Epidemiology and economic importance of fasciolosis of domestic ruminants in selected districts of Tigray Region, Ethiopia

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Abstract

An epidemiological study on fasciolosis of domestic ruminants was conducted in four Districts of Tigray Regional State to determine prevalence, identify *Fasciola* species, assess risk factors and evaluate economic loss. A total of 1708 domestic ruminants were sampled for coprological investigation; in addition 236 slaughtered ruminants were examined at post mortem. The overall prevalence of fasciolosis in domestic ruminants was 21.2% (95% CI: 15.8-26.9%) and 32.6% (95% CI: 29.7–35.6%) based on coprology and post mortem examinations, respectively. The prevalence in cattle, sheep and goats was 25.3%, 35.7% and 11.4% respectively, based on coprology. The highest prevalence was recorded in Ofla District (41.9%) and the lowest in Alamata District (10.8%). The prevalence was higher in the highland (67.9%) than the midland (17.4%) and the lowland (14.4%); aged animals, and in poor than good body condition in all species. The prevalence of *F. hepatica* was 73.1% and 62.7%, and *F. gigantica* 26.9% and 37.3% by egg and fluke examination, respectively. Statistically significant difference was observed in prevalence among districts, animal agro-ecology, age, and *Fasciola* species ($p<0.05$); while no significant association was observed between sexes in animal species ($p>0.05$). The odd of having fasciolosis in the highland than the lowland was more than 4 times higher (OR= 4.77), similarly the risk in sheep compared with goats was higher by more than 4 times (OR=4.33). During the five years period, out of 11,966 inspected livers, 22.62% were condemned due to fasciolosis. The annual direct and indirect economic loss incurred due to fasciolosis in the study area was estimated to be 286,536.21 Ethiopian Birr (31837.36 USD). Out of the total losses 80.9% was from cattle. The present study revealed a high infection of domestic ruminants by *Fasciola* species especially in the highland resulting in huge economic losses, hence, intervention to mitigate fasciolosis is required.

Keywords: Coprology, *Fasciola* spp, Risk factors, Post-mortem, Prevalence, Tigray Region

Introduction

In Ethiopia, helminthosis ranks as the major constraint to animal production causing anemia, diarrhea, and emaciation resulting in reduced weight gains, increased production cost and mortality (Tembely, 1998). Fasciolosis is among the prevalent parasitic diseases, which affects all domesticated animals and humans, inducing significant morbidity, mortality and reduction of livestock products resulting economic losses (Scott, 2003). Domestic ruminants like cattle, sheep and goats are more susceptible compared to other domestic animals (Schoenian, 2003).

Infection of domestic ruminants with *Fasciola hepatica* and *F. gigantica* causes significant economic losses to the agricultural sector worldwide (Hillyer and Apt, 1997). In addition, fasciolosis was recognized an important human health problem (Chen and Mott, 1990). In Africa the prevalence of *F. hepatica* ranges from 10.4 to 23.8% and *F. gigantica* up to 65.2% in domestic ruminants (Torgerson and Claxton, 1999). The prevalence of fasciolosis in Ethiopia ranges from 30 to 90% (Spithill *et al*., 1999). The abattoir prevalence of fasciolosis in domestic ruminants at Mekelle was 26.1% (Takele Abayneh and Feseha Gebreab, 2002). The annual financial loss due to endoparasitism, including fasciolosis, in Ethiopia is estimated to be about 700 million Birr (78 million USD) while decreased productivity alone due to bovine fasciolosis was estimated at 300 million Birr (33 million USD) (Ngategize *et al*., 1993).

In Tigray Region irrigated landmasses are increasing and farmers are rearing their animals in these marshy and wet areas creating potentially favourable ecology for fasciolosis. A systematic epidemiological field study on fasciolosis in cattle, sheep and goats were not conducted to date in the region. The objectives of this study, hence, were to determine prevalence, identify the species of *Fasciola*, assess major risk factors and evaluate financial losses due to fasciolosis in selected districts of Tigray region.

Materials and Methods

Study area

The study was conducted in four Districts in Tigray regional state, northern Ethiopia from September 2007 to May 2008. The Districts selected were Atsibi womberta and Ofla (highland), Hintalowejerat (midland), and Alamata (lowland). The abattoir survey was conducted in three abattoirs namely Korem, Alamata and Atsibi-endasilasie where animals were brought for slaughter from the study districts as verified by asking animal source from traders and abattoir registration. The climate is characterized by tropical and subtropical conditions. The mean ambient temperature varies from 13.75^{o}C to 21.25^{o}C and the mean annual rainfall from 500 to 900 mm. In all the districts there is an intensive microdam construction intended for potable water supply, irrigation and to increase the ground water level. The soil type in the highland areas is moderately light dark brown clay soil capable of holding water. Most of the lowland area is without water except during the rainy seasons; however, a few permanent water bodies exist.

Study animals

For coprological investigation study animals consisted of indigenous breeds of cattle, sheep, and goats that are kept under traditional extensive husbandry system with communal grazing of animals of different sex and age groups were selected, while for postmortem examination animals of these species slaughtered in three slaughterhouses, mentioned above, and one restaurant were considered.

Study design and sampling methods

Purposive sampling was conducted to select districts with irrigated lands while multistage random sampling was used to identify districts, kebeles and village by acquiring their lists from local administration, which were used as a sampling frame to select districts and study animals later, (Thrusfied, 2005). Accordingly, proportional sampling was used based on district's animal population. Thus, a total of 1708 animals consisting of 1015 cattle, 526 sheep and 167 goats were sampled from the three agro-ecological sites estimated at5% absolute precision, 95% confidence level and estimated fasciolosis overall prevalence of 26.1% (Takele Abayneh and Feseha Gebreab, 2002). In all the study areas, the dominant species of animals were indigenous breeds of cattle, sheep and goats with proportion ratio of 0.62, 0.27 and 0.11, respectively (Takele Abayneh and Feseha Gebreab, 2002). Based on the livestock population proportion of the study areas, 434 animals were taken from Atsibiwomberta, 418 from Ofla, 443 from Alamata and 413 animals from Hintalowejerat Districts. Ages of cattle, sheep and goats were determined according to Nicholson and Butterworth (1986), Gatenby (1991) and Mike (1996), respectively while body condition scoring of cattle, sheep and goats was done following techniques recommended by Nicholson and Butterworth (1986), Gatenby (1991) and Mike (1996), respectively.

A total of 211 slaughtered animals from Korem (Ofla District), Alamata (Alamata District) and Atsibi-endaselasie (Atsibiwomberta District) slaughterhouses were considered for post mortem examination. Furthermore, 21 sheep livers obtained from restaurants at Adigudom town (Hintalowejerat district) were examined. Post mortem investigation was conducted to evaluate fluke burden, identify *Fasciola* species and determine prevalence. To assess rate of liver condemnation and economic losses a five years abattoir data (July 2004 to May 2008) was collected and analyzed from all the districts in the study areas.

Coprological examination

Faecal samples were collected directly, from the rectum of the animals, into a clean universal bottle. Examination of faecal samples for *Fasciola* species was made according to the methodology described by Hendrix (1998) and Hansen and Perry (1994). The sedimentation technique was used for all the samples. For *Fasciola* species identification three to four eggs were measured using micrometer at Tigray regional veterinary laboratory. According to Soulsby (1986), an egg size of 130-150 μm in length by 60-90 μm width is *F. hepatica* and 156 -197 μm length by 90-104 μm width is *F. gigantica.* Size overlapping was avoided by taking the larger measurement from each microscopic field. To exclude eggs of *Paramphistomum* species the method of Hansen and Perry (1994) was followed.

Post mortem examination

The liver of each animal was removed, incised or sliced and soaked in saturated salt solution (Hendrix, 1998). *Fasciola* species were identified by measuring the size of flukes according to Soulsby (1986). Categorization of the pathological lesions observed in the affected livers was based on the work of Ogunrinade *et al.,* (1980) as lightly affected, if small portion of the organ is affected and only one bile duct is enlarged on the visceral surface of the liver, moderately affected, if half of the organ is affected and two or more bile ducts are enlarged, and severely affected, if most of the organ is affected and the liver is cirrhotic.

Assessment of financial loss

Economic loss due to fasciolosis in this study was estimated by computing and combining direct loss (condemned liver) and indirect loss (carcass weight loss).

Annual animal slaughter was taken from slaughterhouse records of the last five years, including the study period. The retail market prices of an average sized liver of zebu cattle, local breed sheep and goats was taken from local butchers and restaurants in the study areas. Direct economic loss was then computed based on the work of Ogunrinade *et al*., (1980) as: *ALC= CSRxLcxP* (where: ALC is annual loss from liver condemnations; CSR is mean annual cattle, sheep and goats slaughter in the abattoirs in the study areas; Lc is mean cost of a liver in the slaughter areas; and P is prevalence of fasciolosis).

Hope Cauwdery et al. (1977) and Coop and Skyes (1977) reported a 8-9% and 26% carcass weight loss due to fasciolosis in cattle and sheep and goats, respectively. Average carcass weight of Ethiopian zebu cattle is taken as 126 kg (ILCA, 1991) while 10 kg for Ethiopian sheep and goats (Alemu Yami and Merkel, 2010). The annual carcass weight loss due to bovine fasciolosis was then assessed using the formula set out by Ogunrinade *et al*., (1980) as: *ACW= CSRxCLxBCxP* (Where: ACW is annual loss from carcass weight; CSR is average number of cattle slaughtered per year in the study area; CL is carcass weight loss in individual cattle due to fasciolosis; BC is average market price of beef per kilogram in the study areas; and P is prevalence of fasciolosis in the study area). Hence, the total economic loss due to fasciolosis in the study area was estimated from the *summation of ALC+ACW*. Similar methodology was followed to estimate direct and indirect economic losses for sheep and goats. The economic analysis was conducted by taking the average cost of one liver for 32.00 Birr, average cost of one kilogram carcass for 36.00 Birr, and prevalence of fasciolosis in Korem and Atsibiwomberta of 48.3%, and in Alamata 13.2% for the year 2008 (calculated in the exchange rate of 1 USD=8.8 ETB in June 2008).

Data analysis

All data obtained from field coprology, post mortem and retrospective investigations were coded and entered in Microsoft Excel. Descriptive statistics and graphs were generated using SPSS (version, 15.0). Both overall and specific prevalences of fasciolosis were determined. The specific prevalence rate was determined by district, agro-ecology, species of animal, species of Fasciola, Seoason, sex, age (less than 2 years, 2-3 years and more than 3 years), and body condition based on coprology. Prevalence of fasciolosis was computed by dividing positive animals, with eggs or flukes, by animals examined. Economic loss due to fasciolosis was estimated using the method of Ogunrinade et al., (1980). Univariate and multivariate analyses using SPSS was applied to investigate the association between presence of *Fasciola* eggs with risk factors of district, agro-ecology, species of animal, species of *Fasciola*, season, sex, age and body condition.

Results

Prevalence of fasciolosis by coprology

Out of 1708 faecal samples examined in domestic ruminants 362 (21.2%) (95% CI: 15.8-26.9%) were positive for *Fasciola* eggs (Table 1).

Table 1. Prevalence of fasciolosis in the four Districts on the basis of coprology

District	Animal species	Number of animals examined	Prevalence (%)	95% CI of prevalence
Ofla	Cattle	233	45.0	39.0 - 51.0
	Sheep	150	43.3	35.3- 51.3
	Goats	35	2.0	0.24- 7.0
Atsibiwomberta	Cattle	175	25.7	19.7 - 31.0
	Sheep	211	46.0	39.0 - 53.0
	Goats	48	18.7	7.7 - 29.7
Hintalowejerat	Cattle	308	22.1	17.1 - 27.1
	Sheep	83	20.5	12.5 - 28.5
	Goats	22	0.0	
Alamata	Cattle	299	13.0	9.0 - 17.0
	Sheep	82	13.4	6.4 - 20.4
	Goats	62	4.8	3.5 – 6.3
Overall		1708	21.2	15.8– 26.9

The prevalence was significantly different among districts and agroecology ($p<0.05$) (Table 2). The highest prevalence was recorded in Ofla (41.9%) and the lowest in Alamata district (10.8 %). The highest prevalence was observed in sheep (35.7%). The prevalence in cattle and goats was intermediate being 25.3% and 11.4%, respectively.

Table 2. Coproscopic prevalences of Fasciolosis in function of geographic risk factors in univariate analysis (n=1708)

Risk factor		No. examined	Prevalence (%)	95 % CI	p-value
District:	Ofla	418	41.9	36.9-46.9	0.000*
	Atsbi womberta	434	34.8	30.8-38.8	
	Hintalowojerat	413	19.8	15.7-23.8	
	Alamata	443	10.8	8.1.5-13.8	
Agro ecology:	Highland	852	67.9	64.9- 70.8	0.000*
	Midland	413	16.8	14.7 -19.7	
	Lowland	443	13.9	11.8- 15.8	

*Significant at P = 0.05

Significant difference ($p<0.05$) in prevalence of fasciolosis was observed among the three agro-ecological zones. The highest prevalence of fasciolosis was recorded in the highland (67.9%) than the midland (16.8%) and the lowland (13.9%). Mean while, *F. hepatica* (73.1%) was significantly abundant ($p < 0.05$) than *F. gigantica* (26.9%) in the study areas. *F. hepatica* was common in the highland areas (61.07%) while *F. gigantica* was detected commonly in the lowland (11.6%) (Table 2).

No significant ($P> 0.05$) difference in prevalence of fasciolosis was observed between female and male animals. However, the prevalence of fasciolosis significantly ($p< 0.05$) varied among different age groups. The highest prevalence was recorded in animals aged 2 to 3 years and greater than 3 years (Table 3). Lower prevalence was observed in all ruminant species less than 2 years. The prevalence of fasciolosis in poor and good body condition groups was 31.7% and 16.9% for cattle, 47.4% and 24% for sheep, and 12.9% and 7.5% for goats, respectively (Table 3). Significantly lower prevalence was recorded in animals with good body condition compared to animals with poor body condition.

Table 3. Specific prevalence by risk factors based on coprology and association with fasciolosis by univariate analysis (n=1708).

Risk factor		No. examined	Prevalence (%)	95 % CI	p-value
Age:					
Cattle	< 2 years	308	22.4	17.8 – 27.0	0.000*
	2 -3 years	340	36.7	31.7 – 41.7	
	> 3 years	367	23.7	19.7 – 27.7	
Sheep	< 2 years	152	25.7	19.7 – 31.7	0.000*
	2 -3 years	159	41.5	34.5 – 48.5	
	> 3 years	215	38.6	32.6 – 44.6	
Goats	< 2 years	52	9.6	1.6 – 17.6	0.837
	2-3 years	61	13.1	5.1 - 21.1	
	> 3 years	54	11.1	3.1 – 19.1	
Body condition:					
Cattle	Poor	341	31.7	27.9 – 35.7	0.000*
	Medium	378	26.2	22.2 – 30.2	
	Good	296	16.9	12.9 – 20.9	
Sheep	Poor	192	47.4	40.4 – 54.4	0.000*
	Medium	180	33.3	27.3 – 39.3	
	Good	154	24.0	18.0 – 32.0	
Goats	Poor	54	12.9	4.9 – 20.9	0.567
	Medium	60	13.3	5.3 – 21.3	
	Good	53	7.5	0.5 – 14.5	

*Significant at P = 0.05

Prevalence of fasciolosis by post mortem survey and fluke burden

Out of 236 inspected livers 32.6% (95% CI: 29.7-35.6%) harboured *Fasciola* species. The highest infection was observed in sheep (37.2%) (Figure 1).

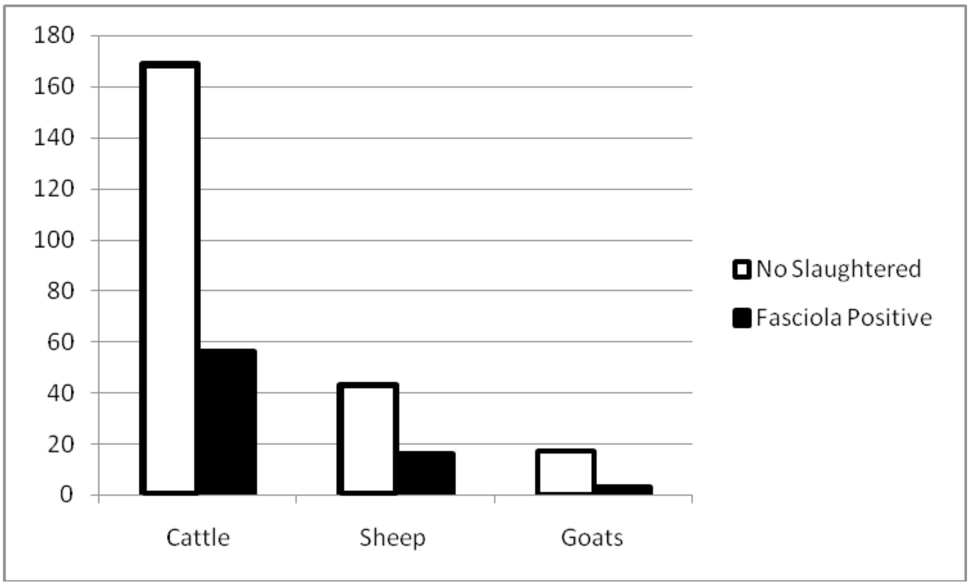

Figure 1: Intensity of liver fasciolosis infection in the study animals.

F. hepatica and *F. gigantica* were observed in 62.7% and 37.3% of inspected livers, respectively. Significantly higher prevalence of *F. hepatica* was observed in highland where as there was no significant difference in *F.gigantica* in function of agro-ecology (Table 4). The mean adult fluke burden in the liver was 73.47 ± 7.30. The parasite burden in severe, medium and lightly infected livers was 99.56 ± 13.96, 63.38 ± 8.88 and 53.36 ± 13.02, respectively.

Table 4. Prevalence of *Fasciola* species by post mortem examinations in different agro-ecologies

	Agro-ecology	Examined animals	Prevalence	95% CI	P-value
Fasciola spp:					0.000*
F. hepatica	Highland	284	61.07	60.1-62.0	
	Midland	42	9.03	8.5-9.6	
	Lowland	14	3	0.6-8.5	
F.gigantica	Highland	32	6.9	5.4-8.7	
	Midland	39	8.4	6.7-10.3	
	Lowland	54	11.6	9.7-13.7	

*Significant at P = 0.05

Risk factors for fasciolosis

Agro-ecology, animal species, body condition, and season were associated with fasciolosis ($p<0.05$) using multiple logistic regression (Table 5). The risk of having fasciolosis was more than 4 times higher in the highland than the lowland (OR= 4.77), similarly the risk of having fasciolosis in sheep compared with goats was higher by more than 4 times (OR=4.33). The risk of acquiring fasciolosis in the late rainy season is higher by almost 2 times (OR= 1.7) than the dry season.

Table 5. Multivariate analysis of the association between risk factors with occurrence of fasciolosis

Risk factors		ß	P-value	OR	95.0% CI for OR
Agroecology.	HL vs. LL	1.60	0.000	4.77	3.44-6.52
	HL vs. ML	0.90	0.000	2.44	1.85-3.20
	ML vs. LL	0.70	0.000	1.90	1.3-2.80
Species	Sheep vs. cattle	0.50	0.000	1.64	1.30-2.06
	Sheep vs. goats	1.50	0.000	4.33	2.60-7.21
	Cattle vs. goats	0.70	0.000	2.90	1.6-4.35

OR = odds ratio, ß = coefficient of regression, HL= highland, LL= lowland, ML= midland

Economic loss

A total annual mean loss of 286,536.21 Ethiopian Birr per (31837.36 USD) was incurred in the study area. More than one out of five livers (22.6%) was condemned due to fasciolosis alone in this study.

Discussion

The occurrence of fasciolosis was high in Tigray Region. The high annual rainfall at Ofla and Atsibiwomberta districts combined with the construction of multiple microdams in Hintalowejerat and Atsibiwomberta districts could be factors responsible for the perpetuation of the intermediate host and hence fasciolosis. Most of the Ethiopian highlands contain pockets of waterlogged marshy areas, which provide suitable habitats year round for the snail intermediate host (Kifle Argaw, 1998). On the other hand, at Alamata District located in the lowland due to the long dry season and hot climatic condition occurrence of the disease was low. The overall prevalence of fasciolosis in this study agrees with reports by Takele Abayneh and Feseha Gebreab (2002) done at Mekelle abattoir in the same region. However, the prevalence in this study was much lower when compared with findings of Malone and Yilma Jobre

(1998) in other parts of Ethiopia. The difference might be due to variations in climate and ecology, which are needed for the development of the snail intermediate hosts, season. Differences in prevalence were observed in various geographical regions depending on the local climatic conditions, availability of permanent water, density of livestock population, specific ecological niches, breed resistance, concurrent infection with other parasites and immunity (Torgerson and Claxton, 1999).

The relative proportion of *Fasciola* species identified was not in agreement with the observation of Takele Abayneh and Feseha Gebreab (2002) who found *F. hepatica* in 15.9% and *F. gigantica* in 57.2% of livers examined. The difference is that since their study was abattoir based most of the cattle for slaughter might majorly originate from the lowland areas. The current study, however, was conducted on sampled animals selected from all types of agroecological zones.

The high prevalence observed in sheep and cattle might denote the frequency of grazing and grazing behavior as well as susceptibility (Torgerson and Claxton, 1999). Though goats are browsers and prevalence of fasciolosis was low, the reasons of accessing the larvae might be scarcity of feed to be browsed due to declining vegetation cover and goats forced to graze around watering points and irrigated lands.

In this study a higher infection rate was observed in older animals. Cowdery (1984) reported that cows and bulls have higher condemnation rate of livers than younger bullock and heifers. In the central highlands of Ethiopia young animals are not often driven with older animals to watering points and pasture because of extended lactation period and due care provided to them, rather are kept near their homestead where the feed is less contaminated. On the contrary Torgerson and Claxton (1999) and Solomon Woldemariam (2005) reported that as the age of cattle increases the incidence decreases due to development of resistance.

The increase in coprological prevalence during the late rainy season might be related to the high number of metacercariae intake. On the other hand, the dry season is characterized by low ambient temperature which is not favourable for the snail intermediate host (Andrews, 1999). The peak of the *Lymnaea* species population is high at the onset of spring and shortly after the heavy rains.

During the dry season, when there is a reduction in moisture in the habitat, the snail population reduces.

The loss of body condition in fasciolosis is due to damage to liver tissue during migration, anemia and loss of plasma proteins. Contrary to the findings in this study other authors reported that in cattle no significant difference was detected between fasciolosis and loss of body condition (Solomon Woldemariam, 2005). Conversely inadequate nutrition may render animals to be susceptible to fasciolosis. Sheep of poor body condition are vulnerable for parasitic diseases (Devendra and Marca, 1982).

Agroecology (OR=4.77) and season (OR=1.7) are found to be strongly associated with the occurrence of fasciolosis. Ideally, by protecting animals from grazing around water logging areas, micro dams, marshes or pockets of water, the level of fasciolosis can be reduced. The reduction can be further increased by treating infected animals twice a year before and after the rainy season.

A total annual mean loss of 286,536.21 Ethiopian Birr per (31837.36 USD) was incurred in the study area. More than one out of five livers (22.6%) was condemned due to fasciolosis alone in this study. Financial loss analysis accounts in addition mortality and cost of treatment, reduced reproductive performance and decreased host resistance (Fabiyi and Adepeye, 1982). However, in this study financial loss due to fasciolosis was calculated from liver condemnation and carcass weight loss only, hence, the actual loss could be even higher.

In conclusion, this study showed that the prevalence of fasciolosis and the resultant financial loss was high in the study districts, especially in the highland, warranting improvement of the health services including strategic treatment of ruminants and control of the snail intermediate host.

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