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Original Research

# Epidemiology of Fasciolosis in Southwest Ethiopia

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## Abstract

The design of strategic deworming programs is one of the control options for fasciolosis, and needs to be supported by local epidemiology knowledge. To address this issue in Southwest Ethiopia, a study using tracer calf and crossectional study methods was made at an endemic area for the disease during 2006–2007. Coprology and necropsy examinations were used to collect information. Results showed that both *Fasciola hepatica* and *Fasciola gigantica* were abundant in the area with almost equal prevalence rates, and infections of animals occur during the wet season from May to October. The mean number of flukes recovered in the positive tracer calves ranged from 3.0 to 42.5 per animal, and the maximum worm count observed in an individual animal was 66 flukes. The overall prevalence of Fasciolosis in the extensively managed local breeds of cattle, yearling calves, sheep and goats was 74.8%, 55.3%, 35%, and 27.1%, respectively. A significant difference was observed in the prevalence of fasciolosis among cattle, yearling calves and sheep population, while no difference was observed among the goat populations of the five provinces. Based on the regional epidemiology of the disease, a twice yearly strategic deworming program has been devised to control the infection in the region.

*Keywords: Fasciola gigantica; Fasciola hepatica*; Fasciolosis; Southwest Ethiopia; Tracer calf

## Introduction

Fasciolosis, caused by trematode parasites of the genus Fasciola, is an economically important disease of cattle, sheep and goats, and limits productivity of animals in tropical and subtropical countries. The two important species: *Fasciola hepatica* and *Fasciola gigantica* are transmitted by snails of the family Lymnaesidae, and the infection is acquired through grazing on swampy pasture (Urquhart *et al*., 1996). Acute fasciolosis often remains undetected in cattle and develops to the chronic form which makes them less resistant to other liver infections, while in sheep, acute fasciolosis most often results in sudden death without other apparent clinical abnormality (Radostits *et al*, 2007).

In Africa, fasciolosis is a serious problem in the humid and sub humid zones (Ogunrinade and Ogunrinade, 1980). There is no vaccine against the disease, and hence chemotherapy is the only viable control method available to date, Triclabendazole being the drug most commonly used due to its effectiveness against both mature and immature forms of the parasite (Brennan *et al*., 2007). Epidemiological studies conducted in the central highlands of Ethiopia showed the significance and wide distribution of the infection (Scott and Goll, 1977; Erich, 1983; Lemma *et al*., 1985; Njau *et al*., 1989). Bergeon (1968) found that the rate of infection was 90 % in Shoa and Gojjam provinces, while Gemechu and Mamo (1979) reported an overall prevalence of 63 % in cattle at different regions of

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the country and estimated the economic loss due to deceased productivity alone to roughly 350 million ETH birr (140 million USD) per annum. The economic significance of the disease was also reported from different abattoirs in the country: Fufa *et al* (2009) reported an average loss of 4000 USD per annum at Soddo municipal abattoir, Rahmeto *et al*. (2010) reported an annual loss of 8312.5 USD at Hawassa Municipal abattoir and Nega *et al*. (2012) reported a loss of 2,566 USD per annum at Gondar ELFORA abattoir.

The South-Western region of Ethiopia is more humid and encompasses vast areas of swampy grazing fields which are conducive for the survival and development of the parasite. However, the infection rate in this area is not known since no previous study has been conducted. Therefore the current study was intended to assess the seasonal occurrence of fasciolosis in Southwest Ethiopia, determine the magnitude and spatial distribution of fasciolosis in ruminant species managed under extensive farming system and design strategic treatment programmes for the control of the disease in the area.

## Materials and methods

*Study area*

The seasonal transmission study was conducted at Abdella village located at a distance of 500 km Southwest of Addis Ababa on the road to Gambela town. The site lies at a latitude of 08 0 21 ' 96 '' North and longitude of 036 0 14 ' 31 '' East, and at an altitude of 1940 m. The area receives an average annual rainfall of 1965 mm and the mean maximum and minimum monthly temperatures are 26$^{o}$C and 12.7$^{o}$C, respectively. The crossectional study was made in five western provinces of Oromia Regional State, namely, west shoa, east wolleg, west wollega, Illubabour and Jimma provinces, found in Southwest Ethiopia.

*Study Animals*

Forty four yearling calves were used as tracer animals to assess seasonal transmission of fasciolosis over a period of two years. The calves were purchased from a fasciola-free area and were quarantined for one month under cercaria-free conditions during which they were dewormed twice with triclabendazole, on days 1 and 20 of quarantine. At the end of the quarantine period the calves were examined coproscopically, and only those calves found free of helminth ovas were used for the study. Preventive and curative measures against prevalent infectious diseases, ectoparasites and other disease conditions were made during this and the rest of the study period. The study population for the survey on fasciolosis was large and small ruminant populations found in 226 peasant Associations (PAs) of 24 districts in the five western provinces of Oromia regional State.

*The tracer animal method*

The tracer animal method was used to determine the seasonal infectivity of animals by fasciola parasites. A batch of tracers consisting 3-4 calves was released to pasture at a bimonthly schedule and remained on pasture for two months. The calves were then moved to a concrete floor house to stay for three months under cercaria free conditions and finally slaughtered for post-mortem examinations. Two calves, designated as control animals to monitor the cercariae-free status of the concrete floor house, were introduced with the first batch of tracers and remained until the end of the study period and were slaughtered three months following necropsy of the last batch of tracer calves.

*Cross-sectional study*

Cross-sectional study design was used for the study on fasciolosis. The sample units were selected randomly at each study PA using the systematic sampling method and the numbers of selected units were proportional to the study population at each PA. Accordingly, a total 11,920 cattle, 3940 yearling calves, 2237 sheep and 958 goats were selected as the sample units for faecal sampling.

*Necropsy*

During necropsy examination, the liver and the gall bladder were removed; the gall bladder was then separated from the liver, emptied and washed in to a glass trough and the contents of the trough were checked for adult fasciola parasites. The bile ducts were opened and searched for adult and juvenile flukes and the liver was cut in to 1 cm thick slices and pressed between the fingers to expose flukes lodged in small bile ducts, and the number of heads recovered in this way were counted.

*Faecal sampling and laboratory examination*

Faecal specimens from the tracer calves were collected and examined at weekly intervals throughout the study period, while the specimens from field animals were collected on a single occasion. All specimens were collected directly from the rectum using sterile gloves, transferred to universal bottles containing 10% formalin, and examined for ovas of fasciola using the sedimentation method as described by Hansen and Perry (1994).

*Meteorological data*

Meteorological data of the study site (Abdella village) was obtained from Jimma and Beddele branch offices of the Ethiopian meteorological service agency.

*Data analysis*

All collected data were entered into a Microsoft Excel spreadsheet and analyzed by the SPSS 11.5 for Windows. Prevalence of Fasciolosis was calculated as the number of parasitological positive animals divided by the total number of animals investigated at that particular time The student's t test and one-way ANOVA were used to compare the mean values in the tracer calves, .while the general linear model (GLM) Univariate Analysis of Variance was used to compare the prevalence of fasciolosis. The association between Fasciola infections and mean monthly rainfall was estimated by the Pearson's correlation coefficient and P-value < 0.05 was considered for significance. The sensitivity and specificity of the sedimentation method was assessed taking necropsy examination as a gold standard for the diagnosis of fasciolosis. The Kappa statistics was used to estimate the degree of agreement between the two methods and values were interpreted as described by Thrusfield (1995).

## Results

Seasonal transmission of fasciolosis was assessed using the tracer calf method at a known endemic site of the disease, Abdella village, in Southwest Ethiopia for a period of two years. All faecal samples collected from the tracer calves during their stay on pasture and up to the second month of their stay on the concrete floor house, as well as samples collected from the control calves that stayed on the concrete floor house throughout the study period were negative for ovas of fasciola. Of the 42 tracer calves used in the study, 26 harboured a total of 474 adult fasciola parasites with a range of 3-66 parasites per calf. Immature flukes were not detected in this study. Of the 12 tracer batches, seven of them that stayed on pasture during March to October harbored a mean number of 3-42.5 flukes per batch, the highest mean count (42.5) was observed during July-August. The batches of calves that stayed on pasture during November–February were free of flukes (Table 1). Inconsistency of infection was noticed between the same months of the two study years, flukes were detected during April-March of the first year but not in the second year.

The t-test analysis further indicates that there was a statistically significant difference in the mean number of flukes recovered between the two study years. The differences were particularly significant during the core fluke infection months of may–June and July-August. It was observed that the mean number of flukes recovered during may-June of the first study year, 24, was significantly higher (p=0.014, 95 % CL= 4.10-23.23) than that of, 10.3, in the second year. In the same manner, the mean number of flukes recovered during July-August of the first year, 42.5, was significantly higher (p=0.026, 95 % CL= 5.391-56.276) than that of 11.7 in the second study year (Table 2). Although there were some differences in the mean numbers of flukes acquired during the rest months of the two years the differences were not statistically significant.

Two species of fasciola, *Fasciola gigantica* and *Fasciola hepatica*, were encountered with a percentage infection of 42.6% (202/474) and 57.4% (272/474), respectively, and mixed infections were observed in 10 (23.8%) of the 26 positive tracer animals. Although *F. hepatica* was the principal species encountered in this study there was no statistically significant difference observed in infection rate between the two species (F=0.253; P=0.994). Results of the study showed that nearly all fasciola infections occur during the wet season (May-October), although few were detected at the end of the dry season (March-April). Rainfall data for the region showed that the rainfall of the area

Table 1. Flukes Recovered from the tracer calves at Abdella study area, southwest Ethiopia

| Batch No | No of calves | study year | Mon on Pasture | Sum | Min | Max | Mean | Std. Dev | 95% CI for Mean | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | LB | UB |
| 1 | 4 | 1 | Mar-Apr | 34 | 5 | 12 | 8.5 | 4.04 | 2.1 | 14.9 |
| 2 | 4 | 1 | May-Jun | 96 | 16 | 29 | 24.0 | 5.94 | 14.5 | 33.5 |
| 3 | 4 | 1 | Jul-Aug | 170 | 27 | 66 | 42.5 | 16.62 | 16.1 | 69.0 |
| 4 | 4 | 1 | Sep- Oct | 12 | 0 | 5 | 3.0 | 2.16 | -0.4 | 6.4 |
| 5 | 4 | 1 | Nov-Dec | 0 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 |
| 6 | 4 | 1 | Jan-Feb | 0 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 |
| 7 | 3 | 2 | Mar-Apr | 0 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 |
| 8 | 3 | 2 | May-Jun | 31 | 8 | 13 | 10.3 | 2.52 | 4.1 | 16.6 |
| 9 | 3 | 2 | Jul-Aug | 35 | 9 | 13 | 11.7 | 2.31 | 5.9 | 17.4 |
| 10 | 3 | 2 | Sep- Oct | 94 | 5 | 45 | 31.3 | 22.81 | -25.3 | 88.0 |
| 11 | 3 | 2 | Nov-Dec | 2 | 0 | 1 | 0.7 | 0.577 | -0.8 | 2.1 |
| 12 | 3 | 2 | Jan-Feb | 0 | 0 | 0 | 0.0 | 0.000 | 0.0 | 0.0 |
| Total | 42 | | | 474 | | | | | | |

CI= confidence interval
LB= Lower Bound
UB= Upper Bound
Mon on Pasture = months passed on Pasture

Table 2. Comparisons of the mean no of flukes recovered from the two batches of tracer calves that stayed on Pasture during the same months of the study years

| Batch No of calves | Months on Pasture | t | Sig. | Mean Diff | 95% CI of the Diff |
|---|---|---|---|---|---|
| 1 and 7 | Mar-Apr | 3.55 | 0.02 | 8.50 | 2.4-14.7 |
| 2 and 8 | May-Jun | 3.67 | 0.01 | 13.67 | 4.1-23.2 |
| 3 and 9 | Jul-Aug | 3.11 | 0.03 | 30.83 | 5.4-56.3 |
| 4 and 10 | Sep- Oct | -2.14 | 0.16 | -28.33 | -84.5-27.8 |
| 5 and 11 | Nov-Dec | -2.00 | 0.18 | 0-.67 | -2.1-0.8 |
| 6 and 12 [a] | Jan-Feb | - | - | | - |

a = flukes were not recovered from tracer calves
Diff= difference

Table 3. Prevalence of fasciolosis in adult cattle and yearling calves in the Five Provinces of Oromia regional state, Southwest Ethiopia

| Province | Adult Cattle examined | Pos. | Neg. | Prev. % | Yearlings examined | Pos. | Neg. | Prev. % |
|---|---|---|---|---|---|---|---|---|
| East wollega | 3031 | 2280 | 751 | 75.2 | 1019 | 473 | 546 | 46.4 |
| Illubabour | 2660 | 2285 | 375 | 85.9 | 958 | 586 | 372 | 61.2 |
| Jimma | 2600 | 1831 | 769 | 70.4 | 652 | 373 | 279 | 57.2 |
| West shoa | 1820 | 1477 | 343 | 81.2 | 573 | 345 | 228 | 60.2 |
| West wollega | 1809 | 1045 | 764 | 57.8 | 738 | 401 | 337 | 54.3 |
| Total | 11920 | 8918 | 3002 | 74.8 | 3940 | 2178 | 1762 | 55.3 |

Pos. = Number of positive animals
Neg. = Number of negative animals
Prev. % = prevalence in percent

is a unimodal type, having six wet and six dry months, with a wet season from May to October. A significant positive linear correlation (r=0.726; P=0.000) was obtained between fasciola infections in the tracer calves and the monthly rainfall distribution in the area (Fig. 1). Nineteen of the 26 tracers that were positive by necropsy examinations were found positive by coprology indicating a 73.1% sensitivity of the sedimentation test used in the study. Furthermore, the kappa statistics revealed a substantial agreement between the necropsy and coprology examinations employed (k=0.674; P=0.000).

All of the PAs surveyed for fasciolosis were found to be infected with liver flukes, showing an overall prevalence of 74.8%, 55.3%, 35%, and 27.1% in adult cattle, yearling calves, sheep and goats, respectively. Among the livestock species, cattle showed the highest prevalence and goats the least prevalence (Table 3 and 4). The highest and lowest prevalence of bovine fasciolosis, 85.9% and 57.8%, were found in Illubabour and west wollega provinces, respectively, and a significant difference (P=0.000) was observed in the prevalence of bovine fasciolosis among the five provinces (Table 5). Further analysis through pairwise comparisons of the prevalence across provinces showed that the prevalence in Illubabour zone is significantly different from east wollega (P=0.006), west wollega (P=0.000) and Jimma (P=0.000) but not different from that of west shoa (P=0.497). There was no statistically significant difference in prevalence of bovine fasciolosis among west wollega, east wollega and Jimma provinces. The highest and lowest prevalence of ovine fasciolosis, 44.5% and 21.3%, were obtained in Illubabour and west Wollega provinces, respectively and the difference in prevalence across the five provinces was statistically significant (P=0.007). The prevalence of fasciolosis in yearling calves was also significant (P=0.018) however no statistically significant difference (P=0.327) was observed in the prevalence of caprine fasciolosis among the five surveyed provinces (Table 5).

## Discussion

The present study at Abdella study area showed that fasciola infections occur during the rainy months of the year from May to October in Southwest Ethiopia. This result differs slightly from the findings of Scott and Goll (1977) and Njau *et al.* (1989) which indicated August-December and July-January, respectively, as the period of high fasciola infections in the central highlands of Ethiopia. Studies carried out at Debre Birhan (central Ethiopia) indicated October-November as the period of maximum infectivity of sheep (Erich, 1983; Lemma *et al*., 1985). The main factor for the occurrence of earlier infections in May in this study at Abdella area might be the relatively higher amount of annual rainfall, 1900mm, falling during the sole rainy season (May-October), as compared to the central highland region possessing a short (February-March) and long (July-September) rainy seasons with a mean annual rainfall of 700 mm (Njau *et al*., 1989). Yilma and Malone (1998) predicted high cercariae-shedding in the humid western region of Ethiopia during May to October, which is in agreement with the findings of the pres-

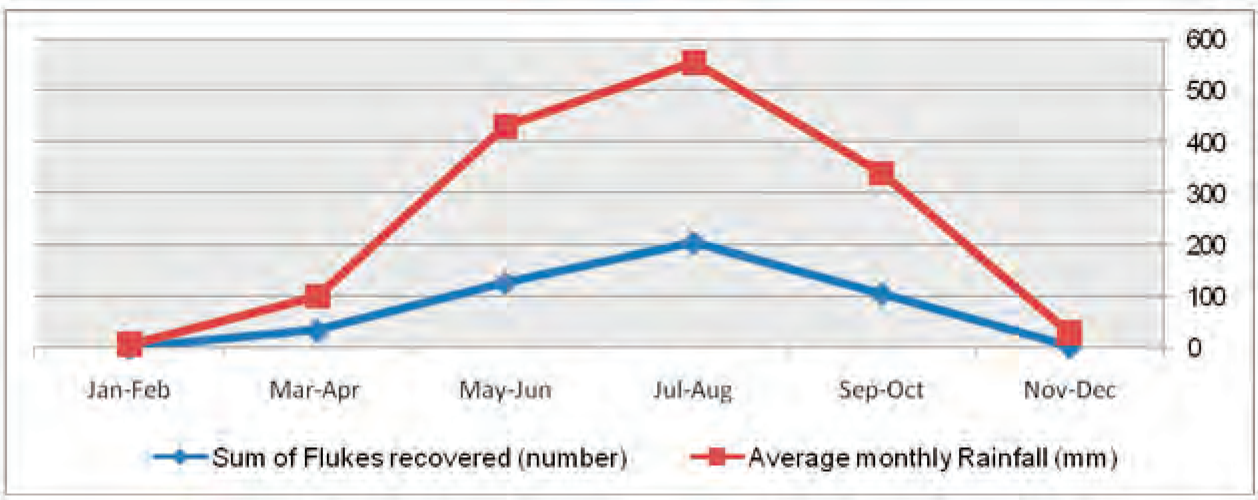


Fig.1. Relationship of rainfall and Fasciola infection in the tracer calves at Abdella study area, Southwest Ethiopia

Table 4. Prevalence of fasciolosis in small ruminant species in the five Provinces of Oromia regional state, Southwest Ethiopia

| Province | sheep examined | Pos | Neg | Prev % | Goats examined | Pos | Neg | Prev % |
|---|---|---|---|---|---|---|---|---|
| East wollega | 446 | 132 | 314 | 29.6 | 162 | 68 | 94 | 42.0 |
| Illubabour | 824 | 367 | 457 | 44.5 | 281 | 78 | 203 | 27.8 |
| Jimma | 344 | 113 | 231 | 32.8 | 205 | 51 | 154 | 24.9 |
| West shoa | 196 | 81 | 115 | 41.3 | 128 | 35 | 93 | 27.3 |
| West wollega | 427 | 91 | 336 | 21.3 | 182 | 28 | 154 | 15.4 |
| Total | 2237 | 784 | 1453 | 35.0 | 958 | 260 | 698 | 27.1 |

Pos. = Number of positive animals
Neg. = Number of negative animals
Prev. % = prevalence in percent

Table 5. Mean Prevalence of fasciolosis in the five Provinces of Oromia regional state, Southwest Ethiopia

| Province | Adult Cattle | | Yearlings | | Sheep | | Goats | |
|---|---|---|---|---|---|---|---|---|
| | mean | 95%C I | mean | 95%C I | mean | 95% C I | mean | 95% C I |
| E. Wollega | 75.2 | 68-78 | 46.4 | 39-54 | 29.6 | 21-38 | 42.0 | 27-52 |
| Illubabour | 85.9 | 81-90 | 61.2 | 52-66 | 44.5 | 37-53 | 27.8 | 18-37 |
| Jimma | 70.4 | 68-79 | 57.2 | 49-66 | 32.8 | 27-46 | 24.9 | 19-40 |
| W. Shoa | 81.2 | 75-88 | 60.2 | 48-68 | 41.3 | 12-42 | 27.3 | 16-49 |
| W. Wollega | 57.8 | 50-61 | 54.3 | 44-61 | 21.3 | 14-34 | 15.4 | 9-33 |

ent study. Mulualem (1998) noted high fasciola infections of cattle during May-December in the north-western region which is in harmony with the findings of the present study, although, no infection was observed during November and December in the present study. Lemma *et al*. (1985) and Erich (1983) emphasized that fasciolosis may be caused by aestivating snails remaining after the long rains which become active again in the small rains of February and March. While the rains during these months are insignificant in the south western region, aestivating snails at some swampy spots might be the causes of infections observed during March and April in the current study.

Due to the ever-growing human population and high demand for grain production, the entire arable land In the south-western region is usually cultivated and covered with crops during the rainy season (May-December), leaving only the swampy fields for livestock grazing. Consequently, gathering of cattle in the swampy pasture coincides with the period of high cercarial shedding in the area leading to massive ingestion of metacercaria and subsequent development of the parasite to its adult stage during September–February. Fasciolosis occurring during this period could be the main source of pasture contamination and the subsequent infection of snails in the following season.

In contrast to the studies in the central highlands of Ethiopia which reported *F. hepatica* as the only species responsible for fasciolosis, both F.gigantica and *F. hepatica* were encountered in this study, revealing the suitability of the climate in the area for both species. Graber (1978) stated that mixed infections by both species may occur in areas where the ecology is favourable for replication of the snail intermediate hosts. The greatest risk for both species occurs in areas of extended high annual rainfall associated with high soil moisture and surplus water (Malone *et al*., 1998). Abattoir survey studies at different parts of the country signify the existence of both species of fasciola (Tolosa and Tigre, 2007; Jibat *et al*., 2008; Fufa *et al*., 2009; Gebretsadik *et al*., 2009). Furthermore, the present study showed the dominance of *F. hepatica* over *F. gigantica* which is in agreement with reports of previous studies in Ethiopia (Tolosa and Tigre, 2007; Mulugeta *et al*., 2011; Nega *et al*., 2012), but differ from a report in Southern Ethiopia (Fufa *et al*., 2009) and other African countries (Wamae *et al*., 1998; Phiri *et al*., 2005; Mungube *et al*., 2006) which indicated the dominance of *F. gigantica*. The risk of *F. gigantica* is present in the western, southern and north-central regions of Ethiopia at altitudes of 1440-2560 m and the greatest risk is in the humid western region (Yilma and Malone, 1998).

The descending sequence in the overall prevalence of Fasciolosis in adult cattle, sheep and goats found in this study is in agreement with the findings of a study at Debrezeit with a prevalence of 39.8%, 28.7% and 13.9%, (Yemisrach and Mekonnen, 2012) and with the findings of a study in India which reported a Prevalence of 10.8, , 2.8 and 2.4 percent in cattle, sheep and goats, respectively. (Rajat *et al.*, 2009). The reason for the higher prevalence in adult cattle as compared to small ruminants could be attributed to the difference in the grazing behaviour of the two species and the difference in management of animals during the rainy season, where calves and small ruminants are kept around homesteads and adult cattle are pastured in swampy areas. The prevalence of ovine Fasciolosis, 35%, obtained in this study was much lower than the 70.2% report in Menz Lalo Midir district of Ethiopia (Chanie and Begashaw, 2012) which could be due to the plane topography and existence of more water lodged marshy pasture in Menz Lalo as compared to the current study area. The prevalence of bovine fasciolosis obtained in this study fall within the range of earlier prevalence reports (11% - 87%) in Ethiopia (Malone *et al*., 1998). The sensitivity of the sedimentation method used in this study, 73.9%, was higher than the 67.13%, 66.7% and 69% reports by Rahmeto *et al*. (2010); Anderson *et al*.( 1999) and Rapsch *et al*. (2006), respectively, which could be due to repeated examinations made in the present study as compared to the single sample examinations by the previous workers. Based on the regional epidemiology of the disease the following strategic deworming program was devised and recommended to control the infection in animals.

Two treatments of animals with products effective against young flukes (e.g. triclabendazole) in July and October, to eliminate the migratory juvenile flukes in the liver of animals before they cause serious liver damage.

Deworming of animals with products effective against adult flukes during the dry season of the year, January–February, to destroy adult parasites dwelling in the liver, and thereby to reduce pasture contamination by Ova of the parasite.

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