Breed and environmental factors influencing prevalence of helminths in sheep

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Abstract

Gastrointestinal parasites impose severe constraints on sheep production worldwide. Information on prevalence of helminthosis in the ovine species could provide a useful guide towards effective control. Investigated in this study was helminthosis prevalence in some Nigerian sheep. The sheep included initial 64 yearlings (12 each of Balami, BL, and Uda, UD, and 20 each of Yankasa, YK and West African Dwarf, WAD, in a sex ratio of 1:1 per breed) and their 156 offspring. Faecal samples were collected from the sheep six-weekly over a period of 3 years and examined for the presence of various helminth species using the modified McMaster technique. Total helminths, Strongyles, Strongyloides, Moniezia, Trichuris and Nematodirus prevalence were 95.9, 87.3, 38.2, 60.6, 45.0 and 46.4%, respectively. Based on prevalence, breeds and seasons ranked ($p < 0.05$) thus: YK = WAD > BL > UD and late rainy > early rainy > late dry > early dry. Females and older sheep (< 4 months) had higher ($p < 0.05$) prevalence than males and lambs (< 4 months), respectively. Prevalence increased with decreased body condition score (BCS). Year, birth type and parity did not influence prevalence. It is concluded that there is high prevalence of helminthosis in the study area, with variation between breeds, sex, age groups and seasons. These variations could be exploited through selective breeding and cross breeding to control the disease with or without minimal use of anthelmintics.

Keywords: Sheep, Breeds, Environmental factors, Helminths, Prevalence

Les Facteurs liés à la race et à l'environnement influençant la prévalence des helminthes chez les moutons

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Résumé

Les parasites gastro-intestinaux imposent de sévères contraintes à la production ovine dans le monde. Les informations sur la prévalence de l'helminthose chez les ovins pourraient fournir un guide utile pour une lutte efficace. La prévalence de l'helminthose chez certains moutons nigériens a été étudiée dans cette étude. Les moutons comprenaient au départ 64 yearlings (12 chacun de Balami, BL et Uda, UD, et 20 chacun de Yankasa, YK et West African Dwarf, WAD, dans un rapport de masculinité de 1 : 1 par race) et leurs 156 descendants. Des échantillons de matières fécales ont été prélevés sur les moutons six fois par semaine sur une période de 3 ans et examinés pour la présence de diverses espèces d'helminthes en utilisant la technique modifiée de McMaster. La prévalence totale des helminthes, Strongyles, Strongyloides, Moniezia, Trichuris et Nematodirus était de 95,9, 87,3, 38,2, 60,6, 45,0 et 46,4%, respectivement. Sur la base de la prévalence, des races et des saisons classées ($p < 0,05$) ainsi : YK = WAD > BL > UD et pluvieux tardif > pluvieux

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précoce> sec tardif> sec tôt. Les femelles et les moutons plus âgés (> 4 mois) avaient une prévalence plus élevée ($p < 0,05$) que les mâles et les agneaux (<4 mois), respectivement. La prévalence augmentait avec la diminution du score de l'état corporel (le 'BCS'). L'année, le type de naissance et la parité n'ont pas influencé la prévalence. Il est conclu qu'il existe une prévalence élevée d'helminthose dans la zone d'étude, avec des variations entre les races, le sexe, les groupes d'âge et les saisons. Ces variations pourraient être exploitées par une sélection sélective et des croisements pour lutter contre la maladie avec ou sans utilisation minimale d'anthelminthiques.

Mots clés : mouton, races, facteurs environnementaux, helminthes, prévalence

Introduction

Sheep contribute 11% of the meat supplied from slaughter houses in the country and even more if rural unregistered slaughters are considered (Oni, 2002). They also play significant role in the nutrition, social and economic life of the people. They play specific roles at weddings and other festivities, and serve as regular source of cash income. The indigenous breeds of sheep of Nigeria in the order of importance are Yankasa (60%), West African dwarf (WAD) (20%), Uda (10%) and Balami (10%) (Ajala *et al.*, 2008). Ages at first lambing are; 11-18, 11-18, 10-16 and 10-16 months, respectively. Lambing intervals are 227 days for Uda, Yankasa and West African dwarf and 282 days for Balami (Anonymous, 1990). The contribution of sheep to Nigeria's economy and their advantages over other farm animal species, cannot be over emphasized. However, optimum productivity is hampered by many constraints. These include nutritional, management, socio-economic, technical, institutional, genetic and disease constraints (Adegbola, 1998). Gastrointestinal nematodes impose severe economic constraints on sheep production in pastoral systems worldwide (Baker *et al.*, 2004; Charon, 2004; Polott and Greeff, 2004). Losses occur through mortalities, reduced production due to subclinical parasitism and direct cost associated with control (Barger, 1982; ILCA, 1992). In the U.S. economic losses in ruminant due to parasites have been estimated at more than

\$3 billion per year (Smith, 2002). According to Kloosterman *et al.* (1992) up to 60% losses in sheep are due to parasites. In Nigeria, 11% loss of value of sheep and goat production was due to helminthosis (Schillhorn Van Veen, 1973). Akerejola *et al.* (1979) reported over U.S \$40 million annual loss in sheep and goat due to gastrointestinal nematode in Kano area alone. There have been many reports of variation among sheep breeds in resistance to internal parasites (Knight *et al.*, 1973; Preston and Allonby, 1978, 1979a; Courtney *et al.*, 1984; Gray, 1991; Orokpo, 1991; Gamble and Zajac, 1992; Chiroma, 1996, Dafur *et al.*, 2008a, b; Biu *et al.*, 2009). These reports except Orokpo (1991), Chiroma (1996) and Dafur *et al.* (2008a) are on non-Nigerian breeds of sheep. Information on differences among Nigerian sheep breeds is therefore scanty. The aim of this study was to evaluate the effect of breeds, sex, age, parity, birth type, year and season on sheep helminthosis prevalence.

Materials and methods

Location and climate

The research was carried out in Pankshin town, Jos Plateau. The Jos Plateau has been described by PADP (2000), WWF (2001) and Plateau State Government Organization (2004). It is a pear-shaped upland located in the middle of Nigeria between latitude 8° and 10° north and longitudes 7° and 11° east, at an average attitude of 1,200m above sea level and reaches the highest peak in the Shere Hills

where it stands at 1,766m.

Experimental animals

The research commenced with a stock of 64 yearling sheep which comprised 12 each of Uda and Balami and 20 each of West African dwarf (WAD) and Yankasa in a sex ratio 1: 1 per breed. The Uda and Balami were bought from Railway market in Bauchi, North Eastern Nigeria while the Yankasa and WAD were sourced from local farmers and markets within Plateau State. The animals were quarantined and acclimatized for 2 months. Later, 156 offspring of the starting stock produced from controlled breeding (only within breed mating) were included.

Sheep management

Before purchase from farmers, sheep were managed under the traditional free-range in the dry season. In the rainy season when arable crops were growing, animals were kept under semi-intensive management. Under this system, sheep were taken out for grazing by a shepherd from late morning till evening. At the research station, sheep were housed in pens constructed with concrete blocks, floored and roofed with corrugated iron sheets. The females and a breeding ram of the same breed were kept together and all other males were collectively housed. Few days to lambing pregnant ewes were isolated and housed in a well littered lambing pen. After lambing, all necessary cleaning and identification processes were observed. New born lambs were kept with their ewes under close observation for 24 hours to ensure that they were suckled with colostrums. Ewes were allowed to graze without their lambs after 3 weeks of lambing. Throughout the period of the experimental study animals were grazed on locally available pasture from 9:00am to 5:00pm. Crop residues such as legumes and corn stalks, leafy shrubs and herbs were made available. In the evening they were returned to the pen and provided with salt

lick and supplementary maize offals, groundnut haulm, cowpea and corn husks. Drinking water was supplied *ad libitum*. Before the start of experiment, animals were dewormed twice at monthly intervals with levamisole and albendazole at dose rates of 7.5 and 5.0mg/kg body weight respectively and no deworming thereafter. Asuntol solution bath was carried out at quarterly intervals to control ectoparasites. Prophylactic treatment with oxytetracycline long acting (LA) was undertaken twice a year to prevent bacterial infections.

Faecal sample collection and analysis

Faecal samples were collected directly from the rectum and sometimes as the animals defaecated using clean polythene bags. The collection was carried out 6-weekly. Samples were properly labelled with a masking tape showing breed, age, sex, date of collection and body conformation score. They were then stored at 4°C until examination within three days. Faecal samples were examined for the presence of eggs of various helminth species and faecal egg counts (FEC), measured as number of eggs per gramme of faeces (epg). It was determined using the modified McMaster technique (Urquhart *et al.*, 1996; Kassai, 1999). Worm eggs were identified as described as Alrifai (2010).

Body condition scores

The body condition scores (BCS) were assessed by combining palpation of the sheep in the lumbar region and around the backbone in the loin area immediately behind the last rib, as suggested by Boden (1991) and the guidelines. The scores used in the study were 1.0, 2.0, 3.0, 4.0 and 5.0 for emaciated, thin, average, fat and obese respectively. Cases which did not fit these categories properly, i.e fell between whole numbers were assigned half scores as recommended by Thompson and Meyer (1994) and additional scores of 1.5, 2.5 and 3.5 were therefore used.

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Age, parity, birth type and season

The ages of the starting stock were determined using the dentition procedure as described by Sastry and Thomas (1980) and information from sheep owners. Subsequently, ages of offspring were determined using birth records. Sheep were categorized into two age groups namely; young (0 – 4 months) and matured (weaning and above). Parity was determined as number of times a dam had lambed. Birth type indicated the number of lambs per parturition (single, twins or triplets). Seasons were categorized as early dry (October - December), late dry (January - March), early rainy (April - June) and late rainy (July - September).

Statistical analysis

Chi-square test was carried out on the effects of breed, sex, year, season, BCS, parity, birth type and age on helminth prevalence in accordance with Steel and Torrie (1980).

The linear model used is as follows:

$$Y_{ijklmnopqr} = \mu + G_i + S_j + P_k + B_l + T_m + C_n + N_p + E_q + A_r + e_{ijklmnopqr}$$

Where:

$Y_{ijklmnopqr}$ = observable characteristic;
 μ = overall mean;
 G_i = i^{th} effect of breed ($i = 1, 2, 3, 4$);
 S_j = j^{th} effect of sex ($j = 1, 2$);
 P_k = k^{th} effect of parity ($k = 1, 2, 3$);
 B_l = l^{th} effect of birth type ($l = 1, 2, 3$);
 T_m = m^{th} effect of age ($m = 1, 2$);
 C_n = n^{th} effect of body condition score ($1, 2, 3, 4, 5, 6, 7$);
 N_p = p^{th} effect of season ($p = 1, 2, 3, 4$);
 E_q = q^{th} effect of year ($q = 1, 2, 3$) and
 $e_{ijklmnopqr}$ = Random error effect.

Results

The prevalence of infection with total helminth species (all helminths taken together), *Strongyles*, *Strongyloides*, *Trichuris*, *Moniezia* and *Nematodirus* by sheep breed, sex, age, body condition score (BCS), birth type, parity, season and year are depicted in Tables 1, 2, 3, 4, 5 and 6, respectively.

All helminth species

In Table 1, 95.9% of the experimental sheep were infected with total helminth species. There was significant ($p < 0.05$) difference

in prevalence among breeds. The highest prevalence was observed in Yankasa (98.6%), and West African dwarf (WAD) (98.4%), followed by Balami (92.5%) while Uda (91.3%) had the lowest. Similarly, there was higher ($p < 0.05$) prevalence in females than males and in adult sheep than lambs with respective values of 98.3 and 93.3%, and 98.5 and 89.8%. Prevalence was higher ($P < 0.01$) in sheep with low BCS as compared to those with high values. The animals with BCS 1.0-2.0 were 100% infected while only 66% of the ones with BCS 4.0 were infected. Birth type and lamb parity had no significant influence on prevalence. The ranges were 91.7% in singles to 100% in triplets and 94.4% in animals born at third parity to 97.2% for their second parity counterparts. Similarly, prevalences were 97.1, 94.7 and 96.0% in the first, second and third years respectively and did not differ significantly. Prevalences of 98.2, 98.2, 96.4 and 92.7% in late rainy, early rainy, late dry and early dry seasons respectively differed significantly ($p < 0.05$) indicating the influence of season.

Strongyles prevalence

As shown in Table 2, infection with *Strongyles* was observed in 87.3% of the experimental sheep. Significant ($p < 0.05$) effect of breed on prevalence was observed; West African dwarf ranked highest followed by Yankasa, Balami, while Uda was lowest with respective values of 93.4, 93.2, 80.0 and 78.3%. similarly, prevalence was higher ($p < 0.01$) in females (92.2%) than males (81.7%) and in adults (95.4%) than lambs (87.2%). Respective early rainy, late rainy, early dry and late dry seasons values of 92.7, 90.9, 83.6 and 81.8% varied significantly ($p < 0.05$). Yearly prevalences of 87.1, 86.7 and 68.0% in the first, second and third years respectively did not differ significantly.

Animals with lower BCS (1.0-2.0) were

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Table 1: Prevalence of total helminths (overall) by sheep breed and environmental factors

	Total	Non-Infected		Infected		X ²
	N	No	%	No	%	
Overall	220	09	04.1	211	95.9	
Breed						
Balami	40	03	07.5	37	92.5	5.362*df ₃
Uda	46	04	08.7	42	91.3	
WAD	61	01	01.6	60	98.4	
Yankasa	73	01	01.4	72	98.6	
Sex						
Male	104	07	06.7	97	93.3	12.176*df ₁
Female	116	02	01.7	114	98.3	
Age (Months)						
0-4	156	16	10.2	140	89.8	14.333*df ₁
>4	64	01	1.5	63	98.5	
Season						
Early dry	55	02	03.6	53	96.4	21.670*df ₃
Late dry	55	04	07.3	51	92.7	
Early rainy	55	01	01.8	54	98.2	
Late rainy	55	01	01.8	54	98.2	
Year						
First	70	02	02.9	68	97.1	3.016 ns df ₂
Second	75	04	05.3	71	94.7	
Third	75	03	04.0	72	96.0	
BCS						
1.0	03	00	00.0	03	100	56.343***df ₆
1.5	09	00	00.0	09	100	
2.0	32	00	00.0	32	100	
2.5	76	02	02.6	74	97.4	
3.0	77	03	03.9	74	96.1	
3.5	20	03	15.0	17	85.0	
4.0	03	01	33.3	02	66.7	
Birth type						
Single	94	04	04.3	90	95.7	2.922 ns df ₂
Twins	57	02	03.5	55	96.5	
Triplet	05	00	00.0	05	100.0	
Parity						
1 st	67	03	04.5	64	95.5	3.031 ns df ₂
2 nd	71	02	02.8	69	97.2	
3 rd	18	01	05.6	19	94.4	

* = significant at 0.05, *** =significant at p < 0.001, ns=not significant, WAD = West African Dwarf.

significantly (p<0.001) more infected than the ones with higher BCS with respective values of 86.8, 84.4, 75.0 and 33.3% for 2.5, 3.0, 3.5 and 4.0. Birth type did not affect prevalence with respective values of 87.2,

87.7 and 80.0% for singles, twins and triplets. Similarly, lamb's parity with respective prevalence values of 88.1, 85.9 and 88.1% in first, second and third did not affect prevalence.

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Table 2: Prevalence of *Strongyles* by sheep breed and environmental factors

	Total (N)	Non-Infected		Infected		X ²
		No	%	No	%	
Overall	220	28	12.7	192	87.3	
Breed						
Balami	40	08	20.0	32	80.0	7.316*df ₃
Uda	46	10	21.7	36	78.3	
WAD	61	04	6.6	57	93.4	
Yankasa	73	05	6.8	68	93.2	
Sex						
Male	104	19	18.3	85	81.7	13.176**df ₁
Female	116	09	7.8	107	92.2	
Age (Months)						
0-4	156	20	12.8	136	87.2	12.272**df ₁
>4	64	03	4.6	61	95.4	
Season						
Early dry	55	09	16.4	46	83.6	24.472*df ₃
Late dry	55	10	18.2	45	81.8	
Early rainy	55	04	7.3	51	92.7	
Late rainy	55	05	9.1	50	90.9	
Year						
First	70	09	12.9	61	87.1	2.670 ^{ns} df ₂
Second	75	09	12.0	66	68.0	
Third	75	10	13.3	65	86.7	
BCS						
1.0	03	00	0	03	100	65.480***df ₅
1.5	09	00	0	07	100	
2.0	32	00	0	32	100	
2.5	76	10	13.2	66	86.8	
3.0	77	12	15.6	65	84.4	
3.5	20	05	25.0	15	75.0	
4.0	03	02	66.7	01	33.3	
Birth type						
Single	94	12	12.8	82	87.2	1.730 ^{ns} df ₂
Twins	57	07	12.3	50	87.7	
Triplet	05	01	20.0	04	80.0	
Parity						
1 st	67	08	11.9	59	88.1	2.076 ^{ns} df ₂
2 nd	71	10	14.1	61	85.9	
3 rd	18	02	11.1	16	88.1	

* = significant at 0.05, ** = significant at p < 0.01, *** = significant at p < 0.001, ns=not significant

***Strongyloides* prevalence**

Strongyloides infected 38.2% of the experimental sheep. Significant (p<0.001) sheep breed effect was observed on *strongyloides* prevalence. The highest prevalence of 47.5% was observed in WAD, followed by Yankasa, 43.8%, Uda, 28.3% while Balami was least 25.0%. There was significant (p<0.05) influence of sheep sex on prevalence with a rate of 33.7% in males and 42.2% in females. Adult sheep had higher prevalence of

70.3% than lambs, with 48.0%. Season also had significant (p<0.01) influence on prevalence. The highest was observed in the early rainy season 54.5% followed by late rainy season, 43.6%, late dry, 29.1% while the early dry had the lowest prevalence of 25.5%. The yearly prevalence rates of 40.0, 36.0 and 38.7 in the first, second and third years respectively did not significantly differ.

Body condition score significantly (p<0.01) influenced prevalence with the highest

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value (100%) observed in animals with BCS 4.0. Lamb's birth type had significant ($p<0.05$) influence on prevalence with twins (52.6%) being more infected than

singles (45.7%) and triplets (40.0%). Lamb's parity with respective values of 46.3, 49.3 and 50.0% for first, second and third had no significant influence on prevalence.

Table 3: Prevalence of *Strongyloides* by sheep breed and environmental factors

	Total	Non-Infected		Infected		X ²
	(N)	No	%	No	%	
Overall	220	136	61.8	84	38.2	
Breed						
Balami	40	30	75.0	10	25.0	10.412***df ₃
Uda	46	33	76.7	13	28.3	
WAD	51	32	52.5	29	47.5	
Yankasa	73	41	56.2	32	43.8	
Sex						
Male	104	69	66.3	35	33.7	12.272*df ₁
Female	116	67	57.8	49	42.2	
Age (Months)						
0-4	156	81	52.0	75	48.0	13.928***df ₂
>4	64	19	29.7	45	70.3	
Season						
Early dry	55	41	74.5	14	25.5	20.892**df ₃
Late dry	55	39	70.9	16	29.1	
Early rainy	55	25	45.5	30	54.5	
Late rainy	55	31	56.4	24	43.6	
Year						
First	70	42	60.0	28	40.0	2.982 ^{ns} df ₂
Second	75	48	64.0	27	36.0	
Third	75	46	61.3	29	38.7	
BCS						
1.0	03	00	00.0	03	100	47.932 ** df ₆
1.5	09	00	00.0	09	100	
2.0	32	04	12.5	28	87.5	
2.5	76	56	73.3	20	22.7	
3.0	77	58	75.3	19	24.7	
3.5	20	15	75.0	05	25.0	
4.0	03	03	100.0	00	00.00	
Birth type						
Single	94	51	54.3	43	45.7	7.323*df ₂
Twins	57	27	47.4	30	52.6	
Triplet	05	03	60.0	02	40.0	
Parity						
1 st	67	36	53.7	31	46.3	4.00 ^{ns} df ₂
2 nd	71	36	50.7	35	49.3	
3 rd	18	09	50.0	09	50.0	

* = significant at 0.05, ** = significant at $p < 0.01$, *** = significant at $p < 0.001$, ns = not significant

Moniezia prevalence

The overall *Moniezia* prevalence in the experimental sheep population was 60.0%. significant ($p<0.01$) influence of breed was observed. The WAD had the highest prevalence rate of 66.7% followed by

Yankasa with 65.8% while Balami and Uda were least with 50.0% each. Similarly, sex had significant ($p<0.05$) influence with females exhibiting higher prevalence rate of 69.8% than males, 49.0%. Age, in addition significantly ($p<0.001$) influenced

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prevalence. Adult had higher prevalence rate of 89.1% than young lambs with 49.4%. Furthermore, season significantly ($p<0.01$) influenced prevalence with respective values of 70.9, 67.3, 56.4 and 45.5% in late rainy, early rainy, late dry and early dry. On the other hand, year did not influence prevalence as the prevalence rates of 62.9, 57.3 and 60.0% in the first, second and third years respectively did not significantly differ. Body condition score had significant influence on prevalence.

The highest prevalence of 100% each was observed in animals with BCS 1.0 and 1.5 while the lowest (0.0%) was observed in BCS 4.0. Similarly, lamb's birth type significantly ($p<0.05$) influence prevalence. Triplets had the highest prevalence rate of 60.0% followed by twins with 50.1% while singles had the lowest rate of 47.9%. Parity did not significantly influence prevalence. The prevalence rates were 50.7, 49.3 and 50.7% respectively for first, second and third.

Table 4: Prevalence of *Moniezia* by sheep breed and environmental factors

	Total (N)	Non-Infected		Infected		X ²
		No	%	No	%	
Overall	220	88	40.0	132	60.0	
Breed						
Balami	40	20	50.0	20	50.0	10.232**df ₃
Uda	46	23	50.0	23	50.0	
WAD	61	20	33.3	41	66.7	
Yankasa	73	25	34.2	48	65.8	
Sex						
Male	104	53	51.0	51	49.0	14.448**df ₁
Female	116	35	30.2	81	69.8	
Age (Months)						
0-4	156	79	50.6	77	49.4	14.021***df ₁
>4	64	09	14.1	45	89.1	
Season						
Early dry	55	30	54.5	25	45.5	19.988**df ₃
Late dry	55	24	43.6	31	56.4	
Early rainy	55	18	32.7	37	67.3	
Late rainy	55	16	29.1	39	70.9	
Year						
First	70	26	37.1	44	62.9	1.998 ^{ns} df ₂
Second	75	32	42.7	43	57.3	
Third	75	30	40.0	40	60.0	
BCS						
1.0	03	00	00.0	03	100	45.877**df ₆
1.5	09	00	00.0	09	100	
2.0	32	04	12.5	28	87.5	
2.5	76	29	38.2	47	61.8	
3.0	77	35	45.5	42	54.5	
3.5	20	17	85.0	03	15.0	
4.0	03	03	100.0	00	00.00	
Birth type						
Single	94	49	52.1	45	47.9	8.009*df ₂
Twins	57	28	49.1	29	50.1	
Triplet	05	02	40.0	03	60.0	
Parity						
1 st	67	34	49.3	33	50.7	3.212 ^{ns} df ₂
2 nd	71	36	50.7	35	49.3	
3 rd	18	09	50.0	09	50.0	

* = significant at 0.05, ** = significant at $p < 0.01$, *** = significant at $p < 0.001$, ns=not significant

Trichuris prevalence

The overall prevalence of *Trichuris* in the study population was 45.0%. Sheep breed effect on prevalence was significant ($p<0.001$). The highest prevalence rate of 56.2% was observed in Yankasa, followed closely by WAD with 55.7%, Uda, 30.4% and lowest (25.0%) in Balami. Significant ($p<0.01$) influence of sex was also observed. Males had higher prevalence of 32.7% than females with 20.3%. Similarly, age significantly ($p<0.001$) influenced prevalence. There was higher prevalence, 65.6% in adult sheep than lambs, 36.5%. Significant ($p<0.01$) influence of season on prevalence was observed. The highest prevalence (61.8%) was in early rainy,

followed by late rainy, 56.4%, late dry, 44.0% while the lowest value of 38.2% was observed in the early dry season. Year did not significantly influence prevalence. The respective yearly prevalence rates were 47.1, 45.3 and 42.7% in the first, second and third.

Body condition scores had significant effect ($p<0.001$) on prevalence. The highest prevalence (66.7%) was observed in animals with BCS 1.0 while the lowest (33.3%) was in BCS 4.0. Lamb's birth type and parity did not significantly influence prevalence. Prevalence rates were 35.1, 38.6 and 40.0% in singles, twins and triplets; and 35.8, 35.2 and 44.4% in first, second and third parities, respectively.

Table 5: Prevalence of *Trichuris* by sheep breed and environmental factors

	Total (N)	Non-Infected		Infected		X ²
		No	%	No	%	
Overall	220	121	55.0	99	45.0	
Breed						
Balami	40	30	75.0	19	25.0	12.033***df ₃
Uda	46	32	69.6	14	30.4	
WAD	61	27	44.3	34	55.7	
Yankasa	73	32	43.8	41	56.2	
Sex						
Male	104	70	67.3	34	32.7	13.972**df ₁
Female	116	51	79.7	65	20.3	
Age (Months)						
0-4	156	99	64.5	57	36.5	13.997***df ₁
>4	64	22	34.4	42	65.6	
Season						
Early dry	55	34	61.8	21	38.2	20.321**df ₃
Late dry	55	42	56.0	13	44.0	
Early rainy	55	21	38.2	34	61.8	
Late rainy	55	24	43.6	31	56.4	
Year						
First	70	37	52.9	33	47.1	2.320 ^{ns} df ₂
Second	75	41	54.7	34	45.3	
Third	75	43	57.3	32	42.7	
BCS						
1.0	03	01	33.3	02	66.7	50.321***df ₆
1.5	09	04	44.4	05	55.6	
2.0	32	14	43.8	05	56.2	
2.5	76	37	48.7	39	51.3	
3.0	77	48	62.3	29	37.7	
3.5	20	15	75.0	29	37.7	
4.0	03	02	66.7	01	33.3	
Birth type						
Single	94	61	64.9	33	35.1	3.523 ^{ns} df ₂
Twins	57	35	61.4	22	38.6	
Triplet	05	03	60.0	02	40.0	
Parity						
1 st	67	43	64.2	24	35.8	3.441 ^{ns} df ₂
2 nd	71	46	64.7	25	35.2	
3 rd	18	10	55.6	08	44.4	

* = significant at 0.05, ** = significant at $p < 0.01$, *** = significant at $p < 0.001$, ns=not significant

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Nematodirus prevalence

The overall *Nematodirus* prevalence was 46.4%. Significant ($p < 0.01$) breed influence on *Nematodirus* prevalence was observed. Yankasa had the highest prevalence 56.9% followed by WAD, 53.4%, Uda, 25.0% and Balami, 22.5%. Sex however did not significantly influenced prevalence. The prevalence rates were 48.1% in male and 44.8% in females. Age significantly ($p < 0.01$) influenced prevalence. Adults had higher prevalence (51.6%) than lambs with 44.2%. Similarly, significant ($p < 0.01$) influence of season was observed. The highest prevalence rate of 63.6% was

observed in late rainy season, followed by early rainy 56.4%, early dry, 45.5% and the least, 20.8% was in late dry. The yearly prevalence rates of 50.0, 48.0 and 41.3% respectively in first, second and third did not significantly differ. Body condition score however significantly ($p < 0.001$) influenced prevalence. Birth type significantly affected prevalence. The highest prevalence rate was observed in singles, 47.9, followed by triplets, 40.0, while twins had the lowest, 38.6%. Prevalence rates were 43.3, 42.9 and 50% respectively in first, second and third parity lambs. There was no significant difference between them.

Table 6: Prevalence of *Nematodirus* by sheep breed and environmental factors

	Total (N)	Non-Infected		Infected		X ²
		No	%	No	%	
Overall	220	118	53.6	102	46.4	
Breed						
Balami	40	31	77.5	09	22.5	9.896**df ₃
Uda	46	30	75.0	16	25.0	
WAD	61	26	46.6	45	53.4	
Yankasa	73	31	43.1	42	56.9	
Sex						
Male	104	54	51.9	50	48.1	3.897**df ₁
Female	116	64	55.2	52	44.8	
Age (Months)						
0-4	156	87	55.8	69	44.2	12.321**df ₁
>4	64	31	48.4	33	51.6	
Season						
Early dry	55	30	54.5	25	45.5	19.720**df ₃
Late dry	55	44	80.0	11	20.8	
Early rainy	55	24	43.6	31	56.4	
Late rainy	55	20	36.4	35	63.6	
Year						
First	70	35	50.0	35	50.0	2.097 ^{ns} df ₂
Second	75	39	52.0	36	48.0	
Third	75	44	58.7	31	41.3	
BCS						
1.0	03	01	33.3	02	66.7	51.332***df ₆
1.5	09	01	11.1	08	88.9	
2.0	32	13	40.6	19	59.4	
2.5	76	41	53.9	35	46.1	
3.0	77	45	58.4	32	41.6	
3.5	20	14	70.0	06	30.0	
4.0	03	03	100.0	00	00.00	
Birth type						
Single	94	49	52.1	45	47.9	7.897*df ₂
Twins	57	35	61.4	22	38.6	
Triplet	05	03	60.0	02	40.0	
Parity						
1 st	67	38	56.7	29	43.3	2.997 ^{ns} df ₂
2 nd	71	40	57.1	31	42.9	
3 rd	18	09	50.0	09	50.0	

* = significant at 0.05, ** = significant at $p < 0.01$, *** = significant at $p < 0.001$, ns=not significant

Discussion

The overall prevalence of gastrointestinal (GI) helminths in the present study is higher than values reported by various workers. Mbap and Chiroma (1998) and Ibukun and Oladunsi (2015) reported an overall prevalence rates of 81.4% and 82.7% in Bauchi and Minna, Nigeria, respectively. Alade and Bwale (2015) found an overall prevalence of 60.4% in Maiduguri, Nigeria. Sangma *et al.* (2012) reported a value of 81.1% in Bangladesh. Pandit *et al.* (2003), Tramboo *et al.* (2015) reported prevalence rates of 65.4%, 62.9% and 77.00% respectively in sheep of Kashmir valley, India. Yadav *et al.* (2006), Khajuria *et al.* (2013) and Tramboo *et al.* (2015) reported prevalence rates of 83.24, 68.54 and 77.00%, respectively in sheep of Jammu, India. Moti (2008), Dagnachew *et al.* (2011), Zerihun (2012) and Diriba and Birhanu (2013) reported overall prevalence rates of 76.3, 79.09, 59.89 and 68.1% respectively from different parts of Ethiopia. Raza *et al.* (2012) reported overall prevalence of 78.0% in Pakistan. Lower overall prevalence rates of 53.97% was reported in Abuja, Nigeria (Solomon-wisdom *et al.* 2014) and 65.5% in Yankasa sheep in Lafia (Hassan *et al.*, 2013). The overall prevalence rate reported in the present study is highest when compared to most previous reports. This might be due to ecological and management difference and especially as the experimental sheep in this study were never subjected to any form of deworming during the research period. In the current finding, overall *Strongyles*, prevalence rate predominated those of other species. The predominance of *Strongyles* infection over other helminth species had been similarly reported. Tramboo *et al.* (2015) found overall *Strongyles* prevalence of 60.92% in Sheep of Kashir valley, India which was predominant over *Moniezia* (7.92%), *Strongloides* (1.67%) and *Trichuris*

(1.50%). Shahnawaz *et al.* (2011) reported overall cestode prevalence of 11.68% in sheep in Ganderbal district of Kashmir valley. Tariq *et al.* (2008) also reported overall 61.6% nemathelminths prevalence in sheep of Kashmir valley. The predominance of *Strongyles* over other nematodes and cestodes in sheep have similarly been reported by Pandit *et al.* (2003) and Wani *et al.* (2011) in Kashmir valley; Khajuria and Kapoor (2003) and Yadav *et al.* (2006) in sheep of Jammu region, India; Raza *et al.* (2014) in sheep of Chodist desert of Pakistan and Ibukun and Oludunsi (2015) in Minna, Nigeria; That overall helminths prevalence in this study ranked breeds in the following order: Yankasa, WAD, Balami, and Uda from the highest to lowest. This differs from the finding of Thlama *et al.* (2016) in Maiduguri, Nigeria. These authors found highest prevalence in Uda (100%) followed by Yankasa (77.1%) while Balami (66.7%) was least. Dafur (2008b) reported that Yankasa had highest prevalence followed by Uda and Balami under communal management system on the Jos Plateau. However, these reports contradict that of Mbap and Chiroma (1996) who found no significant difference in helminths prevalence among Yankasa, Uda and Balami sheep in Bauchi. Difference in findings could be due to ecology, climate and management practices (Dafur *et al.*, 2008a).

Sex

Significant influence of sex on prevalence with females exhibiting higher values than males in this study agrees with previous studies. Higher prevalence in female than male sheep had been reported in Maiduguri (Thlama *et al.*, 2016), Abuja (Solomon-Wisdom *et al.*, 2014), Bauchi (Mbap and Chiroma, 1998), and Jos (Dafur *et al.*, 2008b) in Nigeria. Similar finding was recorded in Pakistan (Raza *et al.*, 2014). However, the present finding contravenes

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the report of Hassan *et al.* (2013) and Ibukun and Oludunsi (2015) in Nigeria and Gatachew *et al.* (2017) in Ethiopia who all found non-significant difference between sex in helminth prevalence.

Age

The significantly higher prevalence of total helminths, *Strongyles*, *Strongyloides*, *Moniezia*, *Trichuris* and *Nematodirus* observed in adult sheep than suckling lambs are in consonance with the reports of various workers. Thlama *et al.* (2016) found higher prevalence of all parasites species, *cestodes* and *strongyles* in adult than young sheep (with respective values of 82.4 vs 65.8%, 2.1 vs 0.0% and 36.0 vs 17.1%) in Maiduguri, Nigeria. Similarly, Hassan *et al.* (2013) found significantly lowest prevalence (2.1%) in lamb (< 6 months old) as compared to 6-12 months (28.7%) and above 12 months (34.7%) in Yankasa sheep in Lafia, Nigeria. Tramboo *et al.* (2015) recorded significantly higher prevalence of all gastrointestinal helminths in adults (> 1 year, 83.00%) than lambs and hoggets (< 1 year, 53.11%) in sheep of Kashmir valley, India. The authors further reported higher prevalence rates of trematodes and nemathelminths in adults than young sheep. Other workers, Swarnkar *et al.* (1996) and Yadav *et al.* (2006) similarly reported higher helminths prevalence in adults than young sheep. Tramboo *et al.* (2015) however observed lower *Moniezia* prevalence in adult than young sheep. Other reports of higher prevalence in young than adult sheep include (Pal and Qayyum, 1992; Getachew *et al.*, 2017). Mbap and Chiroma (1998) on the other hand did not find any significant difference between age groups in helminths prevalence.

Body condition score

In the present study, BCS was observed to affect prevalence of gastrointestinal (GI) helminths, especially in animals with lower BCS values. This is in agreement with some

previous reports. Thlama *et al.* (2016) found higher prevalence of GI parasites and *Strongyles* in emaciated and thin sheep in Maiduguri as compared to those with average BCS. Getachew *et al.* (2017) also found highest prevalence in sheep with poor BCS (73.1%) in Ethiopia compared to the ones with medium BCS (52.6%) and good BCS (37.5%). The lower prevalence of helminths in sheep with good BCS could be due to better immunity. It may also signify the importance of parasites in causing weight loss (Urquhart *et al.*, 1996; Radostits *et al.*, 2007).

Season

Influence of season on prevalence of parasites as seen in the present study especially in wet than dry seasons have similarly been documented by several researchers (Swarnkar *et al.*, 1996; Dafur *et al.*, 2008b; Tramboo *et al.*, 2015). Dafur *et al.* (2008b) observed generally higher prevalence of GI helminths in rainy than dry season in sheep under communal management on the Jos plateau, Nigeria. Tramboo *et al.* (2015) observed higher prevalence in summer followed by spring, autumn while winter was least in Kashmir valley sheep of India. Swarnkar *et al.* (1996) earlier observed peak parasitism in summer under semi-arid conditions. Tramboo *et al.* (2015) suggested that the highest rates of infection in summer was due to favourable environmental condition for hatching and development of free-living larval stages. Okon and Enyenih (1977) and Umoh *et al.* (1982) also suggested that rainfall is one of the epizootiological factors that favour egg and larval development. Gibbs (1982) stated that the most suitable factors that determine larval survival on pasture are temperature, moisture and rainfall.

Year, parity and birth type

Year, dam's parity and lamb's birth type did not influence helminthosis prevalence in the present study. This could be due to

similarities in environmental conditions and management practices. Non-significant higher prevalence was also observed by Ibukun and Oludunsi (2015) in the year 2013 (84.0%) and 2012 (81.2%) in Minna, Nigeria.

Conclusions and recommendations

In conclusion, there was high helminth prevalence in the study area. Nigerian sheep breeds vary in susceptibility to helminthosis with Yankasa and WAD being more susceptible compared to Balami and Uda. Helminth infections are higher in female and older sheep than males and suckling lambs respectively. Helminth infection is higher in wet than dry season. Breed variation in prevalence to helminthosis should be exploited through selection and cross breeding to control the disease without or with minimal use of anthelmintics. Greater attention should be paid to older sheep (> 4 months), females and rainy seasons in worm control.

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