# Fasciolosis: Prevalence, financial losses due to liver condemnation and evaluation of a simple sedimentation diagnostic technique in cattle slaughtered at Hawassa Municipal abattoir, southern Ethiopia

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## Abstract

This study was carried out from November 2007 to April 2008 to determine the prevalence of fasciolosis and costs incurred due to liver condemnation and evaluate the sensitivity of direct sedimentation method for diagnosis of fasciolosis in cattle slaughtered at Hawassa Municipal abattoir. A total of 3251 adult indigenous cattle were slaughtered at the abattoir during the study period, of which 931 animals (28.63%) were found to be positive for fasciolosis. There was a statistically significant ($\chi^2 = 33.10$; $p = 0.004$) variation in prevalence between the study months where the highest (35.6%) and lowest (21.03%) prevalence were recorded in February and April, respectively. *Fasciola hepatica* (58.9%) was the predominant fluke identified compared to *F. gigantica* (10.6%). Mixed infections by both species and unidentified immature flukes were detected in 14.7% and 15.8% of the affected livers, respectively. The mean fluke burden in the affected livers was 55 flukes per liver. As to the severity of infection, 36.63%, 52.31% and 11.06% were lightly, moderately and severely affected, respectively. Moderately affected livers showed the highest mean fluke count (69 ± 1.91) followed by severely (48 ± 1.71) and lightly affected ones (25 ± 1.75) signifying the presence of acquired resistance and local tissue reaction as chronicity of infection supervenes. Taking liver examination as gold standard for diagnosis of fasciolosis, the sensitivity of the direct sedimentation technique was found to be 67.13% and the specificity 100% with substantial agreement (k = 0.74) between the two methods. The financial loss due to liver condemnation was estimated to be 106,400 Ethiopian birr (8312.5 USD) per annum. In conclusion, the observation of such a level of infection in the dry season, high fluke pathogenicity and substantial financial loss associated with condemnation of infected livers warrants the institution of appropriate control measures.

**Keywords:** Cattle, fasciolosis, financial loss, Hawassa abattoir, prevalence, southern Ethiopia

## Introduction

Fascioliosis is an important parasitic disease of domestic ruminants caused by two liver fluke species: *Fasciola hepatica* and *F. gigantica* (Trematoda). *Fasciola hepatica* has a cosmopolitan distribution, mainly in temperate zones, while *F. gigantica* is found in tropical regions of Africa and Asia. Thus, the two fasciolid species overlap in many African and Asian countries and sometimes in the same country, although in such cases the ecological requirements of the flukes and their snail intermediate host are distinct (Mas-Coma *et al.*, 2005). The disease is responsible for considerable economic losses in the cattle industry, mainly through mortality, liver condemnation, reduced production of meat, milk, and wool, and expenditures for anthelmintics (Dargie, 1987; Hillyer and Apt, 1997).

The world-wide losses in animal productivity due to fasciolosis were estimated at US $200 million per annum, to rural agricultural communities and commercial producers (Boray, 1985), with over 600 million animals infected (Ramajo *et al.*, 2001). In developed counties, the incidence of *F. hepatica* can reach up to 77%. In tropical countries, fasciolosis is considered the single most important helminth infection of cattle, with reported prevalence of 30-90% (Spithill *et al.*, 1999). The prevalence of fasciolosis in many parts of Africa has been determined mainly at slaughter. However estimation of economic loss due to fasciolosis at national or regional level is limited by lack of accurate estimation of the prevalence of disease (Phiri *et al.*, 2005)

The presence of fasciolosis due to *F. hepatica* and *F. gigantica* in Ethiopia has long been known and its prevalence and economic significance has been reported by several workers (Graber, 1978; Goll and Scott, 1978; Bahru Gemechu and Ephraim Mamo, 1979; Yilma Jobre and J. B. Malone, 1998; Yilma Jobre and Mesfin Ali, 2000; Tadele Tolosa and Worku Tigre, 2007; Fufa Abunna *et al.*, 2009). A review of available literature 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 deceased productivity alone (Bahru Gemechu and Ephraim Mamo, 1979). More recently, Tadelle Tolosa *et al.* (2007) and Fufa Abunna *et al.* (2009) have reported financial losses of 6300 USD and 4000 USD per annum, respectively due to liver condemnations at slaughter houses.

Most of the published reports in Ethiopia are from the central, western and northern parts of the country (Getachew Tilahun, 1984, unpublished; Yilma Jobre and Mesfin Ali, 2000; Solomon Woldemariam and Abebe Wosene, 2007; Tadele Tolosa and Worku Tigre, 2007) and little is known about the situation of the disease in the southern Ethiopia. Therefore the aim of this study was: (1) to determine the prevalence of bovine fasciolosis at Hawassa Municipal abattoir, (2) to identify the species of Fasciola prevalent in the area, (3) to estimate the cost associated with condemnation of infected livers, and (4) to evaluate the sensitivity of the sedimentation technique used to detect Fasciola eggs in the feces under field conditions.

## Materials and Methods

### Origin of the animals

The study was conducted at Hawassa Municipal abattoir. Hawassa is the capital town of Southern Nations, Nationalities and Peoples Regional State (SNNPRS) and among the fast growing towns in the country. The town is located 275 km south of Addis Ababa with area coverage of 162,804 hectares. The total human population of the town is about 180,500 (CSA, 2003). The abattoir is located 5 km away from the town. Active meat inspection is carried out in the abattoir routinely to provide a wholesome meat to the residents of the town. Animals for slaughter at the abattoir are brought mainly from Hawassa, Shashamane, Arsi-Negelle, Dilla and Wolyta Soddo towns.

### Study animals and design

The study animals were 3251 adult indigenous cattle purchased from the aforementioned markets and brought to the abattoir for slaughtering purpose. All animals slaughtered at the abattoir during the six month study period (November 2007 to April 2008) were included in the study.

### Liver inspection

Livers of all cattle slaughtered at the abattoir were inspected for the presence of liver flukes and to determine the monthly prevalence of fasciolosis at the abattoir. Besides, identification of the fluke species, worm count and assessment of the severity of liver lesions were carried out. The fluke recovery and count was made following the approach of Hammond and Swell (1974): the gall bladder was removed and washed to screen out mature flukes. The liver was cut into slices of about 1 cm thick and put in a metal trough of warm water to allow mature flukes lodged in smaller bile ducts to escape and then all flukes and fluke heads were counted. Collections of flukes from each animal were examined macroscopically and microscopically and classified as adult *F. hepatica*, *F. gigantica* and immature fluke on the basis of size and shape (Soulsby, 1982). Categorization of the affected livers was carried out based on the approach of Ogunrinade and )(1982) as follows: )everely affected: almost the entire organ is involved, the liver is cirrhotic and triangular in outline as the right lobe is often atrophied. The intensity of fluke infection (mean fluke burden) was also correlated with the pathological lesions.

**Sensitivity and specificity of the fecal examination method**

One of the objectives of this study was to evaluate the sensitivity of the direct sedimentation method, which is routinely employed at field to examine the presence of Fasciola species eggs in feces. For this test, fecal samples were taken from the rectum of 585 cattle randomly selected from those brought for slaughter and subjected to liver inspection. The collected samples were taken to the laboratory in tightly closed universal bottles. In the laboratory the samples were processed by the sedimentation technique as described by Hansen and Perry (1994). The sensitivity and specificity of the method was computed by taking liver inspection at postmortem as gold standard for the diagnosis of fasciolosis. Kappa statistic was used to determine the degree of agreement between the two methods of liver fluke diagnosis. The kappa value was interpreted as: slight agreement ($k < 0.2$); fair agreement ($k = 0.2 - 0.4$); moderate agreement ($k = 0.4 - 0.6$); substantial agreement ($k = 0.6$ to $0.8$); and almost perfect agreement ($k > 0.8$) (Thrusfield, 1995).

**Financial loss analysis due to liver condemnation**

The total annual financial loss incurred due to liver condemnation at the abattoir was computed by multiplying the average number of cattle slaughtered annually in the abattoir with the prevalence of fasciolosis obtained from the present survey and mean price of liver in the town. Based on three years meat inspection data, the average number of animals slaughtered in the abattoir annually was found to be 11615 and the mean price of liver in the town was 32 Ethiopian birr.

### Data analysis

Data collected from abattoir survey and fecal examination were entered into a Microsoft Excel spreadsheet and analyzed with STATA 9 statistical soft ware (Stata Corp. 4905 Lake way drive College Station, Texas 77845, USA)). The prevalence of fasciolosis was calculated as the number of infected individuals divided by the number of individuals sampled x 100. Categorical data were analyzed with the Chi-square ($\chi^2$) test for independence whereas, one-way ANOVA was used to examine for differences in mean fluke burden. $p$ value < 0.05 was considered for significance.

## Result

### Post mortem examination

Figure 1 shows the results of liver examination on monthly basis. From the total of 3251 adult indigenous cattle slaughtered at Hawassa Municipal abattoir during the six months study period, 931 animals (28.64%) were found to be infected with Fasciola spp. There was statistically significant ($\chi^2 = 33.10$; $p = 0.004$) variation in prevalence of fasciolosis among study months. The highest prevalence was seen in February (35.6%) while the lowest in April (21.03%).

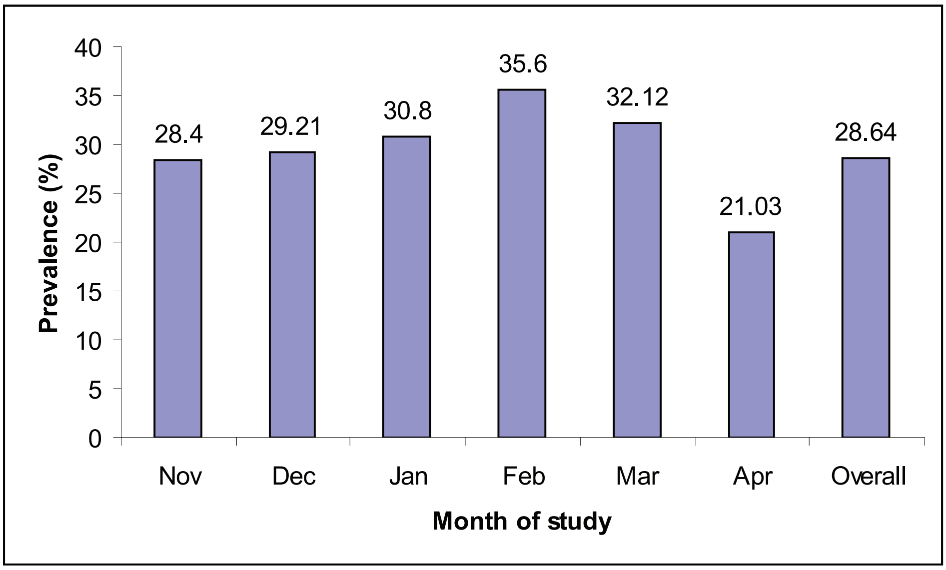


**Figure 1.** Overall and monthly prevalence of fasciolosis in cattle slaughtered at Hawassa Municipal abattoir

*Fasciola hepatica* (58.9%) was the most abundant fluke identified whereas *F. gigantica* was the least (10.6%). Mixed infections by both species and unidentified immature flukes were detected in 14.7% and 15.8% of the affected livers, respectively (Table 1).

**Table 1.** Fasciola species identified and their relative abundance

| Fasciola species encountered | No. of livers infected | Proportion (%) |
|---|---|---|
| F. hepatica | 548 | 58.86 |
| F. gigantica | 99 | 10.63 |
| Mixed | 137 | 14.71 |
| Unidentified (Immature) | 147 | 15.80 |
| Total | 931 | |

### Intensity of infection and severity of liver lesions

The results of fluke count made on 931 infected livers are given in Table. The mean fluke burden observed in this study was 55 flukes per liver (range: 3-165). Of the total cattle subjected to fluke count, 22.7% had between 1 and 20 flukes in the liver. Similarly, 65.4% had counts between 21 and 100 and only 12% had counts greater than 100 flukes.

**Table 2.** Results of fluke count in the representative livers

| **Fluke count interval** | **No. of livers** | **Relative proportion (%)** |
|---|---|---|
| 3-20 | 211 | 22.7 |
| 21-40 | 192 | 20.7 |
| 41-60 | 152 | 16.3 |
| 61-80 | 148 | 15.9 |
| 81-100 | 116 | 12.5 |
| 101-120 | 54 | 5.8 |
| 121-140 | 36 | 3.8 |
| 141-165 | 22 | 2.4 |

Based on the degree of pathological lesions observed, 341 (36.63%), 487(52.31%) and 103 (11.06%) livers were lightly, moderately and severely affected, respectively. The variation in intensity of infection between the three lesion categories was statistically significant ($p$=0.0001). Moderately affected livers showed the highest mean count (68 ± 1.91) while lightly affected ones demonstrated the lowest value (25 ± 1.75) (Table 3).

**Table 3.** Categorization of livers according to severity of lesions and their respective mean fluke burdens

| Severity of liver lesions | No of livers | Relative proportion (%) | Mean fluke burden | SD | p |
|---|---|---|---|---|---|
| Lightly affected | 341 | 36.63 | 25 | 1.75 | |
| Moderately affected | 487 | 52.31 | 68 | 1.91 | 0.0001 |
| Severely affected | 103 | 11.06 | 47 | 1.71 | 0.0001 |

### The sensitivity and specificity of the faecal examination technique

The sensitivity and specificity of the direct sedimentation technique were calculated from the results in table 4 which sets out the numbers of positive and negative tests in animals with and without flukes in their livers (Smith, 1995). Out of the 585 cattle subjected to both fecal and liver examination, 216 had flukes in their livers but only 145 showed Fasciola eggs in their feces. Accordingly, the sensitivity of a single examination by sedimentation method was found to be 67.13% and specificity was 100% with substantial agreement between the two tests (k = 0.74).

**Table 4.** The presence or absence of Fasciola spp. eggs in the feces of cattle with and without Fasciola in the liver

| Faecal examination | Presence of Fasciola spp. in liver | | Total |
|---|---|---|---|
| | Fluke (+) | Fluke (-) | |
| Eggs present (+) | 145 | 0 | 145 |
| Eggs absent (-) | 71 | 369 | 440 |
| Total | 216 | 369 | 585 |

### Cost of liver condemnation

Based on the relevant data mentioned above, the cost associated with condemnation of fluke-infected liver was estimated to be 106,400 Ethiopian birr (8312.5 USD, exchange rate 12.8) per annum.

## Discussion

The abattoir prevalence of fasciolosis obtained from the present study (28.63%) is comparable to previous report of 30.43% in the same area (Hailu Melese, 1995, unpublished) and also to 27.1% and 29.8% reports from Wolisso (Rahmeto Abebe, 1992, unpublished) and Nekemte (Wassei Molla, 1995, unpublished) abattoirs, respectively. However, it is much lower than several reports from different abattoirs in the country viz. 47% at Sodo abattoir (Abduljelal Redi, 1992, unpublished), 56.6% at Ziway abattoir (Adem Abdela, 1994, unpublished), 88.57% at Debre-Brehan abattoir (Tsegaye Tadesse, 1995, unpublished), 90.65% at Gondar abattoir (Yilma Jobre and Mesfin Ali, 2000), and 46.58% at Jimma abattoir (Tadele Tolosa and Worku Tigre, 2007). On the other hand a very low prevalence (14.4%) has been reported from Dire-Dawa abattoir located in the eastern part of the country (Daniel Ferrede, 1995, unpublished). These differences within the country are attributed mainly to variations in the ecological and climatic conditions such as altitude, rainfall, and temperature, although differences in livestock management system and the ability of the inspector to detect the infection may play a part. From African countries, a highest prevalence of 53.9% was reported from Zambian abattoirs (Phiri *et al*., 2005).

This study was conducted in a period known to be dry in Ethiopia; however, the prevalence observed was considerable and reflects the existence of suitable ecological conditions in the area of the origin of the study animals for snail breeding and development of larval stages within the snail intermediate host throughout the year regardless of the season. This finding is consistent with a dry season observation of Yilma Jobre and Mesfin Ali (2000), although they reported a higher prevalence.

*Fasciola hepatica* was the dominant fluke species in the study animals. This may be associated with the existence of favorable ecological biotopes for *Lymnae trancatula*, the recognized intermediate host of *F. hepatica* in Ethiopia (Graber and Dynes, 1974). Relatively small proportion of cattle were found infected with *F. gigantica* alone or mixed infections by both species. This may be explained by the fact that most cattle for slaughter came from high land and middle altitude zones. The present finding accords a previous report in the same abattoir (Hailu Melese, 1995, unpublished) and also studies in different parts of the country (Graber, 1978; Fekadu Regasa, 1988, unpublished; Adem Abdela, 1994, unpublished; Yilma Jobre and Mesfin Ali, 2000), all of whom have shown *F. hepatica* as the most important fluke species in Ethiopian livestock. According to Yilma Jobre and Malone (1998), varying degrees of *F. hepatica* risk occur in all areas of the country except in the arid north-east and east of the country. *F. gigantica* endemic areas occur in the entire western zone of the country with localized foci in the south and east. The authors also reported that both species co-exist in Ethiopia in areas with an altitude range of 1455-1700 m.a.s.l. Mixed infection may occur in the liver of the same animal so long as ecological conditions conducive for replication of both snail species exist and intermingling of cattle from various grazing areas occur (Yilma Jobre and Mesfin Ali, 2000). Studies in other countries of Africa showed that *F. gigantica* was the predominant species encountered (Kithuka *et al*., 2002; Phiri *et al*., 2005; Phiri *et al*., 2006; Yabe *et al*., 2008) whereas, in Europe, the Americas and Oceania only *F. hepatica* is concerned (Mas-Coma *et al*., 2005).

Fluke count conducted on infected livers revealed a mean fluke burden of 55 per liver. This finding of large fluke burden implies very high pathogenicity of flukes in the area. According to Soulsby (1982), the presence of more than 50 flukes per liver indicates a high pathogenicity. It has also been reported that significant production losses occur in infections with 30 flukes and/or herd prevalence of 25% (Dargie, 1987; Vercruysse and Claerebout, 2001). High pathogenicity of liver flukes with mean fluke burdens ranging from 66 to 78 has also been reported by previous studies in the country (Fekadu Regasa, 1988, unpublished; Rahmeto Abebe, 1992, unpublished; Yilma Jobre and Mesfin Ali, 2000). Similarly a number of studies elsewhere in the world have also reported large fluke burdens. In USA, fluke burdens of 40-140 were shown to be common in cattle (Dargie, 1986). In Iran, Nigeria and Zambia mean fluke burdens of 68-100 were reported in cattle (Sahba *et al*., 1972; Schillhorn van Veen *et al*., 1980; Phiri *et al*., 2006).

Analysis of mean worm burden with liver pathology showed significant variation; however, no direct relationship was observed in that the average fluke count in moderately affected livers exceeded that obtained from severely affected ones. This finding agrees with that of Dwinger *et al*. (1982) who have shown a relatively less flukes in severely affected livers of beef cattle. According to these authors, severe fibrosis impedes the passage of immature flukes and acquired resistance and calcification of bile ducts play a role by creating unfavorable microenvironment which results in the expulsion of flukes. Similar observation in the country was reported by Yilma Jobre and Mesfin Ali (2000).

In this study, the sensitivity of the sedimentation diagnostic technique was found to be 67.13% in relation to the results of liver examination and a substantial agreement (kappa = 0.74) was observed between the two tests. However, this test suggests that about 33% infected animals may pass undetected with single examination of feces by sedimentation technique. This may be attributed partly to the fact that Fasciola eggs only appear in feces 8-15 weeks post infection, so most of pathological lesions had already occurred (Sanchez-Andrade *et al*., 2002). Furthermore, detection of Fasciola eggs can be unreliable during the patent period because the eggs are expelled intermittently depending on the evacuation of the gall bladder (Briskey, 1998). The present result is comparable to the reports of 66.7% in Vietnam (Anderson *et al*., 1999) and 69% in Switzerland (Rapsch *et al*., 2006). The latter stated that traditional coproscopy can be very efficient if there is repeated sampling, resulting in sensitivity of approximately 92%.

The financial loss observed in this study (8312.5 USD) is relatively higher than those of previous published studies viz. 6300 USD from Jimma abattoir (Tadelle *et al*., 2007) and 4000USD from Wolyta soddo abattoir (Fufa *et al*., 2009).

## Conclusion

The present study revealed that *F. hepatica* is the most prevalent fluke species in southern Ethiopia. The level of infection observed in this study suggests the existence of conducive climatic conditions throughout the year for the development and survival of the parasite in the area of origin of the study animals. More over, the current study reflected that high fasciolosis pathogenecity is present in southern Ethiopia. The financial loss associated with condemnation of infected livers at the abattoir is also substantial. All these necessitate the institution of an appropriate and feasible control measures. Therefore, in addition to the treatment in the rainy season, at least one strategic flukicidal treatment is justifiable during the long dry season for southern Ethiopia. However, further detailed studies need to be conducted in different seasons so as to generate a complete data set on the epidemiology of fasciolosis and ecology of intermediate host snails, as related to the specific husbandry practices.

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