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Fasciolosis: Prevalence, Evaluation of Flotation and Simple Sedimentation Diagnostic Techniques and Monetary Loss due to Liver Condemnation in Cattle Slaughtered at Wolaita Soddo Municipal Abattoir, Southern Ethiopia

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Abstract
Fasciolosis is a serious problem in Ethiopia when cattle rising are of major importance to the local economy. A cross-sectional study was carried out from November 2013 to March 2014 to determine the prevalence, to evaluate the specificity and sensitivity of the flotation and sedimentation tests for the diagnosis of fasciolosis and economic importance of fasciolosis using postmortem examination on a total of 500 cattle slaughtered at Wolaita Soddo municipal abattoir, southern Ethiopia. Out of the 500 cattle examined, 143(26.8%), 97(19.4%) and 55(11%) were positive for fasciolosis using liver inspection, sedimentation and flotation techniques respectively. Of the total (143) infected livers by fasciola species, *Fasciola hepatica* was the most prevalent one (46.1%) whereas *F. gigantica* , mixed and immature or undifferentiated forms of fasciola species recovered were 27.3%, 18.2% and 9.1% respectively. There was a statistically significant ($P < 0.05$) variation in prevalence between the study months where the highest (40.83%) and lowest (12%) prevalence were recorded in November and March respectively, and there were also a statistically significant ($P = 0.00$) variation was observed in the prevalence of fasciolosis among animals with poor (74%), medium (27.35%) and good (4.52%) body conditions. Statistically no significant variation ($P > 0.05$) in the prevalence of fasciolosis was observed based on the origin of the animals. The mean fluke burden in the affected livers was 52 flukes per liver. As to the liver severity of infection, from a total of 143 infected livers 30.8%, 52.4% and 16.8% were lightly, moderately and severely affected respectively. Taking liver examination as gold standard for diagnosis of fasciolosis, the sensitivity of the direct sedimentation technique was found to be 67.83% and the specificity was 100% with substantial agreement ($k = 0.75$) between the two methods and the sensitivity and specificity of flotation technique was found to be 38.46% and 100% respectively with moderate agreement ($k = 0.472$) between the two tests. The economic loss incurred due to condemned liver and carcass weight loss due to fasciolosis was estimated to be 3,564,990.00 ETB (187,631.053 USD) per annum. Thus, fasciolosis was proved to be widely distributed disease with relatively high prevalence and great impact on the economy. Therefore, more detailed study on ecology and biology of the snail and its effective control measures should be planned.
Keywords: Abattoir, Bovine, Fasciolosis, Monetary loss, Prevalence, southern Ethiopia

1. INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa. Among them the total cattle population for the country is estimated to be about 53.99 million. This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. It is eminent that livestock products and by-products in the form of meat, milk, cheese, and butter supply of the cattle which provide the needed animal protein that contribute to the improvement of the nutritional status of the people. Among livestock, cattle also play an important role in providing export commodities, such as live animals, meat and hides to earn foreign exchanges to the country (CSA, 2013).

Even if, they give these invaluable functions to the development of the county and improving the nutritional status of the people, the livestock production has been constrained by a number of factors including nutrition, diseases, government policies and socio cultural values and attitudes. The share of parasitic diseases in this regard has been of paramount importance. Parasitic infestations have been found to be the single most constraint in ruminant production in the tropics (Mulugeta *et al*., 1989). Among many parasitic problems of farm animals, fasciolosis is a major disease, which imposes direct and indirect economic impact on livestock production, particularly of sheep and cattle. *Fasciola hepatica* and *Fasciola gigantica* are the two liver flukes commonly reported to causes fasciolosis in ruminants. The life cycle of these trematodes involves snail as an intermediate host. Infected cattle can exhibit poor weight gain and dairy cattle have lower milk yield (Keyyu *et al*., 2005; Mihreteab *et al*., 2010).

Fasciolosis caused by the trematode *F. hepatica* is a worldwide parasitic disease and common in ruminants, especially in cattle, buffaloes, sheep, goats, and swine. It occasionally affects humans. Once ingested, parasites migrate through the liver parenchyma to reach the bile ducts. 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 (Sandra and Maria, 2003; Rahmeto *et al*., 2010).

The geographical distribution of trematode species is dependent on the distribution of suitable species of snails. The genus lymnaea in general and *L. trancatula* and *L. natalensis* in particular are the most common intermediate hosts for *F. hepatica and F. gigantica* respectively. *F.hepatica* has a cosmopolitan distribution, mainly in temperate zones, while *F. gigantica* is found in tropical regions of Africa and Asia. Different works so far conducted in Ethiopia reported variable prevalence rates of bovine fasciolosis in different localities of the country. *F. hepatica* was shown to be the most important fluke species in Ethiopian livestock with distribution of over three quarter of the nation except in the arid north-east and east of the county. The distribution of *F. gigantica* was mainly localized in the western humid zone of the country that encompasses approximately one fourth of the nation. In Ethiopia *F. hepatica* and *F. gigantica* infections occur in areas above 1800 m.a.s.l. and below 1200 m.a.s.l respectively which has been attributed to variations in the climatic and ecological conditions such as rain fall, altitude, temperature and livestock management system (Yilma and Malone, 1998; Tadele and Worku, 2007; Rahmeto *et al*., 2010).

Diagnosis of fasciolosis may consist of tentative and confirmatory procedures. A tentative diagnosis of fasciolosis may be established based on prior knowledge of the epidemiology of the disease in a given environment, observations of clinical signs, information on grazing history and seasonal occurrence. Confirmatory diagnosis; however, is based on demonstration of fasciola eggs through standard examination of feces in the laboratory; postmortem examination of infected animals and demonstration of immature and mature flukes in the liver. The latter is helpful in deciding the intensity of infection. For chronic fasciolosis, confirmatory diagnosis could easily carried out by coproscopic examination employing sedimentation technique. Fasciola eggs have high specific gravity and sedimentation is preferred to floatation. When the latter is employed, floating medium such as ZnSo4 should be used. As fasciola eggs may be confused with Paramphistomum eggs, addition of methyline blue in the feacal suspension will facilitate ease identification by providing a blue and contrasting microscopic field (Michael, 2004).

The economic losses due to fasciolosis throughout the world are enormous and these losses are associated with mortality, morbidity, reduced growth rate, condemnation of fluke affected liver, increased susceptibility to secondary infections and expense due to control measures. The total economic loss encountered due to condemnation of infected liver was 55,080.00 ETB per annum (Tadele and Worku, 2007).

Therefore, the objectives of this study were:

- To determine the prevalence of fasciolosis in cattle slaughtered at Wolaita Soddo municipal abattoir.
- To evaluate the specificity and sensitivity of the flotation and sedimentation tests for the diagnosis of bovine fasciolosis.
- To assess the economic importance of bovine fasciolosis due to liver condemnation and loss of beef in the abattoir.

3. MATERIALS AND METHODS

3.1. Study Area

The study was conducted in Wolaita Soddo town of S.N.N.P. Regional state from November, 2013 to March, 2014. The town is located 383 kms southwest of Addis Ababa on the way to Arbamich town and it has a latitude and longitude of 6°54′N 37°45′E with an elevation between 1650 and 2980 meters above sea level. The town is bounded with Damot Gale Woreda to the North, Humbo Woreda to the South, Damot Woide Woreda to East; and Damot Sore Woreda to the West. The annual rain fall and temperature of the area is 1000-1200mm and 25-35°C respectively. The area is categorized under Woina Dega agro ecological climate. The dry season extends from September to February and the rain season stay from March to August, but in this year there is a change in weather condition and due to this reason the area receive extra rain fall in the months of October and November. The livestock population of the area comprised about 1,097,710 cattle; 150,383 sheep; 185,250 goats; 60,055 equines and 734,924 poultry (WSDADO, 2013).

3.2. Study Population

The study populations for the study were all indigenous adult male Zebu cattle brought for slaughter from different localities and livestock markets in their vicinity and categorized based on their origin and body condition.

3.3. Study Design

A cross sectional study was conducted from November 2013 up to March 2014 to determine the abattoir based prevalence, fluke burden and intensity of pathological lesions in cattle by using post-mortem examination of liver of each slaughtered animal, to evaluate the sensitivity and specificity of the two coprological diagnostic techniques (flotation and sedimentation) for the diagnosis of bovine fasciolosis with post mortem examination and its monetary loss due to organ condemnation.

3.4. Sampling Method and Determination of Sampling Size
Simple random sampling method was employed for determining the prevalence of fasciolosis among cattle and the magnitude of direct monetary loss due to liver condemnation and indirect carcass loss at Wolaita Soddo municipal abattoir, Ethiopia. To calculate the total sample size, the following parameters were used: 95% level of confidence, 5% desired level of precision and 50% expected prevalence of bovine fasciolosis in Wolaita Soddo municipal abattoir and the sample size was determined by using the formula given in Thrustfield (2005).

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

Where; n = require sampling size
Pexp = expected prevalence
d^2 = desired absolute precision

According to the above formula, the calculated sample size was 384. However; for the sake of convenience of certain calculations 500 animals were sampled. Therefore, 500 heads of cattle were to be considered for liver examination.

3.5. Study Methodologies
3.5.1. Coprological examination

Coprological examination was carried out on 500 cattle that were brought to Wolaita Soddo municipality abattoir from different localities. Prior to sampling; an identification number was given to each animals presented to the abattoir for the routine meat inspection. At the time of sampling, the date of sampling, the sex, the origin, the body condition and consistency of the feces (diarrhea, semi sold and dry) of the cattle were recorded for each cattle on a recording format. Then after, fecal samples were collected directly from rectum of animals. The feces were collected by hands protected by sterile rubber gloves, using two fingers during anti mortem examination in the liarage before slaughter. The samples were coded and placed separately in the tightly closed universal bottles and taken to the laboratory on the same day of collection and examined for fasciola eggs by using sedimentation and flotation techniques; and their specificity and sensitivity were interconnected with post mortem findings.

3.5.2. Post mortem examination

During meat inspection, the previously identified animals and their livers were carefully supervised and examined for the presence of liver flukes separately to correlate the coprology and postmortem examination of each animal. Examination of livers for fasciola will be carried out immediately after removal of liver from abdominal cavity. The fluke recovery was conducted following the approach of Hammond and Sewell (1974), as follows: the gall bladder was removed and washed to screen out mature flukes. The liver was cut into slices of about 1cm thick and put in a metal trough of warm water to allow mature flukes lodged in smaller bile ducts to escape and then the heads of the flukes were counted for determining fluke burden. Identification of the fluke species involved was carried out based on the morphological features of the agent and classify in to *F. hepatica, F. gigantica*, mixed and unidentified or immature forms of liver fluke (Soulsby, 1982) Whereas pathological lesion categorization of the affected livers was undertaken on the basis of the intensity of lesions. Hence, affected livers were grouped into three categories as per the criteria previously described by Ogunrinade and Adegoke (1982): *lightly affected*: a quarter of the organ is affected, and only one bile duct is prominently enlarged on the visceral surface of liver, *moderately affected:* half of the organ is affected and two or more bile ducts are hyperplastic and *severely affected:* almost the entire organ is involved, liver is cirrhotic and triangular in outline as the right lobe is often atrophied.

3.6. Economic Loss Assessment
The direct annual loss from liver condemnation was assessed by considering the overall prevalence of the disease, the total annually slaughtered animals in the abattoir and the retail market of price liver. The annual number of animals slaughtered was estimated from retrospective abattoir records of the last four years, while average retail market price of liver was determined from the butchers in Soddo town. The average current price of one liver and one Kilogram beef in Soddo town was about 120 and 150 ETB, respectively. The collected information was subjected to mathematical computation using the formula set by Ogunrinade and Ogunrinade (1980).

ALC = MCS x MLC x P

Where ALC=Annual loss from liver condemnation,
MCS= Mean annual cattle slaughtered at Wolaita Soddo abattoir,
MLC= Mean cost of one liver in Soddo town,
P= Prevalence of the disease at the study abattoir.

The indirect economic loss was associated with carcass weight reduction due to fasciolosis. A 10% carcass weight loss due to fasciolosis in cattle was reported by Robertson (1976). Average carcass weight of an Ethiopian zebu was taken as 126 kg (ILCA, 1992). The annual economic loss because of carcass weight reduction due to bovine fasciolosis was assessed using the formula set by Ogunrinade and Ogunrinade (1980).

(ACW) = CSR x CL x BC x P x 126 kg

Where ACW = Annual loss from carcass weight reduction,
CSR = Average number of cattle slaughtered per annum at study abattoir,
CL = Percentage of carcass weight loss in individual cattle due to fasciolosis (10%),
BC = Average price of 1 kg beef in Soddo town,
P = Prevalence of fasciolosis at Soddo abattoir,
126 kg = Average carcass weight of Ethiopian zebu.

3.7. Data Analysis

The raw data generated from the study were entered into Microsoft Excel 2007 database system and arranged using Microsoft Excel spread sheet computer program and were imported to be analyzed by STATA 12 Version. Prevalence of fasciolosis was calculated by dividing the number of cattle harboring *Fasciola* parasites in the liver by the total number of cattle examined (Thrusfield, 2005). Multi-variate logistic regression analysis using the binary data from laboratory and postmortem liver examination for fasciolosis and associated risk factors treated as independent variables were performed during the analysis. A statistically significant association between variables was considered to exist if the calculated p-value is less than 0.05with 95% confidence level.

4. RESULTS

A total of 500 cattle were examined for the presence of fasciolosis using both coprological and post mortem examination methods at Wolaita Soddo municipal abattoir. The prevalence under coprological and post mortem examinations were found to be 19.4% (95%CI=0.1602352 – 0.2314301) and 28.6% (95%CI=0.2467569 – 0.327795) respectively.

4.1. Prevalence of Fasciolosis Using Coprological Examination Test Results and Associated Risk Factors

Table 3: Coprological prevalence of bovine fasciolosis based on body condition scores, month and origin

	No. of examined	Positive	Prev.	OR	P-value	[95% Conf. Interval]	
						Ub	Lb
BCS							
Poor	100	56	56.00	312.9951	0.000	40.73954	2404.69
Medium	223	40	17.94	42.6773	0.000	5.749572	316.7804
Good	177	1	0.56	Ref*	-	-	-
Month							
November	120	36	30.00	Ref*	-	-	-
January	100	19	19.00	0.5929873	0.184	0.2742671	1.282086
February	80	10	12.5	0.2992821	0.008	0.1223211	0.7322513
March	50	3	6.00	0.1215532	0.002	0.0310339	0.4760986
Origin							
Selamber	54	8	14.81	Ref*			
Soddozuria	98	29	29.59	0.7407842	0.594	0.245729	2.233197
Humbo	60	13	21.67	0.8470829	0.779	0.2656236	2.701377
Damote Gale	58	10	17.24	0.506189	0.273	0.1498709	1.709654
Qucha	66	17	25.76	0.6944987	0.527	0.2246824	2.146712
DamoteWoide	50	6	12.00	0.1930022	0.019	0.0486148	0.7662247
Gamo Goffa	44	5	11.36	0.2527271	0.056	0.0617536	1.034289
Damote Sore	38	5	13.15	0.3526811	0.141	0.0880454	1.412725
Tercha	32	4	12.50	0.2996948	0.126	0.0639582	1.404307
Total	500	97	19.4				

Where: - BCS- body condition scores, Prev. - prevalence, OR – odds ratio, Ub - upper bound, Lb-lower bound.

4.2. Prevalence of Fasciolosis Using Post mortem Examination and Associated Risk Factors

Table 4: Abattoir prevalence of bovine fasciolosis based on body condition scores, month and origin

	No. of examined	Positive	%	OR	P-value	[95% Conf. Interval]	
						Ub	**Lb**
BCS							
Poor	**100**	**74**	**74**	**77.92058**	**0.000**	**31.84743**	**190.647**
Medium	**223**	**61**	**27.35**	**8.429839**	**0.000**	**3.85305**	**18.4431**
Good	**177**	**8**	**4.52**	**Ref***	**-**	**-**	**-**
Month							
November	**120**	**49**	**40.83**	**Ref***	**-**	**-**	**-**
January	**100**	**29**	**29.00**	**0.6236569**	**0.188**	**0.3086032**	**1.26035**
February	**80**	**17**	**21.25**	**0.3261003**	**0.006**	**0.1477718**	**0.7196327**
March	**50**	**6**	**12.00**	**0.1316764**	**0.000**	**0.0433501**	**0.0433501**
Origin							
Selamber	**54**	**10**	**15.52**	**Ref***	**-**	**-**	**-**
Soddozuria	**98**	**38**	**38.78**	**1.089298**	**0.865**	**0.4074283**	**2.912341**
Humbo	**60**	**19**	**31.67**	**1.28339**	**0.634**	**0.4600689**	**3.580095**
Damote Gale	**58**	**12**	**20.69**	**0.5229311**	**0.253**	**0.1721696**	**1.5883**
Qucha	**66**	**25**	**37.88**	**1.165855**	**0.765**	**0.4264142**	**3.187556**
DamoteWoide	**50**	**13**	**26.00**	**0.5402873**	**0.297**	**0.1698718**	**1.718415**
Gamo Goffa	**44**	**9**	**20.45**	**0.4777538**	**0.224**	**0.1452369**	**1.571561**
Damote Sore	**38**	**11**	**28.95**	**0.9402649**	**0.916**	**0.3008225**	**2.938936**
Tercha	**32**	**6**	**18.75**	**0.4113872**	**0.203**	**0.1047435**	**1.615751**
Total	**500**	**143**	**28.6**				

Table 5: The distribution of *fasciola species* in the infected liver and their relative abundance

Species of fasciola	Number of livers infected	Proportion (%)
F.hepatica	65	46.1
F.gigantica	39	27.3
Mixed	26	18.2
Immature	13	9.1
Total	143	100

Table 6: Prevalence of bovine fasciolosis based on sedimentation, flotation and post mortem findings

Types of test	No of examined	Positive	Prevalence %	[95% Conf. Interval]	
				Lb	Ub
Sedimentation	500	97	19.4	0.1602352	0.2314301
Flotation	500	55	11.0	0.0839491	0.1407658
Post mortem exam.	500	143	28.6	0.2467569	0.327795

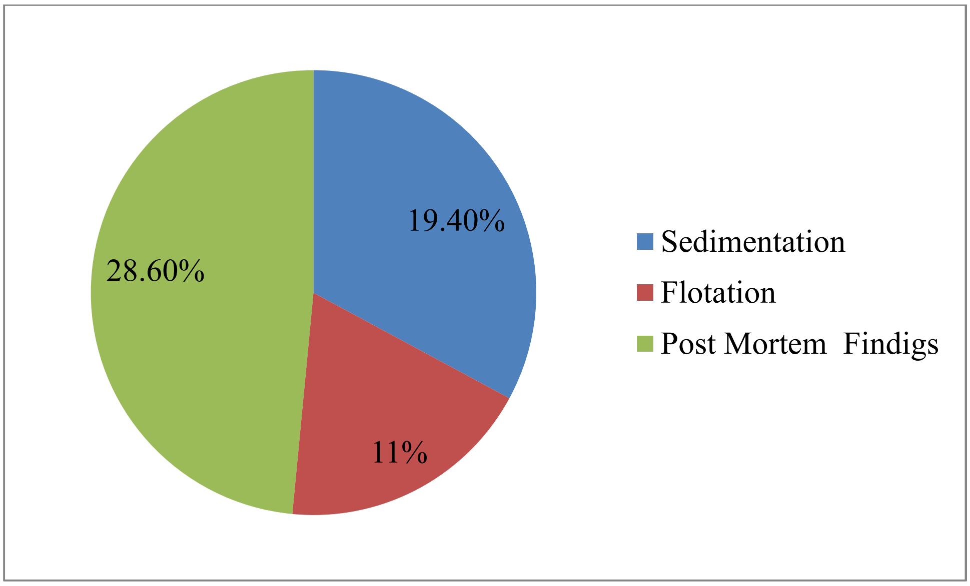

Figure 5: Prevalence of bovine fasciolosis based on sedimentation, flotation and post mortem findings.

Table 7: Fluke count in the fasciola infected livers

Fluke count interval	No of livers	Relative proportion (%)	Mean	Min.	Max.
3-20	40	28	52	4	140
21-40	27	19			
41-60	25	17.48			
61-80	21	14.68			
81-100	15	10.49			
101-120	10	7			
121-140	5	3.5			

Where: - Min. - Minimum, Max. - Maximum

Table 8: Categorization of livers according to severity of lesions and their respective mean fluke burdens

Severity of liver lesions	No of livers	Relative proportion (%)
Lightly affected	44	31
Moderately affected	75	52
Severely affected	24	17
Total	143	100

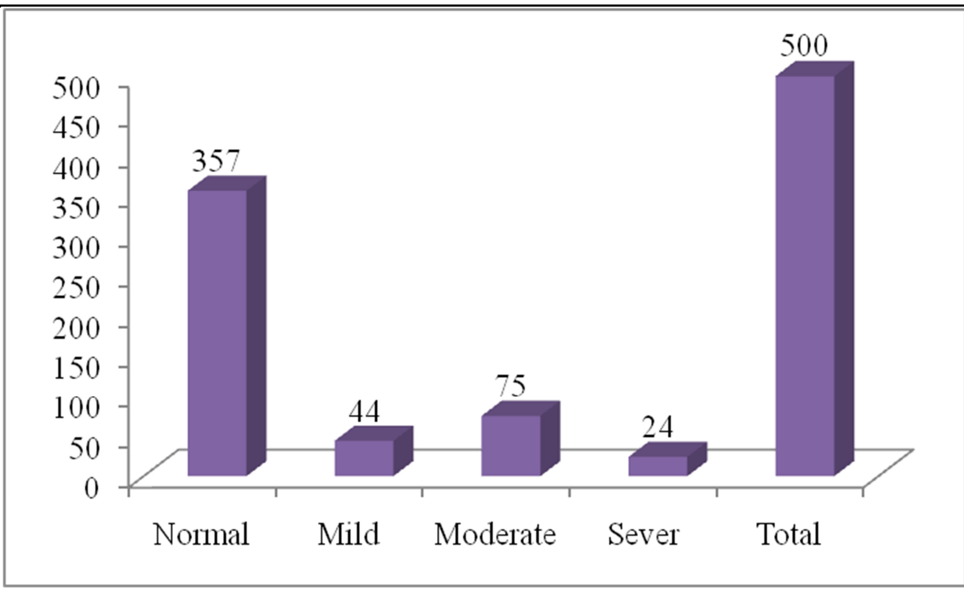

Figure 6: Classification of liver pathology

4.3. Comparative results of different diagnostic tests

The sensitivity and specificity of the flotation and sedimentation methods were 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)

4.3.1. Sensitivity and specificity test for sedimentation technique for the diagnosis of fasciolosis

The sensitivity and specificity of the direct sedimentation technique were calculated from the results in (**Table 9)** which sets out the numbers of positive and negative tests in animals with and without flukes in their livers (Smith, 1995).

Table 9: Sensitivity and specificity test for sedimentation technique

	Presence of fasciola spps in the liver		
Fecal examination			Total
	Fluke (+)	Fluke (-)	
Eggs present (+)	97	0	97
Eggs present (-)	46	357	403
Total	143	357	500

4.3.2. Sensitivity and specificity test for flotation technique

The sensitivity and specificity of flotation technique were calculated from the results in (Table 10) which sets out of the numbers of positive and negative tests in animals with and without flukes in their lives (Thrusfield, 1995)

Table 10: Sensitivity and specificity test for flotation technique

	Presence of fasciola spps in the liver		
Fecal examination			Total
	Fluke (+)	Fluke (-)	
Eggs present (+)	55	0	55
Eggs present (-)	88	357	445
Total	143	357	500

4.4. Economic Loss Analysis

The total economic loss due to fasciolosis in Wolaita Soddo municipal abattoir was estimated from the summation of annual liver condemnation and indirect annual loss due to reduction of meat yield. Partial condemnations of liver were not a common practice in this abattoir. The mean retail price of one liver and one Kilogram of beef in Wolaita Soddo town was taken as 150 and 120 ETB respectively. The average numbers of cattle slaughtered in Wolaita Soddo municipal abattoir were 7500 cattle per year based on 4 years recorded data. Based on this information the total annual economic loss due to fasciolosis was calculated by using the following formula:-

Annual loss from liver condemnation (ALC) = MCS x MLC x P

Where MCS= Mean annual cattle slaughtered at Wolaita Soddo municipal abattoir,
MLC= Mean cost of one liver in Wolaita Soddo town,
P= Prevalence of the disease at the study abattoir (28.6%).

Accordingly, the annual loss from liver condemnation at Wolaita Soddo municipal abattoir was found to be 321,750.00 ETB.

Annual loss from carcass weight reduction (ACW) = CSR x CL x BC x P x 126 kg

Where CSR= Average number of cattle slaughtered per annum at study abattoir,
CL= Percentage of carcass weight loss in individual cattle due to fasciolosis (10%),
BC= Average price of 1 kg beef in Wolaita Soddo town,
P= Prevalence of fasciolosis at Wolaita Soddo abattoir (28.6%),
126 kg= Average carcass weight of Ethiopian zebu.

Hence, the annual loss from the carcass weight reduction was calculated to be 3,243,240.00 ETB

Therefore, the total annual economic loss due to fasciolosis at Wolaita Soddo municipal abattoir was found to be (321,750.00 ETB + 3,243,240.00 ETB) 3,564,990.00 ETB (187,631.053 USD)

5. DISCUSSION

The result of coprological examination (19.4%) on the prevalence of fasciolosis in the present study was lower than that of Tegegn (2008) where he reported a prevalence of 21.2% in his study conducted at Wolaita Soddo municipal abattoir. This could be explained by the fact that awareness has been created in the area on the control and prevention of fasciolosis.

The overall prevalence of fasciolosis (28.6%) observed in this study based on post mortem examination was comparable to 28.63% in Hawassa (Rahmeto *et al.,* 2010*),* 28% in Kombolcha (Nuraddis *et al*., 2009), 29.8%, in Nekemte (Wassie, 1995), 27.1% in Wolisso (Rahmeto, 1992) and 25.33% in the same study area (Edilawit *et al.,* 2012). But the prevalence of bovine fasciolosis found in this study was lower when compared to 90.65% in Gondar (Yilma and Mesfin, 2000), 47% in Soddo (Abdul, 1992), 56.6 % in Ziway (Adem, 1994), 54.5% in Jimma by Abie *et al.* (2012), 53.5% in Kombolcha by Mulugeta (1993), and 46.15% in Jimma by Tadele and Worku (2007) municipal abattoirs. 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, 1995), 20.3% in Addis Ababa (Kassaye *et al.,* 2012) and 24.32% in Mekelle (Gebretsadik *et al.,* 2010) municipality abattoirs. The lower prevalence of fasciolosis among cattle in Wolaita Soddo town and the differences in the prevalence of the present study among other researchers finding within the country are attributed mainly due to variations in the origin of the samples, ecological and climatic conditions such as altitude, rainfall, and temperature; management systems of animals, the sample size and the ability of the inspector to detect the infection may play a part. One of the most important factors that influence the occurrence of fasciolosis in an area is the availability of a suitable habitat for the snail intermediate hosts and essential for the development of fluke eggs, miracidiae searching for snails and dispersal of cercariae (Urquhart *et al.,* 1996).

Of the total (143) infected livers 46.1% of them were found to be positive for bovine fasciolosis infected by *F. hepatica* whereas *F. gigantica*, mixed infection and immature or undifferentiated were recorded to be 27.3%, 18.2% and 9.1% diagnosed as positive for fasciolosis respectively (**Table 5)**.

With regard to the proportion of fasciola species identified, the present study result was lower than the findings of Tadele and Worku (2007) and Nuraddis *et al.* (2009) who demonstrated that the predominant species of bovine fasciolosis in Jimma municipality and Kombolcha Industrial abattoirs was *F. hepatica* as 63.89% and 63.6% followed by *F. gigantica* with prevalence of 24.8% and 24.3% respectively. The prevalence of fasciolosis and the fasciola species found vary with locality.

In Ethiopia *F. hepatica* and *F. gigantica* infections occur in areas above 1800 m.a.s.l. and below 1200 m.a.s.l. respectively which has been attributed to variations in the climatic and ecological conditions such as altitude, rainfall, temperature and livestock management system (Yilma and Malone 1998). The high prevalence of *F. hepatica* may be associated with the existence of favorable ecological biotopes for *L. truncatula,* 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 and therefore drainage ditches are favorable habitat to the intermediate hosts (Urquhart *et al.,* 1996).

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, Americasand Oceania only *F. hepatica* is concerned (Mas-Coma *et al*., 2005).

There was a statistically significant association (P =0.000) between fasciola infection and body condition of the animals (**Table 4**). Poor body condition were 77 times (OR=77) (95%CI=31.84743 - 190.647) more likely to be infected as compared to good body conditions (OR=1). In relation to body condition of the animals, the abattoir prevalence was higher in those animals with poor body condition than in those with medium and good body conditions (74%), (27.35%) and (4.52%) respectively. This finding corresponds with the reports of (Dechasa *et al*., 2012). The prevalence reported by these workers was 73.85%, 49.51% and 51.24% in poor, medium and good body condition animals respectively. This is due to the fact that animals with poor body condition are usually less resistant and are consequently susceptible to infectious diseases. The reason behind is may be due to reduced performance of the animals created by lack of essential nutrients and poor management by the animal owner. In addition to this, the weight of animals' increases as the parasitic infection decreases which could be due to acquired immunity in the host. Body condition improves as fasciola infection decreases since fasciola worms suck blood and tissue fluid and damage the parenchyma of liver due to the migrating immature worms. So this is the most appropriate reason for those animals in order to loss their body condition in the case of fasciolosis. Chronic fasciolosis is the commonest form of the disease in cattle and one of the characteristic sign is weight loss (Graber, 1975; Troncy, 1989; Radostits *et al*., 1994).

From the total of 500 adult indigenous cattle slaughtered at Wolaita Soddo Municipal abattoir during the five months study period, 143 animals (28.6%) were found to be infected with fasciola species (**Table 4**). The highest prevalence was seen in November (40.83%) while the lowest in March (12%). There was statistically significant variation in the prevalence of fasciolosis among study months of February and March ($p<0.05$). The significant variation in these months is due to the area receive additional rain fall in October and November, and this provide the favorable environment for snail population.

According to the origin, the highest prevalence was observed in Soddozuria (38.78%) followed by Qucha (37.88%), Humbo (31.67%) and the lowest prevalence were observed in Selamber (15.52 %) and Tercha (18.75 %) by using post mortem examination (**Table 4**). Statistical analysis of the result revealed that there was no significant difference ($p>0.05$) in prevalence of fasciolosis among the nine origins of animals. But the prevalence difference was seen among different origins, this may be due to variation in ecological and climatic conditions such as altitude, rain fall and temperature which favoured the perpetuation of the intermediate host.

The results of fluke count made on 143 infected livers are given in (**Table 7**). The mean fluke burden observed in this study was 52 flukes per liver (range: 3-140). Of the total cattle subjected to fluke count, 28% had between 1 and 20 flukes in the liver. Similarly, 61.65% had counts between 21 and 100; and only 10.5% had counts greater than 100 flukes. Fluke count conducted on infected livers revealed a mean fluke burden of 52 per liver. The 52 flukes per liver imply very high pathogencity of flukes in the study area. Based on the degree of pathological lesions observed, 44 (30.77%), 75(52.45%) and 24(16.78%) livers were lightly, moderately and severely affected, respectively (**Table 8**). 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 (Rahmeto, 1992; Yilma and Mesfin, 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 (Schillhorn van Veen *et al.,* 1980; Phiri *et al.,* 2006).

Out of the 500 cattle subjected to both fecal and liver examination (**Table 10**), only 97 showed fasciola eggs in their feces by using sedimentation technique. Accordingly, the sensitivity of a single examination by sedimentation method was found to be 67.83% and 100% specificity was observed with substantial agreement ($k = 0.75$) between the two tests. However, this test suggests that about (32.2%) 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 67.13% in Hawassa (Rahmeto *et al.,* 2010), 68.42% in Debreziet (Walei, 2012), 66.7% in Vietnam (Anderson *et al*., 1999) and 69% in Switzerland (Rapsch *et al*., 2006). The other reason may be due to faecal sample test includes numerous steps and that increase the chance of losing eggs as demonstrated by the lower number of positive result recorded in this work. Eggs may remain in the debris while filtering the feces through gauze or may get fixed on the bottom and walls of the container and within the pipette when taking the sediment for microscopic observation (Azanaw, 2008).

Out of the 500 cattle subjected to both faecal and liver examination (**Table 10**), 143 had flukes in their livers but only 55 showed fasciola eggs in their faeces by using flotation technique i.e. the prevalence of bovine fasciolosis was very low by using flotation as compared to sedimentation and post mortem examination indicating that flotation technique is the least sensitive in detecting the actual presence of the disease. Accordingly, the sensitivity of a single examination by flotation method was found to be 38.46% and specificity was 100% in relation to the result of post mortem examination and moderate agreement ($k = 0.472$) was observed between the two tests. However, this test suggests that about 61.54% infected animals may pass undetected with single examination of faeces by flotation technique. The reason for lowest sensitivity of flotation technique may be due to the fact that commonly used flotation procedures open the operculum and sink the fluke egg rather than floating it for surface detection and fluke eggs are comparatively heavier and as a result the eggs do not float in routinely used floatation mediums such as saturated salt solution. However, floatation fluids of higher specific gravity such as saturated zinc solution and magnesium may float the eggs of fasciola but the saturation of these solutions damage to observed eggs is very high and then the egg is distorted and may loss its morphological character and difficult to identify correctly.

Different studies carried out on the importance of fasciolosis in different parts of Ethiopia showed enormous economic impact of the disease mainly due to affected liver condemnation at the abattoirs and loss of livestock production (Graber, 1978).

The total annual economic loss encountered due to bovine fasciolosis in the study abattoir was the summation of losses from organ condemnation and carcass weight reduction which is equal to 3,564,990.00 ETB. This finding is higher than the result reported by (Shiferaw *et al*., 2011) a total economic loss of about 698,700.6 ETB per annum in cattle due to fasciolosis around Assela municipal abattoir and (Dechasa *et al*., 2012) a total economic loss of 3,003,488.1408 ETB per annum in Jimma Municipal abattoir. This is probably due to the ecological and climatic difference between the two localities. The higher calculated loss due liver condemnation and carcass weight reduction in this study is due the current increment of the price of the liver and carcass as compared to the preceding reports.

6. CONCULUSION AND RECOMMENDATIONS

The present study recorded a moderate prevalence of bovine fasciolosis in Wolaita Soddo municipal abattoir. The dominant fasciola species identified was *F. hepatica* that induces economic losses due to liver condemnation and was found economically important disease of cattle at Wolaita Soddo municipal abattoir. Moreover, the current study reflected that the higher prevalence of fasciolosis was present in those of animals with poor body condition and the prevalence was high in cattle that originate from Soddo zuria and the low prevalence was seen in cattle that originate from Selambar and Tercha. The present study indicated that sedimentation is the best diagnostic technique for the diagnosis of fasciola eggs than flotation technique with post mortem examination as gold standard. The annual economic loss of 3,564,990.00 ETB obtained in this study was very high and outcomes of the study signified severity of the problem and the need for effective control measures that should be supported through studies on the economic importance of the infection in bovine species and epidemiology of the disease.

Therefore, from the above conclusion the following recommendations are forwarded:

- Strategic use of anthelminthic should be performed to reduce pasture contamination with fluke eggs.
- Integrated approach with a combination of chemotherapy and vector control should be considered more practically and economically.
- A combination of control measures includes drainage; fencing and molluscides have to be used to ensure satisfactory degree of control in long run.
- The farmers should be well educated and informed about the importance of disease control programs and good management system.
- Further study on the epidemiology of the disease, the ecology and biology of the intermediate snail hosts should be conducted in the study areas.

5.1. Conflict of Interest Statement

We declare that we have no conflict of interest.

6. ACKNOWLEDGMENT

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