Prevalence and associated risk factors assessment of bovine fasciolosis in and around Bahir Dar, Ethiopia

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Abstract

Bovine fasciolosis is a parasitic disease of cattle caused by ingesting metacercariae of liver flukes from the genus Fasciola. A cross-sectional study was conducted from November 2021 to April 2022, encompassing a total of 384 cattle randomly selected from diverse locations. The study included cattle of various ages and genders, aiming to to determine the prevalence of bovine fasciolosis and its associated risk factors in and around Bahir Dar, Ethiopia. Fecal examinations were performed to detect fluke eggs, and data were analyzed using descriptive statistics in STATA Version 20.0 to summarize bovine fasciolosis prevalence. Chi-square tests assessed relationships with infection rates and risk factors, with significance set at $P < 0.05$. Out of 384 fecal samples analyzed, 49.21% tested positive for Fasciola eggs. The prevalence of the condition varied significantly by origin, with rates of 50% in Tikurit, 61.84% in Sebatamit, 27.65% in Latammba, and 59.37% in Kebele 11. In terms of body condition, prevalence was notably higher in cattle classified as poor (64%) compared to those in medium condition (50%) and fat cattle (26.96%), with these differences being statistically significant. Age also influenced prevalence, with young cattle having a rate of 50.38%, adults 47.33%, and old cattle 50.47%; however, these differences were not statistically significant. Sex did not significantly impact prevalence, with males at 49.73% and females at 48.73%. Additionally, local cattle exhibited a prevalence of 51.62%, whereas crossbreeds had a prevalence of 46.15%, with no significant differences observed between these groups ($p < 0.05$). The persistently high rates of bovine fasciolosis highlight the urgent need for comprehensive control measures. Implementing enhanced management practices to minimize cattle exposure to contaminated pastures and water sources is essential for effective prevention and control of this parasitic infection.

Keywords : *Bahir Dar; Bovine fasciolosis; Ethiopia; Fecal examination; Prevalence; Risk factors*

1. Introduction

Ethiopia is home to one of Africa's largest livestock populations, comprising approximately 55.03 million cattle, 27.32 million sheep, and 28.16 million goats as of 2019. Cattle are particularly vital, contributing about 81.2% of the country's annual milk production. Despite their significance, livestock productivity in Ethiopia is constrained by challenges such as diseases, malnutrition, and management deficiencies, with parasitic infections being a major concern (Legesse et al., 2017).

Among parasitic infections, fasciolosis is a prominent issue affecting various animals, including cattle, buffaloes, sheep, goats, and even humans. The disease is caused by the ingestion of metacercariae from liver flukes of the genus *Fasciola*, commonly found in contaminated forage, water, or raw vegetables (Ardo et al., 2013; Figtree et al., 2015; Najib et al., 2020). Livestock acquire the infection directly from contaminated environments (Irsik et al., 2008), while humans typically contract it through the consumption of contaminated food or water (Aleixo et al., 2015).

Fasciolosis can cause severe liver pathology due to the migration of flukes through the liver and other organs, leading to inflammation of the bile ducts and obstruction of the biliary system in both animals and humans (Najib et al., 2020; Sah et al., 2017). The disease is endemic globally (Kleiman et al., 2007; Abunna et al., 2010; Nguyen et al., 2011) and its distribution is influenced by the presence of suitable aquatic snail species, such as *Lymnaea truncatula* and *Lymnaea natalensis*, which act as intermediate hosts (Boray & Love, 2007).

Fasciolosis presents significant economic challenges, including mortality, morbidity, reduced growth rates, liver condemnation, increased susceptibility to secondary infections, and costs associated with control or treatment measures. Additionally, it leads to decreased productivity, including reduced fertility and milk production (Bernardo et al., 2011).

Previous research on the epidemiology of fasciolosis has shown that factors such as age, sex, breed, and livestock management significantly affect disease prevalence (Phiri et al., 2005; Keyyu et al., 2006; Abunna et al., 2010). Regional studies have highlighted the need for further investigation to better understand the local epidemiology of fasciolosis (Aregay et al., 2013; Gebrie et al., 2015; Yitayal & Taddie, 2020). Therefore, the objective of the current study was to determine the prevalence of bovine fasciolosis and its associated risk factors in and around Bahir Dar, Ethiopia.

2. Materials and Methods

2.1. Study Area

A cross-sectional study was conducted from November 2021 to April 2022 in and around Bahir Dar, Ethiopia (Figure 1). Bahir Dar is situated approximately 575 km northwest of Addis Ababa, with an altitude ranging from 1500 to 2600 meters above sea level. The city's coordinates are 12° 29' N latitude and 37° 29' E longitude. It experiences an average annual rainfall of 1200 to 1600 mm and temperatures ranging from 8 to 31°C annually. The region is characterized by plain plateaus covering about 70% of the land, featuring various bush formations, low woods, evergreen lands, and semi-humid highland vegetation. The area is predominantly used for agriculture, cultivating crops such as teff, wheat, maize, and pulse crops (Legesse et al., 2017).

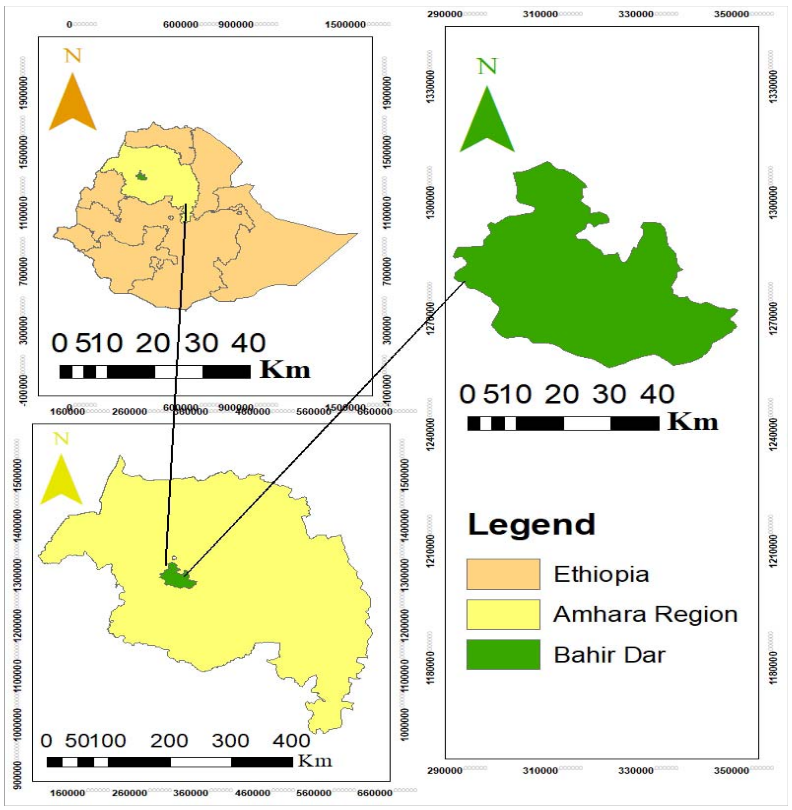

Figure 1 : Map of the the study area

2.2. Study Animal and Sampling Method

The study animals comprised cattle from selected sites in and around Bahir Dar, specifically Kebele 11, Sebatamit, Tikurit, and Latammba Kebeles. These cattle included both local breeds and crossbred Holstein Friesian cattle. A total of 384 cattle, spanning all age groups and both sexes, were randomly selected from various origins. The average age of the cattle was determined using dentition (categorized as young and adult) as described by Cringoli et al. (2002), and their body condition scores were recorded following the guidelines outlined by Nicholson and Butterworth (1986).

2.3. Study Design and Sample Size

A cross-sectional study design was employed to assess the prevalence of bovine fasciolosis and its associated risk factors in and around Bahir Dar town from November 2021 to April 2022. Factors including origin (place), breed, age, sex, and body condition were considered as potential risk factors for the occurrence of fasciolosis. The sample size for collecting fecal samples from the bovine population was determined following the guidelines outlined by Thrusfield (2005), using a 95% confidence interval and 5% absolute precision, assuming an expected prevalence of 50%.

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

Where n represents the required sample size, Pexp denotes the expected prevalence, and d stands for the desired absolute precision.The estimated sample size will be 384 animals.

2.4. Fecal Examination and Identification of Fasciola Eggs

Fecal samples collected directly from animals' rectums were preserved in universal bottles with 10% formalin for transport to the Bahir Dar Regional Veterinary Laboratory for analysis. At the laboratory, the sedimentation technique, following protocols detailed by Faria et al. (2008) and Elelu et al. (2016), was employed to detect fluke eggs present in the samples. To differentiate between Fasciola species eggs and other types, such as Paramphistomum species eggs, a methylene blue solution was utilized on the sediment. Fasciola eggs displayed a distinct yellowish hue, characterized by their larger size and thin, operculated shells, as outlined by Hussein et al. (2010). In contrast, Paramphistomum eggs stained blue, as outlined by Mifsut and Ballarin (2015).

2.5. Data Analysis

The raw data collected from the study were first organized and entered into a Microsoft Excel database using spreadsheet software. Following this, the data underwent analysis using descriptive statistics in STATA Version 20.0 to summarize the prevalence of bovine fasciolosis. To assess the statistical relationships between infection rates and various risk factors (age, sex, breed, and locality), a chi-square (χ^2) test was employed. This test compared infection rates across these factors, with statistical significance set at $P < 0.05$.

3. Results

3.1. Prevalence

The prevalence of bovine fasciolosis across various risk factors is presented in Table 1 and Figure 3. The overall prevalence rate of fasciolosis in the study area was 49.21%. Detailed analysis by origin revealed varying rates: Sebatamit exhibited the highest prevalence at 61.84%, followed by Kebele 11 at 59.37%, Tikurit at 50%, and Latammba at 27.65%. Regarding body condition scores, cattle in poor condition showed the highest prevalence at 64%, followed by those in medium condition at 50%, and fat cattle at 26.96%. Among different age groups, prevalence rates were 50.38% in young cattle, 47.33% in adults, and 50.47% in older cattle. Similarly, prevalence rates across sex groups were 49.73% in males and 48.73% in females. Among different breed groups, local breeds exhibited a prevalence rate of 51.62%, while crossbreeds showed a rate of 46.15%.

Statistical analysis revealed significant differences in prevalence among origin locations and body condition categories. However, no significant differences were observed among age groups, sex groups, and breed groups ($p < 0.05$).

3.2. Identification of Fasciola Eggs

The egg of the Fasciola species detected in the cattle fecal sample in the study is presented in Figure 2. The criteria for identification were established using morphological features guided by Hussein et al. (2010) and Mifsut and Ballarin (2015). These eggs are notably ovoid in shape with a distinctive thick, yellowish-brown shell, often displaying an operculum at one end.

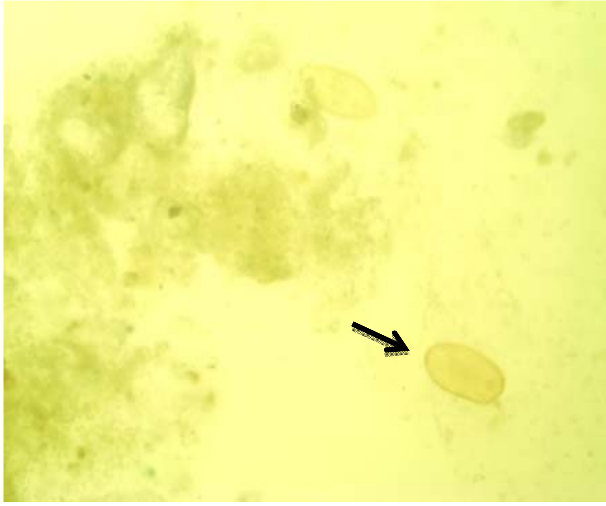

Figure 2 : Egg of *Fasciola* species: yellowish egg (arrow)

Table 1: Prevalence of Bovine Fasciolosis Based on Risk Factors

Factors	Category	Examined	Positive	χ2	P-value
	Tikurit	118	59 (50 %)		
Origin	Sebatamit	76	47 (61.84%)	26.31	0.000
	Latammba	94	26 (27.65%)		
	Kebele 11	96	57 (59.37%)		
Body	Poor	125	80 (64 %)		
condition	Medium	170	85 (50 %)	28.6	0.000
	Fat	89	24 (26.96 %)		
	Young	129	65 (50.38%)		
Age	Adult	150	71 (47.33%)	0.839	0.3503
	Old	105	53 (50.47%)		
Sex	Male	187	93 (49.73%)	0.844	0.3503
	Female	197	96 (48.73%)		
Breed	Local	215	111 (51.62%)	0.287	1.134
	Cross	169	78 (46.15%)		
Total		**384**	189 **(49.21%)**		

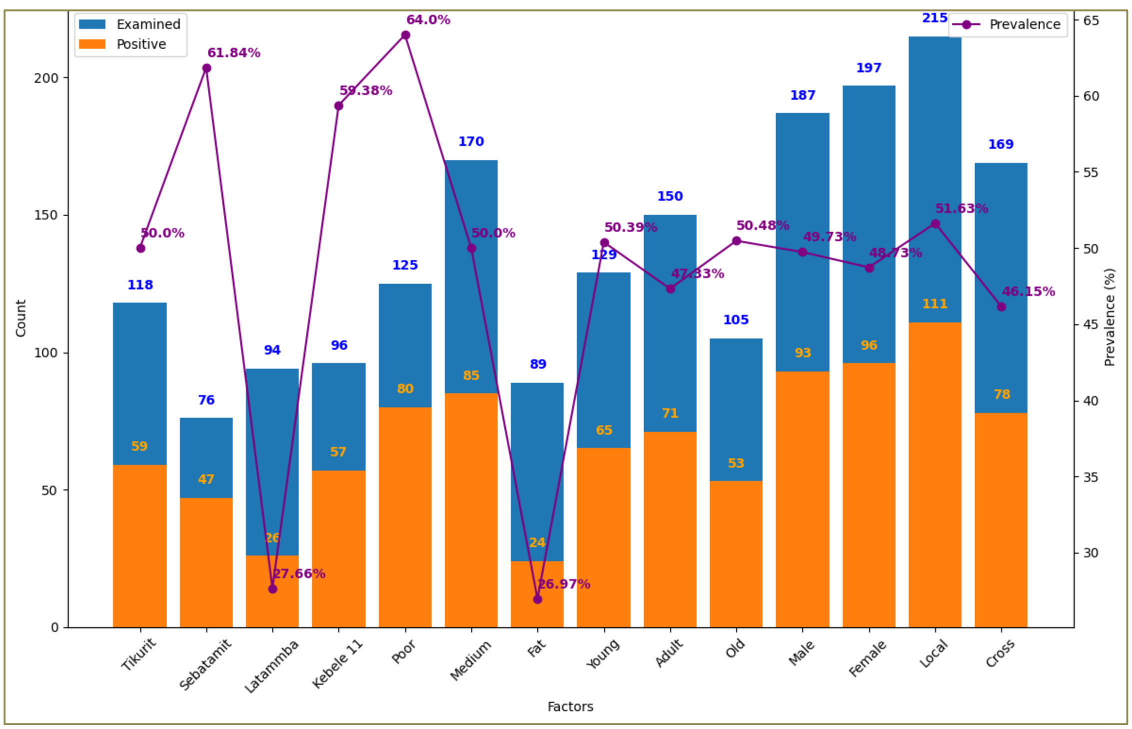

Figure 3: Examined and Positive Case Distribution with Prevalence by Various Factors

4. Discussion

The study reported an overall prevalence of bovine fasciolosis at 49.21% in the examined area, a figure that is consistent with several previous findings. For instance, Tsegaye et al. (2012) observed a prevalence of 41.41% in Woreta, while Demssie et al. (2012) reported a higher rate of 54.5% in Jimma. Other studies, such as those by Eshetu et al. (2017) in Angacha Woreda, Ayelign and Alemneh (2017) in the North-East Amhara Region, and Mohammed et al. (2018) in Eastern Shoa, Kuyu District, found prevalence rates of 40.62%, 47.10%, and 54.2%, respectively. These consistent prevalence rates are likely due to the shared agro-ecological conditions throughout Ethiopia, which support the proliferation of intermediate hosts like Lymnaea snails. Additionally, agrarian practices involving communal water sources and irrigation exacerbate transmission, as contaminated pastures and water are primary infection routes for cattle (Gebrie & Alemneh, 2015).

Conversely, some regions report lower prevalence rates. For example, Soddo in Southern Ethiopia had a prevalence of 4.9% (Abunna et al., 2010), Nekemte in the East Wollega Zone recorded 15.9% (Asrese & Ali, 2014), and Wolaita Soddo in Southern Ethiopia also reported 15.9% (Tilahun et al., 2014). Slightly higher, yet still relatively low prevalence rates, were noted in Mecha District in the West Gojam Zone (31.5%) (Ewnetu et al., 2015), Zenzelma in Bahir Dar (26%) (Legesse et al., 2017), Bahir Dar itself (32.3%) (Gebrie et al., 2015), Shambu in Western Ethiopia (30.8%) (Desa & Mitiku, 2019), and Gondar in Northwestern Ethiopia (23.44%) (Gebrie & Alemneh, 2015). These discrepancies can be attributed to variations in altitude, topography, weather conditions, and differences in disease management practices, such as efforts to protect cattle from infected areas, maintain dry pastures, and remove contaminated vegetation. The variability in the use of anthelmintics by veterinary health personnel may also play a role (Asressa et al., 2012).

Notable differences in prevalence rates were observed among different origins: Sebatamit (61.84%), Kebele 11 (59.37%), Tikurit (50%), and Latammba (27.65%). These findings align with earlier research (Mebrahtu & Beka, 2013; Gebrie et al., 2015; Yusuf et al., 2016; Eshetu et al., 2017; Desa & Mitiku, 2019; Yitayal & Taddie, 2020), which also documented significant variability in prevalence among different origins. However, some studies (Belay et al., 2012; Tsegaye et al., 2012; Petros et al., 2013; Aregay et al., 2013; Tilahun et al., 2014; Asrese & Ali, 2014; Ewnetu et al., 2015; Legesse et al., 2017; Ayelign & Alemneh, 2017; Bayou & Geda, 2018; Zewde et al., 2019) found no significant differences among origins. The variation may be due to differences in climatic conditions (e.g., altitude, rainfall, temperature), animal management systems, and the availability of veterinary services and drug usage (Ayelign & Alemneh, 2017).

Body condition scores revealed significant variability in fasciolosis prevalence: cattle in poor condition exhibited the highest prevalence at 64%, followed by those in medium condition at 50%, and fat cattle at 26.96%. This variation is consistent with several studies (Demssie et al., 2012; Belay et al., 2012; Petros et al., 2013; Asrese & Ali, 2014; Tilahun et al., 2014; Ewnetu et al., 2015; Gebrie & Alemneh, 2015; Yusuf et al., 2016; Eshetu et al., 2017; Legesse et al., 2017; Mohammed et al., 2018; Kassie & Ali, 2019; Desa & Mitiku, 2019; Yitayal & Taddie, 2020). Conversely, some studies (Mebrahtu & Beka, 2013; Aregay et al., 2013; Gebrie et al., 2015; Bayou & Geda, 2018; Zewde et al., 2019) reported no significant differences among body condition categories. The observed variability may result from malnutrition, chronic diseases, or environmental conditions that exacerbate fasciolosis susceptibility. Additionally, the presence of other infections, whether parasitic or non-parasitic, may further compromise the animal's body condition, increasing susceptibility to fasciolosis (Yitayal & Taddie, 2020).

Age did not significantly influence the prevalence of bovine fasciolosis in the study area, with young cattle (50.38%), adults (47.33%), and older cattle (50.47%) exhibiting similar rates. This lack of variability is consistent with several earlier studies (Tsegaye et al., 2012; Belay et al., 2012; Mebrahtu & Beka, 2013; Tilahun et al., 2014; Gebrie & Alemneh, 2015; Gebrie et al., 2015; Legesse et al., 2017; Bayou & Geda, 2018; Mohammed et al., 2018; Desa & Mitiku, 2019). However, some studies have reported significant differences among age groups (Petros et al., 2013; Aregay et al., 2013; Ewnetu et al., 2015; Yusuf et al., 2016; Ayelign & Alemneh, 2017; Eshetu et al., 2017; Kassie & Ali, 2019; Zewde et al., 2019), possibly due to uniform exposure levels or management practices affecting all age groups similarly.

Similarly, sex did not significantly impact the prevalence of bovine fasciolosis, with males (49.73%) and females (48.73%) showing comparable rates. This result aligns with previous studies (Tsegaye et al., 2012; Petros et al., 2013; Aregay et al., 2013; Mebrahtu & Beka, 2013; Tilahun et al., 2014; Gebrie et al., 2015; Ewnetu et al., 2015; Ayelign & Alemneh, 2017; Legesse et al., 2017; Bayou & Geda, 2018; Desa & Mitiku, 2019). Nonetheless, some research (Eshetu et al., 2017; Mohammed et al., 2018; Zewde et al., 2019) has found significant variability in prevalence rates among sex groups. This discrepancy might stem from uniform management practices for both sexes, resulting in similar exposure to contaminated forage.

Breed also did not significantly affect the prevalence of bovine fasciolosis, with local breeds (51.62%) and crossbreeds (46.15%) showing comparable rates. This finding corresponds with studies reporting no significant differences among breed categories (Tilahun et al., 2014; Gebrie & Alemneh, 2015;

Legesse et al., 2017). Conversely, significant variability among breed groups has been observed in other studies (Tsegaye et al., 2012; Aregay et al., 2013; Asrese & Ali, 2014). This variation might be linked to the unknown blood levels in crossbred animals (Legesse et al., 2017).

5. Conclusion

The study reveals a concerning 49.21% prevalence of Fasciola eggs in cattle fecal samples, significantly influenced by localities and body condition, though age, sex, and breed showed no significant variation. The persistently high rates of bovine fasciolosis highlight the urgent need for comprehensive control measures. Implementing enhanced management practices to minimize cattle exposure to contaminated pastures and water sources is essential for effective prevention and control of this parasitic infection.

Data sharing statement

All data generated or analyzed during this study are available upon request from the corresponding author.

Ethical Statement

Fecal samples were collected with the utmost diligence and care to ensure the safety and well-being of the cattle involved. Every measure was taken to adhere to the highest ethical standards throughout the sampling process, prioritizing the animals' comfort and health.

Author's contribution

Abraham Belete Temesgen: Writing – review & editing, Writing – original draft, Resources, Investigation, Conceptualization, Validation. Tesfaye Mesfin: Writing – review & editing, Writing – original draft, Resources, Investigation, Conceptualization, Validation

Finding

None

Conflict of Interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Reference

Abunna, F., Asfaw, L., Megersa, B., & Regassa, A. (2010). Bovine fasciolosis: coprological, abattoir survey and its economic impact due to liver condemnation at Soddo municipal abattoir, Southern Ethiopia. *Tropical animal health and production*, *42*, 289-292.

Aleixo, M. A., Freitas, D. F., Dutra, L. H., Malone, J., Martins, I. V. F., & Molento, M. B. (2015). Fasciola hepatica: epidemiology, perspectives in the diagnostic and the use of geoprocessing systems for prevalence studies. *Semina: Ciências Agrárias*, *36*(3), 1451-1465.

Ardo, M. B., Aliyara, Y. H., & Lawal, H. (2013). Prevalence of bovine fasciolosis in major abattiors of Adamawa State, Nigeria. *Bayero journal of pure and applied sciences*, *6*(1), 12-16.

Aregay, F., Bekele, J., Ferede, Y., & Hailemelekot, M. (2013). Study on the prevalence of bovine fasciolosis in and around Bahir Dar, Ethiopia. *Ethiopian Veterinary Journal*, *17*(1), 1-11.

Asrese, N. M., & Ali, M. G. (2014). Bovine fasciolosis: prevalence and economic significance in southern Ethiopia. *Acta Parasitol, 5*, 76-82.

Asressa Yeneneh, A. Y., Hassen Kebede, H. K., Tewodros Fentahun, T. F., & Mersha Chanie, M. C. (2012). Prevalence of cattle flukes infection at Andassa Livestock Research Center in north-west of Ethiopia. *CABI Databases***,** 2, 85-89

Ayelign, M., & Alemneh, T. (2017). Study on prevalence and economic importance of bovine fasciolosis in three districts of North-East Amhara Region, Ethiopia. *J Infect Non Infect Dis*, *3*, 24.

Bayou, K., & Geda, T. (2018). Prevalence of bovine fasciolosis and its associated risk factors in Haranfama municipal abattoir, Girja District, South-Eastern Ethiopia. *Int J Anim Sci*, *2*(2), 1018s1.

Belay, E., Molla, W., & Amare, A. (2012). Prevalence and economic losses of bovine fasciolosis in dessie Municipal Abattoir, South Wollo Zone, Ethiopia. *European Journal of Biological Sciences*, *4*(2), 53-59.

Bernardo, C. D. C., Carneiro, M. B., Avelar, B. R. D., Donatele, D. M., Martins, I. V. F., & Pereira, M. J. S. (2011). Prevalence of liver condemnation due to bovine fasciolosis in Southern Espírito Santo: temporal distribution and economic losses. *Revista Brasileira de Parasitologia Veterinária*, *20*, 49-53.

Boray, J. C., & Love, S. (2007). Liver fluke disease in sheep and cattle. *Prime fact*, *446*, 1-10.

Cringoli, G., Rinaldi, L., Capuano, F., Baldi, L., Veneziano, V., & Capelli, G. (2002). Serological survey of Neospora caninum and Leishmania infantum co-infection in dogs. *Veterinary Parasitology*, *106*(4), 307-313.

Demssie, A., Birku, F., Biadglign, A., Misganaw, M., Besir, M., & Addis, M. (2012). An Abattoir survey on the prevalence and monetary loss of fasciolosis in cattle in Jimma Town, Ethiopia. *Cell*, *251*(912112251), 912112251.

Desa, G., & Mitiku, W. (2019). Prevalence and Economic Significance of Bovine Fasciolosis in Shambu Municipality Abattoir, Ethiopia. *Acta Parasitol*, *10*, 103-110.

Elelu, N., Ambali, A., Coles, G. C., & Eisler, M. C. (2016). Cross-sectional study of Fasciola gigantica and other trematode infections of cattle in Edu Local Government Area, Kwara State, north-central Nigeria. *Parasites & Vectors*, 9, 1-11.

Eshetu, E., Thomas, N., Awukew, A., Goa, A., & Butako, B. (2017). Study on the prevalence of Bovine Fasciolosis and Estimated financial losses due to liver condemnation: Incase of Angacha Woreda, Kambata Tembaro Zone, Southern Ethiopia. *Journal of Biology, Agriculture and Healthcare*, *7*, 78-83.

Ewnetu, A., Derso, S., & Tesfaye, R. (2015). Prevalence of bovine fasciolosis and its associated risk factor in Mecha District, West Gojam Zone, Northwestern Ethiopia. *European Journal of Biological Sciences*, *7*(3), 132-138.

Faria, R. N., Cury, M. C., & Lima, W. S. (2008). Evaluation of two available methods to detect eggs of Fasciola hepatica in cattle faeces. *Arq. Bras. Med. Vet. Zootec*. 60, 1023–1025

Figtree, M., Beaman, M. H., Lee, R., Porter, M., Torey, E., Hugh, T. J., & Hudson, B. J. (2015). Fascioliasis in Australian travellers to Bali. *Medical Journal of Australia, 203*(4), 186-188.

Gebrie, M., & Alemneh, T. (2015). Prevalence of bovine fasciolosis in and around Gondar, Northwestern Ethiopia. *Acta Parasitologica Globalis, 6*, 231-237.

Gebrie, Y., Gebreyohannes, M., & Tesfaye, A. (2015). Prevelance of bovine fasciolosis in and around Bahir Dar, north west Ethiopia. *Journal of Parasitology and Vector Biology*, *7*(4), 74-79.

Hussein, A. N. A., Hassan, I. M., & Khalifa, R. M. A. (2010). Description of eggs and larval stages of Fasciola, light and scanning electron microscopic studies. *Research Journal of Parasitology*, 5(1), 1-12.

Irsik, M. B., Courtney III, C. H., & Richey, E. (2008). Liver Fluke Control in Beef Cattle: VM120/VM089, rev. 7/2007. *Edis*, *2008*(3).

Kassie, B. S., & Ali, S. F. (2019). Study on the prevalence and economic significance of bovine fasciolosis at Gondar Elfora Abattoir, Gondar, Ethiopia. *Journal of Animal Research*, *9*(5), 623-631.

Keyyu, J. D., Kassuku, A. A., Msalilwa, L. P., Monrad, J., & Kyvsgaard, N. C. (2006). Cross-sectional prevalence of helminth infections in cattle on traditional, small-scale and large-scale dairy farms in Iringa district, Tanzania. *Veterinary research communications*, *30*, 45-55.

Kleiman, F., Pietrokovsky, S., Prepelitchi, L., Carbajo, A. E., & Wisnivesky-Colli, C. (2007). Dynamics of Fasciola hepatica transmission in the Andean Patagonian valleys, Argentina. *Veterinary Parasitology*, *145*(3-4), 274-286.

Legesse, S., Tsegaye, S., Lamesgen, S., Wolelaw, Y., Garikipati, D., & Wondimagegn, W. (2017). Coprological prevalence and associated risk factors of bovine fasciolosis in and around Zenzelma, Bahir Dar, Ethiopia. *Eur Exp Biol*, *7*(5), 34.

Mebrahtu, G., & Beka, K. (2013). Prevalence and economic significance of fasciolosis in cattle slaughtered at Dire Dawa Municipal Abattoir, Ethiopia. *Journal of Veterinary Advances*, *3*, 319-324.

Mifsut, C. L. (2015). Helminths: Handbook for Identification and Counting of Parasitic Helminth Eggs in Urban Wastewater. *Iwa Publishing*.London, 27–56.

Mohammed, C., Nigussie, L., Dugasa, J., & Seid, U. (2018). Prevalence of bovine fasciolosis and its associated risk factors in Eastern Shoa, Kuyu District Central Ethiopia. *Arch Vet Sci Technol*, 1-5

Najib, M. A., Izani, N. J. N., Amilah, W. A. W. W. N., Faez, A. M., & Shafizol, Z. (2020). A scoping review of the prevalence of fascioliasis in Malaysia and risk factors for infection. *The Malaysian Journal of Medical Sciences*, *27*(1), 22.

Nguyen, T. G. T., Le, T. H., Dao, T. H. T., Tran, T. L. H., Praet, N., Speybroeck, N., ... & Dorny, P. (2011). Bovine fasciolosis in the human fasciolosis hyperendemic Binh Dinh province in Central Vietnam. *Acta tropica*, *117*(1), 19-22.

Nicholson, M. J., & Butterworth, M. H. (1986). A guide to condition scoring of zebu cattle. *ILRI* (aka *ILCA* and *ILRAD*), 3-31

Petros, A., Kebede, A., & Wolde, A. (2013). Prevalence and economic significance of bovine fasciolosis in Nekemte municipal abattoir. *Journal of Veterinary Medicine and Animal Health*, *5*(8), 202-205.

Phiri, A. M., Phiri, I. K., Sikasunge, C. S., & Monrad, J. (2005). Prevalence of fasciolosis in Zambian cattle observed at selected abattoirs with emphasis on age, sex and origin. *Journal of veterinary medicine, series B*, *52*(9), 414-416.

Sah, R., Khadka, S., Khadka, M., Gurubacharya, D., Sherchand, J. B., Parajuli, K., ... & Rijal, B. (2017). Human fascioliasis by Fasciola hepatica: the first case report in Nepal. *BMC research notes*, *10*, 1-4.

Soliman, M. F. (2008). Epidemiological review of human and animal fascioliasis in Egypt. *The Journal of Infection in Developing Countries*, *2*(03), 182-189.

Thrusfield M. Veterinary Epidemiology. 3rd ed. UK*: Blackwell Publishing*; 2005. p. 433.

Tilahun, Z., Nemomsa, D., Himanot, H., & Girma, K. (2014). Study on prevalence of Bovine Fasciolosis at Nekemte Veterinary clinic, East Wolega Zone, Oromia, Ethiopia. *European Journal of Biological Sciences*, *6*(2), 40-45.

Tsegaye, B., Abebaw, H., & Girma, S. (2012). Study on coprological prevalence of bovine fasciolosis in and around Woreta, Northwestern Ethiopia. *Journal of Veterinary Medicine and Animal Health*, *4*(7), 89-92.

Yitayal, G., & Taddie, W. (2020). Prevalence Bovine Fasciolosis in Postmortem Examination at Bahir Dar Municipal Abattoir, Bahir Dar, Ethiopia. *J. Anim. Husb. Dairy Sci*, *4*, 30-36.

Yusuf, M., Nuraddis, I., Tafese, W., & Deneke, Y. (2016). Prevalence of bovine fasciolosis in municipal abattoir of Haramaya, Ethiopia. *Food Science and Quality Management*, *48*.

Zewde, A., Bayu, Y., & Wondimu, A. (2019). Prevalence of bovine fasciolosis and its economic loss due to liver condemnation at Wolaita Sodo Municipal Abattair, Ethiopia. *Veterinary Medicine International*, 1, 9572373.