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Prevalence and causes of liver condemnation and its economic significance in cattle slaughtered at Bishoftu municipal abattoir, Central Ethiopia

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Abstract

Liver condemnation at abattoirs represents a significant economic burden and an indicator of underlying animal health challenges affecting the livestock sector across Sub-Saharan Africa. This research was conducted to determine the prevalence, identify the major causes, and estimate the economic significance of liver condemnation in cattle slaughtered at Bishoftu municipal abattoir, Central Ethiopia, from October 2022 to September 2023. A cross-sectional research design was employed, during which a total of 768 cattle were examined through systematic random sampling. Ante-mortem and post-mortem inspections were performed following standard procedures recommended by the Food and Agriculture Organization. The overall prevalence of liver condemnation was 42.3% (325/768). Fasciolosis was the leading cause of liver condemnation, accounting for 32.4% (105/325) of condemned livers, followed by hydatidosis at 24.8% (81/325), hepatic abscess at 15.3% (50/325), calcification at 11.7% (38/325), cirrhosis at 9.2% (30/325), and melanosis at 6.6% (21/325). Statistically significant associations were observed between liver condemnation and age ($p < 0.001$), body condition score ($p = 0.003$), and origin of animals ($p = 0.012$). The total annual economic loss attributed to liver condemnation was estimated at 1,245,680 Ethiopian Birr (approximately 22,648 USD). Older cattle with poor body condition scores exhibited significantly higher rates of liver condemnation compared to younger animals in good body condition. These findings underscore the need for strategic deworming programs, improved livestock management practices, and enhanced meat inspection services to reduce the prevalence of liver condemnation and its associated economic losses in the region.

Keywords: Liver condemnation, cattle, abattoir, *Fasciola hepatica*, hydatidosis, economic loss, meat inspection, Bishoftu, prevalence, Ethiopia

Introduction

What proportion of bovine livers processed at municipal abattoirs across Sub-Saharan Africa are deemed unfit for human consumption, and what are the primary pathological conditions driving these losses? This fundamental question has attracted increasing attention from veterinary researchers and public health professionals as organ condemnation continues to impose substantial economic burdens on livestock-dependent communities throughout the continent. The liver, being one of the most frequently consumed ofal products in many African cultures, holds significant nutritional and commercial value, making its condemnation a matter of considerable economic concern for farmers, butchers, and consumers alike.

Bovine liver condemnation during post-mortem inspection at slaughterhouses is primarily attributed to a range of parasitic, bacterial, and pathological conditions that render the organ unsuitable for human consumption. Among these, fasciolosis caused by *Fasciola hepatica* and *Fasciola gigantica* remains the most prevalent cause of liver condemnation in tropical and subtropical regions, where the environmental conditions favor the survival and transmission of the intermediate snail hosts. Hydatidosis, caused by the larval stage of *Echinococcus granulosus*, constitutes another major cause of hepatic condemnation, particularly in areas where close contact between humans, domestic dogs, and livestock facilitates the maintenance of the parasite life cycle. Ethiopia, with an estimated cattle population exceeding 70 million head, possesses one of the largest livestock populations on the African continent. Despite this substantial livestock resource, the country faces significant challenges related to animal health, Meat quality assurance, and food safety standards at municipal abattoirs. Previous investigations conducted at various abattoirs across the country have reported liver condemnation rates ranging from 25% to 55%,

With parasitic infections consistently identified as the predominant cause of organ rejection during routine meat inspection procedures.

The economic implications of liver condemnation extend beyond the immediate financial loss to individual farmers and butchers. Condemned organs represent wasted animal protein resources that could otherwise contribute to addressing nutritional deficiencies and food security challenges prevalent in many developing nations. Furthermore, the high prevalence of conditions leading to liver condemnation, particularly fasciolosis and hydatidosis, reflects broader deficiencies in livestock disease prevention and control programs, veterinary service delivery, and public health infrastructure.

The Bishoftu area in Central Ethiopia serves as a significant livestock trading hub, with its municipal abattoir processing a substantial number of cattle daily for both local consumption and regional distribution. Despite the economic importance of the Bishoftu abattoir, comprehensive data on the prevalence, causes, and economic impact of liver condemnation at this facility remain limited. Previous research conducted at this abattoir has focused primarily on overall organ condemnation rates without providing detailed analysis specific to hepatic pathology and its financial consequences.

This research was therefore designed to determine the prevalence of liver condemnation in cattle slaughtered at Bishoftu municipal abattoir, identify the major pathological causes of liver rejection, assess the association between liver condemnation and various risk factors including age, sex, body condition score, and origin of animals, and estimate the direct economic losses attributable to liver condemnation during the research period.

Material and Methods

Material

The research was conducted at Bishoftu municipal abattoir located in Bishoftu town, Oromia Regional State, Central Ethiopia, situated approximately 47 kilometers southeast of Addis Ababa at an altitude of 1,920 meters above sea level. The area receives an average annual rainfall of 866 millimeters with a bimodal pattern, and the mean annual temperature ranges from 12.3 °C to 27.7 °C. The abattoir processes an average of 45 to 60 cattle per day, sourced primarily from surrounding districts and major livestock markets in the region. Ethical clearance for the research was obtained from the Institutional Review Board of Bishoftu Institute of Veterinary Sciences (Protocol Number: BIVS/IRC/2022-038), and permission to conduct the research at the abattoir was granted by the Bishoftu Town Administration Agricultural Office.

Methods

A cross-sectional research design was employed from October 2022 to September 2023, covering a complete twelve-month period to account for seasonal variations. The sample size was determined using the formula for estimating a single population proportion, with an expected prevalence of 40% based on previous reports, a 95% confidence interval, and a 5% absolute precision, yielding a minimum required sample size of 369 animals. To increase precision and account for potential data losses, a total of 768 cattle were included in the research through

systematic random sampling, where every third animal entering the slaughter line was selected for detailed examination.

Ante-mortem inspection was performed on each selected animal in the lairage area prior to slaughter, during which the animal identification number, estimated age based on dentition, sex, body condition score assessed on a scale of 1 to 5, and origin were recorded on a standardized data collection form. Body condition scoring followed the methodology described by Nicholson and Buterworth for zebu cattle. Animals were categorized into three age groups: young (less than 5 years), adult (5 to 8 years), and old (greater than 8 years).

Post-mortem examination of the liver was conducted following the procedures outlined by the Food and Agriculture Organization guidelines for meat inspection in developing countries. Each liver was subjected to detailed visual inspection, palpation, and systematic incision along the bile ducts and parenchyma. Pathological lesions were identified and categorized according to their gross morphological characteristics. Liver flukes were identified to species level based on their morphological features, while hydatid cysts were classified as fertile, infertile, or calcified based on cyst content examination. The decision to condemn or approve each liver was made by the abattoir veterinary inspector based on national meat inspection regulations.

Economic loss estimation was calculated using the formula

Annual economic loss = (Number of condemned livers per year × Average weight of a single liver × Average local market price per kilogram of liver). The average liver weight was determined by weighing 50 randomly selected livers using a calibrated digital scale, and the current retail market price of bovine liver in Bishoftu was obtained through market surveys conducted at three local markets during the research period.

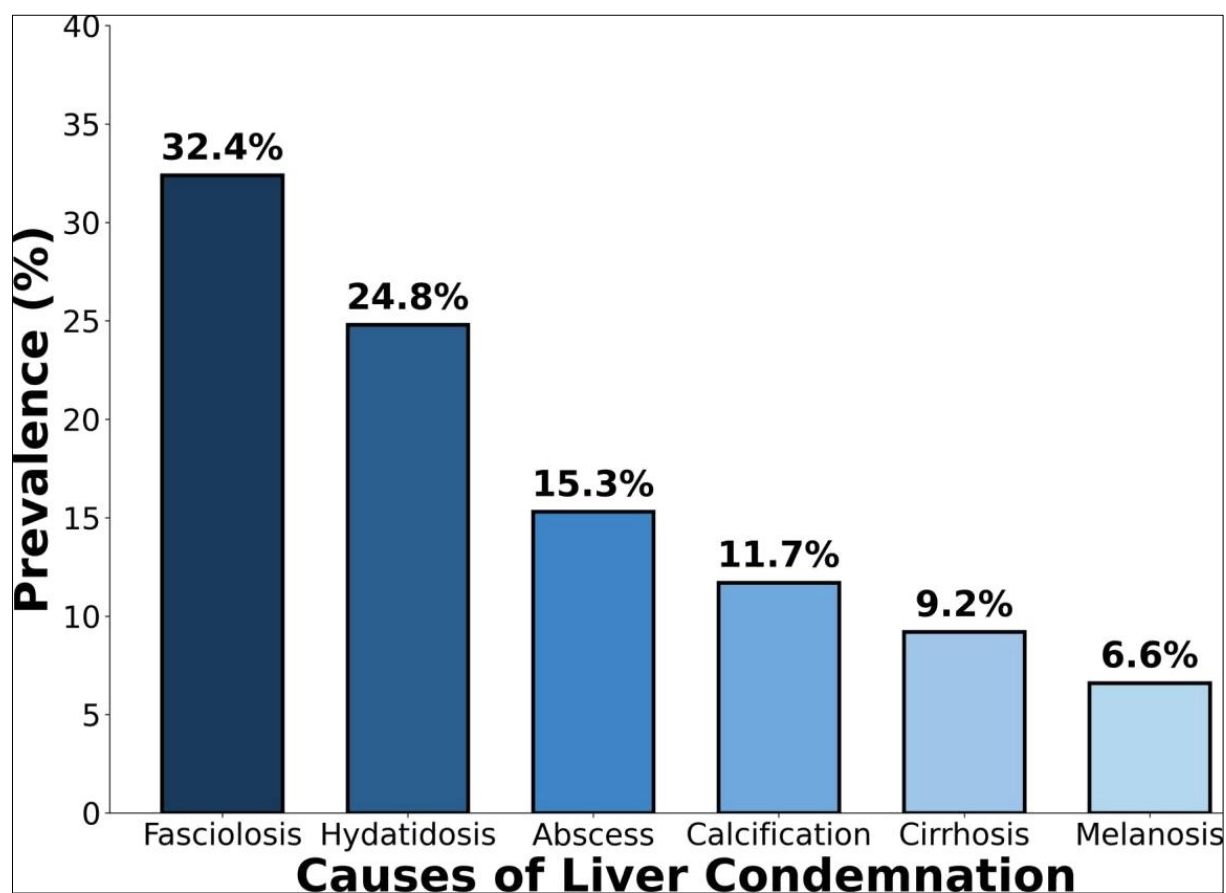
Data were entered into Microsoft Excel spreadsheet and analyzed using SPSS version 26.0 statistical software. Descriptive statistics including frequencies, percentages, and means were calculated. Chi-square tests were used to assess associations between liver condemnation and categorical risk factors. Logistic regression analysis was performed to identify independent predictors of liver condemnation. A *p*-value of less than 0.05 was considered statistically significant for all analyses.

Results

Of the 768 cattle examined during the twelve-month research period, 325 animals had their livers condemned during post-mortem inspection, yielding an overall liver condemnation prevalence of 42.3% (95% CI: 38.8%–45.8%). Male cattle exhibited a higher liver condemnation rate of 44.8% compared to 38.6% in females, although this difference was not statistically significant (*p* = 0.087). The prevalence of liver condemnation varied significantly across age groups, with old cattle (greater than 8 years) showing the highest condemnation rate of 56.2%, followed by adult cattle (5 to 8 years) at 42.8%, and young cattle (less than 5 years) at 28.4% ($\chi^2 = 34.72$, *p* < 0.001). Animals with poor body condition scores demonstrated a significantly higher liver condemnation rate of 58.4% compared to 41.2% in medium condition and 27.6% in good condition animals ($\chi^2 = 38.91$, *p* < 0.001).

Table 1: Prevalence of liver condemnation in cattle by risk factors at Bishoftu municipal abattoir

Risk Factor	Category	Examined	Condemned (%)	χ^2	p-value
Sex	Male	482	216 (44.8)	2.94	0.087
	Female	286	109 (38.6)		
Age	Young (<5 yr)	218	62 (28.4)	34.72	<0.001*
	Adult (5-8 yr)	312	134 (42.8)		
	Old (>8 yr)	238	129 (56.2)		
BCS	Poor	185	108 (58.4)	38.91	<0.001*
	Medium	348	143 (41.2)		
	Good	235	65 (27.6)		
Origin	Highland	312	148 (47.4)	6.28	0.012*
	Midland	268	108 (40.3)		
	Lowland	188	69 (36.7)		

**Fig 1:** Prevalence of major causes of liver condemnation in cattle at Bishoftu municipal abattoir

The distribution of pathological causes of liver condemnation revealed that fasciolosis was the most prevalent cause, accounting for 32.4% (105/325) of all condemned livers. *Fasciola hepatica* was identified in 62.9% of fasciolosis cases, while *Fasciola gigantica* accounted for 28.6% and mixed infections comprised 8.5%. Hydatidosis was the second most

common cause at 24.8% (81/325), with the majority of hydatid cysts found in the right lobe of the liver. Hepatic abscess contributed 15.3% (50/325) of condemnations, calcification accounted for 11.7% (38/325), cirrhosis for 9.2% (30/325), and melanosis for 6.6% (21/325).

Table 2: Distribution of liver condemnation causes across age groups and body condition scores

Cause	Young (%)	Adult (%)	Old (%)	Poor BCS (%)	Good BCS (%)
Fasciolosis	18.5	33.6	42.8	45.2	15.4
Hydatidosis	22.6	25.4	26.1	28.7	18.2
Abscess	19.4	14.2	13.8	12.5	20.6
Calcification	8.1	12.7	13.2	8.4	16.8
Cirrhosis	3.2	8.9	14.5	15.2	4.6
Melanosis	6.5	5.2	8.4	3.8	10.2

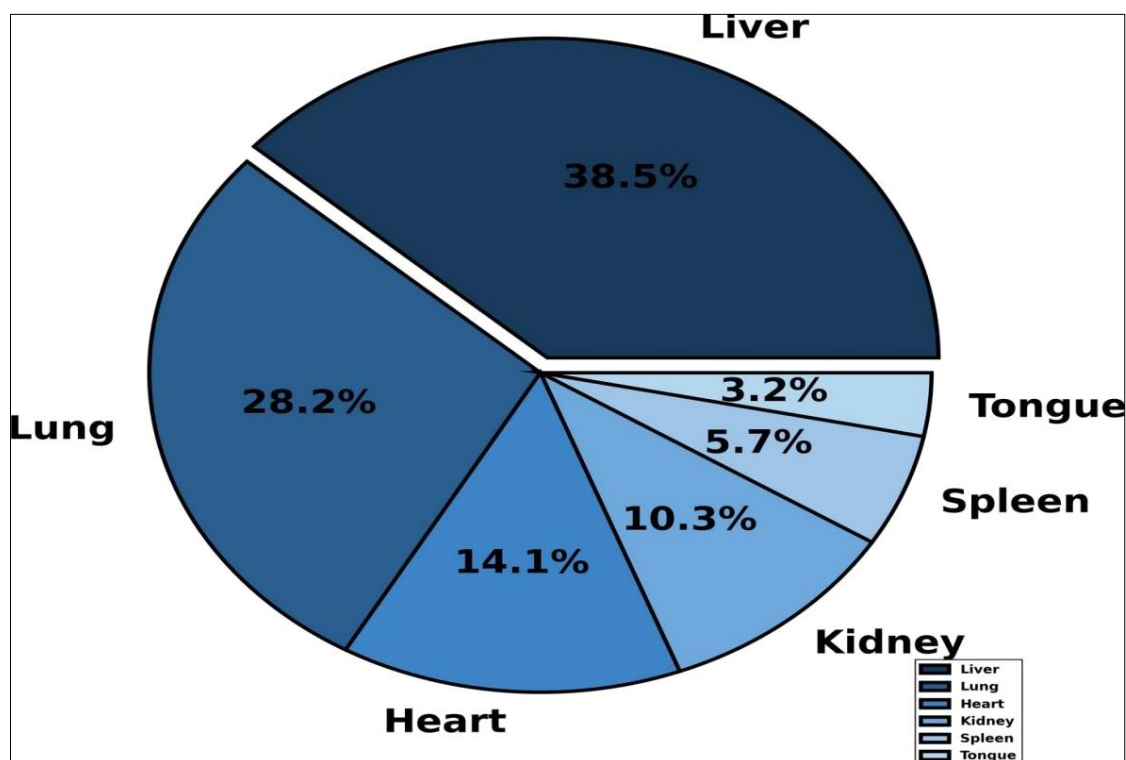


Fig 2: Proportional distribution of condemned organs in cattle at Bishoftu municipal abattoir

Among all organs examined, the liver accounted for the highest proportion of condemnations at 38.5%, followed by the lung at 28.2%, heart at 14.1%, kidney at 10.3%, spleen at 5.7%, and

tongue at 3.2%. The data clearly demonstrate that the liver is the organ most frequently rejected during post-mortem inspection at Bishoftu municipal abattoir.



Fig 3: Correlation between age of cattle and liver condemnation rate at Bishoftu municipal abattoir

A statistically significant positive correlation was observed between the age of cattle and the liver condemnation rate ($r=0.78$, $p<0.001$), indicating that older animals were substantially more likely to have their livers condemned during post-mortem inspection. This relationship is consistent with the cumulative nature of parasitic infections and chronic

pathological conditions that progressively damage the hepatic parenchyma over time. Logistic regression analysis confirmed that age (OR = 2.34, 95% CI: 1.82–3.01, $p<0.001$) and body condition score (OR=1.98, 95% CI: 1.45–2.71, $p<0.001$) were independent predictors of liver condemnation.

Discussion

The overall liver condemnation prevalence of 42.3% recorded in this research represents a substantial proportion of cattle processed at Bishoftu municipal abattoir having their livers deemed unfit for human consumption. This finding is comparable to the 38.7% reported by Regassa and colleagues at Hawassa municipal abattoir in southern Ethiopia [3] and the 45.1% documented by Bekele and Butako at Wolayta Sodo municipal abattoir [7]. However, the current prevalence is notably higher than the 28.4% reported at Gondar ELFORA abattoir [12] and lower than the 52.6% recorded at Jimma municipal abattoir [4]. These variations may be attributed to differences in agro-ecological conditions, livestock management practices, the effectiveness of veterinary services, and the level of awareness among livestock owners regarding preventive health measures across different regions of Ethiopia.

The predominance of fasciolosis as the leading cause of liver condemnation, accounting for 32.4% of condemned livers, aligns with numerous previous investigations conducted across Ethiopian abattoirs. The favorable environmental conditions in the Bishoftu area, characterized by adequate rainfall and the presence of marshy grazing lands that support populations of *Lymnaea* snail intermediate hosts, contribute to the sustained transmission of liver flukes in the region. The higher prevalence of *Fasciola hepatica* compared to *Fasciola gigantica* is consistent with the altitude of the research area, as *Fasciola hepatica* thrives at higher elevations where cooler temperatures favor the development of its intermediate host *Lymnaea truncatula* [5].

Hydatidosis emerged as the second most important cause of liver condemnation at 24.8%, highlighting the persistence of the *Echinococcus granulosus* life cycle in the research area. The maintenance of this parasite cycle is facilitated by the widespread practice of feeding raw offal to domestic dogs, the presence of stray dog populations in proximity to abattoirs, and the inadequate disposal of condemned organs at many slaughter facilities across the country. These findings underscore the critical importance of implementing comprehensive one-health approaches that address both animal and human health components to break the transmission cycle of this zoonotic parasite [10].

The statistically significant association between liver condemnation and age of cattle observed in this research is biologically plausible and consistent with findings from other abattoir surveys conducted in the region. Older animals have longer exposure periods to parasitic infections and are more likely to accumulate chronic hepatic lesions over their lifetime. Furthermore, the significant association with body condition score suggests that animals in poor nutritional status may have compromised immune responses, making them more susceptible to parasitic infections and less capable of limiting the pathological consequences of hepatic parasitism [14].

The significantly higher liver condemnation rate observed in cattle originating from highland areas compared to midland and lowland areas may reflect differences in grazing management practices and exposure to fluke-infested pastures. Highland areas in Ethiopia are characterized by extensive waterlogged grazing lands during the rainy season, providing ideal habitats for the snail intermediate hosts of liver flukes. This geographical variation in liver condemnation rates has important implications for targeting disease control interventions to high-risk areas where the economic impact is most pronounced.

Public Health Implications

The high prevalence of liver condemnation due to parasitic causes at Bishoftu municipal abattoir raises significant public health concerns, particularly regarding the zoonotic potential of fasciolosis and hydatidosis. Human fasciolosis, though often underdiagnosed, has been increasingly recognized as an important food-borne parasitic disease in developing countries, with an estimated 2.4 million people infected worldwide. Hydatid disease remains a major public health challenge in pastoral communities where the close interaction between humans, livestock, and dogs perpetuates the transmission cycle. The condemnation of infected organs during routine meat inspection serves as a critical public health intervention by preventing the consumption of parasitized meat products.

Economic impact assessment

The total annual economic loss attributed to liver condemnation at Bishoftu municipal abattoir was estimated at 1,245,680 Ethiopian Birr (approximately 22,648 USD). This estimate was based on the average weight of condemned livers (4.2 kg), the current retail market price of bovine liver in Bishoftu (180 ETB/kg), and the extrapolated annual number of condemned livers from the research data. Fasciolosis alone accounted for approximately 403,590 ETB of the total loss, followed by hydatidosis at 308,929 ETB. These figures represent direct losses from organ condemnation and do not account for indirect losses associated with reduced animal productivity, weight loss, reproductive impairment, and treatment costs, which collectively may exceed the direct condemnation losses several-fold.

Conclusion

This research aimed to determine the prevalence, causes, and economic significance of liver condemnation in cattle slaughtered at Bishoftu municipal abattoir, Central Ethiopia. The overall liver condemnation prevalence of 42.3% is alarmingly high, with fasciolosis and hydatidosis identified as the two leading causes of hepatic rejection during post-mortem inspection. The estimated annual economic loss of 1,245,680 Ethiopian Birr represents a significant financial burden on the local livestock value chain. Implementation of strategic anthelmintic treatment programs targeting livestock in highland areas during the pre-rainy season, combined with improved abattoir waste disposal practices and public awareness campaigns regarding the zoonotic risks of hydatidosis, are urgently needed to reduce the prevalence of liver condemnation and its associated economic consequences. Future investigations should focus on molecular characterization of *Fasciola* species circulating in the region and evaluation of the cost-effectiveness of various intervention strategies for reducing liver condemnation rates at municipal abattoirs.

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