Cross Current International Journal of Agriculture and Veterinary Sciences
Abbreviated Key Title: Cross Current Int J Agri Vet Sci
ISSN: 2663-2454 (Print) & Open Access
DOI: https://doi.org/10.36344/ccijavs.2025.v07i03.001

Volume-7 | Issue-3| May-Jun, 2025 |

Original Research Article

Prevalence and Impact of *Fasciola gigantica and Dicrocelium dendriticum* Hepatic Co-Infections in Domestic Ruminants from Municipal Slaughterhouses of Diamare Division, Far North Cameroon

Augustin Siama[1*], Ibrahim[1], Alexandre Michel Njan Nlôga[2]

[1]Department of Parasitology and Parasitic Pathology, School of Sciences and Veterinary Medicine, University of Ngaoundere, PO BOX 454 Ngaoundere, Cameroon
[2]Department of Biological Sciences, Faculty of Science, University of Ngaoundere, PO BOX 454 Ngaoundere, Cameroon

***Corresponding author:** Augustin Siama | **Received:** 13.04.2025 | **Accepted:** 19.05.2025 | **Published:** 22.05.2025 |

Abstract: Domestic animals are very often subject to associated hepatic parasitic infestations, the consequences of which are little known on farms. The present study, which aimed to determine the prevalence and impact of hepatic co-infestation with *Fasciola gigantica* and *Dicrocelium dendriticum* in domestic ruminants in butcheries in the Diamaré department, was conducted from January to July 2023. The livers were necropsied by incising the ventral part of the parenchyma along the hepatic and bile ducts in order to find and collect the flukes with the naked eye. Of the 800 cattle, 175 sheep and 1008 goats inspected, only cattle showed co-infestation with an overall prevalence of 4.25% which is significantly lower than that due to singular *F. gigantica* infestation (15.62%) and higher than that due to *D. dendriticum* (1.37%) ($\chi 2=27.7$; ddl=2; $p < 0.000$). These co-infections were higher in females (3.37%) ($p<0.05$), and in 6–7-year-old cattle (5.75%) ($p>0.05$). Their parasite densities were significantly lower than in cases of fasciolosis (24.75±18.21 flukes) but higher than in cases of dicroceliosis (8.11±6.89 flukes) (F=191.91; ddl=79; $P < 0.000$). The level of animal infestation was low for all types of infestation. The economic losses due to this *F. gigantica/D. dendriticum* co-infestation, evaluated at 7,650,000FCFA/year (12,584.25 us$), are lower than those due to single *F. gigantica* infestations (28,116,000FCFA/ 46,250.82 us$/year), and higher than those due to *D. dendriticum* (2,466,000FCFA//4,056.57 us$/year). These results show that parasitic hepatic co-infestation with *F. gigantica/D. dendriticum* exists and remains a serious health and economic problem.
Keywords: Co-Infestation, *Fasciola Gigantica*, *Dicrocoelium Dendriticum*, Ruminants, Abattoirs, Economic Impact.

INTRODUCTION

Livestock production in Cameroon provides income for almost 30% of the rural population and contributes 20% to agricultural GDP (MINEPIA, 2011). Meat production is estimated at around 270,000 tons (MINEPIA, 2021), including 12,304 tons from cattle, 14,232 tons from goats and 7,260 tons from sheep in the Far North region (MINEPIA, 2021). However, this production is still insufficient to meet the animal protein needs of the population due to the lack of control over the breeding system, genetic and zootechnical limitations, and health problems associated with hepatic distomatosis, such as hepatobiliary fasciolosis and dicrocoeliosis (Ali *et al.*, 2011).

Hepatobiliary fascioliasis is a zoonotic parasitic disease caused by invasion of the liver and bile ducts by adult and larval forms of Fasciola trematodes (Braun *et al.*, 1995). Clinically, it is manifested by edema, especially in the panniculus, pale and discolored mucous membranes, subicteric and oily eyes, and diarrhea (Razafindramanga, 2011; Razafindrabe, 2012). Dicrocoeliosis or small liver fluke is a parasitosis caused by infestation of the bile ducts by a trematode flatworm of the genus *Dicrocoelium* (Ait and Bellout, 2017). It affects ruminants and sometimes humans, causing diarrhea, emaciation, altered fleeces, altered general condition, and dilation of the central veins and periportal vessels (GDS, 2017; OSAV, 2021). These two parasitosis can cause chronic lesions such as cholangitis, which, if persistent, promote the development of fibrosis

Citation: Augustin Siama, Ibrahim, Alexandre Michel Njan Nlôga (2025). Prevalence and Impact of Fasciola gigantica and Dicrocelium dendriticum Hepatic Co-Infections in Domestic Ruminants from Municipal Slaughterhouses of Diamare Division, Far North Cameroon. *Cross Current Int J Agri Vet Sci, 7*(3), 55-63.

and cirrhosis of the liver, leading to sudden and significant morbidity and mortality (GDS, 2017; OSAV, 2021).

In Cameroon, and particularly in the Far North Region, the majority of studies on distomatosis have been conducted independently. A paucity of research has addressed the co-infections and consequences of the two parasitosis. The objective of the present study was to contribute to the understanding of the prevalence and impact of hepatic parasitic co-infections in ruminants in slaughterhouses of Diamaré municipality. Specifically, the objective was to

- Determine the prevalence of hepatic co-infestation;
- Determine the level of hepatic parasite on co-infestation;
- Assess the impact of hepatic parasitic co-infestation in ruminants.

1. MATERIALS AND METHODS

1.1 Study Area

The study took place from January to December 2023 in the main slaughterhouses in the Diamare division (Fig. 1).

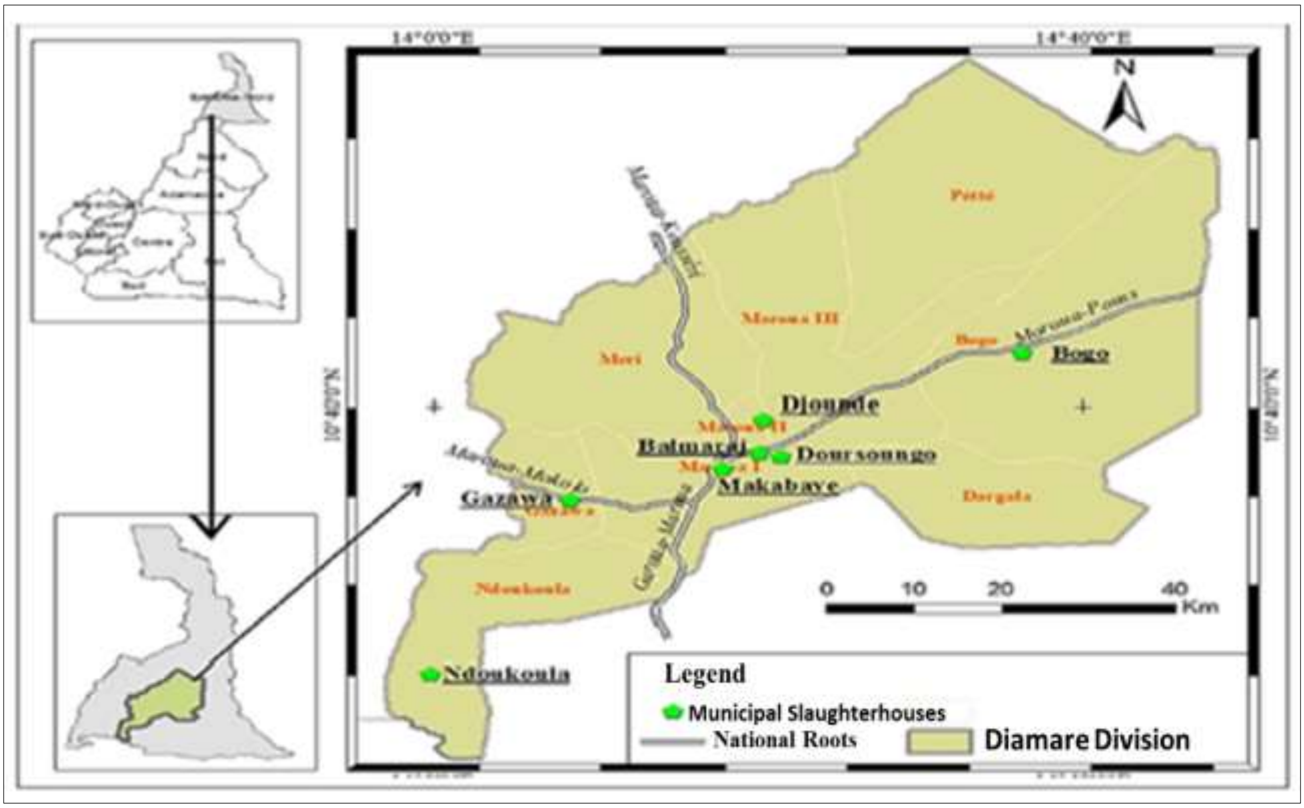

Figure 1: Map showing the location of the study area and sites

The Diamaré department, situated in Cameroon's Far North region between 10° and 11° North latitude and 14° and 15° East longitude, encompasses an area of 4,666 square kilometers (INS 2019). Administratively, the department is divided into nine arrondissements, including Maroua I, Maroua II, Maroua III, Bogo, Gazawa, Meri, Petté, Ndoukoula, and Dargala. The prevailing climate is tropical, classified as Sudano-Sahelian, with a prolonged dry season extending from October to April and a concise rainy season from May to September. Rainfall is generally lower, averaging around 82.4 millimeters per year (Lucas *et al*., 2017). The hydrological network depends on the Lake Chad basin, with seasonal Mayo flows such as the Mayo-Tsanaga, Mayo-Boula, and Kaliao emptying into the Logone (INS 2018). The vegetation of the region consists of a grassy steppe, interspersed with a few thorny shrubs, such as *Azardirachta indica*, *Acacia nilotica*, *A. oblida*, *Mangifera indica*, and *Citrus lemon* (Baye-Niwahl *et al*., 2020). The population is estimated at 864 (185 inhabitants/km2) and engages in agricultural activities such as the cultivation of cereals, including sorghum, maize, millet, and rice, as well as legumes, such as cowpeas, soybeans, groundnuts, and voandzou (INS 2019). Other crops cultivated include onions, potatoes, and sweet potatoes (INS, 2019). Livestock farming is predominantly focused on cattle, sheep, goats, and poultry, with pigs, horses, camels, donkeys, and beekeeping being practiced to a lesser extent (INS 2019).

1.2 Study Sites

The study was conducted in the municipal abattoirs of Maroua 1, Maroua 2, Maroua 3, Bogo, Gazawa, and Ndoukoula (Fig. 1). These abattoirs were selected due to their accessibility, the significance of slaughtering large and small ruminants, and the availability of the personnel working there.

1.3. Sample Size

The study's sample size was determined using the Thrusfield formula: N=Z2 x P (1-P)/M2, where N is the sample size, Z is the critical value for a confidence level of 95%, P is the estimated proportion of the population, M is the margin of error, and 5% was used for M.

$N=Z^2 \times P\ (1-P)/M2$

Where: N=sample size; Z=95% confidence level, Z=1.96;

P=estimated proportion of the population (when unknown, P=0.5 is used);

M=tolerated margin of error (5% is used).

1.4. Liver Autopsy

This consists of carrying out macroscopic inspections of ruminant liver and bile to search for and collect parasites using the method described by Habiba (2015). The inspection begins with a macroscopic observation of both sides and the parenchyma, followed by an incision of the ventral part of the parenchyma along the hepatic and bile ducts to look for staves in the bile and hepatic ducts. The contents of the gall bladders of each animal are also sieved to collect any flukes present. Upon the observation of adult flukes, they are collected and placed in a plastic box. At the conclusion of the inspection, the parasites from each box are rinsed with water and placed in boxes containing 95% alcohol. In the laboratory, identification is based on morphological characteristics specific to each species. When two different parasites (*F. gigantica* and *D. dendriticum*) are identified in the same liver, the animal is considered to be co-infected. The parasite species identified were enumerated to ascertain the parasite load and the extent of infestation.

1.5. Determination of the Infestation Level

The infestation level is estimated based on the number of adult flukes and the parasite species. For *F. gigantica* adults, infestation is low if the number of flukes is ≥20 parasites, medium if it is between 20-50 parasites, and high if it is more than 50 parasites (Boucheikhchoukh *et al*., 2012). For *D. dendriticum* adults, infestation is low if the number of flukes is <100 parasites, medium for 101-200 parasites, and high for 201-300 parasites (Camara *et al*., 1996). For co-infestation, the infestation is combined with the two parasitic species. It is low if the number of flukes is between (0-100) / (≤20), average between (101-200) / (20-50), and high between (201-300) / (≥50/).

1.6 Assessment of Economic Losses

The economic losses were calculated from infested or co-infested livers, and the estimated annual loss due to these parasites was calculated using the formula of Ogunrinade and Adegoke (1982): ALC=CSR x LC x P.

Where, ALC=annual loss; CSR=average annual number of ruminants slaughtered; LC=average cost of a liver; P=prevalence of infestation in slaughtered ruminants.

To do this, the average annual number of cattle, sheep, and goats slaughtered in these abattoirs was evaluated, and the selling price of the liver of each type of animal was known.

1.7. Statistical Analysis

The data collected during the field visit were meticulously compiled, transferred to Excel, and then subjected to rigorous analysis using Sphinx.V5 software. The collated data were meticulously calculated on the basis of percentages to determine prevalences and on the basis of averages to determine parasite loads. The χ^2 test was used to compare percentages and the ANOVA to compare means.

2. RESULT

2.1. Overall Prevalence

A total of 1,983 animals were examined in this study, including 800 cattle, 175 sheep, and 1,008 goats (Table 1). The results of liver and bile autopsies revealed infestation prevalences in cattle of 15.62% for *F. gigantica*, 1.37% for D. dendriticum, and 4.25% for *F. gigantica - D. dendriticum* co-infestation. These results indicate a statistically significant difference (χ^2=27.7; ddl=2; p < 0.000), suggesting that cases of co-infestation are less prevalent than F. *gigantica* infestations, yet more prevalent than *D. dendriticum* infestations. In contrast, no *F. gigantica* or *D. dendriticum* infestations or co-infestations were observed in sheep and goats.

Table 1: Prevalence of co-infestation by species

Méthode	Animaux	NE	*F. gigantica*	*D. dendriticum*	Co-infestation		
			NI(P)	NI(P)	NI(P)	χ^2	P value
Autopsie	**Bovins**	800	125(15.62)	11(1.37)	34(4.25)	27.7	< 0.000
	Ovins	175	00(00)	00(0,00)	00(00)		
	Caprins	1008	00(00)	00(0,00)	00(00)		
	Total	**1983**	**125(15.62)**	**11(1.37)**	**34(1.71)**		

NE=number of animals examined, NI=number of animals infested and P=prevalence in %.

2.2 Prevalence According to Intrinsic and Extrinsic Factors

2.2.1 Prevalence According to Slaughterhouses

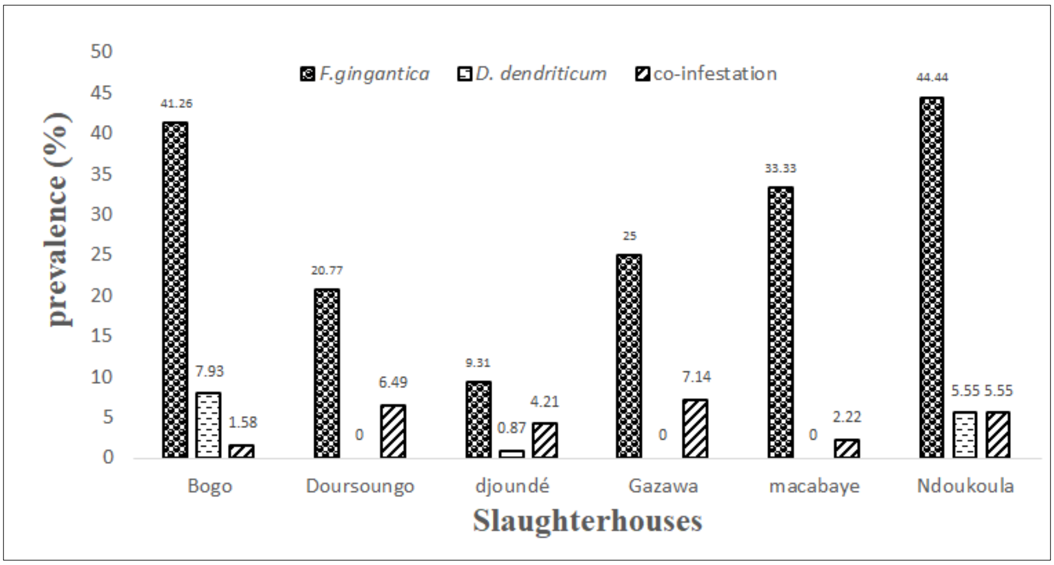

Figure 2: Prevalence of distomatosis co-infestation by slaughterhouses

As demonstrated in Figure 2, the prevalence of co-infections exhibited significant variations, ranging from 1.58% observed in the Bogo municipal slaughterhouse to 7.14% in the Gazawa abattoir (χ^2=17.7; ddl=2; p < 0.000). The Z-test indicates that cases of co-infestation were more prevalent in cattle from Gazawa (7.14%), followed by Doursoungou (6.49%) in Maroua, Ndoukoula (5.55%) and Djoundé in Maroua 1 (4.21%). A further analysis of infestation variations according to slaughterhouse reveals a highly significant relationship (χ^2=197.7; ddl=2; p < 0.000) between co-infestation with *F. gigantica*/*D. dendriticum* (1.58%) and single-species infestation with *F. gigantica* (41.26%) at the Bogo abattoir. % for *D. dendriticum* and 20.77% for *F. gigantica* at the Doursoungo municipal slaughterhouse (χ^2=231.6; ddl=2; p < 0.000), and between 0.87% for *D. dendriticum* and 9.31% for *F. gigantica* (χ^2=1669.91; ddl =2; p < 0.000), between 0.00% for *D. dendriticum* and 25% for *F. gigantica* (χ^2=84.71; ddl=2; p < 0.000), and between 0.00% for *D. dendriticum* and 33.33% for *F. gigantica* (χ^2=148.9 2; ddl=2; p < 0.000), and between 5.55% for *D. dendriticum* and co-infestation with *F. gigantica/D. dendriticum* and 44.44% for *F. gigantica* at the Ndoukoula municipal slaughterhouses (χ^2=56.03; ddl=2; p < 0.000). At the Doursoungou, Djoundé, Gazawa, and Makabaye slaughterhouses, co-infection with *F. gigantica*/*D. dendriticum* was the second most prevalent hepatic parasitosis after hepatobiliary fasciolosis.

2.2.2 Prevalence According to Sex

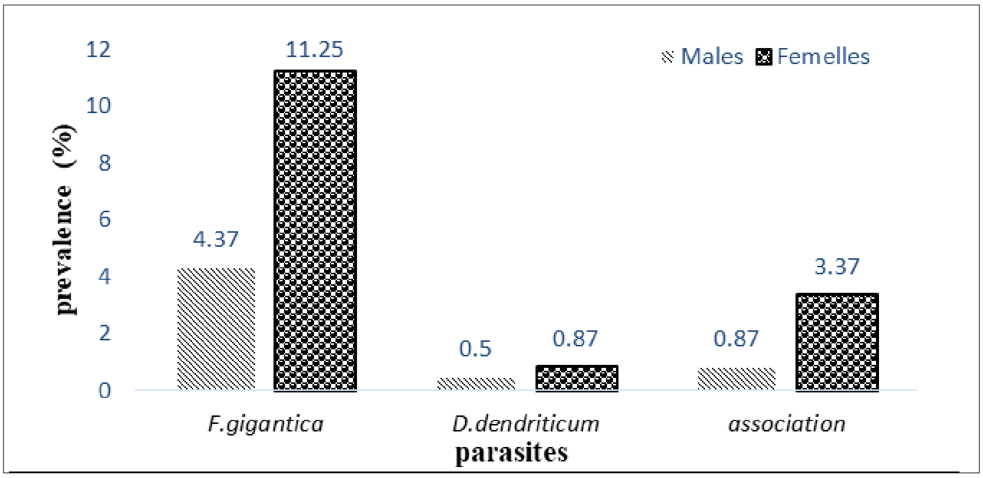

Figure 3: Prevalence of co-infestation according to sex

As illustrated in Figure 3, the prevalence of infestations exhibits variation according to sex, with females demonstrating higher infestation rates compared to males in the context of *F. gigantica* infestation

(11.25%), *D. dendriticum* infestation (0.87%), and *F. gigantica/D. dendriticum* co-infestation (3.33%). However, a statistically significant difference was only observed in the cases of fasciolosis and co-infestation [(χ^2=4.26; ddl=2; P>0.05) and (χ^2=5.26; ddl=2; P>0.05), respectively].

2.2.3 Prevalence by Age Group

The prevalence of cattle according to age (Table 2) reveals a notable prevalence of *F. gigantica* and *F. gigantica/D. dendriticum* co-infections, with the highest incidence observed in adult cattle aged 6-7 years (1.87%), followed by those aged 4-5 years (1.12%) and 8-9 years (0.87%) as illustrated in Table 2. For dicrocoeliasis, infestation levels were observed to be highest in adult cattle aged 4-5 years (0.5%). However, these results did not demonstrate any statistically significant differences [(χ_f^2=5.69; ddl=10; p > 0.05), (χ_d^2=1.29; ddl=10; p > 0.05), (χ_c^2=0.83; ddl=10; p > 0.05)].

Table 2: Prevalence of infestation in cattle as a function of age

Age	*F. gigantica* NI(P)	χ_f^2(Pv)	*D. dendriticum* NI(P)	χ_d^2(Pv)	Co-infestation NI (P)	χ_c^2(Pv)
< 4 ans	4 (0.5)	5.69 (> 0.05)	1(0.12)	1,29 (> 0.05)	0(00)	0.83 (> 0.05)
4-5 ans	35(4.37)		4(0.5)		9(1.12)	
6-7 ans	46(5.75)		2(0.25)		15(1.87)	
8-9ans	20(2.5)		3(0.37)		7(0.87)	
10-11 ans	18(2.25		1(0.12)		3(0.37)	
> 12 ans	2(0.25)		0(00)		0(00)	
Total	**125(15.62)**		**11(1.47)**		**34(4.25)**	

NI=number of infested animals, P=prevalence in % and Pv=p-value

2.3 Parasite Densities and Level of Infestation in Animals

The findings in Table 3 illustrate variations in parasite densities and infestation levels in co-infected and co-infested beef cattle. In cattle co-infected with *F. gigantica* and *D. dendriticum*, the level of infestation was significantly low (55.88%/100%) (F= 191.91; ddl= 79; P< 0.000 Furthermore, parasite loads were determined to be 16.43 ± 12.55 adult flukes, with *F. gigantica* exhibiting a predominance of 24.75 ± 18.21 adult fluke compared to *D. dendriticum* at 8.11 ± 6.89 adult flukes. In cattle with single infestations of *F. gigantica* or *D. dendriticum*, the levels of infestation were found to be significantly low (59.2%; 100%, respectively) and the overall mean densities were 55.25 ± 6.75 adult flukes for *F. gigantica* and 13.91 ± 11.37 adult flukes for *D. dendriticum.*

Table 3: Parasite density and level of infestation in infested animals

		F. gigantica		**Mean Density**
Level of infestation	**NI (Taux in%)**	Min	Max	Mean ± standard deviation
≤20	74(59.2)	1	20	55.25±6,75c
20-50	44(35.2%)	25	47	
≥50	7(5.6)	50	64	
D. dendriticum				
Level of infestation	**NI (Taux)**	**Min**	**Max**	Mean ± standard deviation
0-100	11(100)	4	43	13.91±11,37b
101-200	00(00)	00	00	
2001-300	00(00)	00	00	
Co-infestation *F. gigantica/ D. dendriticum*				
Level of infestation D(F)	**NI_D (Taux)/ NI_F (Taux)**	**Mini F (D)**	**Max F (D)**	Mean ± standard deviation
≤20 (0-100)	19(55.88) /34(100)	4(1)	20(30)	16.43±12,55 (F/D)b 24.75±18,21(F) 8,11±6,89 (D)
20-50 (101-200)	13(38.23) /00(0,00)	23(00)	50(00)	
≥50 (2001-300)	2(5.88) /00(0.00)	57(00)	64(00)	

Values that do not have the same letters are not significantly different at the 5% threshold (P<0.05).
Legend: NI=number of animals infested, Min=minimum, Max=maximum; and P-V=p-value, D= *D. dendriticum*, F= *F. gigantica*.

3.3 Economic Impact

The economic repercussions of *F. gigantica/D. dendriticum* hepatic coinfections, estimated to amount to 7,650,000 FCFA per annum (equivalent to 12,584.25 United States Dollars) in cattle slaughtered in the Diamaré department, is greater than that of *D. dendriticum* dicroceliosis (2,466,000 FCFA or 4,056.57 $us/year), but less than that of *F. gigantica* fasciolosis (28,116,000 FCFA or 28,116,000 $us).

3. DISCUSSION

This study of hepatic parasitic infestations in domestic ruminants from slaughterhouses in the Diamaré Department demonstrates the occurrence of co-infestation with *F. gigantica* and *D. dendriticum* at an aggregate prevalence of 4.25%. This prevalence exceeds the figures reported by Ulayi *et al*., (2007) in Nigeria (0.86%), yet falls short of the findings documented by Florence *et al*., (2018) and Shinggu *et al*., (2019), Ieren *et al*., (2016) and Yaro *et al*., (2022) in Nigeria (22.3%, 21.4%, 50.51% and 58.7%, respectively). Furthermore, Ali *et al*., (2011), Petros *et al*., (2013), and Magaji *et al*., (2014) have documented infestations of Fasciola hepatica and *D. dendriticum* in cattle bile, often without overt signs or symptoms.

The prevalence of *F. gigantica/D. dendriticum* co-infestation (4.25%) is lower than that of *F. gigantica* alone (15.62%), but higher than that of *D. dendriticum* (1.47%). These results contrast with those reported by Shinggu *et al*., (2019), who observed co-infestation prevalences (21.4%) that exceeded those of single *F. gigantica* infestations (6.9%) and were lower than those of *D. dendriticum* (59%) in Nigeria, and those of Ulayi *et al*., (2007) in Nigeria, who report prevalences of co-infestation (0.86%) lower than those of *F. gigantica* (1.37%) and *D. dendriticum* (35.4%) in Nigeria. Ait and Bellout (2017) reported low prevalences of *F. gigantica* fasciolosis in Algeria (0.70%), while high prevalences were highlighted by Bacha (2020) in Algeria (7.04%), Mwabonimana *et al*., (2009) in Algeria (6.7%), and Mohamed *et al*., (2021) in Tanzania (12.3%), Petros *et al*., (2013) in Ethiopia (21.9%), Menya (2017) in Adamaoua, Cameroon (63%), Massamba (2020) in Burkina (67%), and Merdas (2015) in Algeria (21.92%). In contrast, lower prevalences of *D. dendriticum* dicrocoeliosis were observed by Mohamadzadeh *et al*., (2015) in Iran (0.6%) and Mohamed *et al*., (2019) in Algeria (0.52%), while higher Conversely, higher prevalences were reported by Baudin (2005) in Haute-Saône (7.2%), Shinggu *et al*., (2019) in Nigeria (80.5%), and Mamatkulova (2021) in Uzbekistan (62.4%).The high prevalence of *F. gigantica* can be linked to the presence of ecological biotypes that are favorable to its intermediate host, *Lymnaea natalensis*.

When examining variations in infestations according to sex, co-infestation with *F. gigantica* and *D. dendriticum* was observed to be higher in females (3.37%) than in males (0.87%). Florence *et al*., (2018) also reports higher co-infestation with *F. gigantica* and *D. dendriticum* in females (24.5%) than in males (20.0%) in Nigeria. The higher prevalence of *F. gigantica* infestation in females (11.25%) has also been documented by Bacha (2020) in Algeria and Siama and Njan-Nlôga (2018) in the Far North region of Cameroon. According to Howell *et al*., (2015), the high prevalence observed in females can be attributed to the fact that, in herds, females are more numerous and have greater physiological needs (heat, conception, milk production, calf nutrition) which force them to feed more than males and to be more exposed to parasitosis.

The present study found that cattle aged between 6 and 7 years old exhibited the highest risk of infection with *F. gigantica/D. dendriticum* (1.87%) and *F. gigantica* (5.75%). In contrast, the prevalence of a single infestation with *D. dendriticum* was highest in cattle aged 8 to 9 years (0.37%). This finding aligns with the results reported by Linda (2019) in northern Algeria, who observed that animals over 4 years of age are the most affected by dicrocoeliosis (0.25%). Murat *et al*., (2009) reported that older cattle are more susceptible (12.7%) to dicrocoeliosis than younger cattle (3.04%) in Turkey. Higher prevalences in older animals were also reported by Bacha (2020) in Algeria (60%), Mebark and Megane (2018) in Algeria (57.14%), and Petros (2013) in Algeria (31.78%), while young animals were more infested (18.05%) than adults. According to Yaro *et al*., (2022), the higher prevalence in older cattle could be attributed to prolonged exposure to infection, resulting in the weakening of their immune systems over time.

The animals demonstrated minimal infestation levels in cattle with co-infestation (59.2%), fasciolosis (55.88%), and dicrocoeliosis (100%). These results are consistent with those reported by Siama and Njan Nlôga (2018) in Cameroon, Mebark and Megane (2018) in Algeria, Shinggu *et al*., (2019) in Nigeria, Ieren *et al*., (2016) and Yaro *et al*., (2022) in Nigeria. According to Petros (2013), this low level of infestation can be attributed to the acquired immunity of the animals, which limits the number of flukes and dunce during reinfestations through humoral immune responses and hepatic tissue reactions.

The mean parasite density (16.43 ± 12.55 flukes) in animals with coupled *F. gigantica/D. dendriticum* infestations was lower than that of single fasciolosis cases (55.25 ± 6.75 flukes) and comparable to that of animals infested only with *D. dendriticum* (13.91 ± 11.37 flukes). A subsequent examination of the stave composition of co-infested animals revealed a predominance of *F. gigantica* adults (24.75 ± 18.21 staves) over those of *D. dendriticum* (8.11 ± 6.89 staves), suggesting the presence of interspecific competition. These results are consistent with those reported by Mohamed *et al*., (2021), who observed low levels of infestation by *F. hepatica* and *Paramphistomum* sp. Equar and Gashaw (2012), also proposed that interspecific competition, which can manifest as a limitation on the number and size of the weakest parasites, may underlie these observations.

The annual economic losses incurred as a result of liver condemnation in cattle afflicted with co-infestations amount to 7,650,000 F CFA (equivalent to 12,584.25 USD). This figure stands in contrast to the losses associated with a singular *F. gigantica* infestation, which are estimated at 28, 116,000 F CFA/46,250.82 $ us) but higher than for *D. dendriticum* infestations (2,466,000 F CFA/4,056.57 $ us). These results are consistent with those reported by Ali *et al.*, (2011) for ruminants infested with the combination of fasciolosis and dicrocoeliosis (142,763,223.87 FCFA/ $234,845.50). These financial losses are notably lower than those reported by Petros *et al.*, (2013) in Ethiopia due to fasciolosis (740,792,466 FCFA/1,218,603.61 $us) and Razanajatovoarivelo (2015) in Madagascar due to seizure (1443540 FCFA/2,374.62 $us), and Mohamed (2021) in Madagascar (1298281495 FCFA/2,135,673.06 $us). Ethiopia (708929.28 FCFA/1,166.19 $us), and Mohsen *et al.*, (2018) for dicrocoeliosis in Iran (5,687,301.672 FCFA/9,355.61 $us). The elevated costs observed can be attributed to the significant number of animals that were slaughtered. These animals originated from flood plains, where ecological conditions are conducive to the survival and proliferation of intermediate host mollusks and the subsequent transmission of the disease to animals.

4. CONCLUSION

The present study demonstrated that the hepatic parasites *F. gigantica* and *D. dendriticum*, which are responsible for fasciolosis and dicrocoeliosis in cattle, may coexist, with a prevalence of 4.25%, compared with 15.62% for *F. gigantica* and 1.37% for *D. dendriticum*. The overall level of infestation was low in all cases. The parasitic load in co-infested animals was found to be lower than that caused by *F. gigantica*, but higher than that caused by *D. dendriticum*. The annual economic losses due to co-infestation were found to be lower than those associated with liver seizures caused by parasitosis unique to *F. gigantica*, but higher than those associated with *D. dendriticum*. These findings indicate the existence of interspecific hepatic relationships between *F. gigantica* and *D. dendriticum*, characterized by competition for space, resulting in a reduction in their numbers. Consequently, further research in the form of serological studies is necessary to elucidate the immunological elements and mechanisms underlying this competitive relationship between the two parasites.

Statements and Declarations

Funding: No funding was received for conducting this study.

Competing Interests: This study was conducted without any conflict of interest.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Augustin SIAMA, IBRAHIM, and Alexandre Michel NJAN NLÔGA. The first draft of the manuscript was written by Augustin SIAMA and IBRAHIM and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval: No applicable.

Consent to Participate: No applicable.

Consent to Publish: No applicable.

REFERENCES

- Ait MM and Bellout H (2017) La dicrocoeliose et la fasciolose chez les ruminants au niveau de la région de Tizi Ouzou. Mémoire master, faculté des sciences biologiques et sciences agronomiques, université mouloud mammeri de tizi ouzou, 53 p.
- Ali K, Razieh P, Sepideh A, Ghazal N, Alireza B, Ali M, Akhondzadeh-Basti A., Alizadeh-Ilanjegh A and Afshin M., (2011). A Retrospective Survey of Fasciolosis and Dicrocoeliosis in Slaughtered Animals in Meisam Abattoir, Tehran, Iran (2005-2008). *Veterinary Research Forum*ol. 1 (3):174 – 178P.
- Arbabi M, Nezami E, Hooshyar H and Delavari M (2018). Epidemiology and economic loss of fasciolosis and dicrocoeliosis in Arak, Iran. 11(12): 1648-1655 p.
- Bacha H, (2020) Etude sur la fasciolose bovine dans l'abattoir de Biskra. Mémoire master, Faculté des Sciences Exactes et des Sciences de la Nature et de la Vie, Université Mohamed Khider de Biskra, 32 p.
- Baudin M, (2005) L'infestation par *dicrocoelium lanceolatum* dans les élevages de trois Cantons en haute saône, résultats d'une enquête coprologique. Thèse de doctorat Vétérinaire, école nationale vétérinaire d'alfort, 123 p.
- Baye-Niwah C, Gilbert T, Konsala S, Abassi A, Sakitai B and Efuet A (2020) Diversité et usages des plantes ligneuses des agrosystèmes périphériques de la ville de Maroua (Extrême-Nord, Cameroun). *International journal of biological and chimical science*. (https://doi.org/10.4314/ijbcs.v14i3.25). http://www.ifgdg.org.
- Boucheikhchoukh M, Righi S, Sédraou S, et Mékroud U (2012) Principales helminthoses des bovins : enquéte épidémiologique au niveau de deux abattoirs de la région d'El Tarf (Algérie).
- Braun U, Wolfensberger R, Hertzberg H (1995) Diagnosis of liver flukes in cows--a comparison of the findings in the liver, in the feces, and in the bile. Schweiz Arch Tierheilkd. 137(9):438-44. PMID: 7494997.
- Equar Y and Gashaw A (2012) Prevalence of bovine fasciolosis, amplitude of liver condemnation and its economic impact in slaughtered cattle at Municipal Abattoir of Mekelle, North Ethiopia. International *Journal of Agricultural Research*. 1 (2012) 10 – 14p.
- Erick M, Wamae LW, Jewel M, Mungube EO, Bauni SM and Nginyi JM (2006) The prevalence

and economic significance of *Fasciola gigantica* and *Stilesia hepatica* in slaughtered animals in the semi-arid coastal Kenya. *Trop Anim Health Prod .38: 475483.DOI10.1007/s1125000643944.http* ://www.reseachgate.net/publiccation/6560580

- Florence OI, Clement AY, Mercy FP, Agatha EOA (2018) Fasciola hepatica and Associated Parasite, *Dicrocoelium dendriticum* in Slaughter Houses in Anyigba, Kogi State, Nigeria. *Advances in Infectious Diseases*, 8, 1-9. https://doi.org/10.4236/aid.2018.81001.
- GDS (2017) La petite douve du foie Une dominante parasitaire des petits ruminants. Groupement de Défense Sanitaire. https://www.gdscreuse.fr.
- Habiba F (2015) Etude épidémiologique, biochimique et immunologique de la Fasciolose chez les bovins (race locale) dans la région d'Annaba. Thèse De Doctorat, Faculté de Biologie Animale. Université badji mokhtar-annaba, (Annaba, Maroc).
- Ieren II, Ajanusi OJ and Mbaya PY (2016) Prevalence of Liver Flukes in Cattle, and Small Ruminants at Slaughter in Zaria, Nigeria. *Research in Zoology* 2016, 6(3): 33-36 DOI: 10.5923/j.zoology.20160603.01.
- Issa M, Mohammad R, Mehran S, Nabi S, Ali AB and Fereshteh K (2015) Prevalence of dicrocoeliosis in slaughtered herbivores animals in Arak city of Markazi province in Iran. *Journal of Food Safety and Hygiene*. 1(1): 18-21.
- Lucas B., Sophie S., Bernard G., Pierre-Alain A and Auguste O., (2017). Tendances pluviométriques et aléa inondation à l'Extrême-Nord Cameroun. Trends in rainfall and flood hazard in the Far North region of Cameroon. Ecole des Mines d'Alès / Laboratoire de Génie de l'Environnement Industriel et Naturel / Institut des Sciences de Risque. 6, avenue de Clavières, 30319 Alès, cedex.
- Magaji AA, Kabir I, Salihu MD, Saulawa MA, Mohammed AA and Musawa AI (2014) Prevalence of Fascioliasis in Cattle Slaughtered in Sokoto Metropolitan Abattoir, Sokoto, Nigeria. *Hindawi*, Volume 2014, Article ID 247258, 5 pages http://dx.doi.org/10.1155/2014/247258.
- Massamba L (2020) Fasciolose humane à *Fasciola gigantica* contractée au Burkina Faso. Le point sur la fasciolose humaine en France au début du xx^{eme} siècle. Thèse de Docteur en Médecine, Faculté de Médecine de Nice, Université Côte d'Azur, 50.
- Mebarka F and Megrane S (2018) Contribution à l'étude de la fasciolose des ruminants dans la région de Djelfa. Mémoire master, Faculté des Sciences de la Nature et de la Vie, Université Ziane Achour – Djelfa, 42 P.
- Menya EGD (2017) Effet de la fasciolose sur les marqueurs hématologiques chez les bovins à l'abattoir municipal de Ngaoundéré Cameroun. Mémoire de diplômes de docteur en médecine vétérinaire, ESMV, université de Ngaoundéré, 76 p.
- Merdas FH (2015) Etude épidémiologique, biochimique et immunologique de la Fasciolose chez les bovins (race locale) dans la région d'Annaba. Thèse doctorat, Faculté des sciences, université badji mokhtar – annaba, 56.
- MINEPIA (2011) Appui à l'amélioration du contrôle des maladies transfrontalières du bétail Objet du commerce, 46.
- MINEPIA (2021) Situation de la production et des importations du sous-secteur élevage, pèches et industries animales. Une publication de la Division des Études, de la Planification, de la Coopération et des Statistiques (DEPCS). Cameroun.
- Mohamadzadeh T, Shams S, Khanaliha K, Marhamatizadeh MH and Vafa A (2016) A study on prevalence of some helminthic infections of the liver and lungs among ruminants in abattoir of Fars province, Iran. *Archives of Razi Institute*, 71(4): 245-251, DOI: http://dx.doi.org/10.22034/ari.2016.107509.
- Mohamed G (2020) Les trématodoses des ruminants dans la région de Sejnane : Les trématodoses des ruminants Cycle biologique et lutte. Cap Serrat, Bizerte, Journée Scientifique, 44 p.
- Mohamed H (2021) Détection de la fasciolose bovine par l'inspection des viandes à la tuerie d'ankadindratombo-antananarivo. Thèse docteur en médecine vétérinaire, faculté de médecine, université d'antananarivo, 73.
- Mohamed NM, Souad R, Mehdi B, Shehrazed S and Ahmed BA (2021) Investigation of flukes (*Fasciola hepatica* and *Paramphistomum sp*.) parasites of cattle in north-eastern Algeria. *Annals of Parasitology*, 67(3), 455–464, doi: 10.17420/ap6703.358.
- Mwabonimana MF, Kassuku AA, Ngowi HA, Mellau LSB, Nonga HE and Karimuribo ED, (2009). Prevalence and economic significance of bovine fasciolosis in slaughtered cattle at Arusha abattoir, Tanzania. *Tanzania Veterinary Journal*. 26(2). 74 p.
- Ogunrinade A and Adegoke G (1982). Bovine fasciolosis in Nigeria Intercurrent Parasitic and bacterial infection. Trop. Anim. Health Prod. 14 :121-125.
- OSAV (2021) Douves : dicrocoeliose / fasciolose. Maladies parasitaires des herbivores. L'être humain est un hôte accidentel. Office fédéral de la Sécurité Alimentaire et des Affaires Vétérinaires. Confédération suisse. 3.
- Petros A, Addisu K and Amanuel W (2013) Prevalence and economic significance of bovine fasciolosis in Nekemte Municipal abattoir. *Journal of Veterinary Medicine and Animal Health*. 5(8): 202-205. DOI 10.5897/JVMAH2013.0212 2013.
- Razafindrabe TJL (2012). Fasciolose et strongylose gastro-intestinale des bovins de la commune de fandriana. Thèse de doctorat en médecine

vétérinaire, faculté de médecine, université d'antananarivo, 67.

- Razafindramanga JA (2011). Étude de la fasciolose à *Fasciola gigantica* dans la commune rurale de vavatenina. Thèse de docteur en médecine vétérinaire, faculté de Médecine, université d'antananarivo, 79.
- Razanajatovoarivelo P (2017). Impact économique de la fasciolose et l'ascaridiose bovine à ambatofinandrahana en 2015. Thèse, docteur en médecine vétérinaire, faculté de médecine, universite d'antananarivo, 81.
- Shinggu PA, Olufemi OT, Nwuku JA, Baba-Onoja EBT, and Iyawa PD (2019). Liver Flukes Egg Infection and Associated Risk Factors in White Fulani Cattle Slaughtered in Wukari, Southern Taraba State, Nigeria. *Hindawi Advances in Preventive Medicine* Volume 2019, Article ID 2671620, 5 p https://doi.org/10.1155/2019/2671620.
- Siama A and Nlôga AMN (2018) Prévalence et distribution de la fasciolose bovine à *Fasciola gigantica* dans les principaux abattoirs de la region de l'extrême-nord Cameroun. *Afrique Science* 14(2) 371 – 384.
- Ulayi BM, Umaru-S B and Adamu S (2007) Prevalence of *Dicrocoelium hopses* and *Fasciola gigantica* infections in cattle at slaughter in Zaria, Nigeria. *Medwell journal, journal of animal and veterinary advances*. (6) 1680-5593.
- Yaro CA, Abdulazeez TM, Afia UU, Udoudom IH, Onoja-Abutu AE and Opara KN (2022). Status of Bovine Fasciolosis and Dicrocoeliosis in Cattle Slaughtered in Abattoirs, Akwa Ibom State, Nigeria. *Nigerian Journal of Parasitology*. 43(2), https://dx.doi.org/10.4314/njpar.v43i2.16