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RESEARCH ARTICLE

STILESIA HEPATICA IN SMALL RUMINANTS: PREVALENCE, RISK FACTORS AND FINANCIALLOSS ANALYSIS ATTRIBUTEDTO LIVER CONDEMINATION AT ABYSSINIYA EXPORT ABATTOIR, BISHOFTU, CENTRAL ETHIOPIA

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ABSTRACT

*Stilesia hepatica*is a tapeworm parasite having sheep, goats, other livestock and numerous wild ruminants as final hosts. Though non-pathogenic even in massive infection, it causes marked economic loss due to liver condemnation at abattoir due to aesthetic reasons. No matter how the disease is economically important, research data pertaining to the parasite is by far limited. Therefore, a cross sectional study was conducted from November 2018 to April 2019 at Abyssiniya abattoir, Bishoftu, on 480 sheep and goats (240 sheep and 240 goats) originated from Borena zone of Oromia region in an attempt to determine the prevalence of *Stilesia hepatica*, risk factor and to estimate financial loss incurred due to liver condemnation. Ante-mortem physical examination, incision and inspection, microscopic examination and financial loss analysis methods were employed to study the parasite and assess losses associated to it. *Stilesia hepatica* is characterized by whitish color, dorso-ventrally flattened, externally rectangular segmented body. The parasite was measured and found to have an average length of 62cm and an average width of 3mm. SPSS v20 statistical tool was applied to analyze the data. Statistically, the overall prevalence of *Stilesia hepatica* on both sheep and goat was determined to be53.1%. Moreover, the prevalence of the parasiteby animal specieswas calculated for goats and sheep to be 48.3% and 57.9%, respectively. Species of animals and body condition scores were found to be significantly associated (P< 0.05) with the disease and had strong association in between the risk factors with parasite development. The present study has also indicated the annual financial loss attributed to the parasite to be 168,300 ETB or 5,807.45 USD. In conclusion, higher rate of parasitic infection and huge financial loss was observed during the study period urging for action or prevention.

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INTRODUCTION

Livestock, in Ethiopia represents a major national resource (Zeryehun *et al*., 2013) and it provides great chip-in to Ethiopia's national economy and smallholder farmers in providing services, ensuring food security, generating income to farmers, creating job opportunities, and sustains livelihoods (Behnke, 2010). According to Metaferia *et al*. (2011), and Duressa *et al*. (2014), the subsector kick-in about 16.5% of the national Gross Domestic Product (GDP), 35.6% of the agricultural GDP, 15% of export earnings and 30% of agricultural employment.According to the reports CSA (2017), the total livestock population in Ethiopia was estimated as 59.5 million cattle, 56.53 million heads of chicken, 30.70 million sheep, 30.20 million goat, 8.44 million donkeys, 2.16 million horses,1.21 million camels, and 0.41 million mules, are widely distributed across the different agro-ecological zones of the country.Small ruminants are the most important livestock species that have considerable importance to the GDP of the country (Metaferia *et al.*, 2011). They provide animal protein to improve the nutritional value of the people, manure for farm yard to improve the soil fertility, covers more than 30% of all domestic meat consumption and generate cash income from exports of live animals, skin, meat carcass and edible organs, (FAO, 2009). Also, they have advantages over large ruminants for most smallholder farmers such as fewer feed costs, quicker turnover, easily manageable and appropriate size to handle at slaughter (Abegaz, 2002). Despite the large number of small ruminant population in the country and its contribution much to the national economy, their potential uses were hindered by a number of complex and inter-related factors such as uncontrolled widespread disease, poor and inadequate feed, poor husbandry, poor and insufficient infrastructure, shortage of trained manpower, and lack of government policies on disease prevention and control (Negassa, 2011).

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Both infectious and parasitic diseases cause extensive financial losses due to their direct and indirect economic impacts; as a result, it became a major concern to small ruminant industry (Jibat, 2006). Vast numbers of parasitic diseases cause not only a clinical disease and mortalities but also, play a detrimental role in hampering small ruminant production leading to serious economic loss through production losses, inferior weight gain and condemnation of whole carcass and edible organs at slaughter (Eblewengel, 2007). Helminthiasis, especially Parasitic Gastro-Enteritis have a serious health threat and limitation to the productivity of the small ruminants throughout the world due to associated morbidity, mortality, and cost of treatment and control measures especially in developing countries. Among, the helminthic parasite that causes immense direct and indirect losses in domestic small ruminant is*Stilesia hepatica* (Silvestre *et al*., 2000). *Stilesia hepatica* is known as liver tapeworm with taxonomy class of Kingdom-Animalia, Phylum-Platyhelminthics, Class-Cestoda, Order-Cyclophyllidea, Family-Anoplocephallidae,

Geneus-Stilesia and species *Stilesia hepatica*. It is an extremely common cestode parasite (90-100%) in sheep in many parts of Asia, Africa (South Africa) including Ethiopia) with poorly understood epidemiology (Kaufmann, 1996). The adult parasite is found in the bile duct of sheep and goat as well in wild ruminants in large number at slaughter and causes neither clinical sign nor significant hepatic pathology but sometimes liver may show mild cirrhosis with thickening of the bile duct. It affects animals of all age and is considered non-pathogenic. Heavy infections are frequently seen in apparently healthy sheep and goat with almost complete occlusion of the bile duct, icterus, and other signs are not observed in live animals. The life cycle of the parasite is not fully understood but wild animals are considered as their natural reservoir of this parasite and play an important role in its epidemiology. The infection causes a considerable economic loss because infected livers are condemned at the abattoir for aesthetic reasons (Hansen and Perry, 1994). So, this parasite causes significant loss to farmers, butchers, and consumers. It leads to the destruction of the liver of an affected animal. There are other additional losses such as poor carcass quality and quantity due to disruption in liver functions in animals infected with the parasite. It is also a major cause of concern in the trade of small ruminants (Mungube *et al*., 2006). Various Slaughter surveys conducted so far in different abattoirs have intended mostly to estimate the prevalence and economic significance of organ and carcass condemnation in Ethiopia, majority of them have paid more attention to parasitic infection such as Fasciolosis and Hydatidosis commonly on cattle (Jembere, 2001; Yilma, 2003).Though economically important, research data pertinent to *Stilesia hepatica* on small ruminants is unavailable to our knowledge in Ethiopia.Moreover, in Ethiopian context, morphological details of *Stilesia hepatica* have not elucidated yet. Therefore, the objectives of the present study were to estimate the prevalence of *Stilesia hepatica* on small ruminants slaughtered at Abyssinya export abattoir, assess risk factors associated with the parasite andestimate magnitude of financial loss attributed to parasitic infection of liver.

MATERIALS AND METHODS

A cross sectional study was conducted in Bishoftu Town, Ada'a District in East Shewa Zone of Oromia Regional State from November 2018 to April 2019.

The town is located in the central part of Ethiopia, 47-kilo meter southeast of Addis Ababa. Geographically it is stretched between 8°43' North – 8°48' North latitude and 38°00' East – 38°48' East longitude. Moreover, the town is suited in tepid to cool sub-moist mid highland at an average altitude of about 1920 meters above mean sea level with moderate weather condition. The temperature of the area ranges from 16°C to 24°C (OUPI, 2009). The town has a number of abattoirs of which Abyssinia export abattoir is the one which this study had conducted. It is a private owned export abattoir established in 2013 G.C with a total investment of birr 120 Million and exporting cattle, goat, sheep meat to Middle East countries. The abattoir slaughtered male goats and sheep obtained from Borena according to Islamic Religion so called "Halal". It has almost all the required facilities stocking pen, unloading ramp, lairage, slaughter hall, refrigerator room, water supply, electricity, telephone, veterinary office, laboratory, administration office, waste disposal and its head office is located in Addis Ababa, Bole Sub City (CSA, 2011).

Study population: The study was carried on small ruminants slaughtered at Abyssiniya export abattoir. All study animals were male and indigenous breeds of sheep and goats which were brought from Borena zone of Oromia region, Southeastern Ethiopia.

Sampling methods and sample size determinationSystematic random sampling and purposive sampling technique were used to select the study units and the abattoir respectively. The study abattoir (Abyssiniya) was selected purposively for study convenience (easily accessible, absence of previous investigation at the abattoir and comfortable working time (day time slaughter). However, the study units were selected applying systematic random sampling method (selecting an animal at a regular interval of K=5). Hence, to determine the total number of sheep and goats to be included in the study, Thrusfield (2005) formula was applied.

$$N = \frac{(1.96)^2 \times (\text{Pexp}) \times (1 - \text{Pexp})}{\text{d}^2}$$

Where,

N= required sample size, 1.96 = the value of 'Z" at 95% confidence interval.
P_{exp} = expected prevalence.
d = desired absolute precision of ± 5%.

Therefore, applying all the variables into the above formula, using previous prevalence of 32.3% (Muleta and Mekonnen, 2017) in ELFORA industrial export abattoir with 95% CI and P value less than 5%, the total number of study animals was calculated to be 336. However, the total number of study animals was increased to 480 to boost the level of study precision.

Methodology

Ante-mortem examination: During ante mortem examination, the study units were selected using systematic random sampling and categorized as medium and good body condition physically by observation based on body condition score criteria seated by Suiter (2006).Then ropes which have different colors (blue for good body condition and red for medium body condition) for body condition and species of the

animals were tied on their hind leg, for the selected units immediately at the entrance of the slaughter hall. After evisceration, ropes were tied on the liver of the identified animals. Finally, ropes containing liver were placed separately into two kasa according to their body condition score category.

Liver inspection and parasite collection: Livers identified with colors (red and blue) were placed at organ examination room and each liver having rope was consciously visualized by making systematic longitudinal incision on the bile ducts to detect the presence of *S.hepatica*. Of those livers found with *S.hepatica*, the parasite was collected carefully and placed it into a caped plastic bottle containing 10% formalin.

Laboratory examination: Bottles containing parasitic samples were transported to Addis Ababa University College of Veterinary Medicine and Agriculture, Veterinary Parasitology Laboratory. Microscopically, *S. hepatica* from positive samples was characterized morphologically and length & width of the parasite was measured using meter.

Assessment of direct financial loss due to liver condemnation: To assess direct economic loss, liver condemnation was considered. The total annual financial loss analysis was conducted by multiplying the average number of sheep and goats slaughtered annually at the Abattoir by the prevalence of *S.hepatica* obtained from the present survey (rejection rate) and mean market price of liver in Bishoftu town. Average market price of liver was determined by interviewing personnel of the abattoir, marketing department and retailors or hotel owners. Based on information from all sources, the average market price of sheep and goat liver was found to be 11.00 ETB. The total financial loss was quantified in terms of Ethiopian currency (birr) and USD. Financial loss was computed mathematically by using the formula of Ogurinade and Ogurinade (1980) for liver rejection as follows:

$$EL = \sum Srx.Coy.Roz$$

Where:

EL= Estimated annual economic Loss due to organ and carcass condemnation from international or domestic market.
S_{rx} = Annual sheep/goat slaughter rate of the abattoir.
C_{oy}- Average cost of each sheep/goats liver.
R_{oz}- Condemnation rates of sheep/goats liver.

Data management and analysis: The data for this study was gathered and recorded according to the prepared data recording format sheet. Then, all data generated from the post-mortem inspection of livers during the study period was entered into MS Excel spreadsheet and then exported into SPSS V20.

Descriptive statistics was computed to find prevalence, frequency and other related outputs.Pearson's chi-square ($\chi 2$)test was employed to determine the existence of association between the parasite occurrence and risk factors with 95%CI and P value less than 5%. Both bivariate and multivariate logistic regression analyses were computed to measure the strength of association between the parasite occurrence and risk factors at 95%CI and P value less than 5%.

RESULTS

Descriptive statistics: In the present study, a total of 480 animals (240 sheep and 240 goats) were studied both ante-mortally and post-mortally. Data obtained during the study were computed using descriptive statistics and the numeric computations were summarized in Table 1.

Table 1. Descriptive summary of S. hepatica

Variable		Frequency(N)	Percentage (%)
Body condition			
Species			
	Goat	240	50
	Sheep	240	50
Total		480	100

Table 2. Prevalence of *Stilesia hepatica* in Abyssiniya export abattoir, Bishoftu

Variable	No of animals examined	Test result
Species		Positive (%)
Goat	240	116 (48.3)
Sheep	240	139 (57.9)
Total		255(53.1)

Table 3. Summary ofassociation analysis

Variable	No of animals examined		Test result Positive (%)	Pearson's Chi-Square ($\chi 2$)	P-value
Species Goat		240	116 (48.3)	4.426	0.03
Sheep		240	139 (57.9)		
Body condition					
Medium		314	180 (57.3)	6.431	0.01
Good		166	75 (45.2)		

Prevalence of Stilesia hepatica: Of the 480 study animals (240 sheep and 240 goats), a total of 255 (116 goats and 139 sheep) were found to harbor the parasite providing an overall prevalence of 53.1%. Prevalence by study animals was also computed to be57.9% and 48.3% for sheep and goat respectively (Table 2).

The present study has also shown a higher prevalence in sheep compared to goats. A higher prevalence of infection with *S.hepatica* was recorded in medium body condition (57.3%) than good body condition (45.2%).

Analysis of risk factors: To assess the existence of association between parasitic infection and risk factors, Chi-Square ($\chi 2$) analysis was employed and indicated a statistically significant association ($p<0.05$: 0.035) between study species and the parasite. Similarly, a statistically significant association ($P< 0.05$: 0.011) were observed between body condition of study animals and *S.hepatica* infection as shown in (Table 3).

Bivariate and multivariate logistic regression analysis: The strength of association observed between the parasite and risk factors, was further analyzed employing both bivariate and multivariate logistic regression analysis tools using 95%CI and P less than 5%.

Table 4. Bivariate and multivariate logistic regression analysis of factors associated with S.hepatica

Variable	Test result		Bivariate logistic regression analysis		Multivariate logistic regression analysis	
	Negative	Positive	COR (95%CI)	P-value	AOR(95%CI)	P-value
Species						
Sheep	101	139	1.47(1.03, 2.11)	0.036*	1.498(1.04, 2.16)	0.029**
Goat	124	116	1		1	
Body condition						
Medium	134	180	1.630(1.12, 2.38)	0.011*	1.657(1.13, 2.43)	0.009**
Good	91	75	1		1	

COR = Crude Odds ratio; AOR= Adjusted Odds ratio; CI = confident interval; 1= Reference category ** = significant.

Table 5. Direct financial loss incurred annually due to S.hepatica infection

Organ Inspected	Annual Slaughtering rate	Rejection Rate	Average price of a liver	Annual Loss
Liver	28800 shoats	53.1% (**255**/480)	11 ETB	168,300 ETB or (5807.45 USD)

$EL = Srx.Coy.Roz$, $EL = [(28800).(11\ ETB).\left(\frac{255}{480}\right)]$=168, 300 ETB/ 5807.45 USD.

Accordingly, sheep were found to be 1.498 times more likely at risk to be infected by the parasite as compared to goats. Similarly, study animals (both sheep and goats) having medium body condition scores were found to be 1.657 times more likely at risk as compared to good body conditioned study animals (Table 4).

Direct financial loss analysis: The average daily and annual slaughter capacity of the abattoir was recorded to be 80 and 28,800 small ruminants, respectively. Based on these and market price of normal liver price, the direct financial loss due to liver condemnation attributed to the parasite was calculated by substituting the value of annual slaughtering rate (28,800), average cost of liver (11 ETB) and condemnation rate of 53.1% (255/480) into the formula given by Ogurinade and Ogurinade (1980). As a result, the total annual liver loss due to the parasite was estimated to be 168,300 ETB or 5,807.45 USD (Table-5) below.

S.hepatica morphology examination results: Morphometric measurements for 380 *S.hepatica* were performed at Addis Ababa University College of veterinary medicine and Agriculture veterinary parasitology laboratory during the study period and the parasite was found whitish in color, dorso-ventrally flattened, rectangularly segmented body, laterally arranged oval shaped structure called Para-uterine organ. Here, the segment was prominently visible to the hind. Its average length and width of the parasite was found 62cm and 3.3mm respectively.

DISCUSSION

The present study has provided an overall prevalence of *S.hepatica* in small ruminants slaughtered at Abyssiniya abattoir to be 53.1%. The present finding is in agreement with the reports of Anon (1986) and Mungube *et al.* (2006) who reported 51.5% in semiarid costal area of Kenya and 57% in Southern Africa, respectively. On the other hand, the current study has indicated a higher prevalence compared to a study by Zelalem *et al.* (2015), Mulugeta and Mekonnen (2017), Tesfaye *et al*. (2017), Dunn (1978), who reported a prevalence of 26.9% in HELMIX abattoir, 32.3% in ELFORA industrial abattoir, 28.37 % in Modjo modern export, 40% in Malawi, respectively. The variation in prevalence might be due to the narrowed interval (smaller k value) used which could have increased the probability of obtaining infected study units. Moreover, the variation could be due to season difference of study times, breed difference, agroecological difference and management type. However, the present finding was lower than the prevalence reported by Petisca*et al.* (1974) in Mozambique and Anon, (1976) in Republic of South Africa who recorded 96% and 90% prevalence, respectively. This variation could be due to the difference in agro-ecology of the country and difference in temperature, moisture and humidity and soil that might favor multiplication of the intermediate host, inadequate veterinary service, breed of species, and presence of highly contaminated pasture by infective stage containing oribatid mite, production and management differences. The odds of *S.hepatica* in sheep and goat in this study was found to be significantly higher in sheepthan goat (P<0.05:0.029). Sheep were found to be 1.498 times more likely at risk as compared to Goat for the parasite's infection. The present finding agreed with works of Ashenafi (2010), Sisay *et al*. (2008) and Mungube *et al*. (2006) reported statistically significant association (P<0.05) between study animals and the parasite. The higher infection in sheep might be due to grazing nature of sheep, which maximize the chance of ingesting the cysticercoids containing intermediate host, oribatid mite from the ground. Since, the intermediate host occupied the leaf litter and top layers of forest soil that cover the forest floor and moves slowly to small shrubs and grasses cause the sheep easily exposed. But, due to foraging habits of goats, the chance of obtaining the intermediate host from the ground is low. As a result the prevalence value is become low as compared to sheep. However, the current finding was in contrary to the finding of Muleta and Mekonnen, (2017), Tesfaye *et al.* (2017) in ELFORA and Modjo export abattoir respectively, reported as there was no statistically significant difference (P>0.05) on the prevalence of *S.hepatica* between sheep and goats. This contradiction may be due to goats' adoption of grazing on pasture the same to sheep's as the bush became dry during drought season. Management type (use of common grazing site) could be another reason. The small ruminants slaughtered during the study period had different body condition score. Body condition score had statistically significant difference (P<0.05:0.09). As result, study animals with medium body condition were found to be 1.657 times more likely at risk compared to good body conditioned ones. This finding is in contrary with the report of Muleta Legesse and Mekonnen Addis (2017), in ELFORA abattoir, as body condition did not have significant difference for the development of *S.hepatica*. This might be due to poor nutrition, low immunity level, computation in flock forces the medium body condition more susceptible by the parasite

compared to good body condition. The direct annual loss in Abyssiniya abattoir due to condemnation of affected livers due to *S.hepatica* infection was estimated to be 168,300 ETB or 5807.45 USB from international and domestic market. This estimation was lower than the estimate Zelalem *et al. (*2015) and Muleta and Mekonnen, (2017). This variation might be due to low total sample size taken, lower annual slaughter capacity of the abattoir, due to inefficient inspection and control of the parasite *(S.hepatica)* at farm level.

Conclusion

The present study has revealed a moderate range of *Stilesia hepatica* prevalence and indicated as species and body condition status to be influential predisposing factors for the parasitic occurrence. The study has also indicated that sheep were more at risk compared to goats and as medium body condition was a predisposing factor for parasite infection. Moreover, the study has revealed a significant financial loss due to the parasite implying a resolution to be set in place for parasite control.

Therefore based on the above conclusions, the following points forwarded

- Appropriate strategic deworming has to be designed and implemented at the source of small ruminant to minimize the effect of the disease on livestock productivity
- Regular training on meat inspection should be provided to meat inspectors to improve their knowledge and skill in diagnosing *Stilesia hepatica*
- Further epidemiological study should be conducted on *Stilesia hepatica* in sheep and goats.
- Awareness creation should be delivered for the livestock owner about the parasite.

Declarations

Ethics approval and consent to participate: We did our assessment on abattoir on slaughtered sheep and goats. Prior to execution of our work, we have had obtained full permission from Abyssinya Export Abattoirenterprise for live animal examination and liver study.

Consent for Publication: Not applicable

Availability of data and material: The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Authors' contributions:

We authors named WN and BA have read and approved the manuscript ahead of its submission

Abbreviations

AOD	Adjusted Odd ratio
CI	Confidence interval
COD	Crude Odd ratio
CSA	Central Statics Agency
ETB	Ethiopian Birr
FAO	Food and Agricultural Organizations
GDP	Gross Domestic Product
OUPI	Oromia Urban Planning Institute
SPSS	Statistical Package for Social Science
USD	USA Dollar
WHO	World Health Organization
$\chi 2$	Pearson's Chi-Square

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