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Research Article

Prevalence, Intensity and Risk Factors of Gastrointestinal Parasites in Cattle in The Northwest Region of Cameroon

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Abstract | Gastrointestinal (GI) parasites can cause severe impact to livestock health and productivity leading to reduced growth rates, delayed maturity, and reduced weight gains. There is dearth of information on the epidemiology of GI parasitic diseases in the major livestock production zones of Cameroon. The objective of this study was to determine the prevalence, intensity, and risk factors of GI parasite infections of cattle in the Northwest Cameroon. A cross-sectional study was conducted from November 2022 to October 2023 to detect helminth eggs and *Eimeria* oocysts cattle faecal samples based on morphological features using sedimentation and floatation techniques. The infection intensity was graded based on eggs per gram (EPG) into five categories; no infection (0 EPG), light (50–200 EPG), moderate (201–800 EPG), heavy (801–1200 EPG) or very heavy (>1200 EPG) infection. Data on breed, sex, age and body condition score were recorded prior to slaughter. Out of 1907 cattle examined, 1524 [79.92% (78.05–81.69)] were infected with one or more of the parasite species; 65.39% nematodes , 53.91% trematodes , Emeria spp. (10.23%), and 1.73% cestodes. Mixed infections (with two or more parasite species) (74.28%) were more common than single infections (25.72%) among the infected animals. The study showed high prevalence of GI parasitic infections in cattle in Northwest Cameroon. Season, location, breed, body condition score, mixed parasite and intensity of infections were significant risk factors (p<0.01). The significant impact of GI parasitism on cattle health and production, and challenges to the efforts of stakeholders to achieve self-sufficiency in food and animal-derived products were highlighted.

Keywords | Cattle, Gastrointestinal parasites, Prevalence, Intensity, Risk factors, Northwest Cameroon

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INTRODUCTION

Cattle production in Cameroon is a major livestock enterprise and contributes to the country's economic development, food and nutrition security, and poverty reduction (Ebangui *et al*., 2001; FAO, 2000; MINEPIA, 2014, 2020). There are over 8 million cattle heads, with an annual growth rate of 1.97% and contributes about 16% of the national agricultural production and 61% of the national demand for meat in Cameroon (Ebangui *et al*., 2001). It also serves as the main source of exclusive livelihoods for over 35% of the rural communities in the country (MINEPIA, 2000, 2014). Despite the vital importance of cattle husbandry, several challenges prevent breeders from benefiting on this enormous resource due to constraints. The challenges include poor nutrition, inadequate access to portable water, poor production systems, reproductive inefficiency, finance, management constraints, inadequate extension services, insufficient veterinary care, and disease being the most important (FAO, 2000; Awa and Achukwi, 2009; Tadesse and Mengistie, 2016). Gastrointestinal (GI) parasites are among the most important diseases that limit ruminant production globally (Mouiche *et al*., 2023; Ng'ang'a *et al*., 2004; Rafiullah *et al*., 2011; Vlassoff and Leathwick, 2001). Losses due to infection by GI parasites occur through mortalities, reduced production due to sub-clinical parasitism, and direct cost associated with control measures (Atanga *et al*., 2024; Biffa *et al*., 2006; Takang *et al*., 2020; Tembely *et al*., 1997). GI parasites cause considerable economic losses, reduced weight gain, digestive disturbance, lowered production, impaired reproductive performance, condemnation of affected organs and mortality in infected animals (Atanga *et al*., 2024; FAO, 2000; Schutz *et al*., 2012; Takang *et al*., 2020; Verocai *et al*., 2020).

GI parasite infections have been associated with several factors such as host age, sex, physiological status, body condition, breed, parasite species involved, and other epidemiological patterns such as husbandry practices and climate variables that determine the degree of infection (Abass *et al*., 2020; Adedipe *et al*., 2014; Ebene *et al*., 2022; Hamid *et al*., 2016; Luka *et al*., 2018a; Menkir *et al*., 2007; Takeet *et al*., 2016; Tembely, 1998). Environmental conditions such as temperature, rainfall and humidity provide suitable conditions for the development of nematode eggs and free-living stages (Hansen and Perry, 1994; Rossanigo and Gruner, 1995; Tembely *et al*., 1997; Urquhart *et al*., 1996). The contribution of GI parasitism to morbidity, mortality and production losses in cattle in Cameroon is not known. However, prevalence range of less than 10% to over 80% of GI parasites such as nematodes (*Haemonchus* spp., *Oesophagostomum* spp., *Strongloides* spp., *Trichostrongylus* spp., *Bunostomum* spp., *Chabertia* and *Trichuris* spp.); trematodes *(Fasciola, Paraphistomum, Dicrocoelium* spp.); cestodes (*Monezia* spp.); and protozoa (*Eimeria* spp.) have been reported in domestic ruminants in different parts of Cameroon (Abass *et al*., 2020; Atanga *et al*., 2019, 2024; Chollet *et al*., 1994; Ebene *et al*., 2022; Mengoue *et al*., 2025; Ntonifor and Ndaleh, 2012; Ntonifor *et al*., 2013; Takang *et al*., 2020; Takeet *et al*., 2016). The agro-ecological zones of Cameroon provide suitable environments for various livestock production. Domestic ruminants (Cattle, goats and sheep) are reared in traditional systems such as nomadic or pastoral, mixed farming and peri-urban systems (MINEPIA, 2014, 2020). Grazing herds are normally fed on natural pastures, characterized generally by annual grass species. However, these traditional livestock systems cause stress and expose animals to several parasitic diseases, especially in areas with frequent rainfall, relatively high humidity, and mild temperatures (Hansen and Perry, 1994, Hamid *et al*., 2016; Rossanigo and Gruner, 1995; Taylor *et al*., 2016; Tembely *et al*., 1997; Urquhart *et al*., 1996). Also, the occurrence of flooding, water pools and swamps are important habitats for the propagation of snail intermediate hosts of flukes and stages of other parasites (Ntonifor *et al*., 2013; Rossanigo and Gruner, 1995; Taylor *et al*., 2016; Tembely *et al*., 1997; Urquhart *et al*., 1996).

Knowledge of cattle breeders on GI parasitic diseases (Ntonifor *et al*., 2013), and different GI parasite species of cattle (Atanga *et al*., 2019, 2024; Chollet *et al*., 1994; Ntonifor and Ndaleh, 2012; Ntonifor *et al*., 2013; Takang *et al*., 2020; Takeet *et al*., 2016) as well as GI parasitic infections (57.4% in cattle) as the most prevalent infectious diseases of livestock (Mouiche *et al*., 2023) have been reported in different parts of Cameroon. However, GI parasite species/burden may differ with agro-ecological zone, and there is dearth of information on the awareness of hazards caused by GI parasites on husbandry systems, and parasite distribution and abundance in the Cameroon. In addition, priority on infectious and contagious diseases of animals has been heightened in the country with limited attention on GI parasitic diseases. Understanding the epidemiology of GI parasite in a particular region is imperative in developing efficient and effective control programs (Waller, 2006). There is paucity of information on the epidemiology of GI parasites of cattle in Cameroon and the Northwest region. Therefore, this study aimed to determine the prevalence, fecal egg count intensity, and risk factors associated with GI parasitic infections in cattle in the Northwest region of Cameroon.

MATERIALS AND METHODS

Study area and animals

The study was carried out from November 2022 to October 2023 on cattle originating from the administrative divisions of the Northwest region of Cameroon (5°45"–9°9" N and 9°13"–11°13" E) destined for slaughter at the Bamenda municipal abattoir (Figure 1). The Northwest region of Cameroon is located at an altitude of 500 m–3000 m above sea level, and characterized by fertile volcanic soils. The choice of the study area was due to the following:

1. The Northwest region is ranked as a major livestock production area including cattle in the country (MINEPIA, 2020), and has several grazing pasture and assembling sites for ranch farming, communal grazing, and other pastoral activities;
2. The study region has a subtropical type climate with average temperatures ranging from 21°C–27°C, annual rainfall of over 2259 mm, high humidity (75%–80%) and savannah vegetation with forest galleries. The region has two seasons: the rainy season from mid-March to mid-November and dry season from mid-November to mid-March (Molua, 2006; Molua and Lambi, 2006; Sedrique and Nfor, 2021;

Tume, 2021). The warm humid subtropical climate and vegetation type of the study region (Molua, 2006; Molua and Lambi, 2006; Sedrique and Nfor, 2021; Tume, 2021) provides suitable conditions for the growth and development of pathogens including the stages of GI parasites (Rossanigo and Gruner, 1995; Tembely *et al*., 1997; Urquhart *et al*., 1996). There is dearth of information on the status of GI parasite infection and intensity in cattle in the Northwest region of Cameroon.

3. GI parasites have been detected in domestic ruminants (cattle, sheep and goats), and mostly in small ruminants (sheep and goats) in different parts of the country (Atanga *et al*., 2019, 2024; Chollet *et al*., 1994; Ebene *et al*., 2022; Mouiche *et al*., 2023; Ntonifor and Ndaleh, 2012; Ntonifor *et al*., 2013; Takang *et al*., 2020; Takeet *et al*., 2016). Additionally, there are many ethnic agropastoral communities with strong cultures of livestock rearing for livelihood with mix livestock husbandry being widely practiced in the region.

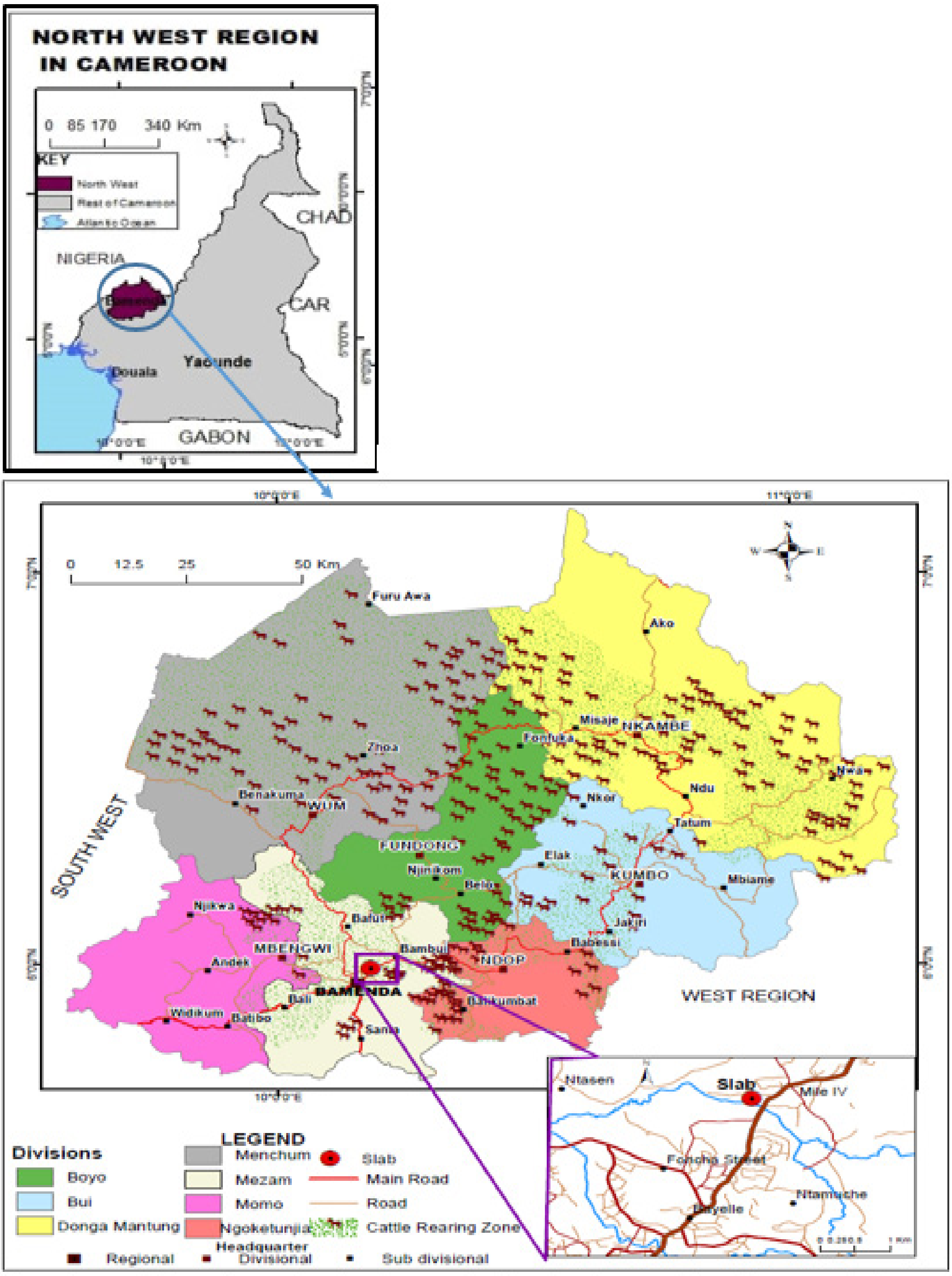

Figure 1: Map of Cameroon showing the seven administrative divisions of the Northwest Region of Cameroon, cattle production villages and location of Bamenda municipal abattoir.
Source: Adapted from NIS, (2015) with information about cattle distribution from the Northwest Regional Delegation of Livestock, Fisheries and Animal Industry.

Sample collection

Determination of the prevalence and intensity of GI parasite infection in cattle was done at the Bamenda municipal abattoir. Selection of individual cattle at the abattoir during the study period was done using previously described systematic random sampling technique (Modupe *et al*., 2017). An individual prevalence rate of 56.7% (Ntonifor *et al*., 2013) was used to estimate the sample size (Thrusfield, 2007) and animal selection sampling procedure was done as previously described (Zachée *et al*., 2020). Briefly, based on a calculated sampling fraction of five (every fifth animal was sampled) for daily use, the first animal was selected by picking one animal by random generation method of the first five animals on the slaughter chain. Thereafter, every fifth animal (adding 5 to previous picked number) was chosen.

Faecal samples were collected per rectum into well-labelled sterile polythene bags and transported in ice packs (Adedipe *et al*., 2014) to the Parasitology laboratory of the Northwest Regional Delegation for Livestock, Fisheries and Animal Industries, Bamenda.

Parasitological analysis

The sedimentation and floatation techniques described by Taylor *et al*. (2016), and Thienpont *et al*. (2003) were used to detect the presence of nematode, cestode and trematode eggs, and coccidian oocysts, while the McMaster technique was used to estimate the number of eggs per gram (EPG) of faeces (Thienpont *et al*., 2003) as previously described. A sample was considered positive when a minimum of one GIP egg/oocyst was detected under the microscope. Eggs were identified based on their morphological features (Taylor *et al*., 2016).

Given that the composition and pathogenicity of parasite populations may differ from area to area due to different climatic zones (Hansen and Perry, 1994; Hamid *et al*., 2016; Rossanigo and Gruner, 1995; Taylor *et al*., 2016; Tembely *et al*., 1997; Urquhart *et al*., 1996), the GI parasite infections was categorized based on faecal egg counts in mixed infections as previously described (Hansen and Perry, 1994; Mollah *et al*., 1996) with slight modification. Briefly, the degree of infections was graded into five categories as no infection, light, moderate, heavy and very heavy infection according to their egg per gram of faeces (EPG) counts. Egg counts of ≤ 200 (50–200), 201–800, 801–1200 and > 1200 eggs per gram of faeces were considered as light, moderate, heavy and very heavy infections, respectively. Information related to breed, sex, age and body condition score of the sampled animals were noted prior to slaughter. Estimation of ages was done by dental inspection and examination of horn rings for animals without teeth (especially old/adult females) and classified according age at slaughter (young/immature ≤ 3 years, Adult/Matured 3 to 6 years, old > 6 years) while the breed of the animals was obtained as previously described (Blench, 1999; Fassi, 2006; MINEPIA, 2002; Turton, 1999). The body condition score was done by assessing the general appearance and palpation of the lumbar region of the animal on a scale of 1 to 5 and further classed into 3 categories: 1–2 (thin), 3 (moderate) and 4–5 (fat) as previously described (Natumanya *et al*., 2008).

Data analysis

All obtained data were initially entered into Excel 2010 and transferred to the Statistical Package for the Social Sciences (SPSS) version 20 (SPSS Inc. Chicago, IL, USA) for further analysis. Data were analyzed using descriptive statistics, chi-square test, odds ratios from logistic regression, and Student's t-test (Thrusfield, 2007) in SPSS version 20. Significance was set at $p<0.05$. The univariate analysis (chi-square test) was used to assess the association between factors and logistic regressions (Odds-ratios) to determine the strength of association of different factors with the prevalence of GI parasite infection in cattle. The 95% confidence interval of proportions was calculated according to Wilson's equation $p \pm z\sqrt{((p(1-p))/n)}$, where p is the sample proportion, n is the sample size and z is 1.96, the z-score for a 95% confidence interval. The student t-test was used to compare mean intensity of GI parasites on the study animals. The statistical significance was set at $P<0.05$.

Ethical consideration

Risk assessments of the project were performed by the researchers to avoid hazards to all persons and animals involved in the study. Permission for the study and ethical approval were obtained from the required authorities in Bamenda-Cameroon [Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) Ref No: MINEPIA/DREPIA/NW/107/40 of 02/11/2022] before carrying out the study. The purpose of the study was explained (with the assistance of resident veterinarians, local community leaders and or trusted intermediaries) to the targeted participants (owners, traders, and butchers) of the Bamenda municipal abattoir. An animal was included in the study after an informed verbal consent was given by the owner or trader-butcher. Apart from procedural restraining manipulations for safety purposes, the animals used in the present study were not subjected to suffering.

RESULTS

Prevalence and assessment of associated factors of gastrointestinal parasites in cattle slaughtered in Bamenda

The cattle slaughtered at the Bamenda municipal abattoir were predominantly zebu breeds, with Red Fulani being the most common, followed by White Fulani and Gaudali, as well as crossbreeds (zebu and exotic). The results revealed that cattle from various administrative divisions within the Northwest region harboured different types of GI parasites, and the rate of infection was high (Figure 2). Out of the 1907 cattle examined, 1524 [79.92% (78.05–81.69] were infected with one or more of the following parasite species; 53.91 % trematodes [*Fasciola* (19.09%) and *Paraphistomum* (39.43%), and *Dicrocoelium* (0.16%)]; 65.39% nematodes [*Ascaris* (3.67%), *Bunostomum* (1.05%), *Trichostrongylus* (31.25%), *Oesophagostomum* (16.83%), *Chabertia* (6.19%), *Haemonchus* (16.10%), *Cooperia* (6.24%), *Nematodirus* (2.57%), *Ostertagia* (2.52%), *Trichuris* (13.48%), *Dictyocaulus* spp. (3.83%) and *Capillaria spp.* (0.05)]; 1.73% cestodes [*Monezia* (1.73%)], and protozoa, Emeria spp. (10.23%) (Figure 2 and Table 1).

Of the 1524 cattle infected, 392 (25.72%) had single infection and 1132 (74.28%) had mixed infections (Table 1). The study revealed that mixed infections (96.41%) were more common than single (3.59%) infections. *Paramphistomum* spp. (46.35%), *Trichostrongylus* spp. (41.69%), *Fasciola* spp. (24.25%), *Oesophagostomum* spp. (16.45%), *Haemonchus* spp. (15.78%), and *Trichuris* spp. (16.78%) were the most prevalent parasites in the two parasite mixed associations, and *Paramphistomum* spp. (60.00%), *Trichostongylus* spp. (54.88%), *Haemonchus* spp. (35.93%), *Oesophagostomum* spp. (34.39%), *Trichuris* spp. (23.41%) and *Eimeria* spp. (20.98%) were predominant in the three parasite mixed associations. For the more than three parasite mixed associations, *Paramphistomum* spp. (>83.12%), *Trichostrongylus* spp. (>62.50%), *Fasciola* spp. (>41.67%), *Haemonchus* spp. (>41.67%), *Oesophagostomum* spp. (>37.50%), *Trichuris* spp. (35.83%) and *Eimeria* spp. (39.17%) were the most frequently observed (Table 1).

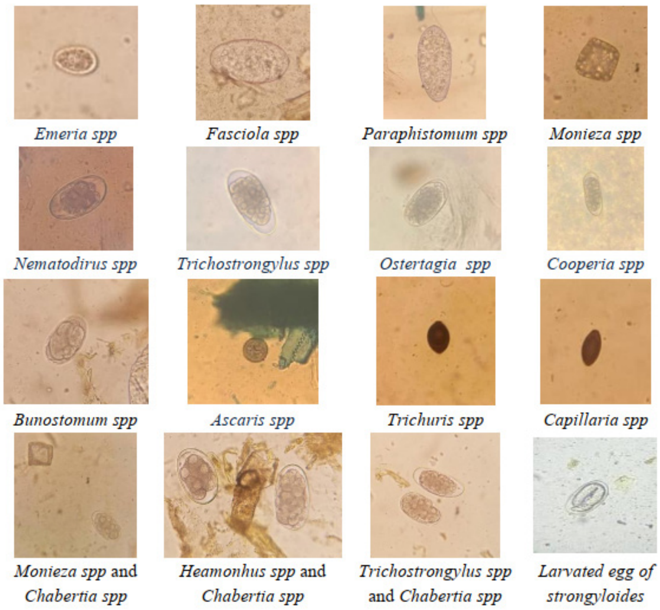

Figure 2: Images of *Emeria* spp. Oocyst and helminth eggs detected in Cattle from Northwest region, Cameroon slaughtered in the Bamenda municipal Abattoir.

Table 1: Prevalence and distribution of gastrointestinal parasites according to type of parasite associations in infected animals Cattle in Northwest region, Cameroon.

Gastrointestinal parasite genera/ species	Total (N=1907); n (%)	Type of parasite associations GIP in infected cattle; n (%)				
		1 parasite	2 parasite associations	3 parasite associations	4 parasite associations	> 4 parasite associations
Overall	1524 (79.91)	392 (100)	602 (100)	410 (100)	105 (100)	15 (100)
Fasciola spp.	364 (19.09)	71 (18.11)	146 (24.25)	97 (5.09)	45 (42.86)	5 (33.33)
Paramphistomum spp.	752 (39.43)	130 (33.16)	279 (46.35)	246 (60.00)	83 (79.05)	14 (93.33)
Dicrcoelium spp.	3 (0.16)	1 (0.26)	1 (0.17)	1 (0.24)	0 (0)	0 (0)
Ascaris spp.	70 (3.67)	2 (0.51)	26 (4.32)	28 (6.83)	11 (10.48)	3 (20.00)
Bunostomum spp.	20 (1.05)	3 (0.77)	5 (0.83)	8 (1.95)	4 (3.81)	0 (0)
Trichostongylus spp.	596 (31.25)	45 (11.48)	251 (41.69)	225 (54.88)	66 (62.86)	9 (60.00)
Oesophgostomum spp.	321 (16.83)	36 (9.18)	99 (16.45)	141 (34.39)	36 (34.29)	9 (60.00)
Chabertia spp.	118 (6.19)	12 (3.06)	34 (5.65)	54 (13.17)	16 (15.24)	2 (13.33)
Haemonchus spp.	308 (16.15)	28 (7.14)	95 (15.78)	135 (35.93)	43 (40.95)	7 (46.67)
Cooperia spp.	119 (6.24)	16 (4.08)	41 (6.81)	42 (10.24)	15 (14.29)	5 (13.33)
Nematodirus spp.	49 (2.57)	7 (1.79)	15 (2.49)	18 (4.39)	8 (7.62)	1 (6.67)
Ostertagia spp.	44 (2.31)	2 (0.51)	20 (3.32)	15 (3.66)	6 (5.71)	1 (6.67)
Trichuris spp.	257 (13.48)	17 (4.34)	101 (16.78)	96 (23.41)	36 (34.29)	7 (46.67)
Dictyocaulus spp.	73 (3.83)	8 (2.04)	23 (3.82)	28 (6.83)	9 (8.57)	5 (33.33)
Capillaria spp.	1 (0.05)	0 (0)	1 (0.17)	0 (0)	0 (0)	0 (0)
Moneiza spp.	33 (1.73)	7 (1.79)	12 (1.99)	10 (2.44)	2 (1.90)	2 (13.33)
Eimeria spp.	195 (10.23)	7 (1.79)	55 (9.14)	86 (20.98)	40 (38.10)	7 (46.7)

N: total number of animals examined. n (%): number of infected animals (proportion of infected animal). GIP: Gastrointestinal parasite.

Table 2: Prevalence and assessment of potential risk factors of gastrointestinal parasites of cattle in northwest region, Cameroon.

Factors	Variables	Number infected	Prevalence % (95%Cl)	P Value (χ^2 value)	Odds ratio, (95%Cl)	P Value (χ^2 Value)
Total (N=1907)		1524	79.92 (78.05–81.69)			
Sex	Male (n=1450)	1152	79.45 (77.28–81.50)	0.364 (0.825)	1	
	Female (n=457)	372	81.40 (77.52–84.86)		1.13 (0.87–1.48)	0.364 (0.83)
Age (X)	X ≤ 3 years (n=240)	191	79.58 (73.92–84.50)	0.888 (0.021)	1	
	3 < X ≤ 6 years (n= 1361)	1088	79.94 (77.71–82.04)		1.02 (0.73–1.44	0.888 (0.02)
	X > 6 years (n= 306)	245	80.07 (75.14–84.39)		1.03 (0.67–1.57)	0.888 (0.02)
Breed	White Fulani (n=598)	492	82.27 (78.97–85.25)	0.0150 (5.9143)	2.32 (1.61–3.34)	<0.0001 (20.96)
	Red Fulani (n=1122)	891	79.41 (76.93–81.74)		1.93 (1.38–2.69)	<0.0001 (15.30)
	Crossbreed (n=15)	13	86.67 (59.54–98.34)		3.25 (0.71–14.84)	0.0894*
	Gaudali (n=172)	128	74.42 (67.22–80.76)		1	
Body condition score	Thin (n=33)	31	93.94 (79.77–99.26)	0.0007 (14.466)	4.24 (1.01–17.81)	0.032 (4.61)
	Medium (n=245)	214	87.35 (82.52–91.24)		1.89 (1.27–2.80)	0.001 (10.26)
	Fat (n= 1629)	1279	78.51 (76.44–80.49)		1	
Origin	Boyo (N=158)	127	80.38 (73.32–86.26)	0.0009 (11.106)	1.43 (0.89–2.28)	0.137 (2.21)
	Bui (N=518)	423	81.66 (78.05–84.90)		1.55 (1.10–2.17)	0.011 (6.49)
	Donga Mantung. (N=199)	169	84.92 (79.18–89.59)		1.96 (1.23–3.12)	0.004 (8.24)
	Menchum (N= 363)	287	79.06 (74.51–83.13)		1.31 (0.92–1.88)	0.135 (2.23)
	Mezam (N= 310)	230	74.19 (68.94–78.97)		1	
	Momo (N=245)	199	81.22 (75.76–85.91)		1.50 (1.0–2.27)	0.0497 (3.85)
	Ngokentunjia (N= 114)	89	78.07 (69.35–85.28)		1.24 (0.74–2.07)	0.413 (0.67)
Season	Dry (n=533)	370	69.42 (65.31–73.31)	<0.0001 (50.79)	1	
	Rain (n=1374)	1154	83.99 (81.94–85.59)		2.13 (1.83–2.92)	<0.0001 (50.79)
Mixed infections (Number of parasites in infected animals) (N=1907)	No (Zero) infection	383	20.86 (18.31–21.95)			
	1 parasite	392	20.56 (18.76–22.44)	<0.00001 (902.382)	3.64 (2.93–4.51)	<0.0001 (152.27)
	2 parasite associations	602	31.57 (29.49–33.71)		6.87 (5.58–8.46)	<0.0001 (396.92)
	3 parasite associations	410	21.50 (19.67–23.41)		4.08 (3.29–5.06)	<0.0001 (184.29)
	4 parasite associations	105	5.51 (4.48–6.53)		1	
	> 4 parasite associations	15	0.79 (0.39–1.18)			
Category of intensity of infection (X EPG) (N=1907)	Light (X<800)	1218	63.87 (61.71–66.03)	<0.00001 (2033.49)	25.42 (20.72–31.19)	<0.00001 (1375.99)
	Moderate (800≤X≤1200	124	6.50 (5.40–7.61)		1	0.0005 (11.95)
	Heavy (X>1200)	182	9.54 (8.23–10.86)		1.52 (1.20–1.92)	

* Fisher Exact Probability test, two tailed; N: total number of animals examined; n : number of animals examined; %: proportion of infected animal; EPG: eggs per gram.

The prevalence of GI parasites in cattle slaughtered in Bamenda according to the studied endogenous and exogenous factors is presented in Table 2. The results showed no significant difference (p>0.05) between the proportion of infected cattle based on sex or age. However, factors such as breed, body condition score (BCS), division of origin, co-infections, intensity of infection as well as season, significantly (p<0.01) influenced prevalence rates (Table 2). The prevalence rates were highest in crossbreeds [86.67% (59.54–98.34)], lean/thin animals [93.94% (79.77–99.26)], Donga Mantung [84.92% (79.18–89.59)] and during rainy season [83.99% (81.94–85.59)]. On the other hand, and lowest prevalence rates were recorded in Gaudali cattle [74.42% (67.22–80.76)], fat animals [78.51% (76.44–80.49)], and cattle from Mezam division [74.19% (68.94–78.97)] and during dry season [69.42% (65.31–73.31)]. The Red Fulani [OR=3.32 (95%CI; 1.61–3.34); χ^2=20.96, P<0.0001] and White Fulani [OR=1.93 (95%CI; 1.38–2.69); χ^2=15.30, P<0.0001] breeds, as well as lean/thin [OR=4.24 (95%CI; 1.01–17.81); χ^2=4.61, P=0.032], and medium [OR=1.89 (95%CI; 1.27–2.80); χ^2=10.26, P=0.001] animals were more likely to be infected with the GI parasites compared to the Gaudali breed, and fat animals, respectively. The highest prevalence rates were observed in cattle from Donga Mantung, followed by Bui, Momo and Boyo divisions, while the lowest rates were recorded in animals from Mentchum, Ngoketunjia, and Mezam divisions. In this light, cattle originating from Bui [OR=1.55 (95%CI; 1.10–2.17); χ^2=6.49, P=0.011] and Donga Mantung [OR=1.96 (95%CI; 1.23–3.12); χ^2=8.24, P=0.004] divisions were more likely to be infected compared to animals originating from Mezam division. Furthermore, infection rates were significantly higher during the rainy season [OR=2.13 (95%CI; 1.83–2.92); χ^2=50.79, P<0.0001] than during the dry season (Table 2).

The infection rates were significantly (p<0.0001) different between mixed parasite infected animals and the category of intensity of infection. Co-infections with 2 or more parasites [59.36% (57.16–61.56)] were significantly higher [OR = 5.30 (4.60–6.10); χ^2 = 574.18; p<0.0001)] than single (01) parasite infections [20.56% (18.76–22.44)]. Mixed parasite associations were widely observed, with significant differences (p<0.05) recorded among the various combinations in infected animals. Animals with 2 mixed parasite infection showed significantly higher (p<0.05) prevalence compared to animals with 3, 4 and more than 4 mixed parasite co-infections (Table 2).

In the present study, animals were more likely infected with single parasite [OR=3.64 (95%CI; 2.93–4.51); χ^2=152.27, p<0.0001)] and double combinations [OR=6.87 (95%CI; 5.58–8.46); χ^2=396.92, p<0.0001], and triple [OR=4.08 (95%CI; 3.29–5.06); χ^2=184.29, p<0.0001] parasite combinations compared to animals with more than 3 mixed parasite combinations (Table 2).

The results revealed that sex, age, breed, body condition score (BCS), location of origin, and season significantly (p<0.0001) influenced prevalence rates of GI parasites based on types of mixed parasite association (Table 3) and the category of intensity of infection (Table 4). The Red Fulani, White Fulani, male, 3 to 6 years old, and fat (good body condition) cattle showed the highest (p<0.05) prevalence rates regardless of the type of parasite association (Table 3) and or the category of infection intensity (Table 4), when breed, sex, age group and body condition scores were considered. Similarly, the highest (p<0.05) prevalence rates, irrespective of mixed parasite association (Table 3) and infection intensity (Table 4) were recorded in animals from Bui, Menchum and Mezam divisions, as well as during the rainy season compared to other divisions and the dry season, respectively.

Monthly and seasonal prevalence (%) of gastrointestinal parasites in cattle in the northwest region of Cameroon

Gastrointestinal (GI) parasitic infections, including single parasite and co-infections were recorded throughout the study period (Figure 3). The monthly prevalence ranged from 60.83–98.57% for infections with at least 1 parasite type. Infection rates varied as follows; 7.14–34.36%, 25.71–40.91%, 8.57–40.25% and 1.99–21.43% for infections with single parasite types, two, three and more than three parasite associations, respectively.

The detection rates of GI parasites varied widely between season with significant differences (p<0.05) in the seasonal and monthly rates, and with several fluctuating peaks observed during the months of November, April, June and September irrespective of the type of parasite association, for infections involving at least 1 parasite type (Figure 3). Furthermore, regression analysis of the overall infection rates recorded during the study period revealed a slope with a positive gradient (Y = 2.6785X + 61.403; R^2 = 0.6095) suggesting an increase in the trend from dry season [(69.42%; 95% CI: 65.31–73.31)] to rainy season [(83.99%; 95% CI: 81.94–85.59)] in GI parasites detection rates in cattle slaughtered at the Bamenda municipal abattoir (Figure 3).

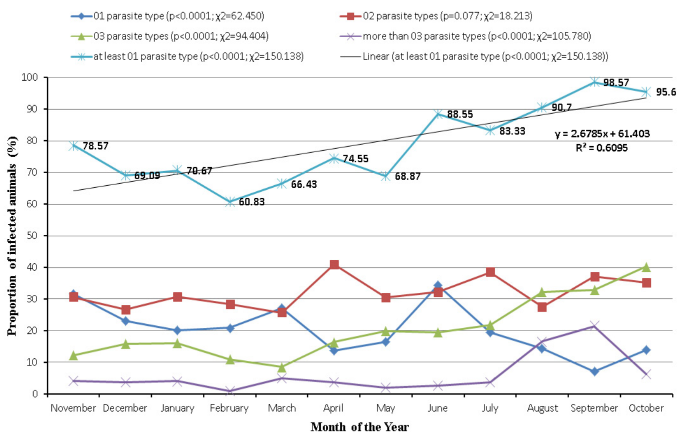

Figure 3: Monthly prevalence (%) of mixed gastrointestinal parasite infections of cattle in northwest region, Cameroon.

Intensity of gastrointestinal parasite infections in cattle slaughtered in Bamenda

The distribution of the relative abundance of GI parasites based on worm egg count (or oocysts count for *Emeria* spp.) per gram of faeces (EPG) according to associated risk factors, mixed parasite associations in infections, and category of intensity of infection are shown in Tables 5 and 6, respectively. Calculation of the EPG data obtained showed significant variations about the average EPG values among infected animals in the study. Though the average EPG obtained in the study based on the intrinsic (breed, sex, age, BCS) and extrinsic (location, Season) factors were < 800, EPG suggesting light (EPG ≤ 200) intensity of GI infections, moderate (200 < EPG ≤ 800), heavy (800 < EPG ≤ 1200) and very heavy (EPG > 1200) intensity GI infections were also frequently observed across all factors

Table 3: Prevalence of gastrointestinal parasite associations of cattle in northwest region, Cameroon according to breed, sex, age, body condition score and season.

Factors	Variables	Type of gastrointestinal parasite associations in infected animals							
		Single parasite		2 parasites		3 parasites		More than 3 parasites	
		Number infected	Prevalence % (95%Cl)	Number infected	Prevalence % (95%Cl)	Number infected	Prevalence % (95%Cl)	Number Infected	Prevalence % (95%Cl)
	Total (N=1907)	392	20.56 (18.74-22.37)	602	31.57 (29.48-33.65)	410	21.50 (19.66-23.34)	120	6.29 (5.20-7.38)
Sex	Male (n=1450)	304	20.97 (18.87-23.06)	451	31.10 (28.72-33.49)	297	20.48 (18.41-22.56)	100	6.90 (5.59-8.20)
	Female (n=457)	88	19.26 (15.64-22.87)	151	33.04 (28.73-37.35)	113	24.73 (20.77-28.68)	20	4.38 (2.50-6.25)
Age (X)	X ≤ 3 years (n=240)	49	20.42 (15.32-25.52)	72	30.00 (24.20-35.80)	58	24.17 (18.75-29.58)	12	5.00 (2.24-7.76)
	3 < X ≤ 6 years (n= 1361)	284	20.87 (18.71-23.03)	428	31.45 (28.98-33.91)	288	21.16 (18.99-23.33)	88	6.47 (5.16-7.77)
	X > 6 years (n= 306)	59	19.28 (14.86-23.70)	102	33.33 (28.05-38.62)	64	20.92 (16.36-25.47)	20	6.54 (3.77-9.31)
Breed	White Fulani (n=598)	137	22.91 (19.54-26.28)	194	32.44 (28.69-36.19)	129	21.57 (18.28-24.87)	32	5.35 (3.55-7.15)
	Red Fulani (n=1122)	227	20.23 (17.88-22.58)	347	30.93 (28.22-33.63)	238	21.21 (18.82-23.60)	79	7.04 (5.54-8.54)
	Crossbreed (n=15)	4	26.67 (4.29-49.05)	6	40.00 (15.21-64.79)	3	20.00 (0-40.24)	0	0 (0-0)
	Gaudali (n=172)	24	13.95 (8.78-19.13)	55	31.98 (25.01-38.95)	40	23.26 (16.94-29.57)	9	5.23 (1.90-8.56)
Body Condition Score	Thin (n=33)	5	15.15 (2.92-27.38)	13	39.39 (27.72-56.07)	9	27.27 (12.08-42.47)	4	12.12 (0.99-23.26)
	Medium (n=245)	57	23.27 (17.97-28.56)	81	33.06 (27.17-38.95)	52	21.22 (16.10-26.34)	24	9.80 (6.07-13.56)
	Fat (n= 1629)	330	20.26 (18.31-22.21)	508	31.18 (28.94-33.43)	349	21.42 (19.43-23.42)	92	5.65 (4.53-6.77)
Origin	Boyo (n=158)	37	23.42 (16.81-30.02)	52	32.91 (25.58-40.24)	28	17.72 (11.77-23.68)	10	6.33 (2.53-10.13)
	Bui (n=518)	97	18.73 (15.37-22.09)	152	29.34 (25.42-33.26)	125	24.13 (20.45-27.82)	49	9.46 (6.94-11.98)
	Donga Mantung. (n=199)	50	25.13 (19.10-31.15)	74	37.19 (30.47-43.90)	41	20.60 (14.98-26.22)	4	2.01 (0.06-3.96)
	Menchum (n= 363)	69	19.01 (14.97-23.04)	121	33.33 (28.48-38.18)	78	21.49 (17.26-25.71)	19	5.23 (2.94-7.53)
	Mezam (n= 310)	53	17.10 (12.91-21.29)	92	29.68 (24.59-34.76)	66	21.29 (16.73-25.85)	19	6.13 (3.46-8.80)
	Momo (n=245)	55	22.45 (17.22-27.67)	78	31.84 (26.00-37.67)	53	21.63 (16.48-26.79)	13	5.31 (2.50-8.11)
	Ngokentunjia (n= 114)	31	27.19 (19.02-35.36)	33	28.95 (20.62-37.27)	19	16.67 (9.83-23.51)	6	5.26 (1.16-9.36)
Season	Dry (n=533)	124	23.26 (19.68-26.85)	154	28.89 (25.04-32.74)	75	14.07 (11.12-17.02)	16	3.00 (1.55-4.45)
	Rain (n=1374)	268	19.51 (17.41-21.60)	448	32.61 (30.13-35.08)	335	24.38 (22.11-26.65)	104	7.57 (6.17-8.97)

n: number of animals examined; %: proportion of infected animal; 95%Cl : 95% Confidence Interval.

Table 4: Prevalence of categories of intensity of gastrointestinal parasite infection of cattle in northwest region, Cameroon according to breed, sex, age, body condition score and season.

Factors	Variables	Category of Gastrointestinal parasite intensity in infected animals							
		Light (X ≤ 200)		Moderate (200<X≤800)		Heavy (800<X≤1200)		Heavy (X>1200)	
		Number Infected	Prevalence % (95%Cl)	Number Infected	Prevalence % (95%Cl)	Number Infected	Prevalence % (95%Cl)	Number Infected	Prevalence % (95%Cl)
	Total (N=1907)	651	34.14 (32.01–36.27)	544	28.53 (26.50–30.55)	149	7.81 (6.61-9.02)	180	9.44 (8.13-10.75)
Sex	Male (n=1450)	494	34.07 (31.63–36.51)	421	29.03 (26.70–31.37)	110	7.59 (6.22-8.95)	127	8.76 (7.30-10.21)
	Female (n=457)	158	34.57 (30.21–38.93)	122	26.70 (22.64–30.75)	39	8.53 (5.97-11.10)	53	11.60 (8.66-14.53)
Age (X)	X ≤ 3 years (n=240)	80	33.33 (27.37–39.30)	72	30.00 (24.20–35.80)	21	8.75 (5.18-12.32)	18	7.50 (4.17-10.83)
	3 < X ≤ 6 years (n= 1361)	456	33.50 (31.00–36.01)	372	27.33 (24.97–29.70)	115	8.45 (6.97-9.93)	145	10.65 (9.01-12.29)
	X > 6 years (n= 306)	116	37.91 (32.47–43.34)	99	32.35 (27.11–37.59)	13	4.25 (1.99-6.51)	17	5.56 (2.99-8.12)
Breed	White Fulani (n=598)	231	38.63 (34.73–42.53)	169	28.26 (24.65–31.87)	38	6.35 (4.40-8.31)	54	9.03 (6.73-11.33)
	Red Fulani (n=1122)	373	33.24 (30.49–36.00)	312	27.81 (25.19–30.43)	98	8.73 (7.08-10.39)	108	9.63 (7.90-11.35)
	Crossbreed (n=15)	6	40.00 (15.21–64.79)	7	46.67 (21.42–71.91)	0	0 (0-0)	0	0 (0-0)
	Gaudali (n=172)	42	24.42 (18.00–30.84)	55	31.98 (25.01–38.95)	13	7.56 (3.61-11.51)	18	10.47 (5.89-15.04)
Body Condition Score	Thin (n=33)	14	42.42 (25.56–59.29)	14	42.42 (25.56–59.29)	0	0 (0-0)	3	9.09 (0-18.90)
	Medium (n=245)	117	47.76 (41.50–54.01)	63	25.71 (20.24–31.19)	8	3.27 (1.04-5.49)	26	10.61 (6.76-14.47)
	Fat (n= 1629)	521	31.98 (29.72–34.25)	466	28.61 (26.41–30.80)	141	8.66 (7.29-10.02)	151	9.27 (7.86-10.68)
Origin	Boyo (n=158)	59	37.34 (29.80–44.88)	45	28.48 (21.44–35.52)	6	3.80 (0.82-6.78)	17	10.76 (5.93-15.59)
	Bui (n=518)	177	34.17 (30.09–38.25)	133	25.68 (21.91–29.44)	43	8.30 (5.93-10.68)	70	13.51 (10.57-16.49)
	Donga Mantung. (n=199)	87	43.72 (36.83–50.61)	55	27.64 (21.42–33.85)	18	9.05 (5.06-13.03)	9	4.52 (1.64-7.41)
	Menchum (n= 363)	135	37.19 (32.22–42.16)	93	25.62 (21.13–30.11)	28	7.71 (4.97-10.46)	31	8.54 (5.66-11.41)
	Mezam (n= 310)	74	23.87 (19.13–28.62)	96	30.97 (25.82–36.11)	32	10.32 (6.94-13.71)	28	9.03 (5.84-12.22)
	Momo (n=245)	85	34.69 (28.73–40.65)	81	33.06 (27.17–38.95)	14	5.71 (2.81-8.62)	19	7.76 (4.41-11.10)
	Ngokentunjia (n= 114)	35	30.70(22.23–39.17)	40	35.09 (26.33–43.85)	8	7.02 (2.33-11.71)	6	5.26 (1.16-9.36)
Season	Dry (n=533)	194	36.40(32.31–40.48)	121	22.70 (19.15–26.26)	29	5.44 (3.52-7.37)	26	4.88 (3.05-6.71)
	Rain (n=1374)	458	33.33 (30.84–35.83)	422	30.71 (28.27–33.15)	120	8.73 (7.24-10.23)	154	11.21 (9.54-12.88)

n: number of animals examined; %: proportion of infected animal; 95%Cl : 95% Confidence Interval.

Table 5: Intensity of categories of intensity of gastrointestinal parasite infection of cattle in northwest region, Cameroon according to breed, sex, age, body condition score and season.

Factors	Variables	Category of intensity of GI infection (egg per gram of faeces; mean±STD)				Total
		Light (X≤200)	Moderate (200<X≤800)	Heavy (800<X≤1200)	Heavy (X>1200)	
	Total (N=1907)	93.01±47.57	450.55±154.67	974.50±130.70	3389.44±2843.17	556.35±1295.56
Sex	Male (n=1450)	91.80±46.90	455.34±154.92	972.27±131.78	3062.60±2734.49	505.48±1166.40
	Female (n=457)	97.47±50.09	436.07±152.43	980.77±129.07	4172.64±2970.13	717.72±1630.40
Age (X)	X ≤ 3 years (n=240)	90.00±45.98	461.11±160.81	983.33±117.62	3258.33±3005.15	498.75±1163.37
	3 < X ≤ 6 years (n= 1361)	92.76±48.06	459.95±156.81	972.61±133.81	3319.31±2869.92	592.62±1358.33
	X > 6 years (n= 306)	93.98±47.68	410.10±134.20	991.67±15.83	4126.47±2463.87	440.20±1085.96
Breed	White Fulani (n=598)	93.51±47.33	432.54±150.02	1003.95±126.48	3384.26±2517.89	527.76±1203.53
	Red Fulani (n=1122)	93.16±49.33	462.18±156.31	969.39±129.56	3535.65±3094.86	584.49±1389.31
	Crossbreed (n=15)	91.67±37.64	350.00±95.74	-	-	200.00±162.57
	Gaudali (n=172)	91.67±36.49	457.27±156.47	926.92±142.33	2527.78±2035.29	503.20±986.83
Body condition score	Thin (n=33)	110.71±56.09	432.14±133.89	-	6433.33±3733.07	815.15±2039.97
	Medium (n=245)	99.15±46.54	405.56±140.88	1056.25±111.60	5032.69±3931.36	720.20±1962.66
	Fat (n= 1629)	91.36±46.54	457.73±155.94	969.86±130.50	3046.03±2472.37	526.46±1140.03
Origin	Boyo (n=158)	95.76±52.76	447.78±178.04	1083.33±68.31	2252.94±1706.37	446.84±872.49
	Bui (n=518)	94.92±48.58	464.66±150.60	962.79±127.75	3917.86±3222.62	761.10±1739.99
	Donga Mantung (n=199)	95.40±49.79	412.73±121.42	955.56±141.31	5005.56±3880.76	468.59±1291.45
	Menchum (n= 363)	97.78±46.06	440.32±157.12	998.21±154.85	3646.77±3047.73	537.60±1325.94
	Mezam (n= 310)	88.51±44.99	461.98±155.72	948.44±126.03	2712.50±2010.28	507.10±965.77
	Momo (n=245)	88.24±46.71	442.59±156.95	967.86±101.16	2626.32±1979.29	435.92±875.31
	Ngokentunjia (n= 114)	78.57±42.51	477.50±162.89	1031.25±92.34	2266.67±1140.03	383.33±591.78
Season	Dry (n=533)	90.72±45.99	432.23±137.37	965.52±134.37	2453.85±1565.63	303.38±647.72
	Rain (n=1374)	94.21±48.44	456.40±158.73	976.67±130.28	3547.40±2980.42	654.48±1460.48

n : number of animals examined; mean±STD : mean EPG ± Standard deviation.

(breed, sex, age, BCS, location and season) (Table 5). Among the infested cattle in the study, the relative average GI parasite intensity was comparable or similar between age groups and breeds except for crossbreeds which had revealed lower intensities (Table 5). However, the average GI parasite intensity seemed higher (P>0.05) in female animals and during the rainy season compared to male animals and the dry season, respectively. Poor body condition score favoured higher GI parasite intensity with lean/thin animals showing the highest intensities followed by medium and fat animals. The average GI parasite intensity was higher in animals from Bui division and lower (p>0.05) in those from Ngokentunjia division respectively, compared to those from the other divisions (Table 5).

The present results showed average GI parasite intensities (EPG) of 93.01±47.57, 450.55±154.67, 974.50±130.70 and 3389.44±2843.17 for light (EPG < 200), moderate (200 < EPG ≤ 800), heavy (800 < EPG ≤ 1200) and very heavy (EPG > 1200) infection intensity categories respectively. While the GI parasite intensity for single (182.02±495.05 EPG) and 2 mixed parasite (488.12±882.05 EPG) infections revealed light and moderate intensities category, heavy intensity of infection was seen in 3 mixed parasite (1143.17±1756.16 EPG) infections, and very heavy intensity for more than 3 mixed parasite (1890.83±2661.86 EPG) infections (Table 5). The average GI parasite intensity increased with the number of parasites in the type of parasite association, reaching its highest level in animals that harboured more than 3 GI parasite associations, followed by those with 3, 2, and single parasites infections. Heavy and very heavy intensities were also observed in animals infected with 3 and more parasite associations, except for crossbreeds (Table 5).

Overall, light intensity-infections (EPG < 200) were observed among individual parasite in the study, among which *Oesophagustomum* spp. (140.14 ± 623.57), *Trichostrongylus* spp. (158.73±540.89), *Haemoncus* spp. (112.77 ± 550.96) and *Trichuris* spp. (52.75 ± 237.66) showed higher EPG values compared to the other GI parasites.

Table 6: Intensity of gastrointestinal parasite associations of cattle in northwest region, Cameroon according to breed, sex, age, body condition score and season.

Factors	Variables	Mixed GI parasite infections (egg per gram of faeces; mean±STD)				Total
		Single GI parasite	2 GI parasite associations	3 GI parasite associations	More than 3 GI parasite associations	
Total (N=1907)		182.02±495.05	488.12±882.05	1143.17±1756.16	1890.83±2661.86	556.35±1295.56
Sex	Male (n=1450)	157.89±317.90	454.77±781.38	948.48±1293.66	1980.00±2808.45	505.48±1166.40
	Female (n=457)	265.34±860.48	587.75±1127.93	1654.87±2544.56	1445.00±1740.46	717.72±1630.40
Age (X)	X ≤ 3 years (n=240)	95.92±143.55	611.11±1391.20	1031.03±1574.77	925.00±608.84	498.75±1163.37
	3<X≤6 years (n=1361)	206.69±554.08	473.60±743.94	1219.27±1816.30	2203.98±3942.77	592.62±1358.33
	X > 6 years (n= 306)	134.75±354.44	462.25±957.52	902.34±1628.77	1092.50±1672.00	440.20±1085.96
Breed	White Fulani (n=598)	233.58±731.36	478.61±1029.28	1196.12±1873.42	1137.50±930.92	527.76±1203.53
	Red Fulani (n=1122)	156.61±311.90	508.21±852.48	1103.99±1716.31	2291.77±3152.59	584.49±1389.31
	Crossbreed (n=15)	125.00±119.02	233.33±112.55	366.67±189.30	-	200.00±162.57
	Gaudali (n=172)	137.50±144.65	422.73±447.82	1263.75±1685.69	1050.00±694.62	503.20±986.83
Body condition score	Thin (n=33)	170.00±268.33	623.08±1355.95	1444.44±3453.39	1237.50±1553.69	815.15±2039.97
	Medium (n=245)	155.26±670.13	416.67±843.36	1458.65±2869.65	2416.67±3603.79	720.20±1962.66
	Fat (n= 1629)	186.82±462.38	496.06±874.74	1088.40±1457.21	1782.07±2408.30	526.46±1140.03
Origin	Boyo (n=158)	155.41±331.41	390.38±351.19	825.00±701.26	2145.00±2441.59	446.84±872.49
	Bui (n=518)	141.24±311.67	588.49±1139.99	1474.00±2327.12	2178.57±2990.82	761.10±1739.99
	Donga Mantung (n=199)	122.00±191.44	368.92±437.28	906.10±1163.52	5675.00±6601.07	468.59±1291.45
	Menchum (n= 363)	315.22±973.75	470.66±1107.13	1281.41±2128.87	868.42±513.76	537.60±1325.94
	Mezam (n= 310)	203.77±326.09	547.83±770.97	1034.09±1300.95	1457.89±1787.40	507.10±965.77
	Momo (n=245)	176.36±398.36	428.36±709.24	766.98±751.85	1773.08±2393.45	435.92±875.31
	Ngokentunjia (n= 114)	114.52±117.75	486.36±483.04	807.89±430.52	1458.33±1513.80	383.33±591.78
Season	Dry (n=533)	196.77±391.56	422.08±730.12	781.33±1025.58	821.88±569.49	303.38±647.72
	Rain (n=1374)	175.19±536.77	510.83±928.21	1224.18±1872.86	2055.29±2816.76	654.48±1460.48

n: number of animals examined; mean±STD: mean EPG ± standard deviation, GI: Gastrointestinal.

DISCUSSION

Gastrointestinal parasites are among the major parasitic diseases that affect cattle productivity in the Northwest region of Cameroon. These parasites, especially parasitic worms cause significant economic losses due to, anemia, diarrhea, poor growth, low weight gain, decreased reproductive effectiveness, condemnation of affected organs, and mortality in infected animals. In addition, some of these parasites, such as *Trichostrongylus* and *Fasciola* spp. have zoonotic potential, posing risks to human health. Gastrointestinal parasites which cause direct and indirect production losses include; Nematodes, Trematodes, Cestodes and Protozoa have been widely reported in cattle in tropical and subtropical regions (Adedipe *et al.*, 2014; Ntonifor *et al.*, 2013; Pfukenyi *et al.*, 2007; Tiele *et al.*, 2023; Umar *et al.*, 2018; Waruiru *et al.*, 1998). The prevalence and intensity of GI parasites are influenced by several factors, including variations in animal immunity, environmental factors such as climate, as well as feeding and management conditions of the animals.

Gastrointestinal helminthes and *Eimeria* spp. infections have been widely reported in cattle, and differences in prevalence rates and infection intensity attributed to variations in immunity of the animals, environmental factors such as climate, as well as feeding and management conditions of the animals. The present study revealed an overall prevalence of gastrointestinal parasitic infection was over 79% with an average infection intensity of about 560 EPG. This study provides valuable information on the burden of GI parasites among cattle in the Norwest region of Cameroon, as the animals slaughtered in this abattoir are representative of the cattle population across the entire region. Nematode and trematode infections were particularly high and similar to previous reports of prevalence for nematode (71.7%, 32.68%), trematode (26.5%, 11.22%) and cestodes (2.01%, 0.49%) in Nigeria (Adedipe *et al.*, 2014; Takeet *et al.*, 2016), respectively. The present study also agrees with those of Hamid *et al.* (2016) who found that infections with nematodes were common especially Strongyles (54%) than other types of worms, followed by trematodes with *Paramphistomum* spp.

being the most prevalent (39.43%), followed by *Fasciola* spp. (19.09%). High nematode and trematode infections have significant negative impact on livestock productivity, leading to reduction in production potentials such as decreased growth rate, weight loss in young calves, delayed maturity of the animals, decreased milk production, and reduced endurance in working animals (Adedipe *et al*., 2014; Ekong *et al*., 2012; Swai *et al*., 2006). Cestodes (1.73%) and *Emeria* (10.23%) infections were less common. However, cestode and trematodes are of significant are of zoonotic and public health concern. *Fasciola* spp. is a zoonotic liver trematode notable for causing huge economic losses and health problems (Adedipe *et al*., 2014; Atanga *et al*., 2019, 2024; Ekong *et al*., 2012; FAO, 2000; Hamid *et al*., 2016; Takang *et al*., 2020).

The overall prevalence of GIPs reported in this study was similar with findings in other regions, such as, 81.4% in Douala Abattoir Cameroon (Ntonifor and Ndaleh, 2012), 80.17% in Bangladesh (Akter *et al*., 2023), 80.71% in Nigeria (Luka *et al*., 2018b) and 95.5% in Southern Ghana (Squire *et al*., 2013). However, it was higher than 56.7% reported in Jakiri, Bui Division, Cameroon (Ntonifor *et al*., 2013), 65.96% in Central Java Indonesia (Hamid *et al*., 2016) and 41-67% in different parts of Nigeria (Adedipe *et al*., 2014; Edosomwan and Shoyemi, 2012; Elele *et al*., 2013; Luka *et al*., 2018b; Nwigwe *et al*., 2013). On the contrary, it was lower than 95.12% reported in Abeokuta Nigeria (Takeet *et al*., 2016). Several factors could be attributed to these observed differences in GI parasite prevalence rates including; the periods or seasons in which the studies were conducted, location or source/origin of cattle sampled, differences in geographical and climatic conditions as well as environmental and ecological factors (Abass *et al*., 2020; Adedipe *et al*., 2014; Ebene *et al*., 2022; Hamid *et al*., 2016; Luka *et al*., 2018a; Menkir *et al*., 2007; Takeet *et al*., 2016; Tembely, 1998; Urquhart *et al*., 1996).

The GI parasite species identified in this study aligns with those previously identified in cattle (Abass *et al*., 2020; Abdoulmoumini *et al*., 2015; Chollet *et al*., 1994; Ebene *et al*., 2022; Ntonifor and Ndaleh, 2012; Ntonifor *et al*., 2013) and goats (Mengoue *et al*., 2025; Nack *et al*., 2024; Pamo *et al*., 2006; Tchoumboue *et al*., 2000) in different parts of Cameroon. Mixed livestock husbandry which includes domestic ruminants (Cattle, goats and sheep) is usually practiced using traditional systems such as nomadic or pastoral farming, mixed farming and peri-urban systems. Management systems range from free-range or extensive systems on natural grazing in less populated areas, to year-round confinement and cut-and-carry feeding in densely populated areas (MINEPIA, 2014, 2020; Ntonifor *et al*., 2013). The findings of this study suggests that the observed similarities in GI parasite profiles could be attributed to the free movement and exposure of the animals to common conditions, such as ecology, pasture quality and humidity which are prevalent in the agro-ecological zones of Cameroon, and provides suitable environments for various livestock production and occurrence of GI parasite. In this study, the sampled cattle were sourced from across the entire Northwest region (seven administrative divisions) of Cameroon before being transported to the Bamenda Municipal abattoir.

In the present study, more male animals than females were sampled. Although GI parasite intensity seemed to be higher in females than in males, male animals were observed to be more aggressive during feeding and heavier feeders than females and thus more likely picked up worm eggs/ova and coccidia oocytes while grazing. However, the findings revealed that neither sex nor age group significantly influenced the prevalence of GI parasites in cattle, and both the male and female animals and all age groups (≤ 3 years, 3 to 6 years and > 6 years old) of animals had an equal likelihood of being infected with GI parasites. While some studies have reported no influence of sex on GI parasite infection rates (Abass *et al*., 2020; Adedipe *et al*., 2014; Ebene *et al*., 2022; Ntonifor and Ndaleh, 2012), others have observed significant differences (Qadeer *et al*., 2018). Previous reports have suggested that male animals were more susceptible to GI parasite infections than the female animals due to hormones debilitating immune functions, which favour growth and spread of parasites in the GI tracks of male animals (Adedipe *et al*., 2014; Apio *et al*., 2006; Urquhart *et al*., 1996). Contrarily, female animals were more likely to be infected during pregnancy due to stress and decreased immune competence (Urquhart *et al*., 1996). Furthermore, poor feeding practices, and inadequate veterinary care which play major role in the susceptibility of animals to GI parasite infections (Awa and Achukwi, 2009) as well as the slaughter of pregnant (Hakoueu *et al*., 2021, 2018) were commonly observed in the study region and abattoir.

Breed, body condition score (BCS), division of origin, co-infections, infection category, and season significantly influenced prevalence rates of GI parasites. These findings agree with previous studies that reported similar influences due to these factors on GI parasites infection of cattle (Abass *et al*., 2020; Adedipe *et al*., 2014; Qadeer *et al*., 2018; Takeet *et al*., 2016). The differences in the prevalence could be due to the presence of favourable environmental conditions necessary for the survival and development of GI parasite life stages (Hamid *et al*., 2016; Rossanigo and Gruner, 1995; Tembely *et al*., 1997; Urquhart *et al*., 1996). Lean-thin and moderate animals showed higher prevalence and harboured more GI parasites in this study contrary to Adedipe *et al*. (2014) who reported that cattle with moderate body condition score had higher prevalence of GI helminths compared to those that were emaciated.

The management system of animals (Regassa *et al*., 2006), and other factors such as better immunity and nutritional status of medium and fat animals (good BCS) in this study provided better protection and/or tolerance against GI parasite infections. Consequently, these animals often remain asymptomatic during the study period (Adedipe *et al*., 2014; Moreau and Chauvin, 2010). On the other hand, malnutrition contributes to the lack of or weakened immunity and increases susceptibility of animals to both single and mixed parasite infections (Hamid *et al*., 2016; Hughes and Kelly, 2006; Moreau and Chauvin, 2010). In agreement with previous works (Abass *et al*., 2020; Abdoulmoumini *et al*., 2015; Adedipe *et al*., 2014; Akter *et al*., 2023; Ebene *et al*., 2022; Ntonifor and Ndaleh, 2012; Ntonifor *et al*., 2013), mixed GI parasite infections, which is defined as the presence of two or more GI parasite species, were more prevalent than single infections in this study. Mixed GI parasite infections cause stress leading to immunosuppression of the host immune system which increases host susceptibility to diseases including GI parasites (Moreau and Chauvin, 2010), resulting in severe morbidity and reduced production in livestock (Kumsa and Wossene, 2007; Kumsa *et al*., 2011). Additionally, factors such as differences in geographic location, climatic conditions, disease resistance, and grazing behavior have been associated with mixed GI parasite infections (Akter *et al*., 2023).

In this study, significant variations were observed around the average egg per gram (EPG) values in infected animals. The average EPG, based on intrinsic factors (breed, sex, age, body condition score [BCS]) and extrinsic factors (location, season), were below 800 EPG, indicating light to moderate intensities of GI parasite infections. However, heavy (800 < EPG ≤ 1200) and very heavy (EPG > 1200) intensities of infections were also widely recorded across all factors (breed, sex, age, BCS, location, and season), including in animals with two or more mixed GI parasite associations. Heavy mixed gastrointestinal helminth infections in cattle can cause significant health and gross economic impact. These infections can result in reduced growth rates, decreased productivity, poor reproductive performance, increased susceptibility to other diseases and even death (Adedipe *et al*., 2014; Swai *et al*., 2006; Ekong *et al*., 2012; FAO, 2000; Hamid *et al*., 2016; Takang *et al*., 2020).

The low prevalence (10.23%) and average intensity (<100 oocysts per gram [OPG]) of *Eimeria* spp. observed in this study suggest that adult cattle, which are predominantly brought for slaughter, still harbour coccidia infections, and that infection with coccidia occurred in adult cattle. Adult cattle often develop immunity and become asymptomatic carriers due to repeated exposure, serving as reservoirs of infection for more susceptible juvenile animals (Abebe *et al*., 2019; Mengoue *et al*., 2025) due to low levels of immunity. Subclinical coccidial infections caused by one or more *Eimeria* species (Hamid *et al*., 2016) and a low prevalence (20.90%) *of Eimeria* spp. in cattle (Ntonifor *et al*., 2013) have also been reported previously. However, the high prevalence and intensities of GI parasite infections recorded in juvenile animals in the present study was associated to failure in separating young animals from the adults and older animals in the various husbandry systems, overgrazing of infested pastures as well as inappropriate and inadequate use of anthelmintics by farmers. Numerous studies have documented wide variations in GI parasite intensity around average EPG values (Ebene *et al*., 2022; Ntonifor and Ndaleh, 2012; Ntonifor *et al*., 2013), and mixed GI parasite infections in ruminants (Abass *et al*., 2020; Adedipe *et al*., 2014; Akter *et al*., 2023; Belem *et al*., 2001; Chollet *et al*., 1994; Ebene *et al*., 2022; Luka *et al*., 2018b; Mengoue *et al*., 2025; Mohamed *et al*., 2023; Ntonifor *et al*., 2013; Terfa *et al*., 2023) with varying infection intensity categories. Therefore, farmers should be educated on the importance of using their own pasture, rotation of grazing pastures and having feed reserves to ensure safe feed for their cattle during periods of scarcity. Also, anthelminthic treatment of animals by farmers at every 3–4 months (Ntonifor *et al*., 2013) and inter-seasonal periods to reduce infection rates and the risk of re-infection is recommended.

The animals used in this study were destined for slaughter and human consumption and selected from the farms located in the administrative divisions of the Northwest region of Cameroon. They were apparently in clinical healthy states and transported usually by trekking (50–80 km for 2–3 days) to the Bamenda municipal abattoir and judged fit for slaughter following standard antemortem inspection procedures as described by the Cameroon veterinary services (MINEPIA, 2000) and supported by manuals on routine meat inspection (FAO, 1994; Grist, 2011). However, the rates and intensity of GI parasite infections obtained in the present study could be under-estimations of the exact situation in the region. Animals that were in poor health and unfit for transportation to the Bamenda municipal abattoir were not selected in the farms around at the level of the divisions. Also, the evolution of GI parasites in infected animals was not investigated since repeat sampling and analysis of the studied animals was not done.

CONCLUSION

This study demonstrates a high prevalence and significant burden of both single and mixed gastrointestinal parasitic infections in cattle across the Northwest region of Cameroon. Juvenile and old animals showed high and similar prevalence rates and intensities of GI parasite infections. The study clearly indicates that season, location, breed, body condition score influenced the variations in GI parasite prevalence and intensity of infections. GI parasitic diseases severely affect animal health and production, leading to reduction in performance and productivity, including slower growth rates, delayed maturity, and reduced weight gains. These challenges hinder the efforts of stakeholders to achieve self-sufficiency in food and animal-derived products. Therefore, to mitigate the adverse effects of GI parasites, effective control measures that make use of the variations in GI parasite prevalence and intensity among the associated risk factors coupled with rational use of anthelmintics must be implemented. Therefore, the assistance of the veterinary services to educate livestock farmers on the importance of using their own pasture, pasteur rotation and having feed reserves to ensure safe feed for their cattle during periods of scarcity; and to strategically deworm their animals with broad spectrum anthelmintics especially at the beginning and end of rainy seasons should be emphasised. Further investigation should be done on the zoonotic potentials GI parasites of cattle and its public health significant in concerned communities. Investigation of the evolution of GI parasites in infected animals would be vital to better understand the degree of influence of risk factors and development of control measures including deworming protocols.

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NOVELTY STATEMENT

This study has highlighted the high prevalence, intensity and significant impact of single and mixed gastrointestinal (GI) parasite infections in cattle in the Northwest region of Cameroon.

AUTHOR'S CONTRIBUTION

MCK, BKN and JAN conceived, designed and coordinated the study. MCK, BKN, PYL and JAN designed data collections tools, methodology and implementation. MCK, PYL, BKN, and PJD contributed materials and carried out field investigation and data entry. MCK and JAN supervised the field and laboratory work as well as data entry. MCK, BKN, PYL and JAN were involved in data validation, statistical analysis and interpretation. MCK and BKN drafted the original manuscript which was reviewed and edited by JAN. All authors participated in preparation and critical reviewed of the manuscript. All authors have read and approved the final version of the manuscript.

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Generative AI and AI-assisted technology statement

The authors declare that they have not used generative AI and AI-assisted technologies in the drafting, reviewing and editing process of this article before submission.

Conflict of interest

The authors have declared no conflict of interest.

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