosis, cysticercosis and hydatidosis. Abattoirs provide the opportunity for detecting diseases of both economic and public health importance (Roji et al., 2010). Antemortem inspection is performed to prevent the introduction of clinically diseased animal into the slaughterhouse and provides information that will be instrumental in performing sound postmortem inspection. The postmortem inspection is important in detecting and eliminating abnormalities, including contaminations in order to ensure the consumers obtain healthy and wholesome meat (Fosse et al., 2008; Gracey et al., 1999; Thomas-Bachli et al., 2014).

The principal causes of organ condemnation during postmortem inspection are diseases caused by parasites, bacteria and virus. Parasitism is one of the major bottlenecks to livestock development in the tropics and Ethiopia. Parasitic infections not only cause clinical diseases and mortalities but also cause economic losses through reduction in weight gain, loss of meat and milk, reduction in working power and condemnation of specific organs at slaughterhouses (Berhe et al., 2010; Bulcha et al., 2014; Kassai, 1999; Swai & Ulicky, 2009).

Among many parasitic problems of farm animals, fasciolosis and hydatidosis have been reported to cause huge direct and indirect economic losses in Ethiopia (Berhe et al., 2010; Bulcha et al., 2014; Fromsa & Jobre, 2012; Kebede et al., 2009) and elsewhere in the world (Mungube et al., 2006; Swai & Ulicky, 2009; Wadood, 2005). However, there is no report on the status of parasitic diseases and the associated economic impact in Butajira municipal abattoir. Therefore, the objectives of this study were to determine the major parasitic causes of edible offal condemnation and to estimate the direct annual financial loss incurred due to edible offal condemnation in male cattle slaughtered at Butajira municipal abattoir.

2. Materials and methods

2.1. Study area
The study was conducted in Butajira municipality abattoir from November 2013 to April 2014. Butajira is located about 130 km South of Addis Ababa and is found in Guraghe Zone, Southern Nations Nationalities and Peoples (SNNP), the regional State of Ethiopia. Butajira is located at latitude 8.12”N and longitude 38.38”E. The climate varies from arid dry lowland areas at altitudes around 1,500 m to cool mountainous areas up to 3,500 m above mean sea level. The average annual rainfall of the area is 945 mm. The area has maximum and minimum temperatures of 10.0°C and 26.3°C, respectively. The cattle population of SNNP is about 11,883,548 (Byass et al., 2010; CSA, 2018; Woyessa et al., 2012).

2.2. Study population
The animals included in the current study were male indigenous cattle. The animals were brought from different localities to the Butajira municipal abattoir for slaughter. The present study included a total of 1120 randomly selected male cattle. Only 7 female cattle were slaughtered during the study periods; as a result, they were excluded from the study so as to avoid discrepancy in statistical analysis of the data.

2.3. Study design and data collection
A cross-sectional study was conducted to determine the major parasitic causes of edible offal condemnation and to estimate the direct annual financial loss incurred due to offal condemnation.
in cattle slaughtered at the abattoir. The study animals were selected using simple random sampling technique. Four days visits were made per week to the abattoir until the end of the study periods. During each visit, animals were randomly selected for antemortem and postmortem examinations until the sample size reached 1120. The age, origin and body condition score of each animal were recorded during antemortem examination. The age of the animal was estimated based on the dentition formula and conventionally categorized as young and adult (Pace & Wakeman, 2003). The body condition scoring was based on the criteria set by Richard (1993), which ranged from 3 to 5 as there was no animal slaughtered with body condition score 0–2. The origin of the study animals was determined during interview with owners of the animals and categorized as from highland and lowland areas based on altitudinal differences. All animals included in the study were physically observed before slaughter when they are in the lairage. Pre-slaughter inspection was performed for any obvious signs of the disease while animals were at rest or in motion. During postmortem examination, livers, lungs, hearts and kidneys were thoroughly inspected through visual inspection, palpation and incision of suspected organs for the presence of parasites.

2.4. Assessment of direct economic loss
Annual economic loss due to offal condemnation was determined by considering the annual slaughter rate of cattle in the abattoir and average local retail prices of healthy organs and the rejection rates of specific organs. Annual slaughter rate was determined from retrospective abattoir records from 2011 to 2013. The average market price of each organ was determined from interviews made with the abattoir personnel and butchers. The economic loss due to organ condemnation was estimated by the formula set by Ogunrinade and Ogunrinade (1980), as follows:

\[
EL = Srx \times Coy \times Roz,
\]

Where:

- \( EL \) = Estimated annual economic loss due to organ condemnation
- \( Srx \) = Average annual cattle slaughter rate of the abattoir
- \( Coy \) = Average cost of each cattle liver/lungs/kidneys/heart
- \( Roz \) = Average condemnation rate of cattle liver/lungs/kidneys/heart

2.5. Data analysis
The data were entered and managed in a Microsoft Excel spreadsheet and analyzed using STATA-11.0. Descriptive statistics were applied to summarize the data and expressed as frequency and percentage. Chi-square (\( \chi^2 \)) test was used to determine the degree of association between different risk factors and organ rejection rates. Univariate logistic regression analysis was conducted for the variable with a \( \chi^2 > 3.84 \) and p-value <0.05 to quantify the degree of association between risk factors and organ rejection rates and expressed as odds ratio (OR) and 95% CI. For all analyses, a p-value of less than 0.05 was considered as statistically significant.

3. Results
From the total organs inspected, 426 (38.04%) livers, 268 (23.93%) lungs, 31 (2.77%) hearts and 13 (1.16%) kidneys were infected by one or more parasites and totally condemned as unfit for human consumption. Of the major parasitic diseases, fasciolosis alone caused 228 (20.36%) liver rejections, while hydatidosis caused 258 (23.04%) lungs rejection. Fasciolosis together with hydatidosis was responsible for the rejection of 44 (3.93%) livers. Cysticercosis was also responsible for the condemnation of significant proportion of liver (6.16%), and a few hearts (15) and lungs (10) were also rejected due to cysticercosis (Table 1).
### Table 1. Summary of the major parasitic causes and the financial loss associated with organ condemnation at Butajira municipal abattoir

| Organ     | Causes                        | No. organ condemned (%) | Financial loss (ETB) |
|-----------|-------------------------------|-------------------------|---------------------|
| Liver     | Fasciolosis                   | 228(20.36)              | 35,670.72           |
|           | Hydatidosis                   | 85(7.59)                | 13,297.68           |
|           | Fasciolosis & Hydatidosis     | 44(3.93)                | 6885.36             |
|           | Cysticercosis                 | 69(6.16)                | 10,792.32           |
| Total     |                               | 426(38.04)              | 66,646.08           |
| Lungs     | Hydatidosis                   | 258(23.04)              | 26,910.72           |
|           | Cysticercosis                 | 10(0.89)                | 1039.52             |
| Total     |                               | 268(23.93)              | 27,950.24           |
| Heart     | Hydatidosis                   | 16(1.43)                | 2087.80             |
|           | Cysticercosis                 | 15(1.34)                | 1956.40             |
| Total     |                               | 31(2.77)                | 4044.20             |
| Kidneys   | Cysticercosis                 | 4(0.36)                 | 168.19              |
|           | Hydatidosis                   | 9(0.80)                 | 373.76              |
| Total     |                               | 13(1.16)                | 541.95              |

### 3.1. Liver condemnation

Fasciolosis alone was found to be the principal cause of liver rejection in slaughtered animals from both highland (54.05%) and lowland (53.47%) areas. Hydatidosis alone also caused rejection of a significant proportion of livers brought in from both highland (23.42%) and lowland (15.35%) areas. In combination with hydatidosis, fasciolosis resulted in the condemnation of 8.56% and 12.38% livers of animals that originated from highland and lowland areas, respectively. Association of liver rejection rate with origin of slaughtered animals was not seemed to be statistically significant ($\chi^2 = 6.5443$, $p = 0.088$). Of the encountered major parasitic diseases (fasciolosis, hydatidosis, fasciolosis and hydatidosis, and cysticercosis), 48.61%, 18.06%, 9.72% and 23.61% were from animals with body condition score 3 and 57.40%, 17.49%, 9.42% and 15.70% were from body condition score 4 animals while 50%, 24.62%, 12.31% and 13.08% were from animals with body condition 5, respectively. However, the association between body condition score of slaughtered animals and the rate of liver rejection was not statistically significant ($\chi^2 = 7.4339$, $p = 0.283$) (Table 2).

### 3.2. Lung condemnation

Hydatidosis was the principal cause of lung rejection in both highland (95%) and lowland (98.15%) animals. Furthermore, it also caused condemnation of a significant proportion of lungs from body condition score three (96.92%), four (95.21%) and five (98.15%) animals. Cysticercosis also caused a total of 10 (3.73%) lungs condemnation. The associations between lung rejection rate and origin ($\chi^2 = 1.7790$, $p = 0.182$) and body condition score ($\chi^2 = 1.1571$, $p = 0.561$) of slaughtered animals were not statistically significant (Table 3).

### 3.3. Organ condemnation based on age categories

Based on the two age categories, 92.86% and 65.11% of organs were totally condemned from young and adult animals, respectively. The liver was the most frequently rejected organ from both young (53.57%) and adult (37.64%) animals. No parasitic disease was encountered in kidneys of young animals, but 3.57% of the heart was rejected due to parasitic disease. The second most affected and rejected organ in adult animals was the lung (23.63%) followed by the heart (2.75%). The association between age and frequency of organ condemnation was statistically significant ($\chi^2 = 9.3405$, $p = 0.002$). The odds of organ rejection due to parasitic disease was 6.97 times in young animals (OR = 6.97, $p = 0.002$) than adult counterparts (Table 4).
3.4. Assessment of direct financial loss

The annual direct economic loss incurred due to organ condemnation at Butajira municipal abattoir was estimated by taking the average annual cattle slaughtered of 5840 cattle at the abattoir and average market price of 30, 20, 8 and 25 Ethiopian Birr (ETB), respectively, for liver, lungs, kidneys and heart at Butajira town. Therefore, the total annual direct financial loss was estimated to be 99,182.47 ETB per year (Table 1).

4. Discussion

The major parasitic causes of edible offal condemnation identified in this study were fasciolosis, hydatidosis and cysticercosis. A similar finding was reported in different abattoirs by other workers in Ethiopia (Gondar; Mesele et al., 2012; Adigrat; Assefa & Tesfay, 2013; Gimbi; Bulcha et al., 2014).

Table 2. Association of liver rejection rate with origin and body condition score of slaughtered animals at Butajira municipal abattoir

| Parasitic diseases     | No. liver condemned (%) Highland | Lowland | Total            | \( \chi^2 \) (p-value) |
|------------------------|---------------------------------|---------|-----------------|------------------------|
| Fasciolosis            | 120(54.05)                      | 108(53.47) | 228(18.81)      | 6.5443(0.088)          |
| Hydatidosis            | 52(23.42)                       | 31(15.35)  | 83(19.58)       |                        |
| Fasciolosis & hydatidosis | 25(12.38)                   | 31(13.96)  | 44(10.38)       |                        |
| Cysticercosis          | 19(8.56)                        | 38(18.81)  | 69(16.27)       |                        |
| Total                  | 222(100)                        | 202(100)  | 424(100)        |                        |

\( BSC = \) Body condition score

Table 3. Association of lung rejection rate with origin and body condition score of slaughtered animals at Butajira municipal abattoir

| Parasitic diseases     | No. lungs condemned (%) Highland | Lowland | Total            | \( \chi^2 \) (p-value) |
|------------------------|---------------------------------|---------|-----------------|------------------------|
| Hydatidosis            | 152(95.00)                      | 106(98.15) | 258(96.27)      | 1.7790(0.182)          |
| Cysticercosis          | 8(5.00)                         | 2(1.85)  | 10(3.73)        |                        |
| Total                  | 160(100)                        | 108(100)  | 268(100)        |                        |

\( BSC = \) Body condition score
This study indicated that fasciolosis was the major cause of liver condemnation. It was responsible for 272 (24.29%) livers rejection. Data for liver rejection due to fasciolosis are in agreement with the 24.24% reported in Wolaita Soddo municipality abattoir, Ethiopia (Abunna & Hordofa, 2013) and 23.41% reported in Zaria abattoir, Nigeria (Raji et al., 2010). However, Fekadu et al. (2012) reported a higher rate (46.7%) of liver condemnation due to fasciolosis in Jimma municipal abattoir, Ethiopia, while Assefa and Tesfay (2013) reported a lower rate (9.26%) at the Adigrat municipal abattoir, Ethiopia. The differences in liver rejection rates due to fasciolosis in different areas might be attributed to the fact that the prevalence of fasciolosis varies in different geographical locations (Hussien et al., 2015).

The present study showed that hydatid cysts were the major cause of lung rejection (23.04%) followed by the liver (11.52%), heart (1.43%) and kidney (0.80%). This data is in agreement with the findings of Fekadu et al. (2012), Abunna and Hordofa (2013), Sheferaw and Abdu (2017), and Abatemam et al. (2018). This might be justified by the fact that livers and lungs are the first capillary beds encountered by the migrating Echinococcus oncosphere (hexacanth embryo) via the portal vein route before any other peripheral organs (Banda et al., 2013).

In addition, Cysticercus bovis was found to cause rejection of liver (6.16%), lung (0.89%), heart (1.34%) and kidney (0.36%). Assefa and Tesfay (2013) also reported cysticercosis as the cause of liver (2.55%) and heart (0.27%) rejection. Similarly, Abay and Kumar (2013) reported rejection of liver (6.74%), heart (0.39%) and lung (0.29%) due to cysticercosis in Mekelle municipal abattoir. The predilection sites for cysticerci are the heart, tongue, masseter muscles, shoulder muscles and diaphragm as they receive the greatest blood (Abay & Kumar, 2013). Nevertheless, all parts of the carcasses except for rumen, fat layers, spleen and skin were equally important as predilection sites for cysticerci (Wanzala et al., 2003).

Statistical analysis of the data did not show any significant difference between organ rejection rates due to parasitosis and body condition score and origin of slaughtered cattle (p > 0.05). Similar conditions were reported in Nekemte municipal abattoir (Efrem et al., 2015) and in Dale Wabera district municipal abattoir (Bayou & Taddesse, 2018). This might indicate that animals are equally exposed to contaminated field and parasitic diseases are widespread in free range grazing areas of Ethiopia (Beyene & Hiko, 2019). Age of slaughtered animals, however, seemed to affect the frequency of organ condemnation (p < 0.05). Organs from young animals were 6.97 times (OR = 6.97; p = 0.002) more likely to be rejected due to parasitic diseases than adult counterparts. Higher prevalence in young animals might be associated with the lack of generation of acquired

| Age         | No. slaug. Animals | No. organ condemned (%) | Total | χ²(p-value) OR (95% CI) |
|-------------|--------------------|-------------------------|-------|------------------------|
|             |                    | Liver | Lungs | Heart | Kidneys |       |       |
| Young Adult | 28                 | 1092 | 15(53.57) | 10(35.71) | 1(3.57) | 0(0.00) | 411(37.64) | 258 (23.63) | 30(2.75) | 12 (1.10) |
|             |                    | Liver | Lungs | Heart | Kidneys |       |       |
|             | 0.646             | 0.01  | 0.00         |       |       |       |
|             | 26(92.86)         | 711(65.11) |       | 6.97 | (1.6446–29.5082) | 9.3405(0.002) | 1 |
| Total       | 1120              | 426(38.04) | 268 (23.93) | 31(2.77) | 12 (1.07) | 737(65.80) |       |       |

No. slaug = Number of slaughtered, 1 = reference category.
immunity in young animals, while, adult animals develop short-term acquired immunity that protects the animals (Khan et al., 2010; Urquhart et al., 1996).

The total direct economic loss incurred due to the condemnation of organs because of parasitic infections in Butajira municipal abattoir was 99,182.47 ETB. Similar economic loss analysis by Mesele et al. (2012) showed annual economic loss of 8,373,383.00 ETB at Gondar ELFORA abattoir. Another report in cattle slaughtered at Jimma municipal abattoir revealed an estimated annual economic loss of 153,346.00 ETB (Fekadu et al., 2012). Similarly, Bulcha et al. (2014) reported annual economic loss of 76,002 ETB at Gimbi municipal abattoir due to parasitic diseases.

In conclusion, the present, as well as previous studies, indicated that parasitic diseases have very important economic and public health impacts in Ethiopia. Hence, appropriate control and prevention strategies to the country should be designed and implemented so as to minimize the public health impact and financial losses associated with diseases.

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