Animal and Veterinary Sciences
2022; 10(4): 83-93
http://www.sciencepublishinggroup.com/j/avs
doi: 10.11648/j.avs.20221004.12
ISSN: 2328-5842 (Print); ISSN: 2328-5850 (Online)

Prevalence and Seasonal Abundance of Gastrointestinal Parasites of Merino Sheep in Maseru District, Lesotho

Moeketsi Solomon Phalatsi[1, *], Mats'olo Seloanyane[1], Mokete Motente[1], Mamasupha Sole[1], Mabusetsa Joseph Makalo[2], Leballo Gilbert Matsepe[3]

[1]Department of Biology, Faculty of Science and Technology, National University of Lesotho, Roma, Lesotho

[2]Department of Livestock Services, Central Veterinary Laboratory, Maseru, Lesotho

[3]Department of Animal Science, Faculty of Agriculture, National University of Lesotho, Roma, Lesotho

Email address:

moeketsiphalatsi@yahoo.co.uk (M. S. Phalatsi)

[*]Corresponding author

To cite this article:

Moeketsi Solomon Phalatsi, Mats'olo Seloanyane, Mokete Motente, Mamasupha Sole, Mabusetsa Joseph Makalo, Leballo Gilbert Matsepe. Prevalence and Seasonal Abundance of Gastrointestinal Parasites of Merino Sheep in Maseru District, Lesotho. *Animal and Veterinary Sciences*. Vol. 10, No. 4, 2022, pp. 83-93. doi: 10.11648/j.avs.20221004.12

Received: June 28, 2022; **Accepted**: July 20, 2022; **Published**: July 29, 2022

Abstract: Gastrointestinal parasites are known to be some of the major limiting factors for successful and productive sheep industry all over the world. Livestock production in Lesotho relies predominantly on communal grazing which presents serious challenges for the management and control of animal diseases. The present study was conducted to investigate the effect of different agroecological zones, animal age and seasonal changes on the prevalence and intensity of gastrointestinal parasites in Maseru District, Lesotho from December 2017 and November 2018. The McMaster technique was used to determine the burdens and prevalence of parasites in three agroecological zones. Three agroecological zones sampled were Lowlands, Foothills and Highlands represented by Korokoro area, Setebing and Mohale Dam area respectively. Gastrointestinal parasites had an overall prevalence of 89.2% of all sheep sampled. The prevalence of three types of gastrointestinal parasites identified and quantified in the present study were 73.3%, 61.7% and 1.9% for *Eimeria spp*, strongyles, and *Monezia spp.* respectively. Strongyles and *Eimeria spp* were present throughout the study period while *Monezia* spp were very low and absent during some winter months. *Eimeria spp* had the highest counts (2386.74 ± 270.71) followed be strongyles (1165.19 ± 107.33) during summer season. Agroecology did not have a significant ($P > 0.05$) effect on infection loads. Prevalence was significantly different ($P < 0.05$) between the Foothills and Highlands. Sheep age had significantly different ($P < 0.05$) effect on strongyles with relatively high adults counts. *Eimeria* spp oocysts were significantly different ($P < 0.05$) by agroecological zones, age and seasonality. *Eimeria* spp infection gravitated towards lambs than adult sheep. There was a remarked drop in oocyst output in February after weaning of lambs. There was significantly ($P < 0.05$) more propensity for higher infections of *Monezia spp* in lambs than in adults. *Eimeria spp* and strongyles were present in sheep the entire study period. The different factors investigated in the study had varying effects on the burdens and prevalence of gastrointestinal parasite of Merino sheep. Seasonal variations had overall significant influence on both prevalence and abundance of parasites in the study area.

Keywords: Gastrointestinal Parasites, Agroecology, Prevalence, *Eimeria spp*, *Monezia spp*, Strongyle

1. Introduction

Livestock production is one of the major contributors towards Lesotho's economy, amounting to about 78% of all agricultural GDP [1]. Wool and mohair are the main livestock product exports which contributed immensely to Lesotho's economy for more than 100 years [1, 2]. In 2017/2018 financial year Lesotho exported wool of about 3,753,064kg amounting to about $25,467,393.00. Small ruminant production remains one of the major economic activities making livelihoods for poor resource communities of Lesotho. Gastrointestinal parasites (GIP) infestation remains a huge limiting factor to successful small ruminant production across the globe [3-5]. Taylor M. A. estimated about 150 endoparasites and ectoparasites infected small ruminants [6].

Gastrointestinal parasite occurrence in hosts offers indicative parasites burdens as a measure of infection rate [7]. These parasites include a strongyle, *Haemochus contortus*, the most pathogenic GIP of small ruminants across the globe [8, 9]. Haemonchosis was recorded as the most widespread and devastating gastrointestinal disease infecting wild and domesticated ruminants worldwide and the only strongyle parasite described in Lesotho to-date [10-13]. The relationship between gastrointestinal parasites' development and the environmental conditions provides an epidemiological context to the diseases they cause. Coccidiosis caused by *Eimeria* spp was largely associated with disparities in sheep production systems and was found predominantly in young animals [14, 15]. *Eimeria* spp are gastrointestinal protozoan parasites which corrode the intestinal epithelial cells causing diarrhea, characteristic of coccidiosis in growing kids and lambs [9, 16]. *Monezia* spp are also important helminths of ruminants.

Sheep in resource poor communities are grazed in communal pastures mixed with other livestock species that include goats, cattle, donkeys and horses [17]. Pasture grazing was reported as major risk facing livestock industry worldwide as animals are continuously exposed to GIP infections [18]. The survival and development of the free-living stages of GIP on the pastures consequently depend on environmental conditions. GIP such as helminths are present in the tropics and their prevalence and intensity reported to follow seasonal trends [8]. Prior studies have reported gastrointestinal helminths to be prevalent during rainy seasons [19, 20]. Pasture infestation and infectivity by *H. contortus* larvae in Nigeria were found to be seasonal owing largely to seasonal rains as major driving force [21]. Nwosu et al. reported gastrointestinal parasites studied in North-eastern Nigeria, stronglyles counts were consistent with the rainy seasons [22]. Magona and Musis found factors such as age, grazing system and agro-climatic zones to have a significant effect on the helminths egg output in Uganda [23].

The effective control of GIP has been achieved in other countries through integrated approach strategically combining factors such as anthelmintic drug administration, pasturelands management and usage of bioactive forages [24]. Different GIPs display different virulence and pathogenicity levels which also influence their propensity to exhibit host morbidity [25]. The importance of parasite identification cannot be overemphasized as it leads to correct diagnosis and appropriate action. Comparative morphological identification of GIP's eggs, adult and larvae continues to be a very important approach in diagnostics. There is however, insufficient information on prevalence, diversity, geographical distribution and seasonal dynamics of sheep GIPs in Lesotho. The study was designed to determine the effects of different agroecological zones, seasonality and sheep's age on GIPs infestation and prevalence in Merino sheep in Maseru District, Lesotho.

2. Material and Methods

2.1. Ethical Approval

The ethical research committee at the faculty of Agriculture, Department of Animal Science sanctioned the study. Participating farmers granted the permission for faecal collection from their animals. Area chiefs and police department were notified as tagging changed the identification of used animals.

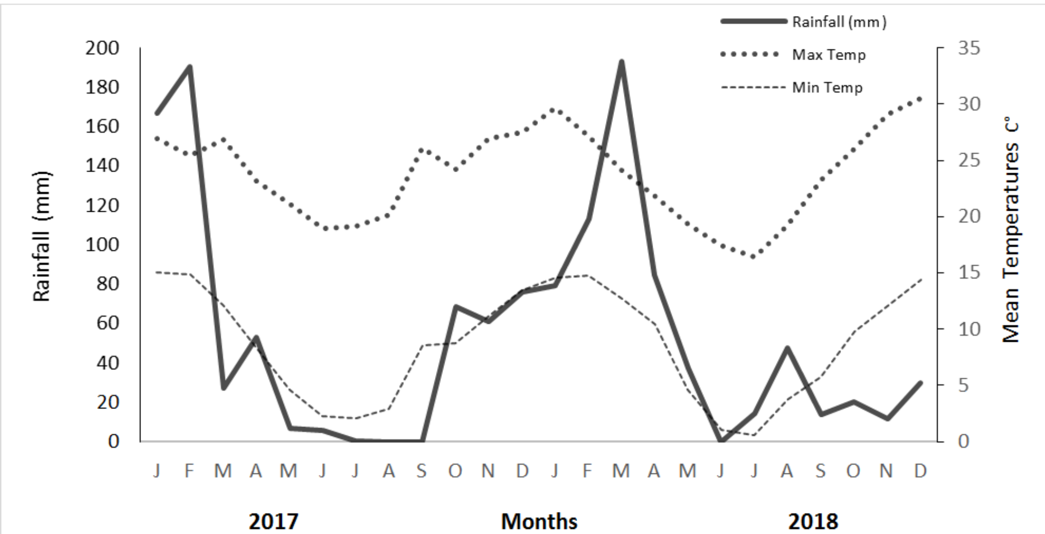

Figure 1. *Mean monthly rainfall (mm), maximum and minimum temperatures (℃) recorded at Mejametalana Weather Station in Maseru District during December 2017- November 2018.*

2.2. Study Area

The study was a longitudinal sectional type carried out over 12 months from December 2017 to November 2018. The research was done in the three agro-ecological zones of Maseru. The Lowlands represented by Koro-Koro area, -

29.5018°S, 27.6420°E and 1530m above sea level. The Foothills covered the Setibing area at -29.3174°S, 27.5188°E and 1800m above sea level while the Highlands were villages nearby Mohale Dam area at -29.4584°S, 28.0973°E and 2100m above sea level. Lesotho, completely landlocked by South Africa is generally characterised as a temperate climate mixed with attributes of an Alpine due to the existence of mountainous topographic landscapes. The country experiences hot summers usually humid and cold and dry winters (Figure 1). The Alpine addition makes winters to be colder than the normal climate character. There are four distinctively well-defined seasons, namely, summer (November, December and January), autumn (February, March and April), winter (May, June and July) and spring (August, September and October). Meteorological data for the present study comprising of mean monthly maximum and minimum temperatures and mean monthly rainfall (mm) in Figure 1 was sourced from Mejametalana Weather Station in Maseru District.

2.3. Animal Selection and Faecal Sample Collection

Three small-scale farmers were randomly selected from the members of wool and mohair association in respective agroecological zone. Each farmer provided 20 sheep comprising of 10 lambs and 10 adults. Lambs aged one to three months (only lambed in October/November) and adult sheep above a year old were selected for sampling. Sheep used were customarily grazed communally. Same animals were tagged and used for the entire 12-month period of the study. When a tagged animal was sold or died, it was replaced with a similar age animal from the same farm. The animals were keep under their owners care for the entire study. Major changes and management activities were recorded as and when they happened. 1804 samples were collected and analysed in the Parasitology Laboratory at National University of Lesotho. Faecal samples were collected directly from animal's rectum for 12 months. They were put in labelled sample bottles and placed in a cooler box with ice packs and transported to the Parasitology Laboratory at the National University of Lesotho for analysis. Samples were immediately placed into a refrigerator set at 4°C on arrival. All samples were analysed within 48 hours of collection. A McMaster technique of faecal egg count (FEC) was used [26]. Identification of the GIPs was done as per guides from Indre et al., Shore D. A. and Soulsby E. J. L. [27-29]. Saturated Sodium Chloride solution was prepared as the floatation solution by mixing 400g with 1000ml of distilled water. For analysis two grams of the faecal sample were measured and placed in a 100ml glass bottle, where 58ml of saturated Sodium Chloride was added and homogenized until the faeces were well dispersed. The faecal solution was then run through a 150µm sieve to remove debris. Few drops of amyl alcohol were also added to the mixture and left for two minutes to breakdown air bubbles. The McMaster slide was wetted and two chambers filled with faecal suspension. The samples were observed under the compound microscope to identify and FEC as helminths' eggs per gram (EPG) of faeces and coccidial oocysts per gram (OPG) were established.

2.4. Statistical Analysis

SPSS statistical package 20.0 was used for data analysis. Descriptive statistics together with one-way analysis of Variance (ANOVA) were used to determine variance of means between different variables where P<0.05 considered to be significant. The Post-hoc Scheffe test was also used to predict the comparisons between groups of variables. Exponential Beta ratios were utilized to assess the odds on levels of susceptibility of sheep to gastrointestinal parasites across all tested variables.

3. Results

An overall prevalence of 89.2% of sheep sampled were positive for all gastrointestinal parasites namely *Eimeria* spp, strongyles and *Monezia* spp. *Eimeria* spp were the most prevalent of all GIPs investigated. *Eimeria* spp, *Monezia* spp and strongyles prevalence rates were 73.28%, 61.7% and 1.9% respectively. Both the strongyle and *Monezia* spp EPG counts were not significantly different (P>0.05) whereas *Eimeria* spp counts were significantly different between AEZs (Table 1). *Eimeria* spp and Strongyles eggs were discovered in both lambs and adult sheep for the entire study period except for *Monezia* spp which was absent in some months. *Eimeria spp* and Strongyles portrayed relatively high burdens from December and February.

Strongyle egg loads of sheep were more in the Foothills than Lowlands and Highlands by not significantly different (P>0.05). Analysis of data under Generalized Estimating Equations (GEE) potrayed the strongyle egg counts with significant (P<0.05) propensity for higher burdens from Lowlands to Foothills while the reverse was eminent from Lowlands to Highlands. The overall *Eimeria* spp OPG counts from sheep in the Lowlands were significantly different (P<0.05) from those in the Foothills. Lambs *Eimeria* spp oocysts were significantly (P<0.05) about twice more likely in abundance for Lowlands (1418.25±156.554) than in the Foothills (823.36±115.248). The Highlands *Eimeria* oocysts counts were not significantly different (P>0.05) from counts registered from Lowlands and Foothills.

Age wise comparison of strongyle burdens showed adults (795.93±55.5.4) had more and significantly different (P<0.05 counts than those found in lambs (682.42±60.312). *Monezia* spp counts in lambs were more than in adults but were not statistically different (P>0.05) between the two age groups. *Eimeria* spp counts in Lambs were different from the helminths in that they showed significant difference (P<0.05) from adults. *Eimeria* spp odds in lambs (1903.11±170.414) were seven times more significantly different (P<0.05) than to those recorded for adult sheep (262.98±20.318) on OPGs. Summer and autumn were both higher on strongyle burdens and were also significantly different (P<0.05) from winter and spring seasons'.

January and February yielded highest strongyle faecal egg counts, 2368.10±288.039 and 1955.33±212.650 respectively and were significantly different (P<0.05) from results of the rest of other months. The summer *Eimeria* spp OPG were significantly (P<0.05) nine times more in abundance than in spring. *Monezia* spp was relatively higher in summer but overall burdens were not found statistically different (P>0.05) with between all three seasons under the Scheffe test. The *Eimeria* spp OPG counts were observed to drop markedly from 3334.36±650.907 in January to 858.67±149.362 in February after recorded weaning of lambs by majority of the farmers (Table 3). It was after this lambing incidence that the overall *Eimeria* spp burdens were maintained below 1000 OPG for nine consecutive months ending in October. *Monezia spp* eggs were not found in sheep from June to October 2018.

Table 1. *The faecal egg counts (EPG/OPG) of strongyles, Monezia spp and Eimeria spp from sheep in the three agroecological zones of the Maseru district in Lesotho from December 2017 to November 2018.*

Parasite	Factors	N	EMM	SD.	SE	Exp (B)	Sig.
AGROECOLOGY							
Strongyles	Highlands	546	667.58[a]	1376.364	58.903	.882	0.000
	Foothills	595	785.41[a]	1654.751	67.838	1.037	0.000
	Lowlands	663	757.16[a]	2056.419	79.865	1	0.000
	Total	1804	739.37	1740.630	40.982		
Monezia	Highlands	546	30.78[a]	456.558	19.539	1.316	0.000
	Foothills	595	115.13[a]	1232.776	50.539	4.923	0.000
	Lowlands	663	23.39[a]	280.611	10.898	1	0.000
	Total	1804	55.88[a]	770.931	18.151		
Eimeria spp	Highlands	546	950.00[ab]	4157.435	177.922	.670	0.000
	Foothills	595	823.36[a]	2811.211	115.248	.581	0.000
	Lowlands	663	1418.25[b]	4031.082	156.554	1	0.000
	Total	1804	1080.32	3723.363	87.663		
SHEEP AGE							
Strongyles	Lambs	899	682.42[a]	1808.346	60.312	1.166	0.000
	Adult	905	795.93[b]	1669.728	55.504	1	0.000
	Total	1804	739.37	1808.348	60.312		
Monezia	Lambs	899	112.02[a]	1089.497	36.337	0.001	0.000
	Adult	905	0.11[a]	3.327	0.111	1	0.000
	Total	1804	55.88	1089.497	36.337		
Eimeria spp	Lambs	899	1903.11[a]	5109.582	170.414	0.138	0.000
	Adult	905	262.98[b]	611.242	20.318	1	0.000
	Total	1804	1080.32	5109.786	170.421		
SEASON							
Strongyle	Summer	543	1165.19[a]	2500.98	107.33	2.722	0.000
	Autumn	425	1025.88[a]	1823.59	88.46	2.396	0.000
	Winter	426	210.33[b]	422.14	20.453	0.491	0.000
	Spring	410	428.10[b]	848.60	41.909	1	0.000
	Total	1804	739.37	1740.630	40.982		
Monezia	Summer	543	134.99[a]	1125.66	48.31	-	-
	Autumn	425	64.02[a]	945.14	45.85	-	-
	Winter	426	0.70[a]	10.82	0.524	-	-
	Spring	410	0.00[a]	0.000	.000	-	-
	Total	1804	55.88	777.931	18.151		
Eimeria spp	Summer	543	2386.74[a]	6308.08	270.71	9.275	0.000
	Autumn	425	730.35[b]	1492.67	72.41	2.838	0.000
	Winter	426	556.34[b]	1571.15	76.127	2.162	0.000
	Spring	410	257.32[b]	386.71	19.098	1	0.000
	Total	1804	1080.32	3723.363	87.663		

N = Number of sheep observed, EMM=Estimated Marginal Means, SD = Standard Deviation, SE = Standard Error, Estimated marginal means with similar subscript ([a,b]) are not significantly different (P=0.05), Exp (B) = Exponential Beta value, Sig= Significant difference value.

Table 2. *Prevalence of strongyles, Monezia spp and Eimeria spp from sheep in the agroecological zone of the Maseru district in Lesotho.*

Categories	Factors	N	Mean Prev%	SD.	SE	Exp (B)	Sig
AGROECOLOGY							
Strongyles	Highlands	546	(317) 58[a]	0.493	0.021	0.975	0.000
	Foothills	595	(393) 66[b]	0.475	0.019	0.746	0.000
	Lowlands	663	(405) 61[ab]	0.489	0.019	1	0.000
	Total	1804	61.7	0.489	0.011		

Categories	Factors	N	Mean Prev%	SD.	SE	Exp (B)	Sig
Monezia	Highlands	546	(55) 1[a]	0.113	0.05	-	0.000
	Foothills	595	(119) 2[a]	0.114	0.06	-	0.000
	Lowlands	663	(199) 3[a]	0.273	0.011	-	0.000
	Total	1804	2	0.196	0.05		
Eimeria spp	Highlands	546	(372) 68[a]	0.466	0.020	1.744	0.000
	Foothills	595	(429) 72[ab]	0.448	0.018	1.369	0.000
	Lowlands	663	(518) 78[b]	0.413	0.016	1	0.000
	Total	1804	73	0.443	0.010		
SHEEP AGE							
Strongyles	Lambs	899	(513) 57[b]	0.493	0.017	0.653	0.000
	Adult	905	(598) 66[a]	0.474	0.016	1	0.000
Monezia	Lambs	899	(36) 4[a]	0.009	.002	-	-
	Adult	905	(0.11) 0.00[b]	0.047	0.002	-	-
Eimeria spp	Lambs	899	(756) 84[a]	0.368	0.012	3.155	0.000
	Adult	905	(571) 63[b]	0.484	0.016	1	0.000
SEASON							
Strongyles	Summer	543	(337) 62[a]	0.485	.021	1.207	0.000
	Autumn	425	(298) 70[a]	0.458	.022	1.010	0.000
	Winter	426	(222) 52[b]	0.500	.024	1.605	0.000
	Spring	410	(254) 62[a]	0.485	.024	1	0.000
Monezia	Summer	543	(22) 4[a]	0.206	0.009	-	-
	Autumn	425	(13) 3[ab]	0.320	0.016	-	-
	Winter	426	(2.33)0[b]	0.068	0.003	-	-
	Spring	410	(0) 0[b]	0.00	0.00	-	-
Eimeria spp	Summer	543	(435) 80[b]	0.404	0.017	.510	0.000
	Autumn	425	(302) 71[a]	0.454	0.022	.836	0.000
	Winter	426	(311) 73[ab]	0.447	0.022	.777	0.000
	Spring	410	(379) 68[a]	0.467	0.023	1	0.000

N = Number observed, EMM=Estimated Marginal Means, Mean% Prev = Mean Percentage Prevalence, SD=Standard Deviation, SE=Standard Error, Mean Percentage Prevalence with similar subscript ([a,b]) are not significantly different (P=0.05), Exp (B) = Exponential Beta Value, Sig= Significant difference value.

Table 3. *The monthly faecal egg counts of strongyle, Eimeria spp and Monezia spp from Merino sheep in the agroecological zones of the Maseru district, Lesotho.*

Parasite/Month		EPG/OPG					
		N	EMM	SD	SE	Exp (B)	Sig.
Strongyles	December	165	805.45[a]	2069.207	161.088	0.884	0.811
	January	163	2368.10[b]	3677.437	288.039	2.914	0.000
	February	150	1955.33[b]	2604.424	212.650	2.503	0.001
	March	119	637.82[a]	1007.177	92.328	0.798	0.356
	April	156	428.2[a]	702.052	56.209	0.548	0.006
	May	129	251.94[a]	478.131	42.097	0.318	0.000
	June	143	220.98[a]	331.844	27.750	0.279	0.000
	July	154	165.58[a]	444.925	35.853	0.195	0.000
	August	141	117.02[a]	294.947	24.839	0.142	0.000
	September	133	327.07[a]	512.440	44.434	0.390	0.000
	October	136	849.4[a]	1242.895	106.577	1	-
	November	215	529.30[a]	845.564	57.667	0.617	0.197
Eimeria spp	December	165	2890.9[bc]	6119.310	476.388	5.068	0.000
	January	163	3334.36[c]	8310.223	650.907	4.574	0.000
	February	150	858.67[a]	1829.299	149.362	1.464	0.181
	March	119	936.97[a]	1610.130	147.600	2.515	0.039
	April	156	449.36[a]	881.018	70.538	0.910	0.723
	May	129	918.60[a]	2389.749	210.406	1.770	0.041
	June	143	511.19[a]	1239.213	103.628	0.997	0.992
	July	154	294.81[a]	688.068	55.446	0.766	0.319
	August	141	175.89[a]	261.288	22.004	0.509	0.036
	September	133	263.16[a]	448.816	38.917	0.848	0.635
	October	136	336.03[a]	414.849	35.573	1	-
	November	215	1281.40[ab]	4206.896	286.908	1.887	0.046

Parasite/Month		EPG/OPG					
		N	EMM	SD	SE	Exp (B)	Sig.
Monezia spp	December	165	187.27 [a]	993.464	77.341	-	-
	January	163	248.47 [a]	1783.579	139.701	-	-
	February	150	177.33 [a]	1587.668	129.633	-	-
	March	119	1.68 [a]	18.334	1.681	-	-
	April	156	2.63 [a]	32.026	2.564	-	-
	May	129	2.33 [a]	19.626	1.728	-	-
	June	143	0.00 [a]	0.000	0.000	-	-
	July	154	0.00 [a]	0.000	0.000	-	-
	August	141	0.00 [a]	0.000	0.000	-	-
	September	133	0.00 [a]	0.000	0.000	-	-
	October	136	0.00 [a]	0.000	0.000	-	-
	November	215	8.84 [a]	129.579	8.837	-	-

N = Number of observed animals, EMM=Estimated Marginal Means, Mean% Prev. = Mean Percentage Prevalence, SD=Standard Deviation, SE=Standard Error, Sig= Significance value, Exp (B) = Exponential Beta value, Estimated Marginal Means and Mean Percentage Prevalence with similar subscript ([a,b,c]) are not significantly different (P=0.05).

Table 4. *The monthly prevalence of Strongyle, Eimeria spp and Monezia spp from Merino sheep in the agroecological zones of the Maseru district, Lesotho.*

Parasites	Months	N	EMM	SD	SE	Exp (B)	Sig.
Strongyles	December	165	49[ab]	0.501	0.039	2.448	0.005
	January	163	78[cde]	0.416	0.033	1.083	0.684
	February	150	89[e]	0.310	0.025	0.682	0.095
	March	119	66[bcde]	0.477	0.044	1.579	0.058
	April	156	55[abc]	0.499	0.040	2.090	0.000
	May	129	54[abc]	0.500	0.044	2.092	0.001
	June	143	62[abcd]	0.486	0.041	1.740	0.027
	July	154	40[ab]	0.492	0.040	3.076	0.000
	August	141	42[ab]	0.495	0.042	2.923	0.000
	September	133	65[bcde]	0.477	0.041	1.580	0.035
	October	136	80[de]	0.400	0.034	1	-
	November	215	61[abcd]	0.435	0.030	1.757	0.023
Eimeria spp	December	165	86[a]	0.347	0.027	0.704	0.122
	January	163	79[ab]	0.408	0.032	0.940	0.787
	February	150	67[ab]	0.473	0.039	1.468	0.045
	March	119	76[ab]	0.431	0.040	1.081	0.655
	April	156	72[ab]	0.451	0.036	1.220	0.207
	May	129	77[ab]	0.424	0.037	1.116	0.629
	June	143	73[ab]	0.447	0.037	1.192	0.285
	July	154	69[ab]	0.465	0.037	1.295	0.111
	August	141	60[b]	0.491	0.041	1.719	0.006
	September	133	65[ab]	0.477	0.041	1.530	0.014
	October	136	79[ab]	0.411	0.035	1	-
	November	215	75[ab]	0.068	0.005	1.281	0.119
Monezia spp	December	165	6[a]	0.241	0.019	-	-
	January	163	3[a]	0.180	0.015	-	-
	February	150	1[a]	0.092	0.008	-	-
	March	119	5[a]	0.492	0.039	-	-
	April	156	2[a]	0.124	0.011	-	-
	May	129	0[a]	0.000	0.000	-	-
	June	143	0[a]	0.000	0.000	-	-
	July	154	0[a]	0.000	0.000	-	-
	August	141	0[a]	0.000	0.000	-	-
	September	133	0[a]	0.000	0.000	-	-
	October	136	0[a]	0.068	0.005	-	-
	November	215	8[a]	0.270	0.021	-	-

N = Number of observed animals, Mean% Prev. = Mean Percentage Prevalence, SD=Standard Deviation, SE=Standard Error, Sig= Significance value, Exp (B) = Exponential Beta value, Estimated Marginal Means and Mean Percentage Prevalence with similar subscript ([a,b,c,d,e]) are not significantly different (P=0.05).

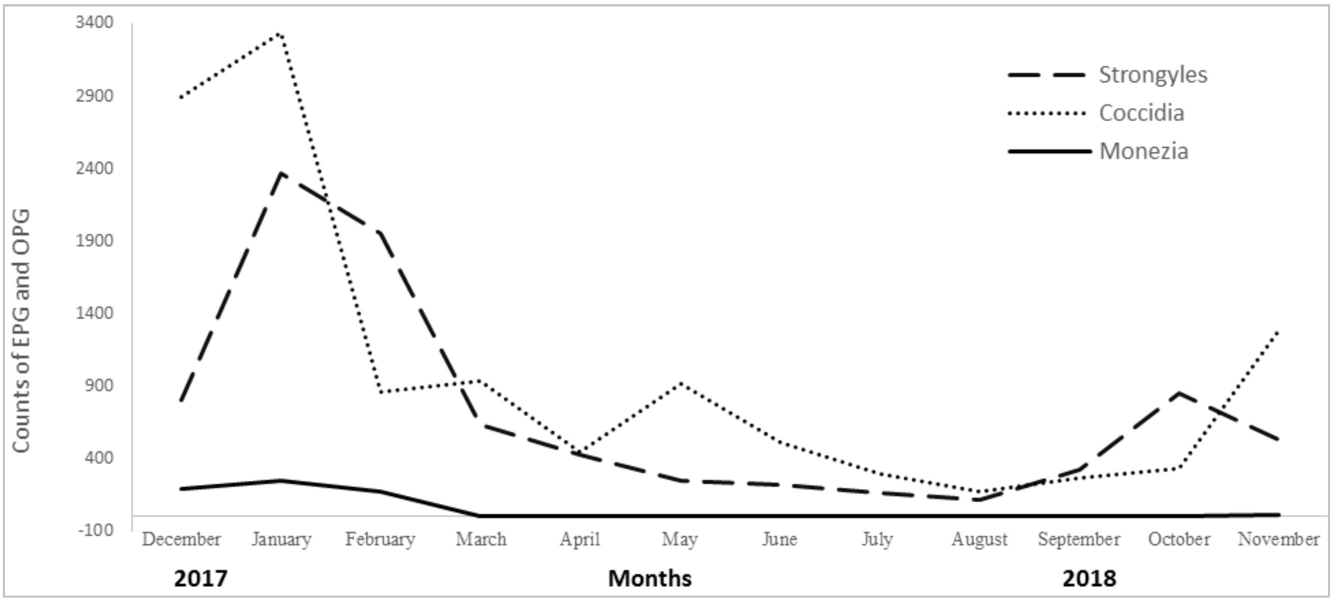

Figure 2. *Mean monthly mean eggs per gram of faeces (EPG) counts for helminths and oocysts per gram (OPG) of Eimeria spp from sheep in Maseru District during 2017-2018.*

The strongyle prevalence in the Foothills (66%) was higher than the Lowlands (61%) and Highlands (58%) but only significantly different (P<0.05) from the later (Table 2). Age wise comparison on strongyle prevalence showed significant difference (P<0.05) between adult sheep (66%) than lambs (57%). There was a significant lessening trend of susceptibility of sheep to strongyle from Foothills to Lowlands through to Highlands. The likelihood of acquiring strongyle infection was about 1.5 times more in adult sheep than in lambs. Season wise analysis on the strongyle showed winter was the lowest and significantly different from the rest of the seasons on prevalence. February had the highest strongyle prevalence (89%) which was significantly different (P<0.05) from December, April, May, June, July, August and November (Table 4 and Figure 2). The lowest strongyle prevalence (40%) was registered in July. *Monezia* spp prevalence though generally low throughout the study, it was significantly different as per seasons, with summer and autumn relatively higher at 4% and 3% respectively. Summer was significantly different (P<0.05) from winter and spring.

Lowlands *Eimeria* spp had highest prevalence rate (78%) followed by the Foothills (75%) but presented significant difference (P<0.05) to the Highlands. December recorded the highest *Eimeria* spp prevalence (86%) which was significantly different from August (60%) lowest. The prevalence of *Eimeria* spp were significantly (P<0.05) more in lambs than in adult sheep. *Eimeria* spp prevalence showed higher susceptibility to infection by significant (P<0.05) inclination to lambs than adult. *Eimeria* spp also showed propensity for increasing prevalence significantly (P<0.05) from spring through autumn to highest in summer. Figure 2 presents the overall dynamics of the GIPs in the study all having relatively more counts in January and February with a marked decline in march through winter months until some increase later in September and October.

4. Discussion

Three types of gastrointestinal parasites, namely the nematodes of Strongyle type, Tapeworms (*Monezia* spp) and protozoan, *Eimeria* spp were found in faecal sample of Merino sheep grazed at communal rangelands of Maseru District. Singh et al. found similar general composition of GIPs were found from sheep and goats from Muthura in India [5]. *Eimeria* spp and strongyles were found throughout the entire study period recording overall prevalence of 73.3% and 61.7% respectively. The *Monezia* spp were the least occurring parasite (1.9%) only found during several months during the study period. Coexistence of *Eimeria* spp*, Mozezia* spp, and strongyles in small ruminants were reported by several reseachers [5, 20, 30-33]. *Eimeria* spp, Strongyles and *Monezia* spp discovered in the present study were also main GIPs found by Mphahlele et al., Moiloa et al. and Mahlehla et al. from small ruminants in other areas of South Africa and Lesotho [20, 31, 32]. *Eimeria* spp were the most prevalent (73.3%) of all GIN found in Merino sheep in the Maseru District. The similar predominating prevalence and parasites counts were also found by Velusamy et al. in sheep and goats in India [34]. Wang et al. also observed more burdens of *Eimeria* spp in lambs and kids than in adult sheep and goats [35]. The findings of the present study differ from those of Mphahlele et al., Moiloa et al. and Mahlehla et al. who all alternatively found nematodes to be the predominating parasite versus the *Eimeria* spp. in the current study [20, 31, 32]. There was high prevalence of *Eimeria* spp found in lambs (84%) compared to older sheep (63%). The predominance of *Eimeria* spp in lambs compared to adults in present study was significantly different (P<0.05) and conformed with work done by Velusamy et al., Yakhchali and Rezaei and Okaiyeto et al. that revealed the increased odds of lambs and kids to coccidiosis infection [34, 36, 37]. Another research on communally grazed indigenous goats by Harper and Penzhorn in Harmmaskral and Nebo reported relatively higher infection rates of *Eimeria* spp than in the present study with 99.6% and 98.2% prevalence respectively [15]. Relatively more soft textured faecal samples were observed from suckling lambs than in weaned lambs and adult sheep. Manifestion of diarrhoea in the present study was similar to Ruiz et al. study where they observed the change of condition from strong to milder symptoms of diarrhoea as kids get older when infected with *Eimeria ninakohlyakimovae* [38]. Coccidiosis is regarded as self-containing infection as it may be found in juvenile of small ruminants in high infection rates for a limited period [39] from which it usually decreases by itself. The above finding was reiterated by Alzieu et al. discovery in that the untreated control group of lambs had a significant decrease of OPG output after a four-week period [40]. December marked the highest *Eimeria* spp prevalence rate (86%) even though the counts (2890.91±476.388) were lower than in January counts (3334.36±650.907). The lambs were weaned in the same month from which the counts dropped significantly ($P<0.05$) in February (858.67±149.362). Harper and Penzhorn associated high burdens of coccidiosis in ovine with immunological naïve young animals and stressed adults [15]. Lamb infection by *Eimeria spp* may high due infection from mother teats, farm management style and high stocking rates [39]. The *Eimeria* spp counts from the Lowlands were found to be significantly different ($P<0.05$) from Foothills while those from Lowlands and Highlands were not significantly different ($P>0.05$).

There was no significant difference ($P>0.05$) between the intensity of strongyle infection in Merino sheep across all agroecological zones in the present study. The abundance of strongyles eggs was therefore not influenced by either AEZ and age ($P>0.05$). This illustrated that the topography does not influence strongyle burdens in sheep. On the alternative the prevalence rate was significantly different ($P<0.05$) between Highlands and Foothills with 66% and 58% respectively. Lesotho has marked seasons with warm and wet summers months to extremely cold winter periods. The present study portrayed a clear trend of relatively fewer counts in cooler months and more in summer as Sharma S. and Busang, M. experienced [41]. The least strongyle burdens recorded in August (175.89±22.004) may have consequently resulted from stalled development of the off-host larval populations in the pastures due cold conditions in June and July. Pal et al. also recorded high gastrointestinal parasites' prevalence in goats post rainy months, conditions that favored off-host egg and larval stages longevity and comparatively faster development [42].

The strongyle burdens showed no significant difference between summer and autumn but both seasons were significantly different ($P<0.05$) in strongyle burdens from winter and spring which had lower counts. Furthermore, seasonal effect on the strongyle counts and prevalence agreed with Prasad et al. suggestion of the presence of a strong correlation between the mean temperatures and the nematodes egg output [43]. Rajarajan et al. study also established some interrelatedness between seasonal diversity of nematodes and varying environmental conditions in which seasons with high precipitation were characterized by comparatively higher parasite burdens [19]. The parasitic infections from Islam et al. study demonstrated high prevalence and infection rate being higher in wet season followed by warmer months [44]. Though the climatic conditions of two countries could not be matched entirely, it was apparent that higher temperatures and wet seasons influenced high burdens and higher prevalence rates in both studies [15]. The strongyle winter prevalence was low (52%) and significantly different ($P<0.05$) from other three seasons. Autumn had prevalence (70%) was due to higher infections in favourable conditions in summer which may increase number of off host parasites the in pastures. The survival and development of the free-living stages of GIN on the pastures consequently depends mainly on environmental conditions [25].

The seasonal dynamics of strongyles and *Monezia* spp were relatively higher in summer and autumn months and showed a trend that reinforced the relationship between the parasite seasonal burdens and climatic conditions [45]. It was discovered that both pasture infestation and infectivity of *H. contortus* larvae in Nigeria were seasonal owing to seasonal rains which were regarded as driving force [21]. Pfukenyi et al. study in Zimbabwe is also in conformity with the present initiative by reiterating on the influence the seasonal conditions affecting seasonal occurrence and nematode egg output [33]. It was also articulated by Taylor M. A. that humid months provided conducive conditions for the third larval stage of strongyles to rise in abundance consequently increasing risk of infection for other uninfected animals utilising the same pastures [6]. Nwosu et al. also reported gastrointestinal parasites studied in North-eastern Nigeria, stronglyles counts were consistent with the rainy seasons [22]. There was some agreement of the present study with that of Magona and Musis who discovered factors such as animal age, grazing system and agroclimatic zones to had varying influence on the helminths egg output in Uganda [23]. The infection of strongyles between lambs and adults was significantly different ($P<0.05$) showing the proneness of the infection to occur more in adults than in lambs. This could be suckling lambs' less exposure of uptake of the strongyles from the pastures due to their limited grazing behaviour. Krecek et al. suggested the survival of *Eimeria* spp and strongyles through cold winter months to early spring was due to an interplay of environmental factors such microclimates and larval vertical movement on the herbage which encouraged overwintering as it happened in the present study [46].

5. Conclusion

The results of the present study illustrated a strong correlation between GIPs of sheep and seasonality in the study area. The composition of GIPs was consistent between lambs and adult sheep and throughout all agroecological zones. Agroecology showed no significant effect on strongyles prevalence and abundance but only for *Eimeria*. Lambs were more susceptible to *Eimeria* spp. and *Monezia* spp. than adult sheep. Adult sheep were more susceptible to strongyles than lambs. *Eimeria spp* and strongyles were present in sheep all year round in Maseru district. *Eimeria* spp. was predominant and recorded relatively higher OPGs in lambs than in adult Merino sheep. All parasites had relatively high EPG and OPG in summer and autumn seasons when conditions were relatively warmer and humid. GIPs peaks in January demonstrated the preceding months had favourable conditions which might have prompted proliferation of parasites both on the pastures and in-host. Despite the low temperatures and rainfall in winter both strongyles and *Eimeria* spp. managed to overwinter portraying their parasitic resilience to prevailing weather conditions. The data may therefore be used as epidemiological information towards establishing effective parasite control strategies. Data may be used to identify appropriate timing for drug administration.

6. Recommendation

Gastrointestinal parasites continue to become economic threat to ruminant production. It is apparent that multisectoral approach which include farmers' and technical staff knowledge need to be appraised regularly on the epidemiological trends regarding GIPs in Lesotho. National policy on strategic epidemiological interventions and formulation of effective parasite control programs in the country should be enacted. It is therefore recommended that a research that investigates off-host GIPs be undertaken to complement the in-host work that has already been done for better appreciation of their overall bioecology. A full epidemiological study may also be conducted to underpin the importance of other inherent epidemiological factors affecting prevalence of GIPs in Lesotho. Grave consideration to institute a decisive and robust control programs on lamb coccidiosis is highly recommended to avoid imminent loss to the sheep industry.

Authors' Contributions

MSP and MS planned and conceptualized the methodology of the study. MSP drafted the manuscript. MSP, MS, MM, MS collected data and did the laboratory analysis. MSP, MJM and LGM did the statistical analysis and reviewed the manuscript. All authors read and approved the final manuscript.

Conflict of Interests

The authors herein declare that there are no conflicting interests in writing up the article.

Acknowledgements

The research fund was provided by the National University of Lesotho. Our gratitude goes to all farmers who participated in the initiative and provided their sheep for this research. People who assisted with data collection and analysis are highly appreciated. Our sincere appreciation goes to The Lesotho Meteorological Services for proving us with climatic data for the study period. Many thanks to Lesotho Wool and Mohair Growers Association for providing us with the statistics and wool sales data.

References

[1] Hunter J. P. (1987). Economics of wool and mohair production and marketing in Lesotho. pp. 59-155.

[2] Mokhethi N. I., Bahta, Y. T. & Ogundeji, A. A. (2015). Wool, P. O. & Lesotho, M. E. O. Trade Structure and Pattern of Wool and Mohair Export of Lesotho 20th International Farm Management Congress, Laval University, Québec City, Québec, Canada.

[3] Cai K. Z. & Bai J. L. (2009). Infection intensity of gastrointestinal nematodosis and coccidiosis of sheep raised under three types of feeding and management regimes in Ningxia Hui Autonomous Region, China. Small Ruminant Research 111-115.

[4] Asif M., Azeem S., Asif S., & Nazir S. (2008). Prevalence of Gastrointestinal Parasites of Sheep and Goats in and around Rawalpindi and Islamabad, Pakistan. J. Vet. Anim. Sci. Vol. 1: 14-17.

[5] Singh V., Varshney P., Dash S. K. & Lal H. P. (2013). Prevalence of gastrointestinal parasites in sheep and goats in and around Mathura, India, Vet. World 6 (5): 260-262, doi: 10.5455/vetworld.2013.260-262.

[6] Taylor M. A. (2012). Emerging parasitic diseases of sheep. Veterinary Parasitology 189: 2-7.

[7] Mushonga, B., Habumugisha, D., Kandiwa, E., Madzingira, O., Samkange, A., Segwagwe, B. E., & Jaja, I. F. (2018). Prevalence of Haemonchus contortus infections in sheep and goats in Nyagatare District, Rwanda. Journal of veterinary medicine, 2018.

[8] Basier, R. B., Kahn, L. P., Sargison, N. D. & Van Wyk, J. A. (2016). The pathophysiology, ecology and epidemiology of Haemonchus contortus infection in small ruminants. Advances in parasitology, 93, pp. 95-143.

[9] Shankute G., Bogale B. & Melaku A. (2013). An Abattoir Survey on Gastrointestinal Nematodes in Sheep and Goats in Hemex-Export Abattoir, Debre Ziet, Central Ethiopia. Journal of Advanced Veterinary Research. Volume 3 60-63.

[10] Lichtenfels, J. R., Pilitt, P. & Hoberg, E. (1994). New morphological characters for identifying individual specimens of Haemonchus spp. (Nematoda: Trichostrongyloidea) and a key to species in ruminants of North America. 107-119.

[11] Dey, A. R., Zhang, Z., Begum, N., Alim, M. A., Hu, M., Alam, M. Z. J. (2019). Genetics & Evolution. Genetic diversity patterns of Haemonchus contortus isolated from sheep and goats in Bangladesh. 68, 177-184.

[12] Almeida, F. A. D., Bassetto, C. C., Amarante, M. R. V., Albuquerque, A. C. A. D., Starling, R. Z. C. & Amarante, A. F. T. D. (2018). Helminth infections and hybridization between Haemonchus contortus and Haemonchus placei in sheep from Santana do Livramento, Brazil. 27, 280-288.

[13] Matsepe L. G., Molapo S., Phalatsi M. & Phororo M. (2021). Prevalence and fecal egg load of gastrointestinal parasites of Angora goats in four agro-ecological zones in Lesotho, Veterinary World, 14 (2): 339-346.

[14] Fthenakisa G. C., Mavrogiannia V. S., Gallidisb E. & Papadopoulos E. (2015). Interactions between parasitic infections and reproductive efficiency in sheep. Veterinary Parasitology 208 56–66.

[15] Harper, C. K. & Penzhorn, B. L. (1999). Occurrence and diversity of coccidian in indigenous, Saanen and crossbred goats in South Africa. Vet. Parasitol. 82, 1–9.

[16] Saratsis Anastasios, Karagiannis Isidoros, Brozos Christos, Kiossis Evagellos, Tzanidakis Nikolaos, Joachim Anja & Sotiraki Smaragda. (2013). Lamb eimeriosis: Applied treatment protocols in dairy sheep production systems. Veterinary Parasitology. 196: 56– 63.

[17] Bekuma, Feyisa, & Bayisa Dufera. (2019) Prevalence of Heamonchosis in Small Ruminants and Its Associated Risk Factors in and Around Ejer e Town, West Shoa, Oromia, Ethiopia. American Journal of Biomedical Science & Research 3, (5) 409-414.

[18] Kandil, O. M., Abdelrahman, K. A., Eid, N. A., Elakabawy, L. M. & Helal, M. A. Krecek, R. C., Groeneveld, H. T., & Van Wyk, J. A. (1991). Effects of time of day, season and stratum on Haemonchus contortus and Haemonchus placei third-stage larvae on irrigated pasture. Veterinary Parasitology, 40 (1-2), 87-98.

[19] Rajarajan S., Palanivel K. M., Geetha M. & Rani N. (2017). Seasonal Dynamics of Haemonchosis in sheep and goats in Tirucherappali District, India. International Journal of Current Microbiology and Applied Sciences. pp. 3645-3649.

[20] Mphahlele M., Tsotetsi-Khambule A. M., Moerane R, Komape & DM, Thekisoe OMM. (2021). Anthelmintic resistance and prevalence of gastrointestinal nematodes infecting sheep in Limpopo Province, South Africa, Veterinary World, 14 (2): 302-313.

[21] Bolajoko, M. & Morgan, E. (2012). Relevance of improved epidemiological knowledge to sustainable control of Haemonchus contortus in Nigeria. 13, 196-208.

[22] Nwosu, C. O., Madu, P. P., & Richards, W. S. (2007). Prevalence and seasonal changes in the population of gastrointestinal nematodes of small ruminants in the semi-arid zone of north-eastern Nigeria. Veterinary parasitology, 144 (1-2), 118-124.

[23] Magona J. W. & Musis G. (2002). Influence of age, grazing system, season and agroclimatic zone on the prevalence and intensity of strongylosis in Ugandan goats. Small Ruminant Research, 44, 187-192.

[24] Rahmann, G. & Seip, H. (2007). Bioactive forage and phytotherapy to cure and control endo-parasite diseases in sheep and goat farming systems–a review of current scientific knowledge. Landbauforschung Völkenrode. Bundesforschungsanstalt für Landwirtschaft.

[25] Molento, M. B., Buzatti, A. & Sprenger, L. K. (2016). Pasture larval count as a supporting method for parasite epidemiology, population dynamic and control in ruminants. 192, 48-54.

[26] MAFF, (1986). Manual of veterinary parasitology laboratory techniques. Ministry of Agriculture Fisheries and Food. 1th ed. Debere Zeit, Ethiopia. Pp. 10-16.

[27] Indre, D., Dărăbuş, G. H., Oprescu, I., Morariu, S., Mederle, N., Ilie, M. S., Imre, H., Balint, A., Sorescu, D. & Imre, M. (2010). Morphometrical studies on some eggs of gastrointestinal nematodes from sheep. Lucrări Ştiinłifice Medicină Veterinară, 1, pp. 30-35.

[28] Shore, D. A. (1939). Differentiation of eggs of various genera of nematodes parasitic in domestic ruminants in the United States (No. 1488-2016-124159).

[29] Soulsby, E. J. L. (1982). Helminths, Arthropods and Protozoa of Domesticated Animals, 7th edition. Baillere Tindall, London. pp. 707-735.

[30] Mpofu, T. J., Nephawe, K. A., & Mtileni, B. (2020). Prevalence of gastrointestinal parasites in communal goats from different agro-ecological zones of South Africa. Veterinary world, 13 (1), 26.

[31] Moiloa, M. J., Phoofolo, M., Matebesi-Ranthimo, P., Molapo, S., Phalatsi & M., Mahlehla, M. J. (2020). Angora goat gastrointestinal parasite knowledge and control practices among Lesotho farming communities. 52, 3077-3083.

[32] Mahlehla M. A., Molapo M. S., Phoofolo M. W., Matebesi P. A., Phalatsi M., & Moiloa M. J. (2021). Prevalence and Faecal Egg Counts of Gastrointestinal Parasites of Merino Sheep in Lesotho. World Vet. J., 11 (1): 85-91.

[33] Pfukenyi, D. M., Mukaratirwa, S., Willingham, A. L. & Monrad, J. (2007). Epidemiological studies of parasitic gastrointestinal nematodes, cestodes and coccidia infections in cattle in the highveld and lowveld communal grazing areas of Zimbabwe. Onderstepoort Journal of Veterinary Research, 74: 129–142.

[34] Velusamy R, Rani N, Ponnudurai G. & Anbarasi P. (2015). Prevalence of intestinal and haemoprotozoan parasites of small ruminants in Tamil Nadu, India. Vet World.; 8 (10): 1205-1209.

[35] Wang C. R., Xiao J. Y., Chen A. H., Chen J., Wang Y., Gao J. F. & Zhu X. Q. (2010). Prevalence of coccidial infection in sheep and goats in northeastern. China Veterinary Parasitology 174: 213–217.

[36] Yakhchali, M. & Rezaei, A. A. (2010). The prevalence and intensity of Eimeria spp. infection in sheep of Malayer suburb, Iran. Archives of Razi Institute, 65 (1), pp. 27-32.

[37] Okaiyeto, S. O., Tekdek, L. B., Sackey, A. K. B., & Ajanusi, O. J. (2008). Prevalence of haemo and gastrointestinal parasites in sheep and goats kept by the Normadic Fulanis in some Northern states of Nigeria. Research Journal of Animal Sciences, 2 (2), 31-33.

[38] Ruiz A., Matos L., Muñoz M. C., Hermosilla C., Molina J. M., Andrada M., Rodríguez F., Pérez D., López A., Guedes A. & Taubert A. (2013). Isolation of an Eimeria ninakohlyakimovae field strain (Canary Islands) and analysis of its infection characteristics in goat kids. Research in Veterinary Science 94 277–284.

[39] Gauly M., Reeg J., Bauer C. & Erhardt, G. (2004). Influence of production systems in lambs on the Eimeria oocyst output and weight gain. Small Ruminant Research 55 159–167.

[40] Alzieu, J. P., Mage, C., Maes, L. & de Muelenaere, C. (1999). Economic benefits of prophylaxis with diclazuril against subclinical coccidiosis in lambs reared indoors. Vet. Rec. 144, 442–444.

[41] Sharma S. & Busang, M. (2013). Prevalence of some gastrointestinal parasites of ruminants in southern Botswana. Bots. J. Agric. Appl. Sci. 9 (Issue 2).

[42] Pal, P., Chatlod, L. R., & Avasthe, R. K. (2017). Seasonal prevalence of gastrointestinal parasites of goats in North-East Himalayan region of Sikkim, India. Indian Journal of Animal Sciences, 87 (5), 558-561.

[43] Prasad M. S. R, Sundaram S. M., Gnanaraj P. T., Bandeswaran C, Harikrishnan T. J., Sivakumar T. & Azhahiannambi P. (2019). Influence of intensive rearing and continuous and rotational grazing systems of management on parasitic load of lambs, Veterinary World, 12 (8): 1188-1194.

[44] Islam M. S., Hossain M. S., Dey A. R, Alim M. A, Akter S. & Alam M. Z. (2017). Epidemiology of gastrointestinal parasites of small ruminants in Mymensingh, Bangladesh. Journal of Advanced Veterinary and Animal Research. 4 (4): 356-362.

[45] Papadopoulos E., Arsenos G., Sotiraki S., Deligiannis C., Lainas T. & Zygoyiannis, D. (2003). The epizootiology of gastrointestinal nematode parasites in Greek dairy breeds of sheep and goats.

[46] Krecek, R. C., Groeneveld, H. T., & Van Wyk, J. A. (1991). Effects of time of day, season and stratum on Haemonchus contortus and Haemonchus placei third-stage larvae on irrigated pasture. Veterinary Parasitology, 40 (1-2), 87-98.