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A Study on Economic Significance and Prevalence of Bovine Fasciolosis in Addis Ababa Abattoirs Enterprise, Addis Ababa, Ethiopia

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Abstract: A cross-sectional study was conducted to determine the prevalence and economic significance of fasciolosis in cattle slaughtered at Addis Ababa abattoirs enterprise, from November 2019 to April 2020. A total of 500 animals were randomly selected from cattle brought to the abattoir. Retrospective assessment, annte-mortem examinations and post-mortem inspections were performed at the study animals. Out of the total examined animals, 23.4% (117/500) were found positive for *Fasciola* parasites. Two species of *Fasciola*: *Fasciola hepatica* and *Fasciola gigantica* were detected with a prevalence of 14.6% (73/500) and 4.4% (22/500), respectively, mixed infections by both species were 1.4% (7/500) and immature flukes were 3% (15/500) of the total infections. The prevalence of the disease was also determined concerning the body condition score of the sample animals. It was found that 47.76% (32/67) of the lean score animals 23.62% (60/254) of the medium score and 13.96% (25/179) fat animals were positive for *Fasciola* parasites and the difference in prevalence between the three subgroups was statistically significant ($P < 0.05$). However, the prevalence was not significantly ($P>0.05$) affected by age, sex and breed of cattle. The annual direct economic loss due to liver condemnation and the annual indirect economic loss due to carcass weight reduction were estimated to be 349, 237.35 USD (9, 778, 645.89 ETB) and 6, 092, 848.59 USD (170, 599, 760.60 ETB) respectively; hence, the total economic loss due to fasciolosis in cattle slaughtered at Addis Ababa abattoirs enterprise was estimated to be 6, 442, 085.94 USD (180, 378, 406.49 ETB) (Exchange rate 1USD =28 ETB). In conclusion, bovine fasciolosis due to *F. hepatica* and *F. gigantica* was observed to be an economically important disease in Addis Ababa abattoirs enterprise.

Key words: Abattoir · Fasciola · Liver · Postmortem Examination · Prevalence · Economic Loss

INTRODUCTION

In Ethiopia, ruminant livestock is an important source of income for rural communities and is one of the nation's major sources of foreign currency from export. However, this great population was not properly exploited mainly due to prevailing traditional management, limited genetic potential and diseases. Out of the diseases causing a serious problem, parasitism represents a major drawback on livestock production in the tropics [1, 2]. Among the parasitic diseases, fasciolosis is an important parasite that imposes direct and indirect economic losses of livestock particularly, in sheep and cattle. In those animals commonly, the affected organ with this parasite is the liver and subsequently causes organ condemnation [3].

Fasciolosis is an economically important parasitic disease, which is caused by trematodes of the genus *Fasciola* that migrate, in the hepatic parenchyma and established in the bile ducts [4, 5]. *Fasciola* is commonly recognized as liver flukes and they are responsible for widespread morbidity and mortality in cattle characterized by weight loss, anemia and hypo-protonema. The two most important species causing the above-mentioned problems are *Fasciola hepatica* found in temperate and cooler areas of high altitude in the tropics and subtropics while that of *Fasciola gigantica* predominates in tropical areas. *Fasciola hepatica* is found in the area between 1200-2560 m.a.s.l. while *Fasciola gigantica* appears to be the most common species in areas below 1800 m.a.s.l. Both species co-exist in areas with altitude ranging between 1200-1800 m.a.s.l [6].

The snails of the family Lymnaeidae are the main intermediate hosts having a great role in the transmission of the fasciolosis and the infection is acquired through grazing on swampy pasture [4]. The genus *Lymnae natalensis* and *Lymnae truncatula* are known as

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intermediate hosts in the life cycle of *Fasciola*. Infection with *Lymnae truncatula* is usually associated with herds and infection with this species is associated with livestock drinking from snails infected watering places as well as with grazing wetland, which is seasonally dependent [7]. *Fasciola hepatica* is the most important fluke species in Ethiopia livestock with the distribution over three-quarters of the nation except in arid northeastern of Ethiopia. The disease is responsible for considerable economic losses in the cattle industry, mainly through mortality, liver condemnation, reduced production of meat, milk, wool and expenditures for anthelminthic [8, 9].

The worldwide losses in animal productivity due to fasciolosis were estimated at 200 million USD per annum, to rural agricultural communities and commercial producers [10]. With over 600 million animals infected worldwide [11]. In developed counties, the incidence of *F. hepatica* can reach up to 77%. In tropical countries, fasciolosis is considered the single most important helminths infection of cattle, with a reported prevalence of 30-90% [12]. The prevalence of fasciolosis in many parts of Africa has been determined mainly at slaughter. However, estimation of economic loss due to Fasciolosis at the national or regional level is limited by a lack of accurate estimation of the prevalence of the disease [13].

In Ethiopia among many prevalent livestock diseases, parasitism particularly is one of the major entities exerting its direct and indirect effects on the economy of the nation. The two species mentioned above are found in different places of the country. The presence of fasciolosis in Ethiopia has a long history and is responsible for causing considerable losses in livestock production. Its prevalence and economic significance have been reported by several researchers in different parts of the country [4, 14-17]. According to Yilma and Malone [6], varying degrees of *Fasciola hepatica* risk occur in different areas of Ethiopia except in the arid northeast and eastern part of the country.

A review of available literature by Biruk [4] and some other scholars strongly suggests that fasciolosis exists in almost all parts of the country. It is regarded as one of the major setbacks to livestock productivity incurring huge direct and indirect losses in the country. Available published reports have indicated that bovine fasciolosis causes economic losses of roughly 350 million Birr per annum due to decreased productivity alone [18]. More recently, Tadelle *et al*. [19] and Fufa *et al*. [20] have reported financial losses of 6300 USD and 4000 USD per annum, respectively due to liver condemnations at slaughterhouses. Even though different researchers in the country investigate the parasite, specific researches are always needed at a particular site to update the disease status and the most prevalent species. With this, the objective of the current study was to determine the prevalence of fasciolosis and to assess its direct economic impact due to total liver condemnation at the abattoir and its indirect economic loss due to carcass weight reduction in slaughtered cattle at Addis Ababa abattoirs enterprise.

MATERIALS AND METHODS

Study Area: The study was conducted at Addis Ababa abattoirs enterprise. Addis Ababa is the capital city of Ethiopia located in the foothills of Entoto Mountain standing 2, 355 meters above sea level. The city is located at 9°1’48N 38°C 44’24” E/ 9.03 degree N 38.7400 degree east. Addis Ababa has subtropical highland climate zones with temperature differences of up to10 degrees centigrade depending on elevation the city has moderate temperature year-round. During the dry season, the daily maximum is usually not more than 23°C and the night time minimum temperature range between 10-15°C with an average precipitation of 1143 mm.

Study Population: The study population was cattle brought for slaughter from different areas of the country to Addis Ababa abattoirs enterprise. The cattle slaughtered in the abattoir were collected from different parts of the country, which is characterized by widely varying climate-ecological conditions mainly due to altitudinal differences.

Study Design: Cross-sectional study design was used to examine the prevalence of bovine fasciolosis for those positive cases from November 2019 to April 2020 in Addis Ababa abattoir enterprise.

Sample Size and Sampling Technique: A systematic random sampling technique was used daily to identify the study animals for inspection during the study period. The sample size was calculated using the formula given by Thrusfield [21] with an expected prevalence of 20.3 which was reported by Kassaye *et al.* [22] at the study area.

$$N = \frac{1.96^2 * P_{\exp}(1 - P_{exp})}{d^2}$$

where,

N = required sample size
Z = reliability coefficient (1.96)
P_{exp} = expected prevalence
D = desired absolute precision
Hence, d=0.05 and p= 0.203(20.3%)

According to above, formula a minimum of 249 samples was supposed to be collected. However, to increase the precision, 500 animals were sampled.

Method of Examination

Ante Mortem Examination: A list of the animals to be slaughtered, from which study animals were selected, was prepared while the animals were kept in lairage. Information regarding sex, age, breed and body condition of the study animals were recorded during the antemortem examination. Body condition was scored following the guidelines set by Nicholson and Butterworth [23].

Post Mortem Examination: From apparently healthy animals, 500 cattle were randomly selected and postmortem examination was carried out through visual inspection, palpation and incision of liver and bile duct during the period of study.

Species Identification: The liver of each study animal was carefully examined for the presence of lesions suggestive of *Fasciola* infection externally and sliced for confirmation. Liver flukes were recovered for the differential count by cutting the infected liver into fine, approximately 1 cm slices with a sharp knife. The sample was taken in a universal bottle to the NAHDIC helminthology laboratory and each mature fluke was identified to species level according to its shape and size. Investigation and identification of Fasciola were done according to their distinct morphological characteristics following the standard guidelines given by Urquhart *et al.* [5].

Economic Loss Assessment: The annual economic loss was estimated as the total of the direct and indirect economic losses resulting from fasciolosis in Addis Ababa abattoirs enterprise.

The Direct Economic Loss: It is the loss resulted from liver condemnation at the abattoir and was assessed using the formula set by Ogunrinade and Ogunrinade [24]. Considering the overall prevalence of the disease, the average number of animals slaughtered in the abattoir during a year and the average market price of a liver in Addis Ababa city.

ALC = MCS * MLC * P

where,

ALC = Annual loss due to liver condemnation,
MCS = Mean Number of cattle slaughtered per year Addis Ababa abattoirs enterprise,
MLC = Mean cost of a liver in Addis Ababa town,
P = Prevalence of the disease at Addis Ababaabattoirs enterprise.

The Indirect Economic Loss: It is the loss due to reduced carcass weight of *Fasciola* infected animals and was calculated by the estimated 10% carcass weight loss due to fasciolosis [25]. The average carcass weight of Ethiopian zebu cattle was taken as 126 kg [26] and the annual economic loss due to carcass weight reduction was assessed using the formula set by Ogunrinade and Ogunrinade , [24].

ACW = CSR* P * BC * CL*126 kg

where,

ACW = Annual loss from carcass weight reduction,
CSR = Average number of cattle slaughtered per annum at Addis Ababa abattoirs enterprise,
CL = Percentage of carcass reduction, (10%)
BC = Average price of 1 kg beef in Addis Ababa town,
The P = Prevalence rate of fasciolosis at Addis Ababa abattoirs enterprise,
126 kg = Average carcass weight of Ethiopian zebu cattle.

The annual slaughtered rate was estimated from the retrospective abattoir records of the last 3 years, while the retail market price of beef/kg and an average size zebu liver was determined from the butcheries in Addis Ababa town.

Data Management and Analysis: The data were recorded on specially designed forms and preliminary analysis was done in Excel 2003. In all cases, STATA version 9 was used. Prevalence of fasciolosis was calculated as the number of cattle found to be infected with fasciola, expressed as a percentage of the total number of cattle examined [21]. The Economic significance was analyzed based on the information obtained during the interview with butchers in Addis Ababa and retrospective data was obtained from the abattoir. Appropriate data were

collected by using ante mortem examination of animals and postmortem examination of the liver. Pearson's Chi-square test was utilized to measure the association between potential risk factors and fasciolosis.

RESULTS

Of the total 500 livers examined at Addis Ababa abattoir, 23.4% (117/500) were found infected with *Fasciola*. *Fasciola hepatica* was the highest with 14.6% (73/500) prevalence, while *F. gigantica* was 4.4% (22/500). Mixed infestation with the two species was recorded in 1.4% (7/500) livers and immature flukes that were not identified to species level were found in 3.0% (15/500) livers. *Fasciola hepatica* was seen to be more prevalent than *Fasciola gigantic* in the study abattoir (Table 1).

The other factor was the body condition score in which lean body condition scored animal livers 47.76% (32/67) were infected dominantly followed by medium 23.62% (60/254) and fat body 13.96% (25/179) conditioned animal livers respectively. The risk of fasciola infection was significantly higher in poor body condition animals than in medium and good body condition animals ($p < 0.05$) (Table 2).

Concerning the age of the animals, the prevalence was higher in animals greater than five years 25.15% (82/326) than in animals less than five years 20.11% (35/174) animals. In cases of breeds, the prevalence was higher in cross 30.77% (4/13) than local breed 23.2% (113/487). However, in terms of age, sex and breed, no statistically significant difference was found between infected animals ($p > 0.05$). The other risk factor was body condition score in which lean body condition scored animal livers 47.76% (32/67) were infected dominantly followed by medium 23.62% (60/254) and fat body 13.96% (25/179) conditioned animal livers respectively($p< 0.05$) (Table 3).

Economic Loss Analysis

Direct Economic Loss: All the affected livers were condemned totally, Partial condemnation is not practiced. Retro perspective data was collected from the abattoir to estimate the economic losses by considering annually condemned livers. Annual data of the last three years regarding animals slaughtered were collected from retrospective abattoir records. The current retail market price of an average liver size was determined from interviews with local butchers in Addis Ababa town. The average weight of a liver was 3kg. Moreover, the average price of the liver was195 ET Birr. This information was used to calculate the annual estimated value of condemned liver using the given formula :(current Exchange rate 1USD =28 birr).

ALC = MCS * MLC * P
ALC = 214, 303 * 195 * 0.234
ALC = 9, 778, 645.89 ETB.
ALC = 349, 237.35USD.

Indirect Economic Loss: It is the loss due to reduced carcass weight of *Fasciola* infected animals and was calculated by using average annual cattle slaughtered estimated to be 214, 303, while the price of 1 kg beef in Addis Ababa city is 270 ETB. Then, the annual economic loss due to carcass weight reduction was assessed using the formula set by Ogunrinade and Ogunrinade [24]; (Exchange rate 1USD = 28 birr).

Table 1: Prevalence of *Fasciola* species in cattle slaughtered at Addis Ababa abattoir (n=500)

Fasciola species	No. of positive animals	Prevalence (%)
F. hepatica	73	14.6
F. gigantica	22	4.4
Mixed	7	1.4
Immature	15	3
Total	117	23.4

Table 2: Prevalence of fasciolosis based on body condition in cattle slaughtered at Addis Ababa abattoir (n=500)

BCS	No. tested	Prevalence%	[95% Conf. Interval]	(χ^2)	P- value
Lean	67	47.76%(32)	0.35 - 0.59		
Medium	254	23.62%(60)	0.18 - 0.28	31.077	<0.001*
Fat	179	13.96%(25)	0.08 - 0 .19		
Total	500	23.4%(117)	0.19 - 0 .27		

*Significant $p<0.05$

Table 3: Abattoir prevalence of bovine fasciolosis associated with risk factors (n=500)

Risk factors	No. tested	Prevalence%	[95% Conf. Interval]	(χ^2)	P-value
Age					
≤ 5	174	20.11% (35)	0.14-0.26	1.606	0.205
>5	326	25.15% (82)	0.20-0.29		
Sex					
Male	496	23.5% (117)	0.19-0.27	1.231	0.267
Female	4	0	-		
Breed					
Local	487	23.2% (113)	0.19-0.26	0.404	0.525
Cross	13	30.77% (4)	0.04-0.56		
BCS *					
Lean	67	47.76% (32)	0.35-0.59		
Medium	254	23.62% (60)	0.18-0.28	31.077	<0.001
Fat	179	13.96% (25)	0.08-0.19		
Total	500	23.4%(117)	0.19-0.27		

* BCS =body condition score

ACW = CSR* CL * BC * P*126 kg
ACW = 214, 303 * (126 * 10%) * 0.234 * 270
ACW = 170, 599, 760.60 ETB
ACW = 6, 092, 848.59 USD

The total annual economic loss due to fasciolosis at Addis Ababa abattoirs enterprise is, therefore; the sum of direct economic loss due to liver condemnation and indirect economic loss due to carcass weight reduction (Exchange rate 1USD = 28 birr).

Total economic loss = direct economic loss + indirect economic loss

Total economic loss = 9, 778, 645.89 ETB + 170, 599, 760.60 ETB

Total economic loss = 180, 378, 406.49 ETB or 6, 442, 085.94 USD

DISCUSSION

The outcome of this study showed that fasciolosis was a serious problem in cattle slaughtered at Addis Ababa abattoirs enterprise causing high economic loss due to liver condemnation and carcass weight reduction. The prevalence of fasciolosis observed in this study 23.4%, was comparable with, 24.3 % reported by Gebretsadik *et al*. [27] from Mekelle. However, it is much lower than that of many other studies from different abattoirs in the country and elsewhere in Africa. Yilma and Mesfin [28] reported a 90.7% prevalence of fasciolosis in cattle slaughtered at Gondar abattoir, while Tolosa and Tigre [29] reported a prevalence of 46.2% at Jimma abattoir. Phiri *et al*. [13] from Zambia and Pfukenyi and Mukaratirwa [30] from Zimbabwe reported 53.9 and 31.7% prevalence, respectively. On the other hand, a lower prevalence of fasciolosis (14.0%) than the current study has been observed in slaughtered cattle at Wolaita Soddo abattoir [20]. It is also higher than the study at Diredawa municipal abattoir 14.4% [31]. The variation in climate-ecological conditions such as altitude, rainfall, temperature, livestock management system and suitability of the environment for survival and distribution of the parasite as well as the intermediate host might have played their role in such differences. One of the most important factors that influence the occurrence of fasciolosis in a certain area is the availability of suitable snail habitat [5].

The present finding revealed that *F. hepatica* 14.6% (73/500) was more prevalent than *F. gigantic* 4.4% (22/500) at the study abattoir (Table 1). In favor of this finding, the prevalence of 45.2% and 26.5%; 56.4% and 9.2% were reported by Gebretsadik *et al*. [27] and Dechasa *et al*. [32] for *F. hepatica* and *F. gigantica*, respectively. Similar findings had also been reported by other researchers in the country [17, 29]. On the other hand, Fufa *et al*. [20] affirmed that *F. gigantica* was the most common liver fluke species affecting cattle at WelaytaSoddo municipal abattoir in Southern Ethiopia. Similarly, studies conducted in Zambia, Phiri *et al*. [13] reported *F. gigantica* as the most common species infecting cattle. The high prevalence rate of *F. hepatica* may be associated with the existence of a favorable ecological biotope for *L. truncatula*. Relatively, small proportions of cattle were found infected with *F. gigantica* alone or having mixed infection with both species.

In the current study, the relatively smaller proportion of cattle which were found to be infected with *F. gigantica* or mixed infection may be explained by the fact that most cattle were brought from lowland and middle altitude zone and flood-prone areas that were not favorable habitat to *L. truncatula* [5].

There was a statistically significant association between *Fasciola* prevalence and body condition of the animals in this study (P <0.05) (Table 2). In a similar study by Kassaye *et al.* [22] and Bekele *et al.* [40] the high prevalence of fasciolosis in cattle with poor body condition was reported compared to cattle in medium and good body condition. The results prove that the weight of animals increases as the parasitic infection decreases, which could be due to acquired immunity in the host. Body condition improves as *Fasciola* infection decreases since *Fasciola* worms suck blood and tissue fluid and damage the parenchyma of the liver due to the migrating immature worms [33]. Chronic fasciolosis is the commonest form of the disease in cattle and one of the characteristic signs is weight loss [3].

The annual total economic loss estimated due to liver condemnation and carcass weight reduction in this study was 6, 442, 085.94 USD and it was higher as compared to the annual loss of 45, 283.00 USD reported by Manyazewal *et al.* [34] at Mettu abattoir. 27, 573 USD reported by Gebretsadik *et al*. [27] from Mekele abattoir, 3, 003, 488 USD report from Jimma abattoir [32], 52, 649.38 USD reported from ArbaMinich abattoir [35]. A similar study carried out in Tanzania revealed an annual loss of 1, 780 and 5, 943 USD due to liver condemnation and carcass weight reduction, respectively [36]. Monitory loss estimates, merely based on losses due to liver condemnation ranging from 4, 000-8313 USD, were reported from different abattoirs in the country [17, 20, 29, 36-39]. The direct economic loss due to liver condemnation at this study was 349, 237.35 USD, (9, 778, 645.89 ETB) and indirect loss due to carcass weight reduction was 6, 092, 848.59 USD, (170, 599, 760.60 ETB). This finding was higher than previous studies conducted at different abattoirs; the difference in the estimated financial losses could be due to the difference in the annual slaughter rate, disease prevalence and the price of beef per kg and liver at the study localities.

CONCLUSION AND RECOMMENDATIONS

The present study conducted on bovine fasciolosis and economic significance in Addis Ababa abattoirs enterprise indicated that *F. hepatica* and *F. gigantic* were found in the study area. As the total economic loss estimation (6, 442, 085.94 USD) due to fasciolosis indicates, it has signified the severity of the problem and the need for effective control measures. Fasciolosis is still one of the major constraints to livestock development in Ethiopia by inflicting remarkable direct and indirect economic losses in the country. As cattle slaughtered at Addis Ababa abattoirs enterprise originate from almost every corner of the country it could be concluded that fasciolosis is still prevalent in cattle in the country. The climate-ecological conditions favorable for survival and development of the intermediate snail hosts for the two species of *Fasciola* are also prevalent in the country. Therefore.

- Detailed epidemiological studies on the prevalence of fasciolosis should be conducted by taking into consideration of the agroecological situation of the parasite.
- The marshy area should be drained.
- All local snails breeding habitat should be fenced off.
- Clearing of aquatic vegetation should be done regularly.
- The farmers of the origin of animals should be well oriented about the hazards of disease to their livestock so that they can actively participate in the control program.
- Awareness creation to the owners and all public about the situation and transmission of fasciolosis should be intervened.

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