Gastrointestinal parasites and relationship with Faecal IgA and Cortisol in farmed rabbits in Bamenda, North West, Cameroon

ABSTRACT

Aim: Parasitic infections represent one of the major causes of death in rabbit's production system, which affect not only the reproductive performance but also the nutritional and dietary qualities. The objectives of the study were to determine the risk factors and prevalence of gastrointestinal parasites and its impacts in production of rabbits.

Methodology: Faecal samples were collected from 130 rabbits and were subjected to floatation and McMaster egg counting techniques for the parasitological analysis and faecal IgA and cortisol using ELISA technique. Moreover, questionnaire was used to assess some reproduction issues.
Place and Duration of Study: The study was carried out in Bamenda, Mezam Division, Northwest region, Cameroon, between April 2022 and July 2022
Findings: The results of this study showed an overall prevalence of gastrointestinal parasites of 48.5% (63/130). The different gastrointestinal parasites species that were obtained are *Coccidia spp* (88.89%), *Passalarus spp* (4.67%) and *Trichostrongylus spp* (6.35%). Moreover, the results showed that the production system (P=0.04) and feeding system (p = 0.04) increase the risk of GIP in rabbits production. In addition, the association *Passalarus spp* + *Coccidia spp* decrease (P=0.049) the litter size while *Coccidia spp* increase (P=0.027) the risk of death of litters. Furthermore, co-infection *Passalarus spp* + *Coccidia spp* lowered (p=0.06) the IgA level in animals while cortisol level is increased (p=0.001) in animals having *Coccidia* (3.065±13.05) compared to uninfected animals (1.03±1.16) as well as in animals with co-infection with *Trichostrongylus spp* + *Coccidia spp* (26.72±46.14) compared to uninfected (p=0.049).
Conclusion: Gastrointestinal parasites are still major health problems resulting to death of litters in rabbit's production in which stress and decrease of immune response may play a keys role.

Keywords: Gastrointestinal parasites, Reproduction, Cortisol, IgA, Rabbits

1. INTRODUCTION

Rabbits make important contributions to human livelihoods in developing economies, because of their high growth rate, reproductive performance, and high nutritional and dietary qualities in meat (Zvinorova *et al,* 2016; Tchoffo *et al.*, 2020). And it is reported that global rabbit meat production is about 1.8 million metric tonnes per year, and rabbit meat production in Cameroon is estimated to be 600 tonnes per year (Lebas *et al*, 2000; Mohamad-Radzi *et al,* 2020). Regardless of how important rabbit productions is, breeders still face a lot of challenges arising from presence of gastrointestinal parasites. Moreover, internal parasites that attack rabbits are worms and protozoa. Worms which often invade the digestive tract of rabbits are *Passalurus ambiguus* and *Taeniapisiformis*, while protozoa commonly intruding the rabbit's digestive tract are *Eimeria sp.* and *Enchepalitozoon cuniculi* (Tanjung *et al,* 2019*).*
The parasites present in the digestive tract, uses host nutrients, consume host tissues or use digestive organ cells to complete the phase of their life (Tanjung et al, 2019). *Enchepalitozoon cuniculi* has a zoonotic potential, especially for immunocompromised adults and children and for that reason, *Enchepalitozoon cuniculi* has received increased attention and hygienic precautions should be undertaken when humans are in contact with rabbits or rabbit products (Morsy *et al*., 2020). This protozoa parasite is responsible for direct and indirect losses of rabbits that are attributed to acute illness and death, premature slaughter, decreased growth rate, weight loss and late maturity of slaughter stock (Morsy *et al,* 2020). Cryptosporidium spp. and Giardia spp. are intestinal protozoa parasites that are said to be prevalent and widespread enteropathogenes of humans and many species of mammals including rabbits. Additionally, Eimeria causes coccidiosis which is pathogenic and Coccidian gastrointestinal parasites can negatively affect total body mass, impair growth and

food utilization, cause epithelial cell damage and inflammation, and result in diarrhoea, weight loss, economic losses, decreased food efficiency, inhibits weight gain and even lead to death (Cizauskas *et al.,*2015; Tanjung *et al,* 2019*).*
Intestinal parasites have become more difficult to manage in rabbit because of the parasites increasing resistance to several drugs and some of these parasites are now recognized as emerging zoonosis by WHO which is known to have serious impact on both public health and transmission through ingestion of infected meat (Rautureau *et al.,* 2010). Moreover rabbits share parasites species which negatively impact the animals health, reduces productivity, reduce weight gain, reduce reproductive performance, impair immune response and increase production cost due poor health (Kornas *et al*., 2015). Depending on the parasite population and host defence mechanism, parasite infestation can provoke clinical signs, mortality, stunted growth and partial or complete condemnation of carcass.
Rabbit's production is essentially traditional in Bamenda and farmers and breeders are still unaware of the hazards or problems caused by gastrointestinal parasites in rabbit. Thus, it is essential to investigate the risks factors and occurrence of gastrointestinal parasites in famed rabbits to improve the productivity and health status of rabbits farmed in Bamenda North West region of Cameroon.

2. EXPERIMENTAL DETAILS

2.1 Study area

The study was carried out in the Northwest region of Cameroon located between latitudes 50 55' N and 60 30'N and Longitudes 100 25'E and 100 67'E (Ndenecho, 2005). Bamenda, the head quarter shows an altitudinal range of 1200 - 1700 m, and is divided into two parts that is a low lying gently undulating part with altitude ranging from 1200 to 1400 m with many flat areas that are usually inundated for most parts of the year, and an elevated part at 1400 to 1700 m altitude that forms the crest from which creeks, streams supplying the low-lying parts take their rise. Bamenda has two rainy seasons, a long rainy season, which runs from mid-March to mid-October, and a short dry season from mid-October to mid-March with an annual rainfall ranges from 1300-3000 mm (Ndenecho, 2005). Bamenda lies between the thermic and hyper-thermic temperature regimes with mean annual temperatures stands at 19.9^{o}C. January and February are the hottest months with mean monthly temperatures of 29.1□C and 29.7□C, respectively. Agriculture is the main human activity of the habitants of Bamenda which involves about 70% of the population (GP-DERUDEP, 2006).

2.2 Study design

The study was carried out from April to July 2022. The list of the farms was obtained from MINEPIA. A snow ball sampling technique was then used whereby a farmer helps locate the next farm. Faecal samples were collected randomly from the chosen farms by taking in to consideration factors such as breed, age, gender, or housing system in a cross-sectional survey from farms and farmers who owned rabbits and wished to participate in the study.

2.3 Sampling

The sample size was determined following the formula reported by Thrustfield (Thrustfied, 2005), with 95% confidence interval and 5% of absolute precision taking in consideration that expected prevalence 50% was used since there is no reported studies on prevalence in rabbit at the Bamenda municipalities or Cameroon.

$$n = \frac{1.96^2 x\ P_{exp}\,(1 - P_{exp})}{d^2}$$

Where, *n* = required sample size P_{exp} = Expected prevalence (50%), d = desired absolute precision (0.05). Accordingly to the above calculation, the required samples size was 104 but, 130 animals were examined for the study.

2.4 Collection of demography and reproduction parameters

Information about the rabbit's reproduction was collected through an interview with the farm owner on the following:

- Number of females that give birth and number of young's born in 3 months
- Number of females with visually confirmed foetal expulsion (abortion)
- Number of females with no gestation
- The viability of the young was registered, differentiating between viable young's (alive three days after birth) and non-viable kits (dead within three days of birth).

2.5 Body Condition Score Assessment

The rabbits were placed on a flat surface and their body condition score was done by palpation i.e. feeling the animals' body (the ribs, pelvis and spine), and animals were graded following the rabbit-0- meter scale as reported by Sweet *et al.* (2013) (**Table 1**).

Table 1: Rabbit size-o-meter for assessing body condition score

0- meter score	Size	Characteristics
1	Very thin	• Hip bone, ribs and spine are very sharp to touch

		• Loss of muscle and no fat • The rump area curves in
2	Thin	• Hip bones, ribs and spine easily felt • Loss of muscle and very little fat cover • Rump areas is flat
3	Ideal	• Hip bones, ribs and spine are easily felt but are rounded, not sharp-ribs feel like pocket full of pens • Rump area is rounded
4	overweight	• Pressure is needed to feel the ribs, spine and hip • Some fat layers • The rump is rounded
5	Obese	• Very hard to feel the spine and hip bones- ribs cannot be felt • Tummy sags with obvious fat padding • Rump bulges out

2.6 Collection of stools

The stool was collected early in the morning. Briefly the rabbit pen was thoroughly swept or cleaned to get rid of the feces accumulated from the previous days. Each rabbit were then separated in different cages. Feed and water were given to them and after 10 to 15 mins, the feces were collected from the selected rabbits in a clean disposable plate. For those that were raised on the floor, after feeding them, rabbits were caught and individually put in to a large clean bucket to defecate and faecal samples were collected. Collected faecal were placed in capped plastic sample containers. of the faecal was immediately divided into 2, one part was used for the parasitological analysis and the other for IgA analysis.

2.7 Parasitological analysis.

Flotation technique using the saturated salt solution (NaCl) as flotation fluid was used to detect the parasites eggs. Quantitative evaluation of the eggs was done using the modified McMaster technique. Briefly, 2 g of fresh faeces was suspended in 60 ml saturated salt solution. The suspension was filtered through a fine filter and the Mc Master slide was filled by the filtrate using a Pasteur pipette. After some 10 minutes, the slide was examined microscopically at 100 and 400 magnifications (Thienpont *et al*., 1986; Verocai *et al*., 2020). The degree of infection was categorized as: mild (50 - 799), moderate (800 - 1200) and severe (> 1200) infestation according to their egg faeces (EPG) counts (Paul *et al.* 2020).

Calculation

Number of eggs in 1 g of faeces (EPG) = EPG = $Volume\ of\ floattion\ solution \div mass\ of\ feace$ = 60÷2
From simple proportion if 1÷0.15 = (60÷2)X, then cross multiplying will give X = 60×1÷2×0.15 = 60÷0.3 =200
EPG = Number of eggs in one compartment of the slide × 200 (Thienpont *et al*. 1986)

2.8 Measurements of faecal IgA ELISAs

Faecal pellets were resuspended in protein extraction buffer [10% goat serum (Fisher Scientific, Waltham, MA) in PBS] at a ratio of 10 mg per 100 µl, and vortexed for 20 min to disrupt pellets. Extracted samples were centrifuged for 10 min at 13,000 x g, and supernatants were collected for subsequent analysis. ELISA was used to determine total IgA antibody concentrations present in rabbit faecal extracts collected. ELISA was performed according to this protocol. Briefly, ELISA plates were coated with goat anti-human IgA (diluted at 1: 10,000) and washed with an ELISA plate washer. Plates were then blocked and washed, and the samples for measurement of IgA from healthy controls, and IgA from IBD patients were diluted with 1% BSA in 1:1000, 1:1200, and 1:3200, respectively. Experimental samples and standards were added to the wells and incubated at room temperature for 2 h, and biotinylated anti-IgA (diluted in 1: 16,000) with HRP-conjugated streptavidin was added for 1 h. Finally, the plates were developed in the dark using TMB substrate and analysed by an ELISA plate reader according to the manufacturer's instructions (Peters *et al*., 2004)

2.9 Measurement of faecal cortisol

Measurement of cortisol concentration in faecal samples was conducted using a commercial cortisol ELISA kit.50 µL of standard and samples were filled into the microplate well. Moreover, 75 µL of assay buffer was filled into the non-specific binding (NSB) wells and 50 µL of assay buffer into the maximum binding well. Afterward, 25 µL of the DetectX cortisol conjugate was added to each well using a repeater pipet. 25 µL of the DetectX cortisol antibody was then added to each well, except the NSB wells. The microplate was then covered with the plate sealer, homogenized for 10 seconds and then incubated at room temperature for 1 hour. After that, the microplate was washed with 300 µL of washing solution four times. Afterward, 100 µL of TMB substrate solution was added to each well and covered with the sealer plate and then re-incubate for 30 minutes at room temperature. Finally, 50 µL stop solution (0.5 M H2SO4) was added to each well to stop

the enzymatic reaction. The absorbance was determined by using an ELISA reader at 450 nm. The concentration of cortisol was then calculated using the Microplate Manager 6 Software (Gholib *et al.*, 2020; Blasco *et al*., 2021)

2.10 Data analysis

Data obtained from laboratory results and some reproductive questions as well as risk factor was entered into micro-soft excel 2013 for descriptive statistic and later transferred to SPSS version 23 for further statistical analysis. Different parameters were compared using the chi-square test. In all analysis, confidence level was held at 95% and P-values less than 0.05 was considered significance

3. RESULTS AND DISCUSSION

3.1 Distribution of rabbits and risk factors of gastrointestinal parasites

The results revealed that 56.9% of the rabbits were adults and the young are the fewer (20%). Farmers have mostly females (76.2%). According to breeds, most of the animals Newzealand white (44.6%). Most of the rabbits are ideal condition (36.2%) and very few are obese (0.8%). Farmed rabbits are mostly intensive (40.8%) with most of the animals were kept on wired cage (50%) and 40.8% of the farmers are mostly used supplemented feed (**Table 2**).

Table 2. Distribution of animals according to the risk factors

Parameter	Variable	Proportion (%)
Sex	Female	99(76.2)
	Male	31(23.8)
Age	Young (0 - 5 Months)	26(20)
	Adult (5 months – 1 year)	74(56.9)
	Old (Above 1 Year)	30(23.1)
Breed	Angora	5(3.8)
	Chinchilla	37(28.5)
	Flemish G	6(4.6)
	French C	7(5.4)
	Mixed Breed	16(12.3)
	Newzealand white	58(44.6)
Body condition score	Ideal	47(36.2)
	Obese	1(0.8)
	Over Weight	2(1.5)
	Thin	38(29.2)
	Very Thin	42(32.3)
Production System	Extensive	38(29.2)
	Intensive	53(40.8)
	Simi Intensive	39(30)
Housing System	Floor	10(7.7)
	Plank Cage	55(42.3)
	Wired Cage	65(50)
Feeding system	Feed and grass	39(30)
	Feed supplementation	53(40.8)
	Forage only	38(29.2)
Reproduction characteristics	Number of females with Litter	68 (70.10)
	Number of females with abortion	4 (4.12)
	Number of females with no gestation	4(4.12)

3.2 Prevalence of gastrointestinal parasites in farmed rabbits in Bamenda

Out of the 130 rabbits examined, 63 (48.5%) were found positive with one or more parasites. The results showed that sex, age, breeds, body condition and the production system did not significantly ($P > 0.05$) influenced the prevalence GIP in

rabbits. In contrast, the housing system significantly (P = 0.002, x^2 = 12.47) influenced the prevalence of GIP in rabbits with high prevalence when the plank was used (60.0%) and 0.00% for floor. The prevalence base on feeding system was statically significant (P = 0.043) with high prevalence (57.9%) when animals are fed with feed and grass (**Table 3**).

Table 3. Proportion prevalence of farm rabbit's in Bamenda following the different demographic factors

Parameter	Variable	No of animal examined	No positive	Prevalence	X^2(P Value)
Sex	Female	99	46	46.5	0.66(0.416)
	Male	31	17	54.8	
Age	Young (0 - 5 moths)	26	11	42.3	0.49(0.782)
	Adult (5 months - 1year)	74	37	50.0	
	Old (above 1 year)	30	15	50.0	
Breed	Angora	5	1	20.0	9.02(0.172)
	Chinchilla	37	18	48.7	
	Flemish g	6	5	83.3	
	French c	7	1	14.3	
	Mixed breed	16	8	50.0	
	Newzealand white	59	30	50.9	
BSC	Ideal	47	24	51.2	1.94(0.746)
	Obese	1	0	0.00	
	Over weight	2	1	50.0	
	Thin	38	16	42.1	
	Very thin	42	22	52.4	
Production system	Extensive	38	22	57.9	1.981(0.371)
	Intensive	53	23	43.4	
	Simi intensive	39	18	46.2	
Housing system	Floor	10	0	0.00	12.47(0.002)
	Plank cage	55	33	60.0	
	Wired cage	65	30	46.2	
Feed type	Feed and grass	38	22	57.9	9.603(0.043)
	Feed supplementation	53	23	43.4	
	Forage only	39	18	46.2	
Total		130	63	48.5	

3.3 Prevalence of single and co-infection of parasites

As shown in **Table 4**, the results revealed that among the infected animals, 43.1% and 5.4% of the animals were infected by single and co-infection of parasite species respectively. Amongst the 63 gastrointestinal parasite infections detected, 56 (43.1%) were infected only by *Coccidia*, 3 (2.3%) were co-infected by *Passalarus* and *Coccidia* and 4(3.1%) were co-infected by *Trichostrogulus* and *Coccidia*.

Table 4. Prevalence of single and co- infections in rabbits in Bamenda

Type of parasite	Number positive	Prevalence (%)
Single infections		
Coccidia spp	56	43.1
Co- infections		

Passalarus spp + Coccidia	3	2.3
Trichostrongylus spp + Coccidia ssp	4	3.1
Total Co-**infections**	7	5.4
Overall prevalence	**63**	**48.5**

3.4 Influence of different risk factors on gastrointestinal parasites density

Of the 63 positive cases, 14(22.2%) had mild infestation, 7(11.1%) had moderate infestation and 42(66.7%) were found severe infestation (**Table 5**). Comparing the prevalence of the severe infestation with regards to different factors, the results showed that sex, age, breed, body condition score and housing system of animals have no significant effect (P> 0.05). But, the results showed a significant effect of the production system ($\chi^2 = 7.98$; P = 0.04) and feeding system ($\chi 2$ = 9.60; p = 0.04). Animals fed with feed and grass had more severe cases (88.9%) as well as animals kept in wired cage (70.0%).

Table 5. Degrees of gastrointestinal parasitic infestation following risk factors

Parameter	Variable	No positive	Mild (50-799)	Moderate (800-1200)	Severe (>1200)	X^2(P value)
Sex	Female	46	12(26.1)	6(13.0)	28(60.9)	2.578(0.27)
	Male	17	2(11.8)	1(5.9)	14(82.4)	
Age	Young (0 - 5 months)	11	0(0.00)	1(9.1)	10(90.9)	4.784(0.31)
	Adult (5 months - 1year)	37	11(29.7)	4(10.8)	22(59.5)	
	Old (above 1 year)	15	3(20.00)	2(13.3)	10(66.7)	
Breed	Angora	1	0(0)	0(0.0)	1(100.0)	12.233(0.27)
	Chinchilla	18	5(27.9)	3(16.7)	10(55.6)	
	Flemish g	5	0(0.0)	0(0.0)	5(100.0)	
	French c	1	1(100.0)	0(0.0)	0(0.0)	
	Mixed breed	8	3(37.5)	2(25.0)	3(37.5)	
	Newzealand white	30	5(16.7)	2(6.7)	23(76.7)	
Body condition score	Ideal	24	3(12.5)	2(8.3)	19(79.2)	7.989(0.4)
	Over weight	1	0(0.0)	0(0.0)	1(100.0)	
	Thin	16	5(31.6)	4(25.0)	7(43.8)	
	Very thin	22	6(27.3)	1(4.6)	15(68.2)	
Production system	Extensive	22	9(40.9)	2(9.4)	11(50.0)	9.603(0.05)
	Intensive	23	4(17.4)	4(17.4)	15(65.2)	
	Simi intensive	18	1(5.6)	1(5.6)	16(88.9)	
Feeding system	Feed and grass	18	1(5.6)	1(5.6)	16(88.9)	9.603(0.04)
	Feed supplementation	23	4(17.3)	4(17.4)	15(65.2)	
	Forage only	22	9(40.9)	2(9.2)	11(50.0)	
Housing	Plank cage	33	10(30.3)	2(6.1)	21(63.6)	3.723(0.15)
	Wired cage	30	4(13.3)	5(16.7)	21(70.0)	
Total		63	14(22.2)	7(11.1)	42(66.7)	9.44(0.036)

3.5 Influence of gastrointestinal parasite on litter size and viability of young in infected and uninfected rabbits.

Results revealed that *Coccidia* as well as the co-infection *Trichostrongylus* and *Coccidia* have no significant (P>0.05) effect on the litter size. In contrast, the association *Passalarus* and *Coccidia* have a significant difference (P = 0.049), with a decrease in the litter size of co-infected animals (**Table 6**). As shown in table 6, it was noted that animals infested with *Coccidia* had significantly (P = 0.027) less number of viable litters (5.87 ± 1.76) compared to uninfected (6.08 ± 2.44). However, they were no significant difference in number of litters in animals co-infected with *Passalarus* and *Coccidia* (P = 0.15) as well as those co-infected with *Trichostrongylus* and *Coccidia* (P = 0.45).

Table 6. Size and number of viable litters in infected and uninfected farmed rabbits

Parasite species	**Infected**	**Uninfected**	***P value***
Size of litters			
Coccidia spp	6.03±2.54	6.08±2.44	0.87
Passalarus spp + coccidian spp	4.28±1.74	6.08±2.44	0.049

Trichostrongulus spp + Coccidia spp	6.12±2.60	6.08±2.44	0.45
Number of litters viable			
Coccidia spp	5.87±1.76	6.0875±2.44	0.027
Passalarus spp + Coccidia spp	6.10±0.55	6.0875±2.44	0.154
Trichostrongulus spp + Coccidia spp	6.12±2.62	6.0875±2.44	0.45

3.6 Influence of gastrointestinal parasite species on IgA and cortisol level for infected and uninfected rabbits

As shown in **Table 7**, the results revealed that the mean of IgA in infected animals with *Coccidia* (116.21±96.81) was high than that of uninfected animals (95.94±70.79), but there no was significant difference (p=0.64). Similarly, there was no difference (p=0.12) in co-infected with *Trichostrongylus* and *Coccidia* (1.31±1.58) and uninfected (0.32±1.12), while animals with co-infection of *Passalarus* and *Coccidia* (9.82±17.49) was significantly low (p = 0.06) than that of uninfected (30.45±38.66). The results also showed that cortisol level was significantly (p = 0.001) high in animals having *Coccidia* (3.065±13.05) compared to uninfected animals (1.03±1.16) as well as in animals with co-infection with *Trichostrongylus* and *Coccidia* (26.72±46.14) compared to uninfected (6.01±1.20) (p = 0.049). There was no difference in cortisol level in animals co-infected with Passalarus and Coccidia and those uninfected (p = 0.24).

Table 7. IgA and cortisol level following the parasites species in rabbits

Parasite	IgA (µg/ml)		P value	COR (ng/dl)		P value
	Infected animal	Uninfected animal		Infected animal	Uninfected animal	
Coccidia spp	116.21±296.81	95.94±270.79	0.64	3.065±13.05	1.03±1.16	0.00
Trichostrongulus spp+Coccidia spp	1.31±1.58	0.32±1.12	0.12	26.72±46.14	6.01±1.20	0.04
Passalarus spp + Coccidia spp	9.82±17.49	30.45±38.66	0.06	0.57±0.99	0.55±1.32	0.24

Discussion

Parasitic diseases constitute a major impediment to livestock production in sub-Saharan Africa owing to the direct and indirect losses they cause. Gastrointestinal parasite infestations are widespread in livestock and are major constraint to livestock production in many countries including Cameroon. Rabbits harbour a variety of gastrointestinal parasites. The results of this study revealed an overall prevalence of gastrointestinal parasites in rabbits to be 48.5%. The high prevalence of gastrointestinal parasites of rabbits in the study can be attributed to the poor management and husbandry practices. The results of this present study are in contrast with those of Ilić *et al*. (2018) who reported a prevalence rate 82.68% in their study on the external and internal parasites of rabbits. The high prevalence in this study could also be attributed to illiteracy on the side of the rabbit's keepers and their ignorance or avoidance tendency of preventive measures. The differences in prevalence of gastrointestinal parasites in this study may also be associated with differences in environmental conditions, stocking rate, nature of their diet immunity status of the animal.

The result of this present study with respect to the species of parasites revealed that *Coccidia* was the highest parasite that affects farm rabbits in Bamenda with prevalence of 88.89% this high prevalence could be attributed to the poor feed management and the fact that most farmers use little or no anti-coccidia drugs in rabbit health management. Similar results were obtained by Ilić *et al* (2018) who reported high prevalence of *Coccidia* among other internal parasites. In rabbits the most frequent are mixed infections of intestinal *Coccidia*, which cause clinical coccidiosis in offspring, with anaemia, diarrhea, dehydration, lagging in growth and development (Sadzikovski *et al*., 2008; Pakandl, 2009). Coccidiosis is controlled with prophylactic application of anti-coccidia. But, these variations were likely due to wide usage of grass, silage and grain as rabbit diet, making the administration of anticoccidials in feed impracticable in small farms, although practice other than anticoccidials was also employed in rabbit farming, poor hygienic conditions and suboptimal temperatures were observed on some small individual rabbit farms in most farms in Bamenda, which can favour the occurrence of *Eimeria* spp. Infections. The present finding was lower than that reported in some previous studies. This may be attributed to various factors, including the difference in environmental conditions prevailing in each region, meteorology and agro-ecology.

In this research *Trichostrongylus* spp was diagnosed to be 6.35% and the parasites were prevalent in old, adults and young animals. It is reported that Sometimes wild rabbits *Trichostrongylus* spp. of ruminants may parasitize (Ilić *et al*., 2011), demonstrating that these wild animals' species can be vectors of domestic rabbits (Ilić *et al*., 2011; Ilić *et al*., 2014). *Passalarus* was diagnosed with prevalence of 4.76%. The prevalence of this parasite varies depending on age and season (Nosal *et al*., 2006; Ashmawy *et al*., 2010). In Egypt, *P. ambiguus* is one the most prevalent helminthes found in

domestic rabbits, up to 40 % of samples are infected with it and younger animals are more commonly infected than adults (Ashmawy *et al*., 2010). However, the prevalence rates were relatively lower than that recorded previously in eastern Scotland (14.2%) and in Egypt (26.7%) by Ashmawy *et al*. (2010). These variations were likely to be due to difference in environmental condition, management care, nature of pasture and the level of humidity from place to another place.

Results revealed no significant difference among different risk factors of gastrointestinal parasites of rabbits such as the age, sex, breed, and production system. This result contradicts the findings of Ilić *et al* (2018) who reported a significant higher prevalence of gastrointestinal parasites in rabbits of different sex and age. Moreover, influences of age, sex and breeds were also taken into consideration by Pakandl *et al.* (2008) who reported that there was a lower resistance or less immunity to coccidian infection in young rabbits than older animals which is responsible for the high prevalence of coccidiosis in young rabbits (47.1%). Additionally, host sex exercises a great significant influence on parasitism, as females harboured more infection compared to males, agreeing with various studies. Similar risk of infection could be due to the fact that both young and adult rabbit were exposed to the same risk of infection by the infective stage of *P.* ambiguus due to the lack of knowledge about the hygienic measures as kits remain in contact with their dams, as well as might be attributed to the nature of the study area as reported by Abdel-Baki & Al-Quraishy (2013). The differences in prevalence of gastrointestinal parasites in this study may also be associated with differences in environmental conditions, stocking rate, nature of their diet immunity status of the animal.

Result of this study revealed that the body conditions of the animal were not affected by the prevalence of the parasites and degree of EPG which is in agreement with study of Keyyu *et al*. (2003), but this is in contrast with the results of fikru *et al*. (2006). This could be explained by the fact that loss of body condition in the study animals could be due to other factors, such as seasonal change of forage feed stuff and the presence of other concurrent disease conditions (Keyyu *et al*., 2003). However, statistically significant effects of housing and feed type have been observed in this study. This is in line with the findings of Seth *et al.* (2014) who reported that nutrition influences the incidence rate and severity of infection with GI nematodes in animal. This finding also showed an existence of difference in degree of parasitic infestation with the variation of species, age and sex of the animals. However, there was no significant difference in EPG among different age groups, sex and species.

It was observed that the co-infection *Passalarus and Coccidia* cause a decrease in the litter size of co-infected animals and also animals having *Coccidia* had few viable litters. This suggest that that gastrointestinal parasites affect directly or indirectly the reproduction in females, which concur with facts started by Mavrogianni *et al.* (2011) that parasites also affect reproduction by affecting litter size, delaying onset of puberty, reduced mating activity of rabbits, increases the inability of the animals to conceive, abortion or abnormal delivery of young one. The fact that *Coccidia* spp affects the viability of young is in line with the findings of Kusiluka & Kambarage (1996). This may be that younger rabbits are immunological naive and are susceptible to infection from adult carriers especially after weaning (Pakand *et al*., 2008). Moreover, weaning stress has been reported to lower the immunity of rabbits to infections and the ingestion of coccidian parasites couple with contaminated solid feed may raise the intensity of infection in young there by increasing mortality in the young.

4. CONCLUSION

Gastrointestinal parasites are still major health problems in rabbit production. The major groups of parasites present are *Trichostrongylus, Coccidia* and *Passalarus*. These parasites are resulting to death of litters in rabbit's production in which stress and decrease of immune response may play a keys role.

ETHICAL APPROVAL

The studies were reviewed and approved by Departmental Scientific Board of the department of Animal production, College of Technology, The University of Bamenda, Cameroon

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