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Gastro intestinal helminths and protozoa in sheep (*Ovis aries*) and goats (*Capra hircus*) from four localities of Sangmélima District (South Region of Cameroon).

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ABSTRACT

This study aims to investigate the epidemiology of gastro intestinal helminths and protozoa in some selected localities of Sangmélima town in Cameroon. Stool samples were collected from 96 small ruminants, and examined for the detection of gastro intestinal parasite species. At least 15 parasite species, including 12 (80 %) helminths and 03 protozoa (20 %) were detected. *Strongyloides* spp (92.71 ± 3.79%) was the most diagnosed species, and *Cryptosporidium* the least diagnosed (3.13 ± 1.78 %). *Strongyloides* spp, *Monieza* spp, *Cooperia* spp, *Dicrocoelium* spp and *Trichostrongylus* spp exhibited statistically significant ($p < 0.05$) difference in term of prevalence in the study localities. Globally, the age, nature and sexes of examined animals did not significantly ($p > 0.05$) influenced the prevalence of the detected parasite species. The body condition scores were higher in animals with low mean of parasitic frequency. Ninety-for (97.92 %) animals were polyparisitized, and pentaspecific parasitic association was the most common.

Keywords: Helminths, prevalence, protozoa, Sangmélima, small ruminants

1.INTRODUCTION

Small ruminants farming plays an important role in livestock production systems in tropical areas, espicially in sub-saharan Africa, where it represents a major source of income, animal proteins, and socio economic security for rural population (Adams *et al* ., 2021 ; Tarekegn, 2021 ;). They are considered easy to rear, and based on their hardiness and their short reproductive cycle, they are well adapted to several agro-ecological conditions, particulary in extensive and semi-extensive systems (Adje *et al*., 2026).

Despite the benefits of rearing small ruminant, their production faces several challenges such as limited feed availability during the dry season , contagious diseases such as contagious caprine pleuropneumonia (ccpp), brucellosis, and gastro intestinal parasitic infections (Teshome *et al* ., 2021 ; Lhermie *et al* ., 2022 ; Nuvey *et al*., 2022, Cai *et al*., 2023).

Gastrointestinal parasitic infections are diseases caused by the presence of protozoa (*Eimeria*, *Giardia,* and *Cryptosporidium*) and helminths (Nematodes, Cestodes, and Tremadodes) in the digestive tract (Terfa *et al* ., 2023). They are responsible of disrupting nutrient absorption, enterits, the decrease in body condition score, the reduction of reproductive performance, and the increase of mortality in their hosts (Cuna *et al*., 2026). The simultaneaously presence of more than one parasite species in a single host individual had been observed in previous studies (Ruhoolah *et al* ., 2021 ; Nack *et al* ., 2024). This situation, known as polyparasitism may increase the severity of the diseases symptoms induced by coinfecting parasites (Hellar *et al* ., 2015).

Numerous factors, including host-related factors (host species, the animal's sex, age, bodily condition, and breed/genotype), and environmental factors the abundance and the distribution of parasitic infections in livestock ruminants (Kołodziej-Sobocińska, 2019 ; Dey *et al* ., 2021). As the global population increases

continuously, livestock production needs to be more efficient to sustain food security espececially meat and dairy products (Morgan *et al*., 2013). Therefore, there is a need for constant epidemiological surveys to understand the pattern of infections and the various risk factors in different aress.

Several previous studies reported prevalences of gastrointestinal parasitic infections in small ruminants in various areas of Cameroon, notably in the West region (Ntonifor e*t al* ., 2013) ; in the North West Region (Malla *et al* ., 2021, 2023) ; in the Littoral Rgion (Nack *et al* ., 2024). Howeever, there is a lack of data concerning the fauna of gastro intestinal helminths and protozoa in small ruminants in Sangmélima. It is thus relevant to conduct this study with the main objective of investigating the epidemiology of gastro intestinal helminths and protozoa in small ruminants of some selected localities of the Sangmélima town. Specifically, the diversity of gastro intestinal parasites of goats and sheep of the selected localities, their prevalence, and also associations between identified parasite species will be assessed.

2.MATERIAL AND METHODS

2.1.Study araea

The study was conducted from march to September 2024 among farms from the 04 selected localities in the municipality of Sangmélima (2°56'07''N, 11°58'43''E and 711m above the sea level), Dja et Lobo Division, in the south region of Cameroon. The city of Sangmélima covers an area of approximately 2931 km^2 and is bordered to the North by the commune of Zoetele, to the North West by the commune of Ngoulemakong, to the South East by the commune of Meyomessi, to the South West by the commune of Mvangan, to the East by the commune of Meyomessala and to the West by the communes of Mengong and Biwong-Bulu (figure 1).

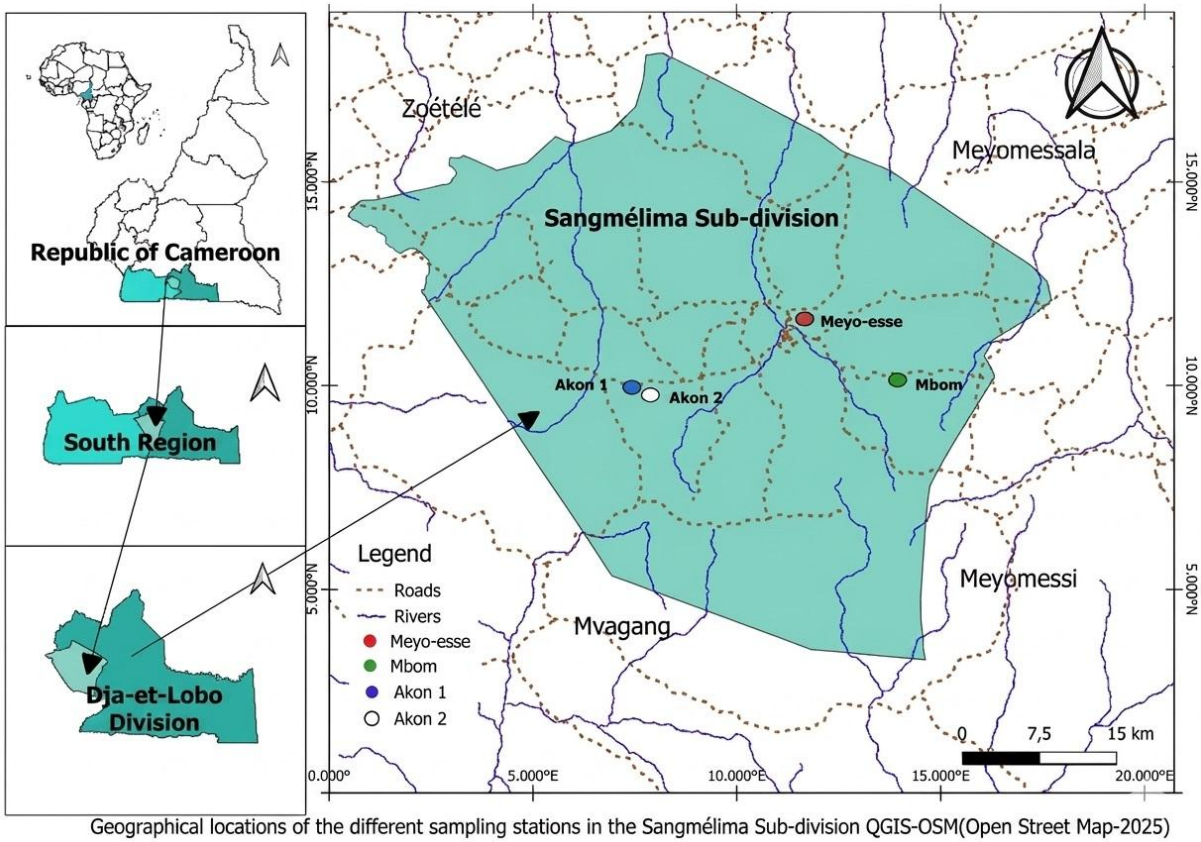


Figure 1: Map of the study area (Open streets Map 2024-QGIS)

2.2. Selection of the study population and stool sampling

The study population was comprised of goats and sheep of both sexes, aged 03 months and older, belonging to one of the four selected sites. Farmers were provided with a pre-established questionnaire to collect information concerning the socio-technical characteristics of their farms, farming technics, sanitary conditions of their animals, and knowledge about gastrointestinal parasites of small ruminants. In total of 96 small ruminants, including 29 goats and 67 sheep were examined for this cross-sectional study. A single stool sample was collected from the rectum using gloves previously coated with Vaseline, following a stratified random sampling method. Each stool sample was stored in a sterile polyethylene container and approximately 2 mg of 99 % sodium azide

used as fixative was added inside containers before being transported to the Laboratory of Parasitology and Ecology of the University of Yaoundé I for further analysis.

2.3. Estimation of the age of small ruminants

The age of selected small ruminants, in this study, was determined by dental examination. Teeth characteristics used to estimate the age of goats and sheep are presented in the table I.

Table I: Relation between dental characteristics and approximative age of small ruminants (Herzog *et al*., 2019)

Approximative age	Characteristics of dentition	Description
< 1 year	All the teeth are temporal	Small, white, well ranged
1 year	02 permanent incisors in central position	Bigger than temporal teeth
2 years	04 permanent incisors (2 pairs in central position)	The two central pairs are permanent
3 years	06 permanent incisors (3 pairs in central position)	Dentition is more solid
4 years	08 permanent incisors (complete dentition)	Complete dentition
> 5 years	Progressive attrition of teeth	Discarded teeth, spoiled, some times absent

2.4. Fecal analysis

Stool samples were analyzed throughout three parasitological diagnostic methods: fresh examination technique, Kato-Katz technique and Willis's flotation method.

Wet mount examination technique

Fresh examination technique, permits the detection of cysts/trophozoites of protozoa, and eggs/larvae of helminths. Briefly, the identification number of each animal was written at one of the ends of the slide, a drop of 2 % Lugol was placed in the middle of the slide. Using a wooden applicator, and a small portion of stool sample was taken and mixed with the drop to create homogeneous solution. The solution was gently covered with a coverslip to avoid air bubbles, the slide was then placed on a binocular optical microscope and examined under 10 X and 40 X objectives (Guigen *et al*., 2021).

Kato Katz examination technique

The Kato-Katz technique is a widely used method for diagnosing intestinal parasitic infections, particularly helminths (worms), and requires a Kato-Katz solution, composed of a mixture of 100 mL of distilled water, 100 mL of pure glycerin, and 1 mL of 3 % green Malachite solution. In this method, a small portion of stool was obtained with the help of a wooden applicator, pressed through a mesh screen to remove large particles. A portion of the sieved sample was then placed in the hole of a template (opening of about 41.7mg) placed at the center of a microscope slide, the excess was thus removed by scraping the surface of the template. Cellophane paper previously soaked in Kato solution for at least 24h, was removed with the help of a forceps and placed over the stool sample, which was then spread by gently rolling a test tube over the cellophane paper. The preparation obtained was analyzed under an optical microscope at a magnitude of 10 X and then 40 X (Altman *et al*., 2025).

Willis's flotation technique

Willis's flotation technique, is based on the use of a solution, containing saturated sodium choride (NaCl) (250 g of NaCl + 750 mL of distilled water), with higher density than parasites, making the latter float to the surface and adhere to a coverslip. The method consisted to take, with a Wooden applicator, a portion of 3g of stool, and to triturate it inside a mortar. After this, the stool sample was homogenized inside a graduated glass, containing 60 mL of saturated sodium chloride solution. The mixture was then sieved, and transferred into test tube, and allowed to rest for about 15 to 20 minutes. A cover slip was then gently placed on the test tube for 15 minutes, then observed under optical microscope at a magnitude 10 X and then 40 X (Matheus *et al*., 2019).

2.5. Evaluation of the body condition score

The body condition score (BCS) is a widely used for monitoring the body condition of farm animals. It is assessed based on visual obsevation or manual palpation of some areas of the body, mainly around the spine, and is scored on a scale of 1 to five, with sometimes half marks for greater position. The BCS is evaluated in this study in order to determine the influence of gastrointestinal parasites in this parameter. The most commonly used palpation areas, whihe determining the BCS are the lumbar area, the posterior ribs and tail and the base of the tail in some breeds (Vall *et al* ., 2025). The typical scale of the BCS is presented in table II.

Table II : Typical scale of the notation of the body condition score

Body Condition Score (BCS)	Description
1	Very thin : very prominent bony structures, no palpable pulpil
2	Slim : bones are perceptible, little pulpil
3	Good condition : bones are apparent and surrounded by a moderate layer of flesh
4	Fat : bones are difficult to palpate, there is significant fat deposit
5	Very fat: bones are not visible and not palpable, there is obvious excess of fat

2.6.Identification of gastrointestinal parasites

The identification of gastro intestinal parasites of small ruminants was carried out following the method described by Jan *et al*. (2004). After microscopique examination of stool samples in the labroratory, eggs, cysts and larvae of intestinal parasite species were identified based on their morphology, forms, colours and the nature of the cover membrane

2.7. Evaluation of the prevalence of parasite species

The prevalence of intestinal parasite species were were calculated using the followig formula described by Achi *et al.*(2003).

2.8.Statistical analysis

Raw data collected from the study, were computerized into Microsoft Excel for descriptive analysis. Subsequently, the data were analyzed using Past software version 2.9, and XLSTAT 2024 for inferential analysis. The Chi-square test was used to compare parasitic prevalences between localities, animal age classes, animals group (goats and sheep), and sexes. The Kruskall-Walis H statistics was used to assess the impact of parisitism on the BCS. All calculations were performed using Past software version 3.1 and XLSTAT 2024 at the 5% margin of error.

3. RESULTS

$$\text{Prevalence (\%)} = \frac{\text{Number of infested animal (s)by a parasite especieds}}{\text{Total number of examined animals}} \text{ x100}$$

fested by intestinal parasites in goats and sheep showed the presence of at least 15 parasitic species including 12 helminths (80%) and 03protozoa (20%). *Strongyloides* spp (92.71 ± 3.79%), *Toxocara* spp (83.33± 3.80%)) and *Moniezia* spp (45.83 ± 5.09%) were the most diagnosed species in the group of helminths. While, *Ostertagia* spp (9.38% ± 2.98 %), *Haemonchus* spp (12.50 ± 3.38 %) and *Dicrocoelium* spp (13.54 ± 3.49 %) were the least identified species in this group. Three (03) protozoa speries namely : *Eimeria* spp (58.33 ± 5.03%), *Entamoeba* spp (38.54 ± 4.96%) and *Cryptosporidium* spp (3.13 ± 1.78%) were observed. In total 283 parasites were counted in the goup of nemathelminth, 87 in the group of plathelminth and 96 in the group of protozoa (Table III).

Table III : Diversity of parasite species identified in small ruminants.

Parasites group	Classes	Species	ni (pi ± SE)
Nemathelminths	Nematodes	*Haemonchus* spp	12(12.50 ± 3.38%)
		Trichostrongylus sp.	31(32.29 ± 4.77%)
		Ostertagia spp	9(9.38 ± 2.98%)
		Cooperia spp	25(26.04 ± 4.48 %)
		Toxocara spp	80(83.33 ± 3.80%)

		Chabertia spp	24(25.00 ± 4.42%)
		Trichuris spp	13(13.54 ± 3.49%)
		Strongyloides spp	89(92.71 ± 3.79%)
	Total		**283**
Plathelminths	Cestodes	*Moniezia* spp	44(45.83 ± 5.09%)
	Trematodes	*Fasciola* spp	14(14.58 ± 3.70%)
		Dicrocoelium spp	13(13.54 ± 3.49%)
		Paramphistomum spp	16(16.67 ± 3.80%)
	Total		**87**
Protozoa	Sporozoa	*Eimeria* spp	56(58.33 ± 5.03%)
		Cryptosporidium spp	3(3.13 ± 1.78%)
	Amoeba	*Entamoeba* spp	37(38.54 ± 4.96%)
	Total		**96**

ni : number of small ruminants infected with i parasite species ; pi : prevalence of i parsite species ; SE : Standar error.

3.2.Prevalence of helminths and protozoa in goats and sheep accross the localities of stool collection

The statistical analysis of data obtained from parasitological examination of stool samples collected in the four study localities revealed that the prevalence of certain gastro intestinal parasite species, significantly varied ($P < 0.05$) according to the sampling localities. This is case of *Strongyloides* spp, whose prevalence significantly varied in the different study localities with a maximum observed in Akon 2 and Meyo-esse (100 ± 0.00%) ; *Monieza* spp with a higher prevalence in Mbom (76.47 ± 10.29 %) and a lower prevalence in Akon 1 (22.22 ± 8.00%) ; *Cooperia* spp whose prevalence was particulary higher in Mbom (52.94 ± 12.11%) and lower in Akon 1 (14.81 ± 6.84 %) ; *Dicrocoelium* spp with a prevalence of 46.15 ± 13.49% in Meyo-esse against 3.70 ± 3.63 % in Akon 1; *Trichostrongylus* spp with a prevalence of 53.85 ± 13.83% in Meyo-Esse and 12.82 ± 5.35% in Akon 2. In contrast the other species, including *Toxocara* spp, *Ostertagia* spp, *Paramphistomum* spp, *Haemonchus* spp, *Eimeria* spp, *Cryptosporidium* spp and *Entamoeba* spp, prevalences were comparable ($P > 0.05$) in the study localities (table IV).

Table IV : Comparison of the prevalence of helminths and protozoa species in small ruminants according to the study localities

Parasite especies	Akon 1 ni (pi ± SE)	Akon 2 ni (pi)	Mbom ni (pi)	Meyo-esse ni (pi)	Statistical analysis
Strongyloides spp.	23 (85.18 ± 6.84%)	39 (100 ± 0.00%)	14 (82.35 ± 9.25%)	13 (100 ± 0.00%)	Chi-2= 9.05; p = 0.029*
Moniezia spp	6 (22.22 ±8.00%)	20 (74.07±7.02%)	13 (76.47±10.29%)	5 (38.46±13.49%)	Chi-2= 13.24; p = 0.004*
Chabertia spp	8 (20.51± 7.77%)	12 (30.77± 7.39%)	3 (17.65± 9.25%)	1 (7.69 ± 7.39%)	Chi-2= 3.57; p = 0.312
Ostertagia spp	1 (3.70 ± 3.63 %)	2 (5.13 ± 3.53%)	4 (23.53 ± 1.29%)	2 (13.38 ± 9,38%)	Chi-2= 6.41; p = 0.093
Cooperia spp	4 (14.81 ± 6.84%)	8 (20.51 ± 6.47%)	9 (52.94 ± 12.11%)	4 (30.77 ± 12.80%)	Chi-2= 8.92; p = 0.030*
Toxocara spp	20 (74.07 ± 8.43%)	34 (87.18 ± 5.35%)	14 (82.35± 9.25%)	12 (92.30 ± 7.39%)	Chi-2= 2.86; p = 0.416
Paramphistomum spp	4 (14.81 ± 6.84%)	4 (10.26 ± 4.86%)	3 (17.65 ± 9.25%)	5 (38.46 ± 13.49%)	Chi-2= 5.68; p = 0.118
Dicroecelium spp	1 (3.70 ± 3.63 %)	3 (7.69 ± 4.27%)	3 (17.65 ± 9.25%)	6 (46.15 ± 13.49%)	Chi-2= 15.43; p = 0.001*
Fasciola spp	6 (22.22 ± 8.00%)	2 (5.13 ± 3.53%)	5 (29.41 ± 11.05%)	1 (7.69 ± 7.39%)	Chi-2= 7.56; p = 0.056
Trichirus spp	4 (14.81 ± 5.18%)	2 (5.13 ± 3.53%)	5 (29.41 ±11.05%)	2 (13.38 ± 9.38%)	Chi-2= 6.09; p = 0.107
Haemonchus spp	1 (3.70 ± 3.63 %)	4 (10.26 ± 4.86%)	5 (29.41 ± 11.05%)	2 (13.38 ± 9.38%)	Chi-2= 6.64; p = 0.085
Eimeria spp	12 (44.44 ± 9.56%)	22 (56.41 ± 7.94%)	11 (64,70 ± 11.59%)	11 (84.61 ± 12.80%)	Chi-2= 6.18; p = 0.103

Cryptosporidium spp	2 (7.40 ± 5.04%)	1 (2.56 ± 2.53%)	-	-	Chi-2= 2.64; p = 0.450
Entamoeba sp.	15 (55.55 ± 9.56%)	11 (28.20 ± 3.53%)	7 (41.18±11.94%)	4 (30.77±12.80%)	Chi-2= 5.44; p = 0.142
Trichostrongylus spp.	11 (40.74 ± 9.46%)	5 (12.82 ± 5.35%)	8 (40.05 ± 12.80%)	7 (53.85±13.83%)	Chi-2= 12.10; p = 0.007*
Total	27	39	17	13	

3.3.Effect of the age of small ruminants on the prevalence of parasite species

The analysis of the effect of the age of small ruminants, on the prevalence of gastro intestinal parasite especies, revealed no statistically significant difference (p > 0.05), in term of prevalence, in the different age classes. Furthermore, species such as *Oestertagia* spp, *Trichuris* spp and *Cryptosporidium* spp were not detected in older animals (i e those of the[5-10[age class) (table V).

Table V : Comparison of the prevalence of gastro intestinal parasites according to the age of small ruminants

Parasite especies	Age classes			
	[0 ; 1 [	[1 ; 5[	[5 ; 10[	Statistical analysis
	ni (pi)	**ni (pi)**	**ni (pi)**	
Strongyloides spp	30(96.77 ± 3.18%)	49(89.1 ± 4.20%)	10(100 ± 0.00%)	Chi-2=2.60 ; df =2 ; p = 0.27
Moniezia spp	16(51.61 ± 8.98%)	22(40 ± 6.61%)	6(60 ± 15.49%)	Chi-2=1.97 ; df =2 ; p = 0.37
Chabertia spp	7(22.58 ± 7.51%)	14(25.45 ± 5.87%)	3(30 ± 14.49%)	Chi-2=0.23 ; df =2 ; p = 0.88
Ostertagia spp	5(16.13 ± 6.61%)	4(7.27 ± 3.50%)	-	Chi-2=2.98 ; df =2 ; p = 0.22
Cooperia spp	7(22.58 ± 7.51%)	17(30.91 ± 6.23%)	1(10 ± 9.49%)	Chi-2=2.20 ; df =2 ; p = 0.33
Toxocara spp	26(86.67 ± 6.10%)	44(80 ± 5.39%)	10(100 ± 0.00%)	Chi-2=2.44 ; df =2 ; p = 0.29
Paramphistomum spp	5(16.13 ± 6.61 %)	9(16.36 ± 4.99%)	2(20 ± 12.65%)	Chi-2=0.09 ; df =2 ; p = 0.95
Dicroecelium spp	3(9.68 ± 5.31%)	8(14.54 ± 4.75%)	2(20 ± 12.65%)	Chi-2=0.79 ; df =2 ; p = 0.67
Fasciola spp	3(9.68 ± 5.31%)	10(18,18 ± 5,20%)	1(10 ± 9.49%)	Chi-2=1.33; df =2 ; p= 0.51
Trichirus spp	6(19.35 ± 7.10%)	7(12.73 ± 4.49%)	-	Chi-2=2.49 ; df =2 ; p = 0.28
Haemonchus spp	3(9.68 ± 5,31%)	6(10.91 ± 4.20%)	3(30 ± 14.49%)	Chi-2=3.15 ; df =2 ; p = 0.20
Trichostrongilus spp	8(25.81 ± 7.86%)	19(35.55 ± 6.45%)	4(40 ± 15.49%)	Chi-2=0.99 ; df =2 ; p = 0.60
Eimeria spp	16(51.61 ± 8.98%)	33(60 ± 6.61%)	7(70 ± 14.49%)	Chi-2=1.19 ; df =2 ; p = 0.54
Cryptosporidium spp	1(3.22 ± 3.17%)	2(3.64 ± 2.53%)	-	Chi-2=1.42 ; df =2 ; p = 0.49
Entamoeba spp	10(32.26 ± 8.40%)	24(43.64 ± 6.69%)	3(30 ± 14.49%)	Chi-2=0.37 ; df =2 ; p = 0.83
Total	31	55	10	

df : degree of freedom

3.4.Prevalence of gastro intestinal parasites in the studied host species

The comparison of the prevalence of gastrointestinal parasite species, identified in stool samples of sheep and goats, showed no statistically significant difference (P > 0.05), excepted *Dicrocoelium* spp whose prevalence was statiscally higher (P < 0.05) in goats (31.03 ± 8.59%) than in sheep (5.97 ± 2.89%). What ever the host, *Toxocara* spp (81.08 ± 3.91 % in sheep, and 86.21 ± 3.52% in goats) and *Eimeria* spp (58.21 ± 5.03 % in sheep, and 58.62 ± 5.03 % in goat) were the most prevalent parasites (table VI).

Tableau II: Comparison of the prevalence of gastrointestinal parasites in sheep and goats

Pasasite especies	Sheep	Goats	Statistical analysis
	ni (p±SE)	**ni (p±SE)**	

Strongyloides spp	19(28.4 ± 5.51%)	12(41.4 ± 9.15%)	Chi-2 =1.57 ; df =1 ; p = 0.21
Moniezia spp	36(53.73 ± 6.09 %)	8(27.58 ± 8.30%)	Chi-2 =5.57 ; df =1 ; p = 0.2
Chabertia spp	20(29.85 ± 5.59%)	4(13.79 ± 6.40%)	Chi-2 =2.78 ; df =1 ; p = 0.095
Ostertagia spp	5(7.5 ± 3.22%)	4(13.79 ± 6.40%)	Chi-2 =0.95 ; df =1 ; p = 0.33
Cooperia spp	15(22.38 ± 5.09%)	10(34.48 ± 8.83%)	Chi-2 =1.53 ; df =1 ; p = 0.21
Toxocara spp	55(82.08 ± 4.69%)	25(86.21 ± 6.40%)	Chi-2 =0.25 ; df =1 ; p = 0.62
Paramphistomum spp	10(14.92 ± 4.35%)	6(20.68 ± 7.52 %)	Chi-2 =0.48 ; df =1 ; p = 0.48
Dicroecelium spp	4(5.97 ± 2.89%)	9(31.03 ± 8.59%)	Chi-2 =10.86 ; df =1 ; p = 0.001*
Fasciola spp	11(16.42 ± 4.53%)	3(10.34 ± 5.65%)	Chi-2 =0.60 ; df =1 ; p = 0.44
Trichuris spp	10(14.93 ± 4.35%)	3(10.34 ± 5.65%)	Chi-2 =0.36 ; df =1 ; p = 0.55
Haemonchus spp	7(10.45 ± 3.74%)	5(17.24 ± 7.01%)	Chi-2 =0.85 ; df =1 ; p = 0.35
Trichostrongilus spp	19(28.36 ± 5.51%)	12(14.38 ± 6.52%)	Chi-2 =1.57 ; df =1 ; p =0.21
Eimeria spp	39(58.21 ± 6.03%)	17(58.62 ± 9.15 %)	Chi-2 =0.01 ; df =1 ; p = 0.97
Cryptosporidium spp	2(2.98 ± 2.08%)	1(3,45 ± 3.39%)	Chi-2 =0.01 ; df =1 ; p = 0.90
Entamoeba sp.	22(32.84 ± 5.74%)	15(51.72 ± 9.28%)	Chi-2 =3.05 ; df =1 ; p = 0.08
Total	67	29	

3.5. Sex related gastrointestinal parasites in sheep and goats

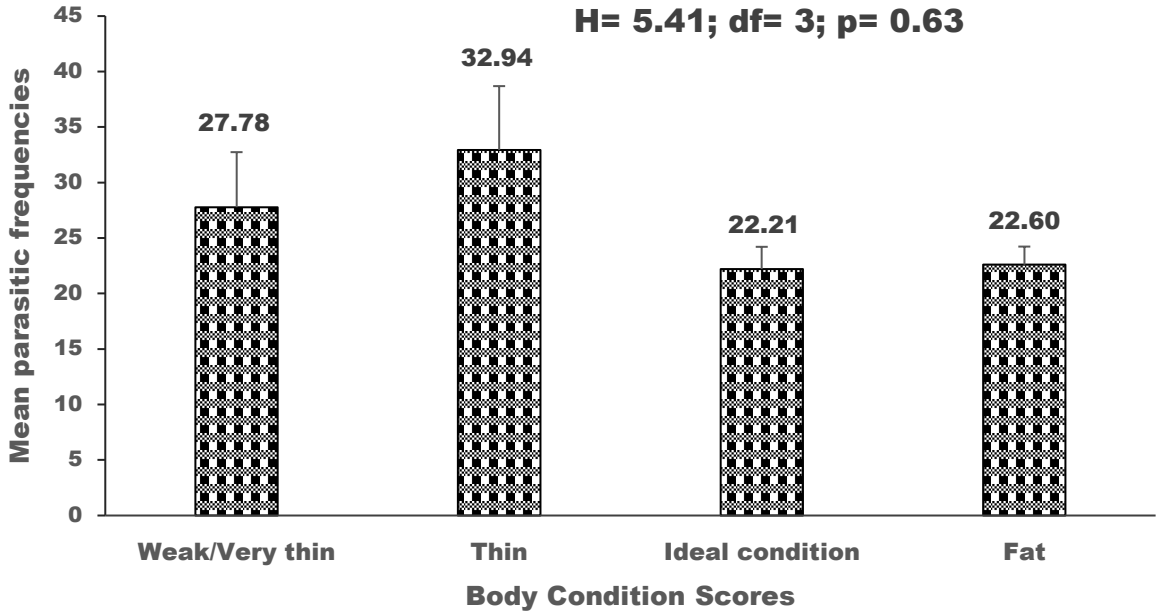
The comparison of the prevalence of gastro intestinal parasites according to the sex of small ruminants highlighted that, excepted *Chabertia* spp which was statiscally more prevalent ($p < 0.05$) in females (32. 25 ± 5.84%) than in males (12. 5 ± 5. 85%) and *Paramphistomum* spp which was statiscally more prevalent ($p = 0.03$) in males (28.13 ± 7.95 %) than in females (10.94 ± 6.25 %), the sexe of small ruminants showed no significant influence ($p > 0.05$) on the prevalence of the other gastro intestinal parasite especies. Furthermore, *Cryptosporidium* spp was diagnosed only in females (4.69 ± 2.64%) (table VII).

Table VII: Comparison of the prevalence of gastro intestinal parasite species according to the sexes of small ruminants

Parasite species	Females	Males	Statistical analysis
	ni (p)	**n i (p)**	
Strongyloides spp	58(90.62 ± 3.54%)	31(96.87 ± 3.08%)	Chi-2= 1.23 ; df =1 ; p = 0.26
Moniezia spp	27(42.18 ± 6.17%)	17(53.13 ± 8.82%)	Chi-2=1.02 ; df =1 ; p = 0.31
Chabertia spp	20(32.25 ± 5.84%)	4(12.5 ± 5.85%)	Chi-2= 4.00 ; df =1 ; p = 0.04*
Ostertagia spp	4(6.25 ± 3.03%)	5(15.63 ± 6.42%)	Chi-2= 2.20 ; df =1 ; p = 0.137
Cooperia spp	16(25 ± 5.41%)	9(28.13 ± 7.95%)	Chi-2=0.11 ; df = 1 ; p =0.74
Toxocara spp	52(81.25 ± 4.88%)	28(87.5 ± 5.85%)	Chi-2=0.60 ; df =1 ; p = 0.43
Paramphistomum spp	7(10.94 ± 6.25 %)	9(28.13 ± 7.95 %)	Chi-2=4.53 ; df = 1 ; p = 0.03*
*Dicroecelium s*pp	10(15.63 ± 4.54%)	3(9.37 ± 5.15%)	Chi-2=0.71 ; df =1 ; p = 0.39
Fasciola spp	11(17.19 ± 4.72%)	3(9.37 ± 5.85%)	Chi-2=1.04 ; df = 1 ; p = 0.30
Trichirus spp	8(12.5 ± 4.13%)	5(15.63 ± 6.42%)	Chi-2= 0.17; df =1 ; p = 0.67
Haemonchus spp	8(12.5 ± 6.25%)	4(12.5 ± 5.85%)	Chi-2= 000 ; df =1 ; p = 1.000
Trichostrongilus spp	18(28.13 ± 5.62%)	13(40.63 ± 8.68%)	Chi-2= 1.52 ; df =1 ; p = 0.217
Eimeria spp	40(62.5 ± 6.05 %)	16(50 ± 8.84%)	Chi-2= 1.37 ; df = 1 ; p = 0.242
Cryptosporidium spp	3(4.69 ± 2.64%)	-	Chi-2=1.59 ; df =1 ; p = 0.213
Entamoeba spp	24(37.5 ± 6.05 %)	13(40.62 ± 8.66%)	Chi-2=0.06 ; df =1 ; p = 0.77
Total	64	32	

3.6. Parasitic frequencies in small ruminants according to the body condition score of examined animals

The assessment of the relation between intestinal parasite frequencies in small ruminants and their BCS revealed that, the average of parasite frequencies was higher in weak and thin animals (27.78 and 32.94) compared to that observed in animals in ideal condition, and those which were fat (22.21 and 22.60) (figure 2).



H: Kruskal Wallis's value

Figure 2: Mean parasitic frequencies in small ruminants related to their body condition score

3.7. Assessment of parasitic associations in small ruminants of the study area

The enumeration of parasitic associations in small ruminants revealed that 94 out of 96 animals excreted at least two parasite species in their stools (97.92 % of polyinfestation rate). Pentaspecific association was the most frequent and was recorded in 27 animals, followed by trispecific association (recorded in 17 animals), and hexaspecific association (recored in 11 animals). In total 75 combinations were recorded in polyinfested animals, with *Strongyloides* spp.+*Toxocara* spp.+*Entamoeba* spp, **and** *Strongyloides* spp.+*Moniezia* spp +*Toxocara* spp +*Eimeria* spp being the most common combinations with 5 cases each (figure 2).

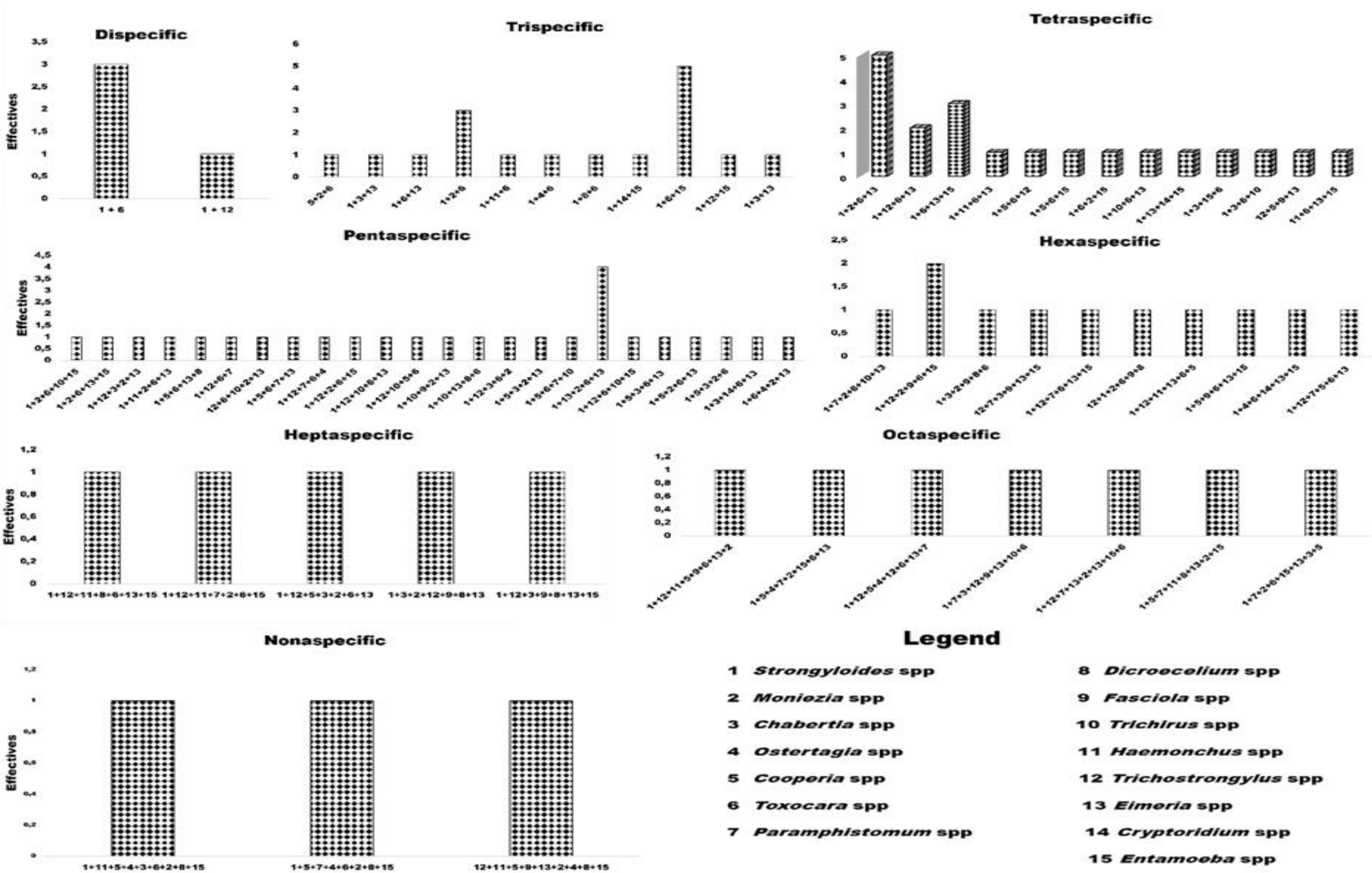


Figure 2 : Parasitic associations and combinations recorded in small ruminants of the study area.

4.DISCUSSION

This study showed the existence of gastrointestinal parasites in small ruminants of the study localities, with an overall prevalence of 100 %. The high rate of parasitic infestation in this study, could be due to factors such as the animal husbandry system, the low percentage of deworming practice, the presence of the infective forms of identified parasites in the grazing environment of small ruminants. The glogal prevalence of gastro intestinal obtained in this study is higher than those reported by Mpofu *et al.* (2020) in South Africa (37.1 %) ; Malla *et al*. (2021) in Cameroon (89.5%) and Ismail and Abdullali (2022) in Nigeria (84.16 %). This numerical difference, betwenn the overall prevalence reporte by the above authors and ours, could be due to the enrionment which would be favorable to the maintenance and the transmission of gastro intestinal parasites to animals in our study localities, and the poor deworming practice observed in this study (for example, in this study, all farmers did not deworm their animals).

The high prevalence of helminth species (80%) compared to that of protozoa (20%) in this study, may be attributed to the multiple routes of helminths infection (oral and dermal) compared with the single route for protozoan infection (oral) (Hadiza *et al.,* 2019), and also the climate which could favor the dissemination and transmission of the infective forms of gastro intestinal parasites to the examined hosts. Inside the helminths group, nematodes were more abundant (283 individuals in total) than Cestodes (44 individuals in total)) and Trematoda (43 individuals in total). This observation could be due to the fact that Nematodes have a direct or monoxene life cycle whereas Cestodes and Nematodes need an intermediate host to achieve their life cycle, thus their infestation depends on the presence of their intermediate hosts (Ntonifor *et al*., 2013). This result aligns that of that of Chukwudi *et al*. (2024) who implied that infections due to the nematodes accounted for most of the animals examined.

The highest prevalence recorded with *Strongyloides* spp (92.71 %) and *Toxocara* spp (83.33 %) could be due to their reproduction cycle characterized by a daily laying of a large number of eggs by females, and the susceptibility of the examined hosts to these parasitic species (Eke *et al.* 2019). However, this finding is not in agreement with the observation of Dugaza (2019) who reported high prevalence with *Haemonchus contortus*; Berhanu (2023) who reported *Monezia* spp as the most prevalent species and Malla *et al*. (2024) who reported *Trichostrongylus* spp as most the common species in their study.

The pronounced prevalence of *Eimeria* spp among protozoa, could be due to factors such as management system, sanitary conditions, agroecology, climatic and environmental conditions, that favor the direct fecal oral transmission cycle and the distribution of Eimeriosis in different host (Khodaram-Tafi and Hashemnia, 2017; Tieli *et al*., 2023). According to Das *et al*. (2015) *Eimeria* is the most serious intestinal diseases of domestic animals that causes high anemia, electrolyte deficits and dirrhea (Shiferaw *et al* ., 2017).

The prevalence of gastrointestinal parasite species from the four study localities were comparable ($P > 0.05$) excepted *Strongyloides* spp, *Cooperia* spp, *Dicrocoelium* spp and *Trichostrongylus* spp whose prevalence were statistically different ($P < 0.05$) among the study localities. This situation could be due to the heterogeneity of environnmental factors in the sudy localies such as temperature and moisture which can favour or inhibate the development of some parasitic species in the environment.

The sex-wise prevalence analysis reavealed that, globally gastrointestinal parasites occured with similar frequency in males and females, suggesting that, both sexes were generally exposed in the same way, to the infective forms of gastrointestinal parasites in this study. This observation aligns those of Ekehe *et al*. (2019) and Malla *et al*. (2021). who reported no statistically significant difference between the prevalence of intesinal parasite infection in male small ruminants and their female counterparts. Unlike the other intestinal parasite species diagnosed in this study, *Chabertia* spp was statiscally more prevalent ($p = 0.04$) in females (32.25 ± 5.84%) than in males (12.5 ± 5.85%), while *Paramphistomum* spp was more prevalent ($p = 0.03$) in males (28.13 ± 7.95 %) than in females (10.94 ± 6.25 %). The significant difference concerning the prevalences of *Chabertia* spp and *Paramphistomum* spp in males and females could be attributed to a genetic predisposition and hormonal control. For example, testossterone is known for its immunosuppressive activity, and this had been often cited as the main reason for the greater suceptibility of males, to a wide variety of infectious diseases, including parasitic diseases (Stephano *et al* ., 2021 ; Henrique and Cristino, 2023). The higher prevalence of *Chabertia* spp in females compares to males could be attributed to the reproduction, which plays a role in infection, by lowering the resistance of females to infection (Jegede *et al* ., 2015).

The present study showed no satatiscally significant difference ($P > 0.05$) between age groups, regarding the prevalence of gastrointestinal parasites species in small ruminants, although animals aged between 5-10 years, were found to be more infested than the two other classes (3 mounths-1 year and 1-5 years). This finding corroborates that of Ismail and Abdullahi.(2022) who reported higher prevalence of gastrointestinal parasites in

adults compared to young animals. This observation may be due to the fact that, in this study, animals aged between 5-10 years may have been exposed to parasites for a longer time, than those aged between 3 months - 1 year and 1-5 years and therefore, more vulnerable to infections.

The analysis of the relation beween mean parasite frequencies and BCS of animals in this study, showed that mean parasite frequencies, were higher in small ruminant in poor conditions than those in good condition. This finding suggests that, gastrointestinal helminths and protozoa, could dicrease the reproductice capacity of animals, because, previous studies revealed that, animals with low BCS had a too low reproductive capacity (Ana *et al.,* 2024 ; Sebastiano *et al*., 2025).

Data from this study, confirmed a high polyparasitism rate in small ruminants, mainly through pentaspecific and trispecific associations. Coinfections with varied gastrointestinal parasite species within the same host in this study, could be due by the nomadic system of management, which allaws the animals to access a wide range of habitats, and possibly encounter diverse parasites, with a relatively high risk of infection. The common mode of transmission of diagnosed species in this study, could also induced the simultaneous presence of several parasite species in the same host (Bilong Bilong *et al*., 2021 ; Adjakaye and Adejuyigbe, 2024). The presence of mixed infection in animals has been linked to morbidity, poor productivity and the suppression of immune system, thus increasing their vulnerability to other illness or parasites (Kumsa *et al* ., 2011 ; Mabbott, 2018 ; Hananeh *et al*, 2020). This result aligns that of Ntonifor *et al.(*2013) and Cai *et al*.(2023) who also recorded high rates of mixed infections in their studies.

CONCLUSION

This study highlighted the significant prevalence and complexity of gastrointestinal parasitic infections, in small ruminants of the study lacalities of Sangmélima District (South Region of Cameroon), revealing an overall prevalence of 100 %. The parasitic fauna of smal ruminants consisted of at least 15 species, with *Strogyloides* spp, *Toxocara* spp, *Eimeria* spp and *Moniezia* spp as the most prevalent species identifiied in examined animals. Among the diagnosed species, *Strongyloides* spp, *Monieza* spp, *Cooperia* spp, *Dicrocoelium* spp and *Trichostrongylus* spp exhibited significant difference in term of pravlence in the study localities. Globally, the age, sex and host nature did not significantly influenced the prevalence of intestinal parasites in small ruminants. The BCS of small ruminants was influenced by gastro intestinal parasites. Among parasitic associations recorded in this study, penataspecific association was the most frequent. This study contributed to the knowledge of the epidemiology of intestinal parasites in small ruminants, and constitutes a useful basis for the implementation of control strategies.

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