ISSN: 2640-1223

MEDDOCS Open Access Publisher

Journal of Veterinary Medicine and Animal Sciences

Open Access | Review Article

Study on Prevalence of Bovine Fasciollosis and its Economic Importance in Gursum Woreda Municipal Abattior, Oromia Regional State, Eastern Ethiopia

Nesredin Oumer; Abdurezak Mohamed*; Dino Abdi

Team of Veterinary and animal science, Gursum woreda Agricultural office, Oromia region, Eastern Ethiopia.

***Corresponding Author(s): Abdurezak Mohamed**

Team of Veterinary and animal science, Gursum woreda Agricultural office, Oromia region, Eastern Ethiopia.

Email: jemilauma@gmail.com & mohamedabdurezak443@gmail.com

Received: Jan 17, 2024

Accepted: Feb 22, 2024

Published Online: Feb 29, 2024

Journal: Journal of Veterinary Medicine and Animal Sciences

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/

Keywords: Bovine; Gursum; Municipal Abattoir; Economic Loss; Fasciolosis; Prevalence.

Abstract

Fasciolosis is a cosmopolitan's disease, its occurrence being dependent on the presence of biotypes suitable for the parasites as well as the snail intermediate host. A cross sectional study was carried out from November 2022 to April 2023 with the objectives of determining the prevalence, risk factor and economic importance of bovine fasciolosis in Gursum woreda municipal abattoir. Over all prevalence of 50.4% (192) was observed. Based on body condition of animals, prevalence rates of 80.3%, 53.8%, and 31% were recorded for poor, medium and good respectively. The difference between the prevalence of bovine fasciolosis in animal of different body conditions was statistically significant (P<0.05). Of 192 infected livers 49%, 28.1%, 13% and 9.9% were infected with Fasciola hepatica, Fasciola gigantica, mixed and immature flukes, respectively. The direct economic losses incurred due to fasciolosis in Gursum woreda municipal abattoir were estimated about 151, 315.9 ETH Birr annually. High value of economic losses suggested the adoption of suitable measures for the control of disease. It is concluded that fasciolosis is prevalent in cattle in the study area. Hence, this disease deserves serious attention by the various stakeholders in order to promote the beef industry in the study area in particular and in general in the country.

Introduction

Fasciolosis is a cosmopolitan's disease, its occurrence being dependent on the presence of biotypes suitable for the parasites as well as the snail intermediate host [1]. Both Fasciola hepatica and F. gigantica are the two liver flukes commonly reported to cause fasciolosis in cattle. The life cycle of these flukes involves an intermediate host snail L. truncatula and L. natalensi respectively [2].

Ethiopia's rich potential from the livestock sector is not efficiently exploited due to several constraints including suboptimal nutrition, traditional management and diseases [3]. The presence of fasciolosis due to Fasciola hepatica and F. Gigantica in Ethiopia has long been known and its prevalence and economic significance has been reported by several workers [4]. A review of available literature strongly suggests that fasciolosis exists in almost all parts of the Ethiopia [5]. It is regarded as one of the major setbacks to livestock productivity incurring huge direct and indirect losses in the country [6].

Cite this article: Oumer N, Mohamed A, Abdi D. Study On Prevalence Of Bovine Fasciollosis And Its Economic Importance In Gursum Woreda Municipal Abattior, Oromia Regional State, Eastern Ethiopia. J Vet Med Animal Sci. 2024; 7(1): 1140.

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 [5]. Available published reports have indicated that bovine fasciolosis causes economic losses of roughly 350 million Birr per annum due to decreased productivity alone [5].

Fasciola hepatica and Fasciola gigantica are the two liver flukes commonly reported to cause fasciolosis in ruminants [5]. Bovine fasciolosis exists in almost all region of Ethiopia. However, the prevalence, epidemiology and Fasciola species involved vary with locality. This is mainly attributed to the variation in the climate and ecological condition such as altitude, rainfall, temperature and livestock management system [7].

Fasciola hepatica was shown to be the most important fluke's species in Ethiopian livestock with distribution over three quarters of the nation except in the arid, north east and east of the country [5]. The distribution of F. gigantica was mainly localized in the western zone of the country that encompasses approximately one fourth of the nation [8].

The life cycle of these trematodes involves snail as an intermediate host [9]. 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 [8]. The world-wide losses in animal productivity due to fasciolosis were estimated at USD 200 million per annum, to rural agricultural communities and commercial producers with over 600 million animals infected [10].

The prevalence of fasciolosis in many parts of Africa has been determined mainly at slaughter. Apart from its veterinary and economic importance throughout the world, fasciolosis has recently been shown to be a re-emerging and widespread zoonosis affecting many people [11].

Therefore, this study was designed with the aims of determining the prevalence of fasciolosis in cattle and the magnitude of direct monetary loss due to liver condemnation at Gursum woreda municipal abattoir, Oromia regional state, Eastern Ethiopia.

Therefore, the objectives of the study were:

✓ To determine the prevalence of bovine fasciolosis in Gursum woreda municipal abattoir.

✓ Also, to determine direct economic significance of bovine fasciolosis due to liver condemnation.

Letrature Review

Fasciolosis: Bovine fasciolosis is an economically important parasitic disease of cattle in tropical and subtropical countries that limit productivity of animals and caused by fascioliases, which are trematode of the genus Fasciola [12]. The two most important species of this genus are Fasciola heparica and Fasciola gigantica [13]. Both F. Hepatica and F. Giganifica are transmitted by the snails of the family Lymnaesidae. Infestation with fasciolosis is usually associated with grazing wet land and drinking from the snail infesting watering places [8].

The disease is found in vast areas of the world, with the smaller F. hepatica (3.5x 1cm) in temperate countries and the larger F. Gigantica (7.5x 1cm) in tropical regions is the commonest species [2].

The development of infection in definitive host is divided into two phases, migratory phase and the biliary phase [14]. The parenchyma phase begins when encysted juvenile flukes penetrate the intestinal wall. After the penetration of the intestine, flukes migrate within the abdominal cavity and penetrate the liver or other organs and cause lesion [15]. F. Hepatica has a strong predilection for the tissues of the liver and cause severe intensity of liver lesion, second phase (the biliary phase) begins when parasites enter the biliary ducts of the liver and flukes mature, feed on blood, and produce eggs [16].

Lymnaeid mud snails are intermediate host and release the infective form, the metacercaria, on to herbage [13]. The snails are amphibious and although they spend hours in shallow water, they periodically emerge onto surrounding mud. L. truncutulu is the most widespread and important species involved in the transmission of F. hepatica. L. truncatulo is a small snail, the adults being about 1.0cm in length [13]. The shell is usually dark brown and has a turreted appearance, being coiled in a series of spiral whorls [17].

Life cycles and Transmission: Fasciola hepatica and Fasciola gigantica belong to the genus Fascioliases. The adult parasites reside in the liver of the definite hosts causing associated pathologies, and use lymnacid snail intermediate hosts to complete their life cycles [2]. The definitive host range of these parasites is very broad. While herbivorous animals are the most susceptible hosts, other animal species and humans may also be infected [5].

The adult fluke can produce up to 20000 eggs per day that are passed with the feces to contaminate the environment. In a moist environment, miracidia hatched from these eggs may penetrate the intermediate snail host [8]. After development and multiplication inside the snail, cercariae are released and attach to submerged blades of grass or other vegetation to become metacercariae. Humans and animals get infected by eating aquatic plants and by grazing, respectively, and by drinking water contaminated with metacercariae [12]. Wide variety of wild animals including, deer, rabbit, and hare may also get infected with Fasciola spp, and become major reservoir host populations that contribute significantly to the worldwide dissemination of the parasite [8].

The essential point of the life cycle is that whereas one nematode egg can develop into only one adult, one trematode egg may eventually develop into hundreds of adults [15]. This is due to the phenomenon of pathogenesis in the molluscan intermediate host, i.e., the production of new individuals by single larval forms [3].

The success of the life cycle depends on the development and hatching of eggs, infection of the snail host by a miracidium, development of larval stages within the vector, cercarial emission from the snail and formation of metacercariae on herbage, and finally establishment within the final host [18]. Completion of such phases of cycle eventually depends on how successfully the parasite can overcome complex interactions continually present in the environment and host [19].

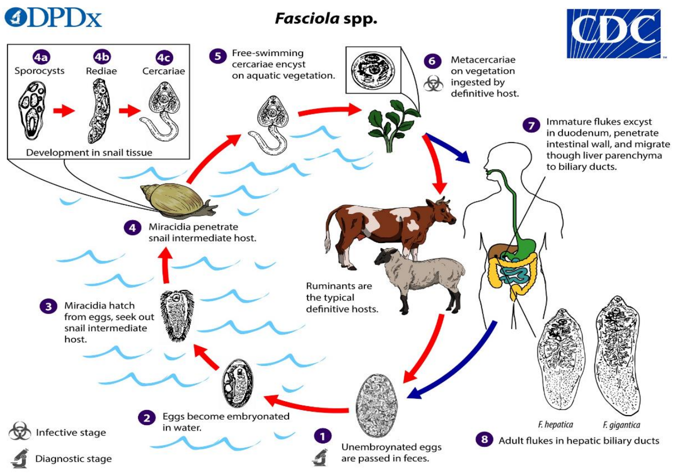

Figure 1: Showing life cycles of bovine fasciolosis.

The image was copied from [20].

Epidemiology: The geographical distribution of F. hepatica and F. gigantic differ due to the different distributions of their intermediate snail hosts. F. Hepatica is mainly found in temperate regions of Europe, America and Australia [21], where the lymnaeid amphibian snail Galba truncarula is the most important intermediate host, being found mainly in mild and cold climatic zones [22] and. F. Gigantic is present in tropical and sub-tropical regions of Africa and Asia, where Lymnaea spp. Such as, L. Natalensis and L. Rubiginosa are among the main intermediate host species [23]. However, some Lymnaea species (Radix peragra, L natalensis, and Galba truncatun) are suitable intermediate hosts for both F. gigantic and F. Heparica [24]. As a result, the distribution of these species overlaps in a number of African and Asian countries [25].

The development of fasciolosis involves the presence of an intermediate host (Lymnaea sp.), suitable habitats for mollusks and environmental factors such as high humidity, adequate temperature and rainfall [26]. Furthermore, when infecting the definitive host, mature flukes lay eggs that spread in the environment and cause pasture recontamination [27].

Pathogenesis and Clinical Signs: The development of infection in definitive host is divided into two phases, migratory phase and the biliary phase. The parenchyma phase begins when encysted juvenile flukes penetrate the intestinal wall. After the penetration of the intestine, flukes migrate within the abdominal cavity and penetrate the liver or other organs and cause lesion [13]. F. hepatica has a strong predilection for the tissues of the liver and cause severe intensity of liver lesion, second phase (the biliary phase) begins when parasites enter the biliary ducts of the liver and flukes mature, feed on blood, and produce eggs [28].

The damage caused by liver flukes to the animal host includes the destruction of tissues during their migrations in the body, especially in the liver and, in the case of F. Hepatica, thickening of bile ducts. Such livers, when they are seriously damaged, are subject to condemnation at meat inspection [29]. The parasites are avid blood suckers, thus causing loss of blood. Also, the entire metabolism of the animal host undergoes functional deterioration [26].

In acute cases of fasciolosis, sudden death, severe anemia, occurs due to the migrating young flukes through the liver [21], however, no fluke's eggs are passed in the feaces. In sub-acute cases, signs of rapid loss of condition, anemia, high fluke egg count, death occurs 12-20 weeks after infection, and in chronic fasciolosis gradual wasting severe anemia with ascites edema, bottle jaw and very high fluke egg counts may lead to death more than 20 weeks after infestation [12].

Diagnosis: A tentative diagnosis of fasciolosis may be established based on prior knowledge of epidemiology of the disease in a given environment, observation of clinical sign, information on grazing history, seasonal occurrence, and identification of snail habitats. Confirmatory diagnosis however, is based on demonstration of Fasciola spp eggs through standard examination of feces in the laboratory, post mortem examination of infected animals [6]. Even though it is impossible to detect Fasciola in live animals, liver examination at slaughter or necropsy was found to be the most direct, reliable, and cost-effective technique for the diagnosis of fasciolosis [30]. Serologic diagnoses have been developed as an alternative approach to faecal egg detection. Serological methods can test a large number of sera at a time and also detect infection earlier than faecal egg examination. There are evidences to show that serodiagnosis can detect the presence of infection as early as 2 weeks after infection [5].

Economic Importance: The economic losses due to fasciolosis through associated with mortality, morbidity, reduced growth rate, condemnation of fluke liver, increased susceptibility to secondary infections and expense due to control measures[10]. F. hepatica infects more than 300 million cattle and 250 million sheep worldwide. Together with F. gigantica, it causes significant economic losses to global agriculture, estimated at more than USS 3.2 billion annually, mainly through loss of productivity, such as reduction of milk and meat yields [7].

When cattle become clinically ill as a result of a parasitic infection, the economic ramifications are clear. However, clinical disease is uncommon and cattle tend to harbor parasitic infections that are clinically unapparent [4]. Although infected cattle may not appear ill, subclinical parasitic infections are recognized as causing economically important reductions in animal productivity. Economic losses from liver flukes may result directly from increased liver condemnations at slaughter and indirectly from decreased livestock productivity [14].

Although direct losses are easier to measure, indirect losses are considered to be far more economically important. Beef producers are affected by increased culling of cows, reduced sale weights of culled cows, lowered reproductive performance in the brood cow herd, reduced calf weaning weights, and reduced rates of growth in stockers [31]. Economic losses in feedlots result from reduced feed-conversion ratios and lowered average daily gains, and fluke-infected dairy cows produce less milk [22].

Zoonotic Importance's of Fasciolosis: Human fasciolosis has a worldwide distribution, but most problems of public health concern are encountered in the Andean countries of Bolivia, Peru, Chile and Ecuador. In those countries, school children are most affected by fasciolosis, with prevalence rates as high as 68.2% in the Andean Altiplano and 24.3 % in Puno, Peru [32]. In some other parts of the world, human fasciolosis is endemic or emerging. In Egypt, in northern Africa, the overall prevalence of human fasciolosis is estimated at 3% [18].

Thousands of cases were reported in the Caribbean areas (e.g., Cuba), in Western Europe (Portugal, France and Spain), in the Caspian areas (Iran and neighboring countries) and in

Asia (Thailand and Vietnam) [32]. Because of its great impact on public health, fasciolosis was added on the list of the most important parasitic diseases at the Third Global Meeting of the Partners for Parasite Control held in WHO Headquarters Geneva in November 2004 [25].

The prevalence of fasciolosis in humans is usually measured based on data from hospital diagnosis. However, it may be very difficult to clinically differentiate Fasciola infection from other hepatic diseases in humans [13]. Diagnostic techniques, including direct parasitological, indirect immunological and other non-invasive methods, as well as response to antiparasitic treatment may help confirming clinical diagnosis [26]. In animals, it was demonstrated that the true prevalence of fasciolosis could be estimated by using Bayesian techniques on data from multiple diagnostic techniques combined with expert opinion [7].

Treatment, Prevention and Control: Current recommendations for the control of liver flukes in cattle are based on strategically timed treatments with flukicidal drugs. The optimal timing of these treatments has been determined by studying the seasonal transmission dynamics of liver flukes in numerous locations throughout the world [18]. Because of the long time required to complete the fluke life cycle, the window of receive meaningful benefit is fairly large. To properly understand the rationale behind recommended control programs, reasonable deviations that can be made from these recommendations and issues pertaining to the economic impact of fluke infections in cattle, the complex life cycle of liver flukes needs to be appreciated [25].

Liver fluke transmission is dependent on the presence of its snail intermediate host, therefore, the distribution of the parasite is limited to geographic areas where the appropriate snail species is present [6]. In the US, liver flukes are enzootic primarily in the Gulf coast and western states, where high annual rainfall, large areas of poorly drained pasture, and certain soil types provide suitable lymnaeid snail habitats [23].

Control of fasciolosis has been shown to be very difficult. Despite all control efforts the parasite persists in most endemic areas and husbandry systems, including highly controlled conditions in industrialized countries [7]. Most control measures have been based on reducing infections in animals and humans by the use of anthelmintics, combating the intermediate snail hosts: reducing parasite transmission by management on the farm and by public health measures [22]. Novel approaches for control include, vaccination, breeding Fasciola resistant animals [29] or using competition in snail intermediate hosts between Fasciola and other trematode species [3].

Triclabendazole has been the drug of choice for treatment of liver fluke infections in livestock for more than 20 years and it is also the only drug used for treatment of buman fasciolosis [17]. Triclabendazole has a high efficacy (approximately 99\%) against both the mature adult worms in the bile duct and the migratory immature flukes [22]. However, Triclabendazole resistant fluke populations have been reported in lreland, the UK, Netherlands, Spain and Australia [25].

Although some flukicidal compounds such as, Closantel retain their efficacy against Triclabendazole-resistant fluke population, novel fasciolicidal compounds or anti- Fasciola vaccines should be developed in the future [22]. Although many fascioliscides are available on markets, it is believed that some of them are not completely effective in treating liver flake [19].

However, the cattle infection was chronic which it causes weight gain loss, reduction in the milk yield fertility problems and Liver cirhosis was determined [17]. Basically, fascioliasis control in ruminants depends on the administration of anthelmintics. Using flukicides effective against immature flukes, and administration of these flukicides at certain times of the year cause destruction of the parasite life cycle achieving successful control of bovine fasciolosis [32].

However, since the variety of flukicides is very limited and animals are usually treated year after year without any monitoring of the efficiency of treatment, flukicide-resistant parasite populations may arise, making the control of fasciolosis difficult [5]. This problem is particularly relevant considering that various authors have reported the development of parasite populations resistant to triclabendazole which is the only anthelmintic drug known to be effective against different stages of Fasciola species (immature and mature) [29].

Materials and Methods

Study Area: The study was conducted from November 2022 to April 2023 in municipal abattoirs of Gursum Woreda, Eastern Haraghe, Ethiopia. The area is located, 579 km east of Addis Ababa. The estimated animal population in the area is about 90121 cattle, 25352 sheep, 65665 goats, 13885 donkeys, 6870 camels and 52886 chickens. Topographically, it is situated at altitude of 1200 - 2950 m above sea level with the mean annual minimum and maximum temperature 16°C and 27%, respectively. There are four seasons, a short rain season (from March to mid-May), a short dry season (from end of May to end of June), a long-wet season (early July to mid-October) and a long dry season (end of October to end of February). The Gursum area receives an average annual rain fall of approximately 700 mm, with a bimodal distribution pattern, picking in mid-April and mid-August [33].

Study Population: The study population was a total sample of 381 adult male indigenous cattle brought to the abattoir for slaughtering purpose from the different kebeles of Gursum woreda. Sampled animals slaughtered at the abattoir during the sixth-month study period were included in the study.

Study Design: A cross-sectional study was conducted from November 2022 to April 2023 to determine the prevalence and economic significance of bovine fasciolosis in the study animals. Systematic random sampling technique was the sampling strategy used to determine the abattoir-based prevalence on body condition and Fasciola species. Moreover, the direct economic loss due to liver condemnation was assessed through questionnaire and by using retrospective and perspective secondary data.

Sampling Method

Sample Size Determination: The numbers of animals required for the study was 381 adult male cattle was included using 54.5% [34] which was registered during past research based on the formula given by [35] for systematic simple random sampling.

$$N = \frac{1.96^2 P_{exp}(1-P_{exp})}{d^2}$$

where N = Required sample size.

Pexp = expected prevalence.

d = desired absolute precision (0.05).

Sampling strategy

A total of 381 samples were collected during the study period from Gursum woreda municipal abattoir using systematic random sampling. The species of animals sampled was only bovine and adult male indigenous cattle systematically sampled in abattoir. During ante-mortem examination details about the species, breeds, age, origins and body conditions of the animals were recorded.

During post-mortem inspection, all livers having Fasciola species were registered and Species identification was made using criterion provided by [35] And each liver visually inspected, palpated and incised based on routine meat inspection by [36].

Financial Loss Analysis: The total financial loss incurred due to fasciolosis in Gursum woreda municipal abattoir was estimated based on liver condemnation. The mean retail price of one liver was taken according to the interview obtained from local butcher houses. The average number of cattle slaughtered at the abattoir is used. The direct loss was thus computed according to the formula adopted from [37] as follows: Therefore, the annual financial loss incurred as a result of liver condemnation due to fasciolosis was estimated by the following formula.

Annual cost of condemned liver =NAL x %COND x CL

Where, NAL = Average number of cattle slaughtered in Gursum woreda Abattoir per year.

%COND. = Percentage of liver condemned due to fasciolosis.

CL = Mean cost of one liver in Gursum woreda.

Data Analysis: The recorded data were entered in to Epi. info version 7.1 software and statistical analysis was done using SPSS 29.0. Prevalence rate was calculated by dividing the proportion of cattle infected with Fasciola species by total number of animals examined multiplied by 100%. The determinants of Fasciola species investigated using percent values and Pearson's chi-square(X^2).

Results

Postmor tem Examination Inspection: A total of 381 adult indigenous cattle were slaughtered at Gursum woreda abattoir and examined for fasciolosis. From the total of cattle slaughtered and examined, 192(50.4%) were found to be positive for lesion of fasciolosis.

Fasciola Species Identification: From a total of 192 livers found positive for fluke infection during post mortem inspection of slaughtered animals, 94 livers (49%) harbored F. hepatica, 54 livers (28.1%) F. gigantica, 25 livers (13%) mixed and 19 livers (9.9%) infected with unidentified species due to immature fluke (Table 1).

Table 1: Species of Fasciola encountered in affected livers during postmortem examination of slaughtered animals.

Species of Fasciola	No. of livers condemned	%
F. hepatica	94	49
F. gigantica	54	28.1
Mixed	25	13
Immature (unidentified)	19	9.9
Total	192	50.4

Prevalence of Bovine Fasciolosis Based on Body Condition: Animals brought to Gursum woreda Municipal abattoir to be slaughtered were examined and grouped in to three body condition categories. From these categories, the highest fasciolosis prevalence was recorded in poor (80.3%) followed by medium (53.8 %) and good body condition (31.0%) as shown in Table 2. This result revealed the existence of statistically significant (P<0.05) difference in the occurrence of Fasciola among the three body condition categories.

Table 2: Host related risk factors for fasciolosis.

Body condition	No. of animals examined	No. of positives	Prevalence (%)	X2	p-value
Poor	76	61	80.3	49.584	0.000
Medium	160	86	53.8		
Good	145	45	31		
Total	381	192	50.4		

Financial Loss Analysis: The economic significance of fasciolosis was analyzed based on the information obtained during post mortem examination and interview. The analysis was done for liver condemnation due to Fasciola infection.

Annual cost of condemned liver = NAL x %COND. x CL = 8578x50.4% x 35

=151315.9 ETH Birr (7759.79 USD) was annually lost at Gursum woreda municipal abattoir with liver condemnation due to bovine fasciolosis.

Discussions

The result of the present study proved the prevalence of fasciolosis in cattle to be 50.4%. The result of the present study was higher than the findings of [38] that reported 30.1% of prevalence rate at Asella Municipal Abattoir, [39] at Wolaita Sodo (12.7%), 25.6% prevalence of fascioliosis in six districts of Punjab viz., Lahore, Gujranwala, Sheikhupura, Sargodah, Jhang and Faisalabad by [40]. The reason for these variations might be due to the differences in temperature, moisture, humidity and soil that might favor multiplication of intermediate snail hosts [16].

On the other hand, present study shows lesser prevalence as compared with the previous reports in different parts of Ethiopia Mulualem (1998) in South Gondar (83.08%), 81.6% in west shoa by Yadeta (1994), and 83.6% in Debere Berhane. This might be due to difference in climate and ecological conditions such as altitude, rainfall, and temperature and livestock management system and suitability of the environment for survival and distribution of the parasite as well as the intermediate host might have played their own role in such differences [10]. The finding of the present work was found to be in line with that of Mulugeta (1993) and Adem (1994) who revealed 53.5% and 56.6% fasciolosis in cattle in Kombolcha and Zeway abattoir, respectively.

The prevalence of fasciolosis was found to be 80.3%, 53.8% and 31% in poor, medium and good body conditioned animals, respectively. The results of the present study indicated that infections in poor body condition animals were significantly higher (P < 0.05) than that of medium and good body condition animals. This proves the importance of fasciolosis in causing weight loss and emaciation to be a characteristic sign of the disease.

Additionally, this high prevalence of fasciolosis in poor condition animals could be justified by the fact given by Devendra and Marca, (1983) who indicated cattle of poor body condition are vulnerable to parasitic diseases. The current finding was seen to be higher than the study of Yohannis (2008) who reported 42.4%, 36.8% and 21.8 % for poor, medium and good body condition, respectively. This variation may be attributed to the variations in food availability and management system of the animals between the study areas [34].

From the total livers proved to be infected by Fasciola, 49% of them were found to be infected by F. hepatica whereas F. gigantica, mixed and unidentified or immature flukes of Fasciola species were recorded to be 28.1%, 13% and 9.9%, respectively. Amsalu (2008) reported infection rate of cattle with F. hepatica (49.78%), F. gigantica (29%) and mixed infection (20.98%) at Bahir Dar municipal abattoir. Wakuma (2009) showed prevalence of F. hepatica (64.5%), F. gigantica (24.8%) and mixed (10.7%) at Bedele municipal abattoir. Tadele and Worku (2007) at Jimma municipal abattoir recorded prevalence of F. hepatica (63.89%), F. gigantica (24.07%) and mixed (16.5%). This difference might be attributed due to differences in season of the study and geographical differences of the study areas.

The total economic loss encountered due to condemnation of infested liver from one year data recorded from abattoir in this study was 151315.9 ETB per annum. These findings were relatively in agreement with the results reported by Adem (1994) and Daniel (1995) a total economic loss of about 154, 188 and 215,000 ETB per annum in cattle due to fasciolosis at Ziway and Dire Dawa municipal abattoir respectively. This is probably due to the similarities in ecological and climatic conditions between the two localities [41].

Conclusion and recommendations

This study has revealed that the prevalence of fasciolosis in Gursum woreda municipal abattoir was moderate. The prevalence was significantly associated with body condition of slaughtered animals. This result showed that fasciolosis is an important disease-causing considerable loss of revenue due to condemnation of affected liver in the study area. Based on the above conclusion the following recommendations were forwarded:

Strategic anthelmintics treatment with appropriate flukicide drug should be practiced twice a year, before and after rainy seasons to eliminate fluke burden of the host of animal and minimize pasture contamination by faecal egg shedding thus interrupting the life cycle.

Control of snail which has been the major facet of fluke control for many years, need careful ecological studies, but the tremendous reproductive potential of snails and the high cost needed for their control makes the snails control program often unsuccessful.

A combination of control measure includes drainage, fencing and molluscides have to be used to ensure a satisfactory degree of control in long run.

Further study on epidemiology of the disease, biology and ecology of the snail, intermediate host are useful in planning and programming control strategies.

Finally, the farmer should be well educated and informed about the importance of the disease control programs and good management systems.

Acknowledgements: All praise is for ALLAH, the almighty, and may he send peace and blessings on Prophet Mohammed, on his family and on his companions.

Funding: We are grateful to the Gursum woreda Agricultural office for financial support. Special thanks to the staff of Gursum woreda Municipal abattoir for their assistance.

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