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Prevalence of Gastrointestinal Parasites in Sheep and Goats of Bui and Donga-Mantung Divisions of the North West Region of Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MEM, VKP, YC, NACN, ML and MR contributed to the design of the study, data collection, led the analysis and drafting of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background: The aim of this study was to determine the prevalence, intensity of infection and management systems associated with gastrointestinal parasites in small ruminants (sheep and goats) from 12 villages in the Bui and Donga-Mantung Divisions for a period of one year.
Methods: A total of 704 stool samples were collected from 321 sheep (153 males and 168 females) and 383 goats (189 males and 194 females) consisting of 463 adults and 241 young (kids/lambs). These animals aged 5 months to 7 years were examined for gastrointestinal parasites. Qualitative and quantitative analysis of stool samples were carried out using the McMaster technique.

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Results: Of the 704 stool samples examined, 630 samples were found positive with one or more gastrointestinal parasites giving an overall prevalence of 89.5%. Sheep recorded the highest prevalence (90.0%) contrary to 89.0% in goats. Nine types of nematode eggs and a single protozoan oocyst were identified. In sheep, *Haemonchus species* (18.7%) and *Trichostrongylus species* (13.7%) recorded the highest prevalence while in goats, *Strongyloides species* (10.4%) and *Trichuris species* (2.4%) recorded the least prevalence. Mixed infections of *Haemonchus species* and *Eimeria species* were most prevalent in sheep 64(19.9%) than in goats 26(6.8%) while mixed infections of *Trichostrongylus sp.*/*Strongyloides sp*/*Eimeria sp* were least prevalent in goats 8(2.1%) than in sheep 5(1.5%). In the two types of animals, mean intensity for *Haemonchus species* was higher in goats (694.4 ±1904.2) than in sheep (189.5±137.3). In sheep, adults were more infected 198 (94.3%) than the young 91(82.0%) while in goats, adults were still the most infected 227 (89.7%) compared to the young 114(87.7%). Generally, adults were the most infected (91.8%) compared to the young (85.5%) ruminants but with no significant difference (P>0.05). Based on sex, male sheep recorded the highest prevalence (93.5%), followed by male goats (91.0%). Female goats and sheep recorded prevalence of 87.1% and 86.9% respectively. However, the overall prevalence of infection in the different sexes generally showed that, male animals were the most infected (92.1%) than the female animals (87.0%) with no significant difference (P>0.05). Concerning the various management techniques, prevalence of was higher in free range grazing animals (95.5%), followed by tethered animals (84.5%) while animals confined in paddocks had a low prevalence (76.8%).
Conclusion: This study indicates a very high prevalence of gastrointestinal parasites in sheep and goats of Bui and Donga-Mantung Divisions. From these results, it is very urgent and important to sensitize the farmers of these areas on good rearing techniques, they should use strategic methods like some medicinal plants that can be used to reduce the infection rate and finally to put in place a campaign that will help in the deworming of these animals in these Divisions thereby reducing economic losses.

Keywords: Gastrointestinal parasites; ruminants; prevalence; Bui; Donga-Mantung; Cameroon.

1. INTRODUCTION

Gastrointestinal parasites are known to be widespread in Cameroon and limit livestock production in many areas and countries of the world. Studies have shown that these parasites are by far the most serious causes of production losses in small ruminants and nematodes are the cause of serious production losses to ruminants in sub-Saharan Africa, and worldwide [1]. Cameroon being an agricultural country, its economy is mainly based on profitable agricultural production where sheep and goat farming plays an important role in the growth of its economy through the production of meat, milk, skin, hair and manure [2]. The production performance of these animals depend on good health conditions and better management and can therefore be affected by poor managerial practices and diseases caused by various pathogens like bacteria, viruses, fungi, parasites etc [3].

In Africa and Cameroon in particular, parasitic infection is one of the most common problems of sheep and goats where these animals are mostly affected by parasitic diseases caused by helminths, arthropods and protozoa but gastrointestinal parasites are most common and widely distributed parasites worldwide [2]. Gastrointestinal nematodosis is the commonest in these animals and is caused by a variety of nematodes such as; *Haemonchus spp, Ostertagia sp, Trichostrongylus sp, Strongyloides sp, Cooperia sp, Nematodorius sp.* resulting to parasitic gastroenteritis (PGE) in Sub Sahara Africa and worldwide [3]. Among these parasites, *Haemonchus contortus* is a predominant and highly pathogenic gastrointestinal nematode responsible for impaired productivity in small ruminants throughout the world [4]. A higher prevalence of nematode parasites has been recorded in ruminants worldwide, together with other gastrointestinal parasites like the trematodes (Liverflukes), cestodes (*Taenia species*) and coccidians (*Eimeria species*) have also shown higher prevalence rates in most countries of the world [4]. Prevalence studies also reveal that *Fasciola species* are by far the most economically important trematodes of ruminants in the tropics [5]. Prevalence of parasitic infections is most commonly found in tropical regions like Cameroon where environmental factors like temperature, humidity

and rainfall are conducive for propagation of pre-parasitic stages [6]. The prevalence of gastrointestinal infections in Cameroon greatly varies from region to region due to diversity in agro-climatic conditions. Some of the regions in Cameroon have their borders to the west of the Atlantic Ocean which makes them marshy and swampy, thus suitable for survival of most of these parasites [7].

In Cameroon, ruminants are reared or managed in traditional systems. Cattle, sheep and goat rearing systems are: pastoral and mixed farming systems [8]. Production and management systems vary from free range in less populated areas, to year-round confinement and cut-and-carry feeding in densely populated areas [9]. Ruminants under extensive systems rely on natural grazing. Because of shortage of water, malnutrition is often the major limiting factor for profitable production of ruminants particularly during the dry season. Grazers of the Fulani tribe in the North West Region of Cameroon seek refuge during the dry season in valleys. Animals suffer from stressful and disease effects especially during the periods of transhumance. In most cases, the animals are reared in large herds, concentrated in confined areas or tethered on pegs where they are likely to pick up infective larvae or oocysts from contaminated pastures [3]. These poor management systems have contributed immensely to economic losses in ruminant production in sub-Saharan countries of the world and Cameroon in particular and as a result, most livestock farmers do not pay keen attention to parasites that may likely cause death of their animals [2]. Accordingly, the enormous economic losses induced by gastrointestinal parasites in sheep and goats in this part of the country necessitate detailed investigation on their prevalence in order to organize efforts to at least minimize these losses.

The control of gastrointestinal parasites in sheep and goats is difficult due to drug resistance and lack of other effective control methods [10]. The rapid development of resistance to commonly used drugs against these infections, associated with high cost, have given new interest in the introduction of medicinal plants as an alternative source of anthelmintic drugs. Therefore, there is urgent need for alternate methods of control to reduce worm burden in these ruminants, which should be less toxic, cheaper safe and available. The distribution of gastrointestinal parasites also varies and depend on temperature, rainfall, types of vegetation, age, sex and species of animals. Therefore, in order to formulate an effective control strategy against these diseases, it is necessary to obtain epidemiological data of the parasite in a particular area.

Based on these findings and reports from a significant number of scientific publications demonstrating a high prevalence and intensity of these gastrointestinal parasites and their effects on the health status of sheep and goats [11]; we decided to conduct this research in order to find out if the health status of ruminants in these Divisions is affected by the above parasites.

2. MATERIALS AND METHODS

2.1 Area of Study

The study was conducted in Bui and Donga-Mantung Divisions with Kumbo and Nkambe as headquarters respectively in the North West Region of Cameroon. The climate of this region is characterized by a long rainy season ranging from Mid-March to October, while annual average rainfall ranges from 1,500 to 2,000mm and an altitude of about 1,100m above sea level [12]. The dry season stretches from November to Mid-March, with monthly average temperatures in June reaching a maximum of about 21°C. These two Divisions are typical mountainous areas covered with grassy hills and valleys which constitute the major natural resource that the ruminant population (of livestock) depends on. The main form of agriculture practiced here is mixed crop/livestock production system. Most families are also involved in livestock farming, especially rearing sheep and goats. Flock sizes under the tethering system in these Divisions are in the order of 1 to 10 goats or sheep per household. Also, livestock farmers with large animal sizes like cattle are mostly owned by the Fulani tribes and they form separate communities in the upland grazing zones of Kumbo and Nkambe.

2.2 Selection of Study sites and Farms

The study sites (Fig. 1) below were selected on the basis of having a higher concentration of livestock. The sites included the following twelve villages: Tobin, Kikaikom, Mbah, Nkar, Shukai, Oku, Jakiri, Shisong, Ndu, Nkambe centre, Tabiken and Bom.

2.3 Criteria for Choosing Study Subjects

A total of 704 animals consisting of 342 males and 362 females were examined for

gastrointestinal parasites. Of this, 383 were goats and 321 sheep. Also, 463 of these animals were adult ruminants while 241 were kids/lambs. For animals to be qualified as subjects, the sheep and goats must have been living in the study area and or its environs for the past three months. Samples were collected from ruminants of both sexes. Ages of the animals were determined from interviews with the farmers. Animals with ages ranging from 0-11 months were classified as young stock (lambs for sheep, kids for goats) while those from 12 months and above were categorized as adults. A larger number of goats were sampled because of their predominance in the area. Animals were sampled from 8 villages in the Bui Division and 4 villages in the Donga Mantung Division. Examination of animals was done by close inspection after proper restraining and by taking faecal samples to the laboratory for further processing.

2.4 Study Design

A preliminary survey was carried out prior to sample collection to sensitize interested farmers on the objectives of the study. Questionnaires were administered to farmers whose animals were selected for examination. It included information on the age/sex/breed of the animal, farm management practices and health conditions of the animals.

2.5 Collection of Faecal Samples

During sample collection, biodata of the sheep and goats such as their age, sex, village and type of husbandry management system were recorded and labels put on the plastic containers. A total of seven hundred and four (704) faecal samples from sheep (321) and goats (383) in twelve villages of the two divisions was collected and submitted to the Laboratory during the study period for analysis and examination of eggs (helminth) and oocysts (protozoan) of gastrointestinal parasites.

2.6 Faecal Analysis

About 15 faecal pellets of the samples were taken directly from the rectum of the animal using gloves and placed in sealable plastic containers. The samples were kept in a transported in a cooler to the Laboratory of National Centre for Animal Husbandry and Veterinary Training School in Jakiri (Bui Division), and stored in a refrigerator until analysis. All along, samples were kept cool until analysis, in order to prevent larvae from hatching.

Fig. 1. Map of North West Region showing a flowchart of the study areas

2.7 Procedure and Microscopic Examination of Faecal Samples

Two grams of faeces were weighed and placed in one mortar and crushed with a pestle. 60 ml of saturated sodium chloride solution was measured and a small amount of this volume (about 5ml) was added and the faeces allowed to soak for one minute after which, the faeces were well crushed. The saturated sodium chloride solution works to dissolve the faeces and allows ova to go into solution [13]. Once the faeces were well broken up, the remaining sodium chloride (about 55ml) was added to bring the total volume to 60ml and stirred. The faecal suspension/pellets were filtered through a tea strainer into another mortar. The faecal pellets were pulverized in the tea strainer using a stirring device. Straining and pulverizing were repeated until only undigested herbage was left in the tea strainer. The suspension was mixed by decanting it from one mortar into the other repeatedly. Immediately after mixing thoroughly, a sub-sample was taken with a Pasteur pipette to fill the McMaster counting chambers.

The charged McMaster counting chambers were allowed to stand for about 10-15 minutes to allow any eggs to float to the top. Actual egg counting was done using the 10X objective (total magnification was 100X, because eyepiece has 10X magnification). Reading of the slides is systematic, starting in the far left chamber at the lower corner of grid and counting the number of eggs in each of the six areas on each side of the slide by following a serpentine pattern (scan up the first column, then move over to the second column, scan down the second column, then move over to the third column, scan up the third column, and so on [14]. The numbers of eggs are counted on both counting chambers on the slide, within 60minutes to prevent drying or crystal formation of sample in the chamber. The presence of an egg was easily indicated with the use of an egg counter.

Sedimentation of faecal examination was also performed to look for the presence of eggs of Trichuris and other helminth eggs. For this, after strongyle egg per gram, the supernatant fluid was discarded and the whole sediment was transferred on a clean glass slide and then examined for the presence of parasite eggs and number of eggs was also recorded.

The number of eggs per gram of faeces was determined as follows:

The egg counts (X_1, X_2) from both chambers of the McMaster's slide were summed (for each type of egg counted) and the total (N) multiplied by a factor of 200.

$$EPG = \frac{EPG1+EPG2}{2} \times 200$$

2.8 Faecal Egg Quality (FEQ)

When no eggs were found within the engraved area of the McMaster counting chamber, flotation method was performed using the same faecal sample preparation (suspension) to determine the presence of low egg counts. A sub sample was used to fill a test tube to the brim. A cover slip was placed onto the surface of the suspension in the test tube and allowed to stand for about 10 minutes. Due to specific gravity, the eggs floated to the under sides of the cover slip. Using a pair of thumb forceps, the cover slip was removed from the test tube and mounted onto a clean glass slide. The sample was then examined thoroughly under a microscope at 100 magnification for the presence of nematode eggs or oocysts, on the basis of morphology and egg size [15].

2.9 Identification of Gastrointestinal Parasite Eggs/Oocysts

The identification of gastrointestinal parasite eggs and oocysts was done following the method previously described by [16]. A microscopic examination of stool samples was carried out in the laboratory to look for different parasites affecting the digestive tract of the ruminants. Eggs of the parasites were identified based on their morphology such as diameter or size, form, nature of the cover or membrane, colour, [17,18].

2.10 Statistical Analysis

Data were stored in a Microsoft Excel spread sheet cleaned by checking for errors or missing variables and then exported to SPSS (Statistical Package for Social Science, Version 20) Software for analysis. Summary statistics were generated using the same software. For the purpose of modeling these data, explanatory variables were first explored for associations between parasites using Chi-square ($\chi 2$) test. The prevalence of helminth parasites was compared between demographic parameters using the chi square test. The Chi square test was equally used to examine the effects of the various risk factors. The non-parametric test of Kruskal Wallis was used to compare mean

intensity between age group and locality, intensity with animal gender, breeding system and state of health. Before comparison of intensity of infection (EPG), non-infected hosts were discarded. Egg per gram of each parasite was used as variable and breeding system, gender, state of health of animal, age group and locality as factors. They were all tested at 95% significance level.

3. RESULTS

3.1 Overall Prevalence of Gastrointestinal Parasites in Sheep and Goats in the Study Area

A total of 704 stool samples were collected from the animals in Bui and Donga-Mantung Divisions. Out of this number, 630 ruminants were infected with at least one or more gastrointestinal parasites, giving an overall prevalence of 89.5%. Sheep recorded the highest prevalence (90.0%) compared to goats (89.0%) and no significant difference (P> 0.05) existed between prevalence of gastrointestinal parasites in these ruminants (Fig. 2).

3.2 Prevalence and Intensity of Gastrointestinal Parasites in Sheep and Goats

Ten gastrointestinal parasites were identified from faecal samples (8 nematodes, a trematode and a protozoan). The most prevalent parasites were; *Haemonchus spp* (36.7%), *Trichostrongylus spp* (24.9%), *Strongyloides spp* (19.4%), *Oesophagostomum spp* (21.7%) and *Eimeria spp* (21.2%) with no significant difference for both sheep and goats. The prevalence of nematodes was highest in goats with *Haemonchus spp* being the most prevalent (18.0%) while the lowest prevalence was observed in sheep with *Trichuris spp*. being the least prevalent (2.4%) with no significant difference (P>0.05). The prevalence of trematode (*Fasciola spp*) was 7.0% in goats and 6.2% in sheep while *Eimeria spp* were more prevalent in sheep (13.4%) than in goats (7.8%).Concerning intensity of infection of these parasite, faecal egg counts revealed overall low mean egg per gram of faeces (Table 1).

3.3 Prevalence of Mixed Infections in Sheep and Goats

The animals had mix infections, with most of the combinations being *Haemonchus spp./Eimeria spp.* The highest prevalence of *Haemonchus spp./Eimeria spp.* was observed in sheep while the lowest prevalence of *Trichostrongylus spp/Strongyloides spp/Eimeria spp was* 1.5% still in sheep (Table 2).

3.4 Age Related Prevalence of Gastrointestinal Parasites In sheep and Goats in the Study Area

A total of 463 adult ruminants and 241 young kids/ lambs were examined during the study. Out of these, 425 adults (198 sheep and 227 goats) were infected with prevalence of 94.3% in sheep and 89.7% in goats with a general overall prevalence of 91.8% while 205 young (91 sheep and 114 goats) were infected with prevalence of 82.0% in sheep and 87.7% in goats with a general overall prevalence of 85.1%. However, the Chi square value revealed no significant differences between prevalence and the different age groups (P>0.05) (Fig. 3).

3.5 Sex Related Prevalence of Gastrointestinal Parasites in Sheep and Goats in the Study Area

A total of 321 sheep (168 females and 153 males) and 383 goats (194 females and 189 males) were examined during the study. Out of these, 315 females (164 sheep and 169 goats) and 315 males (143 sheep and 172 goats) were infected with a general prevalence of 87.0% % in females and 92.1% in males. However, the overall prevalence of gastrointestinal parasites in the different sexes generally showed that, sheep were the most infected (90.0%) than goats (89.0%) with no significant difference statistically (P>0.05) (Table 3).

3.6 Prevalence of Gastrointestinal Parasites in Sheep and Goats Raised Under Traditional Management Systems

The present study also revealed details on the prevalence of gastrointestinal parasites in animals kept under different traditional management systems. It was generally observed that, animals confined in paddocks showed lower overall prevalence (76.8%) compared to free range grazers (95.5%) and tethered animals (84.5%). Confined animals in paddocks had prevalence rates of 97.7% and 51.8% for sheep and goats respectively, with sheep recording the highest prevalence (Table 4). Tethered animals had highest infection of 100% and 90.8% for both sheep and goats respectively, with all tethered

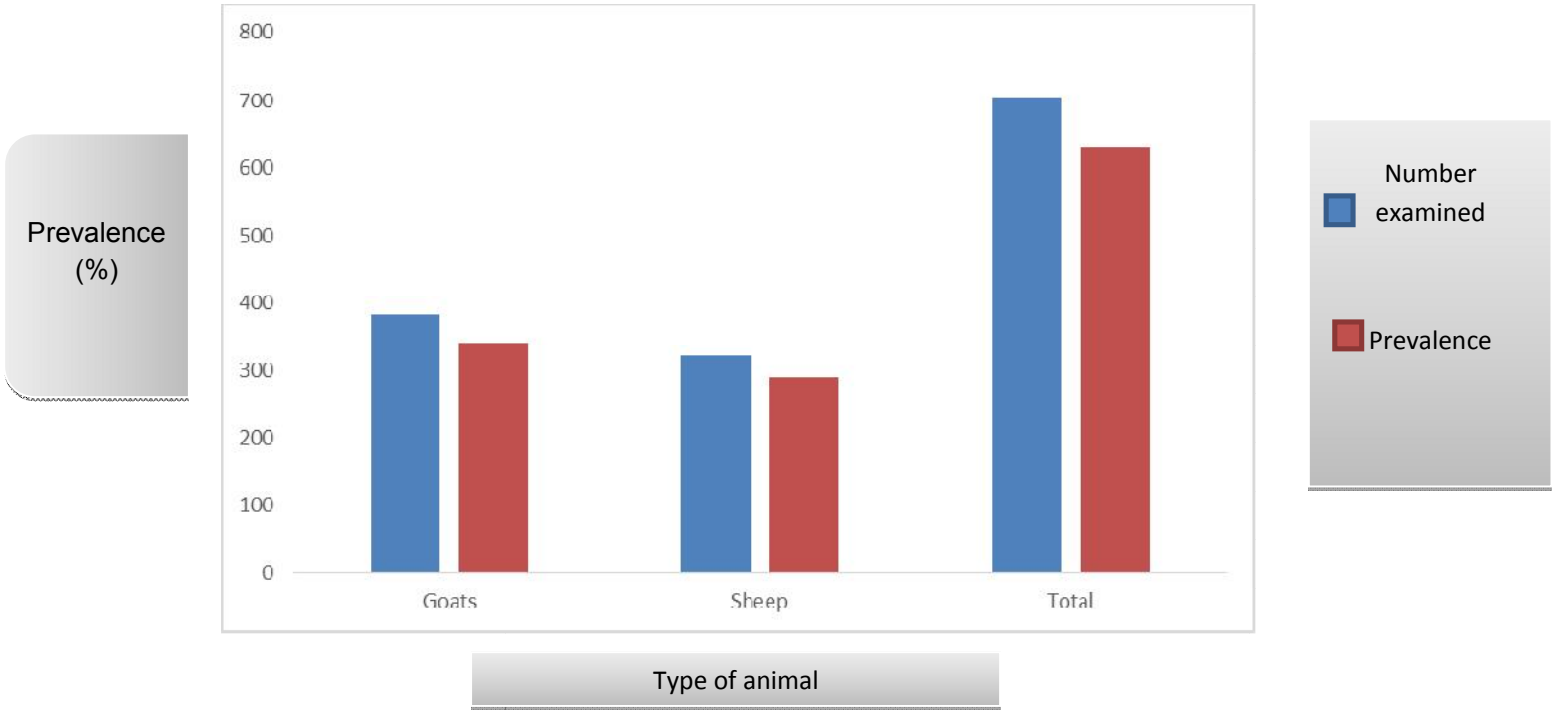
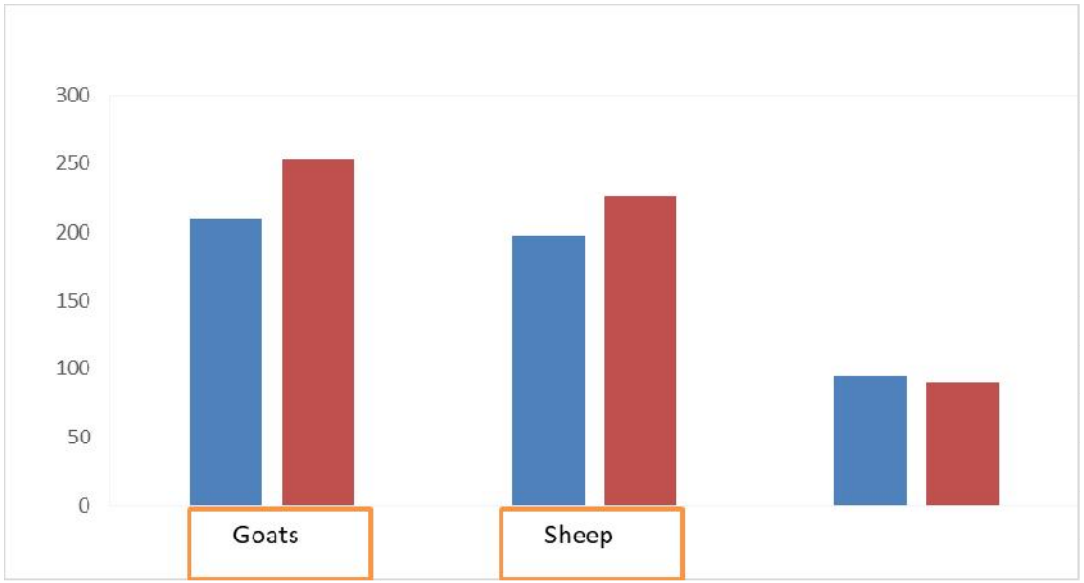


Fig. 2. Overall prevalence of gastrointestinal parasites in sheep and goats in the study area

Table 1. Prevalence and Intensity of gastrointestinal parasites in sheep and goats

Parasite species	Goat (N=383)		Sheep (N=321)	
	No Infected (%)	Intensity	No Infected (%)	Intensity
Nematodes				
Haemonchus spp	69(18.0%)	694.4 ±1904.2	60(18.7%)	189.5±137.3
Trichostrongylus spp	43(11.2%)	355.2 ±1252.6	44(13.7%)	87.6±416.4
Oesophagostomum spp	39(10.2%)	13.7 ±51.7	37(11.5%)	5.5±31.3
Strongyloides spp	40(10.4%)	364.8 ±862	29(9.0%)	76.6±418.8
Toxocara spp	24(6.3%)	12.8±50.4	28(8.7%)	4.3±20.1
Nematodorus spp	20(5.2%)	3.8±12.6	22(6.8%)	1.4±8.1
Teladorsagia spp	16(4.2%)	2.7±14.58	19(6.0%)	6.1±11.03
Trichuris spp	12 (3.1%)	15.8±32.7	8(2.4%)	8.7±23.1
Trematodes				
Fasciola spp	27(7.0%)	4.3 50.7	20 (6.2%)	2.7 ±27.0
Protozoa				
Eimeria spp	30 (7.8%)	65.6±231.4	43(13.4%)	47.2±9.0

N=number of animals examined


300
250
200
150
100
50
0
Goats
Sheep
Adults examined
Prevalence

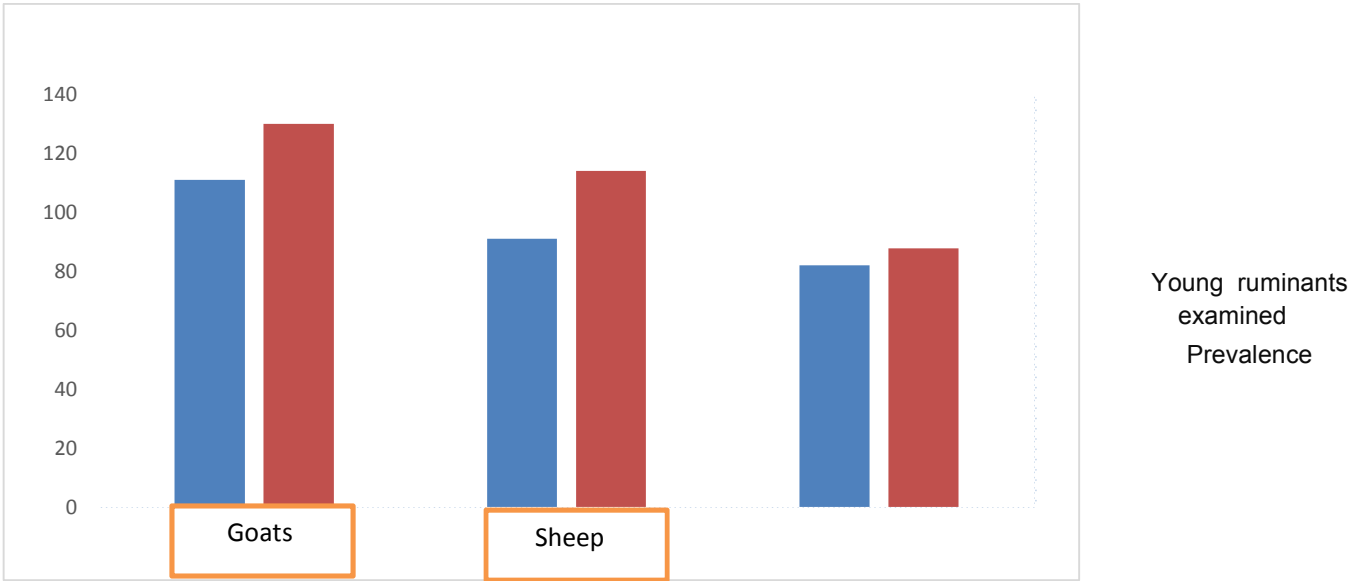


Fig. 3. Age related prevalence of gastrointestinal parasites in sheep and goats

Table 2. Prevalence of mixed infections in sheep and goats in the study area

Mixed Infections	Goats (N=383)	Sheep (N=321)
	No Infected (%)	No Infected (%)
Trichostrongylus spp/Haemonchus spp	18 (4.7%)	47(14.6%)
Trichostrongylus spp/Strongyloides spp	13(3.4%)	28(8.7%)
Trichostrongylus spp/ Haemonchus spp/Eimera spp	21 (5.5%)	14(4.4%)
Trichostrongylus spp/Strongyloides spp/Eimeria spp	8(2.1%)	5(1.5%)
Haemonchus spp/Eimeria spp	26 (6.8%)	64(19.9%)
Trichostrongylus spp/Eimeria spp	12 (3.1%)	27(8.4%)
Strongyloides spp/Eimeria spp	19(5.0%)	32(9.96%)

Table 3. Sex related prevalence of gastrointestinal parasites in sheep and goats

Sex	Ruminant	No Examined	No Infected	Prevalence (%)	P value
Females	Sheep	168	146	86.9%	-- --
	Goats	194	169	87.1%	
	Total	362	315	87.0%	>0.05
Males	Sheep	153	143	93.5%	
	Goats	189	172	91.0%	
	Total	342	315	92.1%	>0.05

Table 4. Prevalence of gastrointestinal parasites in ruminants confined in paddocks

Ruminants	No. Examined	No. Infected	Prevalence (%)	P value
Sheep	88	86	97.7%	
Goats	72	37	51.4%	<0.05
Total	160	123	76.8%	

Table 5. Prevalence of gastrointestinal parasites in tethered ruminants

Ruminants	No. Examined	No. Infected	Prevalence (%)	P value
Sheep	269	269	100%	
Goats	263	239	90.8%	>0.05
Total	532	508	95.5%	

Table 6. Prevalence of gastrointestinal parasites in free range grazing ruminants

Ruminants	No. Examined	No. Infected	Prevalence (%)	P value
Sheep	36	35	97.2%	
Goats	48	36	75.0%	<0.05
Total	84	71	84.5%	

sheep infected (Table 5). Free range grazers had prevalence rates of 97.2% and 75.0% for sheep and goats respectively with sheep still recording the highest prevalence (Table 6). A significant difference (P<0.05) in prevalence was observed in both sheep and goats reared under these different grazing systems.

4. DISCUSSION

This study was aimed at determining the prevalence and intensity of infection of sheep and goats grazed under different management systems. Ten gastrointestinal nematode species *(Haemonchus spp, Oesophagostomum spp, Teladorsagia spp, Strongiloides spp, Nematodrus spp, Trichostrongylus spp, toxocara spp, Fasciola spp, Trichuris spp and Eimeria spp*) were identified.

This study revealed an overall prevalence of gastrointestinal parasites to be 89.5% with 90.0% and 89.0% in sheep and goats, respectively. The higher prevalence in sheep and goats in the study area might be due to poor management systems, no knowledge on medication by some

farmers and climatic situation of the area [19]. In the North West Region of Cameroon, especially in the Bui and Donga Mantung Divisions where this study was conducted, mixed crop livestock farming dominates where few numbers of small ruminants are kept together. Majority of the animals are tethered on farm lands. As a result, most of the animals become more infected due to pasture contamination as they graze within a confined region for several months. These results with a high prevalence corroborate with the findings of in Ethiopia and in Nigeria [20,21] who equally recorded a higher prevalence of these parasites. The high prevalence of gastrointestinal parasites in small ruminants as a whole agrees with most reports [22].

The higher prevalence of gastrointestinal parasites in sheep compared to goats is because the grazing habits of sheep (grazing closer to the earth soil) warrant these animal species to be more infected than goats [3]. However; in the present study, the difference in prevalence with the previous findings may be because of the fact that majority of goats are kept under poor veterinary infrastructure and medication. This may be due to slower development of immunity to gastroinestinal parasites in goats as compared to sheep [6].

Strongyles, Strongyloides eggs and Eimeria oocyst were the most prevalent gastrointestinal parasites. The presence of these parasites could be due to the climatic conditions of the study area which is highly suitable for survival and transmission of these strongyle nematodes. The high prevalence of strongyle nematodes could also be due to poor farm management techniques such as poor hygienic conditions of the farms, constructions, feeding and watering systems. These results corroborate many findings in Africa [1,2,3,22].

However, it is important to note that in many regions of Africa, endemic haemonchosis overlaps with other important parasitic causes of anaemia in small ruminants, notably fasciolosis and trypanosomosis. The prevalence of *Trichuris spp* and *Fasciola spp*. in the study area for the two animal groups was extremely low. Such low prevalence for *Fasciola spp*. may be due to vegetation cover of the two Divisions. The typical mountainous area covered with grass on the hills does not favor propagation of the snail intermediate hosts. It is probable that, the few ruminants infected with *Fasciola spp* might have had their infection during transhumance in the neighboring villages with valleys, a period during which there is scarcity of pasture and water in most mountainous villages in the study area [8].

Based on age, adult animals had a slightly higher prevalence of infection compared to young animals and was statistically not significant ($P>0.05$). The higher prevalence in adult animals compared to the low prevalence in young animals might have been due to the use of anthelmintic treatment of individual young animals by some herdsmen, which might have reduced the intensity of group mean egg counts for the young male and female groups before the study. These results contradict the findings of [23,24] whose results revealed that, lambs and kids were the most infected because they are more susceptible to infection than adults due to low levels of immunity. Better hygiene and separate grazing for different age groups would likely reduce eggs or oocysts shedding, the rate of infection, and the prevalence of gastrointestinal parasitic infection among sheep and goats of the study area. Although infection intensity was lower among the young than adults, the prevalence of gastrointestinal parasitic infections was higher among adults. This result suggested that adult sheep and goats could be an important factor in distributing gastrointestinal parasitic infections among the herds [25].

Sex related prevalence and intensity revealed that male animals were the most infected (93.5% in sheep and 91.0% in goats) compared to the female animals (87.0% in sheep and 86.9% in goats) though there was no significant difference. However, from this study, higher prevalence (100%) of parasitic infection was not also associated with sex ($P>0.05$). Though not statistically significant, single parasites actually recorded a higher prevalence of gastrointestinal parasitic infection in females than males. Only *Haemonchus spp* was significantly more prevalent in males. Out of the ten gastrointestinal parasites that were observed, nine of them *(Nematodorius spp*, *Oesophagostomum spp, Strongyloides spp, Teladorsagia spp, Toxocara spp, Trichostrongylus spp, Trichuris spp, Fasciola spp*. and *Eimeria spp*) were more prevalent in females than in males with a significant difference ($P<0.05$). This high rate of infection in females could be due to the fact that female ruminants appear to be more susceptible to infections than males. This finding is consistent with other reports, and it was not surprising because naive females frequently graze the same areas, hence resulting to high

infection rate and intensity. The intensity of infection however is reportedly related to the level of hygiene. This finding is contrary to the work of other authors who reported a low prevalence in females compared to males [26].

Although not statistically significant, tethered system animals actually showed a higher prevalence of individual gastrointestinal parasite infection than free range animals and animals kept in paddocks. The highest mean egg per gram value of (525.7± 607.9) was also shown in tethered animals though *Haemonchus spp* had the highest mean egg per gram value of (1540.2±1794.8) in free range sheep and goats. This high infection rate and intensity in tethered sheep and goats could be explained by the fact that tethering is a stress factor and again most people in the study area tether these animals in the same area throughout the tethering period with little rotation. Consequently, the grazing environment becomes contaminated with various gastrointestinal parasites eggs and oocysts which infect the sheep and goats [27]. Generally, the higher prevalence (100%) of parasitic infection in each systems was not associated with husbandry management of the animals (P>0.05). However, inadequate nutrition which is common in the study area, might have led to the course of high rates of gastrointestinal parasitic infections. The animals are generally malnourished and suffer from other diseases, and are thus not resistant to nematode infections [28].

5. CONCLUSION

This study was conducted to determine the prevalence and intensity of infection of gastrointestinal parasites associated with management systems in sheep and goats from 12 villages in the Bui and Donga Mantung Divisions. It is worth noting that from a total of 704 stool samples collected from these animals (383 goats and 321 sheep), 630 ruminants were infected with at least one or more gastrointestinal parasites, giving an overall prevalence of 89.5%. Sheep recorded the highest prevalence (90.0%) followed by goats (89.0%). There was no significant difference (P>0.05) in prevalence of gastrointestinal parasites in these ruminants in the study area. The Gastrointestinal parasites identified were nematodes, trematodes and protozoans with *Haemonchus spp*., *Trichostrongylus spp., Strongyloides spp., Oesophagustomum spp* and *Eimeria spp*. being the most prevalent parasites. From the results obtained, of the eight nematodes identified, goats recorded the highest prevalence with *Haemonchus spp* (18.0%) being the most prevalent while sheep showed the least prevalence (2.4%) in *Trichuris spp*. with no significant difference (P>0.05). The overall prevalence of gastrointestinal parasites among the different age groups showed that adults were the most infected (91.8%) while in the young, a prevalence of 85.5% was recorded with no significant difference among the different age groups (P>0.05). The overall prevalence of infection in the different sexes showed that male animals were the most infected (92.1%) while the female animals recorded a prevalence of 87.0% with no significant difference (P>0.05). The present study also revealed details on the prevalence of gastro intestinal tract parasites in animals kept under different traditional management systems. It was noted that, animals confined in paddocks recorded low infection rates of 76.8% compared to free range grazers (84.5%) and tethered animals (95.5%). A significant difference in prevalence was observed in both sheep and sheep and goats kept under the different grazing systems.

This study indicates that there is a high rate of infection of animals by helminth and protozoan parasites associated with management systems and therefore there is urgent need for control measures to be implemented. Tethered animals should not be allowed to graze on a particular farm continuously for several weeks or months. Grazing farms should be rotated in on order to reduce the chances of ruminants being re-infected from contaminated pastures. Age, sex and management systems were noted as risk factors of gastrointestinal parasite infection in the current study. The problem is still very serious and there are still animals suffering from gastrointestinal parasitism in parasite control campaign areas in the region, hence threatening the national economy, sheep and goat population and tanning industries as a whole. Lack of proper awareness creation and absence of control on animal movement and poor quarantine policy could have been the reason for high rates of infection due to limited control campaigns. This threat of gastrointestinal parasites on overall sheep/goat productivity and tanning industry in the North West Region of Cameroon as a whole warrants urgent strategic control intervention. Therefore, field veterinarians should assist sheep and goat farmers in strategic deworming campaigns with effective use of anthelmintics and introduction of medicinal plants

too. This should also be followed by periodic inspections unannounced to these farmers and other farmers if possible. Periodic seminars or workshops should be organized as a means of creating awareness in these farmers in order to fight against these infections in the animals.

CONSENT AND ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

AVAILABILITY OF DATA AND MATERIALS

Data and material are available to other researchers upon request.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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