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Coinfection prevalence of gastrointestinal parasites and ticks of small ruminants in Bui and Donga-Mantung Divisions, North West Region of Cameroon

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Abstract

Background: This study was conducted to determine the coinfection prevalence of gastrointestinal parasites and tick infestation of small ruminants in Bui and Donga-Mantung Divisions.

Methods: 704 animals were physically examined for tick infestation and stool samples collected for the detection of gastrointestinal parasites, of which 383 were goats and 321 sheep.

Results: Out of this number of animals examined, 378 were infected with one or more gastrointestinal parasite and ticks, giving an overall prevalence of 53.7% with the highest prevalence recorded in goats (P>0.05). The most common mixed infections recorded were *Haemonchus* sp/*Eimeria* sp/ticks, *strongyloides* sp/ *trichostrongylus* sp/ticks. Generally, the overall prevalence of these parasites and tick infestation among the different age groups showed that, adults had the highest overall prevalence (64.4%) while the young recorded the lowest prevalence (33.2%). It was however observed that females were the most infected (57.4%) compared to males (49.7%) (P>0.05). Locality based prevalence revealed that Bui Division was the most infected, with goats recording the highest prevalence (55.4%) while in Donga Mantung Division, the highest prevalence was recorded in sheep (50.4%) (P>0.05).

Conclusion: This study provides an important step to reduce animal infection and infestation and minimize economic losses in small ruminants. it also provides information that will help farmers of these areas to use strategic treatment methods and medicinal plants to reduce parasite infestations on the animals and also to practice the right traditional management techniques.

Keywords: Coinfection; Prevalence; Parasites; Ruminants; Bui; Donga-Mantung.

1. Introduction

Growing human population, rising affluence and urbanization are translating into increased demand for livestock production, particularly in developing countries. Livestock demand is projected to increase by 70% to feed a population estimated to reach 9.6 billion by 2050 [1]. Small ruminants such as goats and sheep represent an important source of proteins and revenue for the developing world with Cameroon not making and exception [2]. In Cameroon, the number of small ruminants is estimated at 5.3 million and accounts for 18% of domestic meat production in the North West Region and these animals are reared by subsistence farmers in the rural areas on natural grass pastures [3]. Due to the extensive use of the land for crop farming purposes, there is limitation on the land available for grazing. This leads to overgrazing of the available land which predisposes the small ruminants to a very high risk of infection. Also, there are farmer-grazer problems in this region which usually results when the small ruminants enter and occupy crop farms

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resulting in a further restriction of the animals to a very limited area [4]. Majority of these animals spend their nights confined in paddocks in very small areas which increase the chances of spreading diseases amongst them and between animals and man in the case of zoonosis. In tropical areas, the major constraints to indigenous livestock production are the interactions of high disease incidence and low nutritional levels. In Cameroon, the constraints of small ruminants include: parasites and diseases, malnutrition, lack of improved breeding stock for redistribution to farmers, poor education on management strategies, inadequate market facilities and lack of interest to invest in this domain due to low productivity [5]. Some common gastrointestinal parasites of small ruminants include helminth infections mostly caused by *Haemonchus contortus,* Trichostrongylus spp*.,* Fasciola spp*.* and protozoan diseases including coccidiosis [6]. High prevalence of parasitic infections have been commonly reported in tropical and sub-tropical regions where environmental factors like temperature, humidity and rainfall are conducive for propagation of pre-parasitic stages [7]. Apart from gastrointestinal infections affecting small ruminants, ticks also transmit a great variety of pathogenic microorganisms that cause disease in both humans and livestock [8]. Globally, ticks are first among vectors of diseases affecting livestock [9] and in Cameroon, the case is not different. Their direct effects on the hosts include anemia and excessive grooming, stress, toxicosis and immunosuppression, which often lead to diminished productivity [10]. Data on the economic impact of ticks and tick-borne diseases are scarce in Cameroon but it has been estimated that, globally, about 20–30 billion US dollars are lost annually due to tick-borne diseases [11]. In a study conducted in Cameroon, approximately 63% of animal mortality in the Wakwa research station situated in the principal cattle rearing region was attributed to tick-borne diseases [12]. This situation has seriously constrained attempts to rear high performing exotic dairy small ruminant breeds which are highly susceptible to tick-borne diseases including babesiosis, ehrlichiosis and dermatophilosis [13]. However, increased demand for animal food products in Cameroon due to rapid population growth has accelerated trans-boundary livestock movements for trade across the region. Consequently, there is an increased risk of animal disease transmission [14, 15]. Since there is little information in Cameroon on small ruminant health production, the impact of parasitic infections and co-infection of internal and ectoparasites, and the indigenous remedies for their control, this study is therefore necessary.

Current knowledge of gastrointestinal parasites and tick infestation is important to reduce their impact on livestock health and production. It is important to clarify the knowledge of the biology of these parasites and their influence on the health of the animals [16]. Ineffective methods of control remain the cause of low productivity in most local farms. According to the information obtained from the farmers, only a small proportion of farmers occasionally use anthelmintics against these parasites. Also, proper control strategies may be insufficient, firstly because of resistance to anthelmintics and multiple hosts which have helped to maintain the parasite population to steady levels [17]. The ecological impact of effective anthelmintics is insufficient in these areas and so, knowledge on anthelmintics to fight these parasites in small ruminants has to be improved [18]. Most of the studies conducted on the prevalence of gastrointestinal parasites and ticks in the country tend to be concentrated in the Far North and Adamawa Regions and very little information is known about the prevalence and intensity of these parasites infecting small ruminants in the North West Region. Therefore there is urgent need for alternative methods of control to reduce worm and tick burden, which should be less toxic, cheaper, safe, available and eco-friendly and hence obtaining epidemiological data of these parasites in these regions was necessary.

2. Materials and methods

2.1. Area of study

The study was conducted in two divisions, 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 from Mid-March to October, with annual average rainfall ranging from 1,500 to 2,000mm and an altitude of about 1,100m above sea level [19]. Bui Division has a total population of 322.877 inhabitants, located between latitude 6.2542^0N and longitude 10.7549^0E with 2.297km^2 while Donga-Mantung has a total population of 337.533 inhabitants located between latitude 6.400^0N and longitude 10.496^0E with 4.279km^2. The dry season stretches from November to Mid-March, with monthly average temperatures in June reaching a maximum of about 21°C. The rainy season and the beginning of the dry season correspond to the period of activity of adults and nymphs of many gastrointestinal parasites and tick species previously identified in Cameroon. These species, found in Cameroon play an essential role in the transmission of many blood and stool infections [20]. Reason for the choice of the period of the rainy season and the beginning of the dry season to conduct this study.

2.2. Selection of study sites and farms

The study sites (Figure 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, Bom, Shisong, Ndu, Nkambe centre and Tabiken.

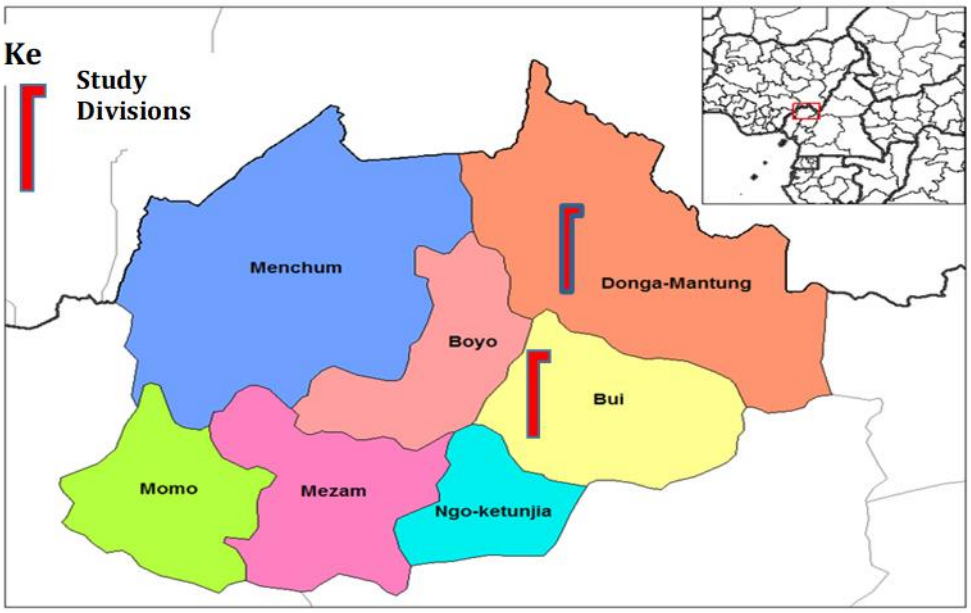

Figure 1 Map of the North West Region showing the location of Bui and Donga Mantung Divisions

2.3. Criteria for choosing study subjects

A total of 704 animals consisting of 342 males and 362 females were examined for the presence of ticks and stool samples collected for the presence of gastrointestinal parasites. Of this number, 383 were goats and 321 sheep (463 adults and 241 kids/lambs). For animals to be qualified as subjects, the small ruminants must have lived in the study area and or its environs for the past three months. The ages of the animals were determined from interviews with the farmers and using the dental formula below. Animal ages ranging from 0-11months were classified as young stock (lambs for sheep, kids for goats) while those from 12months and above were categorized as adults. A larger number of sheep and goats were sampled because of their predominance in the area. Sample size was determined using the equation on parameters of study. The expected prevalence was estimated at 80% in the study area. The physical examination of animals was done by close inspection and collection of ticks stool samples after proper restraining.

2.4. Study design

An investigation was carried out before sample collection to sensitize interested farmers on the objectives of the study. Questionnaires were administered to some of the farmers whose animals were to be examined. The questionnaires included information on the age/sex/breed of the animal, farm management practices and health status of the animals.

2.4.1. Collection of stool samples and identification of ticks

A cross sectional study was conducted in animals present in twelve villages in Bui and Donga Mantung Divisions. Animals were selected and examined for the presence of gastrointestinal parasites and ticks. Prior to examination, each animal selected was categorized based on its sex, age and species. The age of animals was determined using the following Dental formula on parameters of study. When lambs and kids were less than 1 year of age, they were considered as young and animals from 1 year and above were included in the adult age group. A good number of gastrointestinal parasites and tick species encountered were identified based on their morphology, color, size.

Both stool samples and ticks were collected from 704 sheep and goats in the two Divisions. Before tick collection, the animals were restrained and kept standing and half of the body of the animal was examined. Only visible adult ticks were collected. All visible ticks were collected by hand-picking, where the base of the rostrum (capitulum) was targeted and by rotating while pulling gently, so as not to lose the clips of the tick in the skin of the animal. They were then

transferred to a tube containing 70% ethanol, immediately labeled with information about the host (age, sex, ID number and Division). The morphological identification of tick species was made using a stereo-microscope with a magnification of up to 100× following published work on taxonomy [21, 22]. The parasite load per animal (intensity) was obtained by multiplying the number of ticks counted by two. For gastrointestinal parasite determination, about 15 warm, moist, soft faecal pellets were taken directly from the rectum of the animal with the finger using gloves and placed in sealable plastic containers. Few minutes after collection, the samples were placed in a cooler and then transported to the Laboratory of the National Centre for Animal Husbandry and Veterinary Training School Jakiri, Kumbo, Bui Division, and stored in a refrigerator for analysis. The sedimentation technique was used to detect presence of helminth eggs and coccidian oocysts. The eggs per gram (EPG) of faeces were quantitatively analyzed to determine intensity of infection using the McMaster technique [23].

2.5. Parameters of study

2.5.1. Prevalence (P)

The prevalence of was calculated generally and for each parasite using the formula:

$$\textbf{Prevalence of infestation } (\mathbf{P}) = \frac{\text{Number of infested animals}}{\text{otal number of animals examined}} \times \mathbf{100}$$

Abundance = Number of parasites/ total number of animals.

2.5.2. Determination of Sample size

$$\mathbf{n=1.96^2\ pq/L^2}$$

Where; n = sample size, **p** = expected prevalence, **q = 1– p**

L = limits of error on the prevalence (absolute precision at 95% confidence interval).

The expected prevalence was estimated at 80% in the study area [24].

2.5.3. Determination of age of the animals

The age of animals was determined using the following Dental formula:

2(I 0/4; P 3/3; M 3/3)=20

Where; I=Incisors, P= Premolars and M=Molars

The first number = sets of teeth in the upper jaw;

The second number = sets of teeth are in the lower jaw [25].

2.6. Statistical analysis

Data was stored in a Microsoft Excel spread, cleaned by checking for errors or missing variables and then exported to SPSS (Statistical Package for Social Science, Version 20) Software for analysis. The effects of the type of parasite infection were evaluated using one way ANOVA (Analysis of variance), followed by the Student t- test, for means separation when a significant difference existed. The prevalence of gastrointestinal parasites and ticks was compared between demographic parameters using the Chi square test. 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 (χ2) test. The Chi-square test was also used to examine the effects of the various risk factors. The non-parametric test of Kruskal Wallis was used to compare prevalence between age group and locality, prevalence with animal gender, management systems and state of health. The Chi-square test (X2) was equally used to analyze data collected and differences were considered as significant when p-value was less than 0.05.

2.7. Ethical approval and consents to participate

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.

3. Results

3.1. Overall co-infection prevalence of gastrointestinal parasites/tick infestation

Out of the 704 small ruminants examined during the study, 378 ruminants were infected with one or more gastrointestinal parasite and tick infestation, giving an overall prevalence of 53.7% with goats recording the highest prevalence (56.1%) (Table 1) with no significant difference (P>0.05). The most common mixed infections found in the ruminants were *Haemonchus species/ Eimeria species/ticks, strongyloides species/ trichostrongylus species/*ticks.

Table 1 Coinfection prevalence of gastrointestinal parasites and tick infestation

Small Ruminant	No Ex.	No Infect. (%)	P Value
Goats	383	215 (56.1)	0.078
Sheep	321	163 (50.7)	
Total	704	378 (53.7)	

No Ex.=number examined, No Infect. =number infected, P-value=probability

3.2. Age related coinfection prevalence of gastrointestinal parasites and tick infestation

A total of 463 adult ruminants and 241 young kids/lambs were examined during the study. Out of these lots, adult goats recorded the highest prevalence of gastrointestinal and tick-borne parasites (73.1%), followed by the adult sheep (53.8%), and the least prevalence was observed in young goats (kids) (23.1%). However, the overall prevalence of gastrointestinal parasites and tick infestation among the different age groups generally showed that, the adult sheep and goats had the highest overall prevalence (64.4%) while the young goats (kids) and young sheep (lambs) recorded the lowest prevalence (33.2%) (Table 2). However, no significant difference was observed among the different age groups (P>0.05).

Table 2 Age related co-infection prevalence of gastrointestinal parasites and tick infestation

Age	Ruminant	No Ex.	No Infect. (%)	P value
Adults	Sheep	210	11 (353.8)	
	Goats	253	185 (73.1)	
	Total	463	298 (64.4)	0.65
Young	Sheep	111	50 (45.0)	
	Goats	130	30 (23.1)	
	Total	241	80 (33.2)	0.55

No Ex. =number examined, No Infect. =number infected, P-value=probability

3.3. Sex related coinfection prevalence of gastrointestinal parasites and tick infestation

Out of 362 females (168 sheep and 194 goats) and 342 males (153 sheep and 189 goats) examined, female goats recorded the highest prevalence of gastrointestinal parasites and tick infestation (60.8%), followed by the female sheep (53.6%), and then male goats (51.3%) while the least prevalence was observed in male sheep (47.7%). However, it was generally observed that, females were the most infected (57.4%) while males recorded a prevalence of 49.7% (Table 3). No significant difference was observed among the different sexes (P > 0.05).

Table 3 Sex related coinfection prevalence of gastrointestinal parasites and tick infestation

Sex	Small Ruminant	No Ex.	No Infect. (%)	P value
Females	Sheep	168	90 (53.6)	0.71
	Goats	194	118 (60.8)	
	Total	362	208 (57.4)	
Males	Sheep	153	73 (47.7)	0.59
	Goats	189	97 (51.3)	
	Total	342	170 (49.7)	

No Ex. =number examined, No Infect. =number infected, P-value=probability

3.4. Co-infection prevalence of gastrointestinal parasites and tick infestation based on locality

Locality based prevalence revealed a prevalence of 55.4% in Bui Division (the most infected division) with goats having the highest prevalence, and 50.4% in Donga Mantung Division, with sheep having the highest prevalence (Table 4). There was no significant difference between prevalence and locality (P>0.05).

Table 4 Locality based coinfection prevalence of gastrointestinal parasites and tick infestation

Locality	Small Ruminant	No Ex.	No Infect. (%)	P Value
BUI	Sheep	224	109 (48.7)	0.04
	Goats	234	145 (62.0)	
	Total	458	254 (55.4)	
DONGA MANTUNG	Sheep	97	54 (55.7)	0.86
	Goats	149	70 (47.0)	
	Total	246	124 (50.4)	

No Ex. =number examined, No Infect. =number infected, P-value=probability

Table 5 Factors associated with the overall prevalence of both gastrointestinal parasites and tick infestation

Factors (Responses)	(N)	(n)	Prevalence (%)	X^2	P-value
Divisions					
Bui	458	416	90.8	8.145	0.89
Donga Mantung	246	214	86.9		
Rearing system					
Tethered	505	484	87.8	1.127	0.27
Free ranged	79	71	59.1		
Sex of animal					
Females	362	315	87.0	0.109	0.94
Males	342	315	92.1		
Age (Month)					
Young	241	105	55.1	0.18	0.89
Adults	463	250	41.8		

anthelmintics acaricides use					
No	500	250	75	0.23	0.074
Yes	274	200	73		
Those who give vaccines No	650	100	22.3	19.5	0.052
Yes	154	30	3.48		

N=number examined, n=number infected, $X^{2=}$ Chi square, P-value=probability

From table 5 above, there was generally no significant difference between the associated risk factors and prevalence (P>0.05).

4. Discussion

For co-infection of these parasites, it was found that 378 out of the 704 animals examined recorded an overall prevalence of 53.7% for gastrointestinal parasites/tick infestation. These results indicate a high level of infection and this high infection rate may partly explain the low productivity of small ruminants in the study area. This phenomenon of a high co-infection prevalence is not new in tropical countries like Cameroon. Similarly, high levels of co-infection for example, 83.1%, 88.9% and even 100% have been reported in some tropical countries like Rwanda, India and Pakistan, respectively [7, 26]. In the present study, sheep and goats (small ruminants) were raised under an extensive management system mostly in low-lying pastures where stocking densities were high, with limited nutrition, and veterinary care was almost non-existent in most villages. A positive correlation between co-infection and land elevation was also demonstrated by [26]. These factors promote the exposure of livestock to infective form of pastures and ectoparasites leading to the establishment of infections in small ruminants [27].

A slightly higher proportion of these infections in goats (56.1%) than in sheep (50.7%) indicate that goats are more susceptible to these these parasites than sheep. This observation is not consistent with the findings in Ethiopia which instead showed higher infections in sheep than in goats [28]. However, [29] reported a higher co-infection prevalence of gastrointestinal parasites/tick infestation in goats (71.3%) than sheep (67.57%) which corroborates with the results of this study. Studies in Uganda have reported the prevalence of goats shedding nematode eggs and harboring ticks at 53.7% [6], which is close to the prevalence reported in this study. This may be explained by the differences in management practices such as stocking density and eco-climatic factors. Hot humid areas that receive high rainfall are ideal for reproduction of nematode parasites, contamination of pastures, and survival of infective larvae and ticks. Higher stocking densities promote pasture contamination and within-flock transmission of nematode infections/ectoparasites. The results of this study contradicted the findings of [30] in Bangladesh who reported a higher co-infection prevalence of gastrointestinal parasites/tick infestation in goats (35.56%) than in sheep (20%).

Young animals are generally considered to be more susceptible to co-infection of gastrointestinal parasites/tick infestation than adults due to immature active immunity and lack of adaptation in the young [7]. On the other end, immunity also wanes with age. In this study, the differences in these infections between adult and young small ruminants were statistically significant. The high prevalence recorded in adults (64.4%) than in the young (33.2%) might have been due to the fact that most farmers prefer to send out the adult animals during grazing instead of the younger ones. The finding of having a difference in young animals than the old contradicts the report of [31], which indicated that these infections affect both young and adult animals equally. The results in this study contradict the findings of other authors who reported that older animals would not influence the result much because most families sell the biggest (usually the oldest) animals in order to raise more money for their needs [32]. There were statistically significant differences in the prevalence of gastrointestinal parasites/tick infestation between male and females. These results contradict those of [31] in Ethiopia and [33] in Bangladesh who reported that there was no significant difference between the prevalence of these parasites with respect to sex. In this study, a slightly higher number of females than males showed a high prevalence. Previous studies have shown that female animals are at risk of heavy nematode burdens and tick infestation due to the immunosuppression associated with pregnancy and periparturient periods [34, 35]. In our study, this phenomenon was apparent in males but not in females.

Our study on co-infection focused on gastrointestinal parasites/tick infestation because they have been reported in many studies as the predominant and most pathogenic of sheep and goat parasites [36] that causes considerable economic losses to the small ruminant industry.

5. Conclusion

This study was conducted to determine the prevalence of gastrointestinal parasitic infections ad tick infestations in small ruminants (sheep and goats) from 12 villages in the Bui and Donga Mantung Divisions. It is worth noting that the prevalence of gastrointestinal parasitic infections ad tick infestation evaluated for the concerned sample was high (53.7%). It was found out that prevalence was high in most of the small ruminants examined. The presence of more than two parasites in their bodies will definitely leads to multiple infections ad infestations, decreased immunity and hence death.

Our results showed high rate of infection and infestation in small ruminants. This threat of gastrointestinal parasites and tick infestation on overall small ruminant productivity in the study area in particular and the North West Region in general warrants urgent strategic control intervention based on peculiar characteristics of each agro-ecological zone. The data obtained from our results will help the state and private institutions incharge of livestock to put in place new rearing strategies in order to fight against gastrointestinal and tick-borne parasites in the rearing areas in general, and in Bui and Donga Mantung Divisions in particular. The results suggested that field veterinarians should assist livestock farmers in strategic deworming campaigns and in treating their animals with effective acaricides used at the beginning and after the end of the rainy season together with effective anthelmintics. Medicinal plants should equally be introduced to the farmers of this community in order to fight against these infections and infestations in the small ruminants. Finally, farmers should be educated on the importance of using dry season feed reserves as means to ensure safe feed for zero-grazed ruminants. Awareness should be created in these farmers and periodic seminars or workshops organized so as to improve on the productivity of their animals and reduce death rate of the small ruminants in the study area.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared that they have no competing interest.

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