Middle East Journal of Agriculture Research
Volume: 11 | Issue: 02| April – June| 2022

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2022.11.2.30
Journal homepage: www.curresweb.com
Pages: 511-518

Prevalence of Gastrointestinal Parasites in Small Ruminants in Jarra East District, the Gambia

Musa Bah[1, 2], Abdoulie Ceesay[1,3], and Sainey Keita[1]

[1]School of Agriculture and Environmental Sciences, University of The Gambia, Serekunda 3530, Republic of The Gambia
[2]Department of Livestock Management, University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan.
[3]Department of Livestock Services, Abuko, Ministry of Agriculture, The Gambia

Received: 16 April 2022 **Accepted:** 15 May 2022 **Published:** 30 May 2022

ABSTRACT

Gastrointestinal (GIT) parasites infestation is a major problem for animal health that causes major economic losses, particularly in the tropics and sub-tropical countries, like The Gambia. The prevalence of GIT parasites on small ruminant livestock was assessed from selected villages in Jara East District of The Gambia. 320 small ruminant fecal samples (160 sheep and 160 goats) were collected for qualitative fecal examination. Descriptive analysis of the collected data was done using IBM SPSS version 23. The results revealed an overall prevalence of 277 (86.0%) in the small ruminants. The number of goats that were infested with GIT parasites eggs was more compared to sheep (141 goats vs 136 sheep). 10 different GIT parasitic eggs were identified. The GIT parasites were more prevalent in the poor body condition animals followed by the medium and the least GIT parasite infection was in the good body conditioned animals. However, there was no significant difference in the prevalence of GIT parasites between the villages, sex, age, and species of animals. This study showed that GIT prevalence in sheep and goats was above 80% with more than 60% of the animals infected with more than one type of GIT parasite worm egg. Hence, effective strategic treatment and public awareness creation should be instituted in the study area and such study should be done in other areas of the country.

Keywords: Goat, helminthes, nematodes, risk factors, sheep.

1. Introduction

Small ruminants constitute one of the main resources for achieving the improved living standards in many rural households in the developing world. Their farming has a prominent role in the sustainability of rural communities around the world (Nardone *et al.*, 2004) as well as being socially, economically, and politically highly significant at national and international levels, analogous to other livestock species (Morgan *et al.*, 2013). However, the role they play in food security and poverty reduction in most developing countries like The Gambia is often underestimated (Wodajo *et al.*, 2020). In The Gambia, sheep and goats serve as a primary source of savings and investments and provide cheap manure in vegetable gardens. They also serve as security against deficits in household earnings in instances of crop failure, and aid in settling medical bills and school fees (Oluwatayo *et al.*, 2012).
Gastrointestinal infections are the main prevalent parasitic diseases affecting small ruminant productivity worldwide, particularly in the tropics and sub-tropics (Calvete *et al.*, 2014). The climatic and many environmental conditions of tropical African countries like The Gambia provide quite favorable conditions for the survival and development of gastrointestinal parasites (Perry *et al.*, 2002). This is worsening in many resource-poor communities by irregular deworming and poor management practices (Hailelul, 2002), that provide gastrointestinal (GIT) parasites the opportunity to survive and

Corresponding Author: Musa Bah, School of Agriculture and Environmental Sciences, University of The Gambia, Serekunda 3530, Republic of The Gambia.
E-mail: mmbah@utg.edu.gm

multiply. The end result is mainly economic losses through reduced productivity (Hailelul, 2002) and increased morbidity and mortality (Perry *et al.*, 2002). The loss due to productivity is related to reduced food intake, stunted growth (Paddock, 2010), cost of treatment, and control (Odoi *et al.*, 2007). Associated risk factors such as age, sex, husbandry, species anthelmintic application, etc influence the prevalence and burden of GI nematodes in ruminants (Muhammad *et al.*, 2010). According to Lamy *et al.* (2012), the prevalence of gastrointestinal parasites differs in species and the severity of infection varies depending on the environmental condition, vegetation, and management practices.

Small ruminants managed under extensive and intensive production systems are extremely susceptible to the effect of wide ranges of endoparasites (Abebe and Esayasu, 2001). A study on the parasite spectrum and seasonal epidemiology of gastrointestinal nematodes of small ruminants in The Gambia from 1990 to 1991, revealed a large spectrum of 16 helminth species found in 101 (97%) infected animals (Fritsche *et al.*, 1993). To our knowledge, no report had been published on the prevalence of small ruminant helminthiasis in the present study area, where sheep and goats are important assets to the local farmers. Knowledge of the prevalence and risk factors would help in designing strategies to control and prevent GIT parasitic infections. The objective of this study was to determine the prevalence of GIT parasites, risk factors associated with the parasites, and the different parasites in small ruminants in four selected villages in Jarra East District of The Gambia.

2. Materials and Methods

2.1. Study area

This study was conducted between June 2017 to December 2017 in four villages (Medina Sancha, Sara Samba, Massembeh, and Kaiaf) in Jarra East District. Jarra East District is one of the six districts of the Lower River Region (LRR) on the south bank of The Gambia. The main management system of small ruminants in this area is tethering during the rainy season and a free-range system during the dry season (MOA, 2016). The vegetation of the area is of the Savannah type with shrub and grass understory. The average temperatures in The Gambia range from 18 to 28 in January to 23 to 36°C in June Jaiteh and Sarr, 2015). The country experiences a long dry season (October to May) with a short rainy season (June to September) with the highest rainfall estimate of 1200 mm on the south bank (GoTG, 2012).

2.2. Sampling method

Thirty-two (32) farm households were selected through multi-stage sampling for the study. At stage one, 4 villages (Medina Sancha, Sara Samba, Massembeh and Kaiaf) were purposively selected based on accessibility and logistic considerations as study areas. In each village, a simple random approach was applied to select 08 households. Lastly, 320 (160 sheep and 160 goats) were randomly selected from the 32 households.

2.3. Study animals

A total of 320 ruminants (160 sheep and 160 goats) were sampled for fecal collection. Ten small ruminants, 05 sheep, and 05 goats from each selected household were randomly selected.

2.4. Sample collection and analysis

Approximately 05 grams of fecal sample was collected directly from the rectum of each sampled animal using a plastic gloved finger. The collected samples were put in a plastic bag, labeled, and stored in a cool box with ice packs. The animal's biodata like species, sex, breed, and age were recorded in a format prepared for this purpose. The age of each animal was determined using their dentition as described by Aiello and May, (1998) with the help of the farmer. Conventionally animals were categorized as an adult (≥ 2years) and young (< 2 years). They were also body conditioned scored according to the method described by Kripali *et al.* (2010) and categorized into three scores as good, medium, and poor.

The collected fecal samples and completed form were transported to the Central Laboratory of the Department of Livestock Services Abuko where qualitative (Sedimentation and Flotation) analysis for the investigation of the types of the GIT parasite (worms) was performed. A simple test tube of salt saturated flotation and sedimentation technique described by Hansen and Perry, (1994) were used and

the slides prepared were examined under a microscope (x10). The eggs of different helminths were identified on the basis of morphological appearance and size of eggs (Foreit, 1999).

2.5. Statistical analysis

The data were entered in a Micro-Soft Excel sheet, coded, and analyzed using SPSS version 23. Descriptive statistics were performed to quantify the problems and the Chi-square test was used to compare the association between independent variables (sex, age, body condition scores) with the result. The confidence interval was set at 95% and with a 5% degree of precision. A statistically significant association between variables was considered to exist if the computed P-value was less than 0.05.

3. Results

This study revealed an overall prevalence of 86.6% in small ruminants, with 85 and 88.1% in sheep and goats, respectively (Table 1). The GIT parasites of small ruminants were more prevalent in Sara Samba (92.5%) among the three villages, and Medina Sancha and Kaiaf had similar GIT parasite prevalence (83.8%).

Table 1: Prevalence of GIT parasites in relation to the village and ruminant species in Jarra East District

Variable	Total No.	No. Positive	Prevalence (%)	χ^2	P-value
Village					
Medina Sancha	80	67	83.8	3.519	0.318
Sara Samba	80	74	92.5		
Massembeh	80	69	86.3		
Kaiaf	80	67	83.8		
Total	320	277	86.6		
Species					
Sheep	160	136	85.0	0.672	0.412
Goat	160	141	88.1		
Total	320	277	86.6		
Breed					
Dj'allonke[1]	159	135	84.9		
WAD[1]	160	141	88.1		
Sahelian[2]	1	1	100		
Total	320	277	86.6		

(Note: χ^2 = Chi-square)
[1]Dj'allonke and West African Dwarf (WAD) is the indigenous sheep and goat breeds, respectively.
[2]Sahelian breed is mainly from neighbouring Senegal

During the study period, the prevalence was assessed between the risk factors. Accordingly, 89.4% and 85.5% in males and females, respectively (Table 2). We observed higher GIT parasite prevalence in adult animals than in the young (87.1 vs. 85.4%, respectively; Table 2). There was a statistical difference in the occurrence of GIT between body conditions of animals ($P < 0.05$; Table 2). All the poor body conditioned animals were positive for GIT parasite infections, while less than 75% of the good body conditioned animals were infected (Table 2).

Table 2: Prevalence of GI parasite in relation to sex, age, and body condition of the small ruminants (n = 320)

Variable	No. examined	No. infected (%)	χ^2	*P*-value
Sex				
Male	85	76 (89.4)	0.808	0.369
Female	235	201 (85.5)		
Total	320	277 (86.6)		
Age				
Adult	224	195 (87.1)	0.155	0.694
Young	96	82 (85.4)		
Total	320	277 (86.6)		
Body condition				

Good	155	116 (74.8)	36.497	0.000
Medium	76	72 (94.7)		
Poor	89	89 (100.0)		
Total	320	277 (86.6)		

(Note: χ^2 = Chi square)

The majority (86.6%) of the sampled animals were positive for worm infection, and 60.7% were infected with more than one type of worm; only 0.3% were infected with four different worms (Table 3). The different number of worms per species of ruminant varied slightly.

Table 3: Prevalence of number of different worms by ruminant livestock in three selected villages in Jarra East (n = 320; sheep and goats n=160 each)

Ruminant	**No. of different worms**				
	0	**1**	**2**	**3**	**4**
Sheep	24 (15)	40 (25)	55 (34.4)	40 (25)	1 (0.6)
Goat	19 (11.9)	43 (26.9)	53 (33.1)	45 (28.1)	0 (0)
Total	43 (13.4)	83 (25.9)	108 (33.8)	85 (26.6)	1 (0.3)

In this study, mixed nematode eggs were also examined with respect to the different risk factors (Table 4). There were ten types of GIT parasites within and between the risk factors (Table 4). However, no statistically significant difference was observed, which is why the Chi-square P-value was not included (Table 4)

4. Discussion

There are limited studies of this type of study in The Gambia, hence discussion and comparisons were focused more on other countries. The present study revealed the existence of GIT parasites with an overall prevalence of 86.6% in small ruminants, with 85 and 88.1% in sheep and goats, respectively. Similar to this study, other studies had reported a high prevalent of GIT parasites in small ruminants, as had been reported by Gupta *et al.* (2013) in and around Jabalpur, India with a prevalence of 97%, Islam *et al.* (2017) in Mymensingh, Bangladesh with a prevalence of 74.8% and Belina *et al* (2017) with a GIT parasite infection prevalent of 56.25 and 51.30%, respectively. Different GIT parasite infections prevalent had been attributed to differences in deworming strategies or intensity and management practices (Ratanapob *et al.*, 2012). The higher GIT parasite prevalence in goats than sheep in our study had been reported in previous studies; Muluneh *et al.* (2014) in Dembia District, Northwest Ethiopia**,** Gupta *et al.* (2013) in Jabalpur, India. Contrary to our study, Belina *et al.* (2017) reported a higher prevalence in sheep. In both trends, whether higher prevalence of GIT parasites in goats than in sheep or the reverse could be attributed to the different rearing and management of the small ruminants along with nutritional status (Islam *et al*., 2017). It is assumed that sheep do have a considerably higher immunological response to gastrointestinal parasites compared with those goats (Urquhart *et al*., 1996). In our study, the ruminants were tethered during the rainy season. When goats are tethered, they are compelled to graze instead of browsing, making them highly susceptible to worm infection. The last livestock census in The Gambia showed that 71.2 and 78.8% of sheep and goat owners, respectively tethered their animals during the rainy season. Furthermore, the region of the study area was ranked second with 86.4% of practicing tethering in the country (MOA, 2006). The similar rearing and management practices of the small ruminant in the four villages suggested the lack of significant difference among the villages. In The Gambia, tethering is done during the rainy season to prevent crop destruction, hence avoiding conflict between livestock and crop farmers and also to avail more labour for crop production. The grazing of small ruminants and cattle together on the same pasture may reduce the infection, as very little cross-infection of GIT parasites may occur between the animal species.
Similar to our study, Belina *et al.* (2017) reported a higher GIT parasite prevalent in adult ruminants (54.37%) than the young ruminants (45.45%). Similarly, Singh *et al* (2017) also revealed that the adult small ruminants were significantly more prone to parasitic infection. It could be explained that higher nematode prevalence in adults might be due to grazing on a larger area of pastures being contaminated with various flocks and different stress conditions such as climate, long daily traveling or tethering time,

Table 4: Prevalence of small ruminant GIT parasites in relation to the ruminant, sex, body condition score, and age of the animals

Variables (No. examined)	Type of parasites									
	CHA Positive (%)	OES Positive (%)	COO Positive (%)	HAE Positive (%)	STR Positive (%)	BUN Positive (%)	NEM Positive (%)	OST Positive (%)	PAR Positive (%)	TRI Positive (%)
Sheep (160)	39 (24.4)	31 (19.4)	37 (23.1)	37 (23.1)	29 (18.1)	29 (18.1)	10 (6.3)	23 (14.4)	5 (3.1)	36 (22.5)
Goats (160)	39 (24.4)	40 (25)	29 (18.1)	30 (18.8)	31 (19.4)	27 (16.9)	14 (8.8)	26 (16.3)	5 (3.1)	40 (25)
Male (85)	25 (29.4)	23 (27.1)	18 (21.2)	14 (16.5)	14 (16.5)	19 (22.4)	8 (9.4)	13 (15.3)	3 (3.5)	25 (29.4)
Female (235)	53 (22.6)	48 (20.4)	48 (20.4)	53 (22.6)	46 (19.6)	37 (15.7)	16 (6.8)	36 (15.3)	7 (3.0)	51 (21.7)
Good (155)	23 (14.8)	21 (13.5)	17 (11.0)	20 (12.9)	25 (16.1)	20 (12.9)	7 (4.5)	12 (7.7)	7 (4.5)	28 (18.1)
Medium (76)	22 (28.5)	16 (21.1)	14 (18.4)	17 (22.4)	16 (21.1)	12 (15.8)	7(9.2)	14 (18.4)	3 (3.9)	18 (23.7)
Poor (89)	33 (37.1)	34 (38.2)	35 (39.3)	30 (33.7)	19 (21.3)	24 (27.0)	10 (11.2)	23 (25.8)	0 (0.0)	30 (33.7)
Adult (224)	57 (25.4)	51 (22.8)	46 (20.5	51 (22.8)	41 (18.3)	42 (18.8)	16 (7.1)	35 (15.6)	8 (3.6)	51 (22.8)
Young (96)	21 (21.9)	20 (20.8)	20 (20.8)	16 (16.7)	19 (19.8)	14 (14.6)	8 (8.3)	14 (14.6)	2 (2.1)	25 (26.0)

(Note: CHA = *Chabertia*, OES = *Oesophagostomum*, COO= *Cooperia*, HAE = *Haemonchus*, STR = *Strongyloides*, BUN = *Bunostumum*, NEM = *Nematodirus* OST = *Ostertagia*, PAR = *Paramphistomum*, and TRI = *Tricostrongylus*)

and gestation (Radostits *et al.*, 1994). The young animals are less susceptible to parasitic infections due to less exposure to grazing as they depend more on milk feeding. Contrary to our findings, Getachew *et al.* (2017) reported less GIT nematode infection in adult small ruminants than the young ones (47.1 vs. 56%, respectively). The lack of statistically significant difference in GIT parasite infections for age in this study had been reported earlier in the country (Fritsch *et al*., 1993).

The higher prevalence of GIT parasites recorded in animals with poor body conditions than in other groups of animals agrees with the findings of Admasu and Nurlign (2014). This had been attributed to malnutrition, other concurrent diseases, or the current parasitic infection which might have led to a poor immunological response to the infective stage of the parasites as reported earlier by Watson *et al.* (1994) and more recently by Admasu and Nurlign (2014). In the Gambia, a mass vaccination against Peste des Petits Ruminants (PPR)/ Pest of small ruminants via projects at gratis or at a cost less than 3 GMD ($0.06) is commonly done by the Government annually. However, deworming is almost entirely the responsibility of the farmer and the average cost of deworming one animal is less than or equal to 10 GMD ($0.20; personal communication). In this area, only a few farmers follow the deworming guidelines recommended by the Department of Livestock Services due to a lack of purchasing power for the drugs (personal communication). The more female animals sampled than males could be attributed to the higher number of female animals for both ruminants in the area (MOA, 2006). The percentage of Sahelian sheep breeds in the district is less than 2% (MOA, 2006). This could justify the reason for having only one Sahelian sheep in the study as sampling was done randomly.

In this study, a large spectrum of gastrointestinal parasites was found. This agrees with Fritsche *et al.* (1993), who reported a spectrum of 16 nematode species in The Gambia. Similar to this study, Fritsche *et al.* (1993) also reported more *Trichostrongylus, Haemonchus Oesophagostomum, and Strongyloides*. However, in their study, they reported *Gaigeria* that was not found in our study. We also found *Chabertia* that they did not report. The difference in the prevalence of *Chabertia* could be attributed to the time of sampling. The low prevalence of *Paramphistomum* in this study was also reported by Fritsche *et al.* (1993). Both our study and Fritsche *et al*. (1993) did not report the prevalence of liver fluke. This could be attributed to the low rainfall and grazing of the animals in areas of the savannah. The principal author spent three years in the national central abattoir as a meat inspector and five years as an extension worker responsible for meat inspection among others but had never found a case of liver fluke in small ruminants (personal communication).

4.1. Limitation of the Study

It is relevant to acknowledge the main limitation of our study. The small sample size and lack of molecular confirmation of the parasites were both due to limited resources.

5. Conclusion

This study was based only on faecal examination of eggs of GIT parasites to estimate the prevalence and associated risk factors. GIT parasites are a major animal health constraint in sheep and goat production and contribute to loss in productivity and economy. A wide range of parasites was found in the area. The study revealed a high GIT parasite prevalence in both sheep and goats in the study area. The infection was higher in the animals with poor body conditions. Therefore, we suggest a detailed awareness creation and the need for further investigation to develop control and prevention strategies.

Acknowledgements

The authors acknowledged the contributions of Kumba Saine and her colleagues at the Central Laboratory Unit of the Department of Livestock Services, Abuko during the laboratory work. Finally, we thank the farmers for their voluntary participation, cooperation, and assistance throughout the data collection period.

Declarations

Source of funding

The work is part of the second co-author's BSc dissertation which he did with his own personal funding. However, the Management of the Department of Livestock Services and the staff at the Central Laboratory Unit supported the entire laboratory work.

Competing Interests Statement

The authors have no conflict of interest concerning the publication of this paper, whether financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this research work.

References

Abebe, W. and G. Esayasu, 2001. Survey on ovine and caprine gastrointestinal helminthiasis in the eastern part of Ethiopia during the dry season of the year. Rev. Med. Vet. 152(5):379-384.

Admasu, P. and L. Nurlign, 2014. Prevalence of gastrointestinal parasites of small ruminants in Kuarit District, North West Ethiopia. Afr. J. Basic Appl. Sci. 6 (5): 125-130.

Aiello, S. and A. Mays, 1998. The Merck veterinary manual, 8th ed., Merck and Co, Inc, White house station, NJ. USA, Pp: 131-133.

Belina, D., A. Giri, S. Mengistu and A. Eshetu, 2017. Gastrointestinal Nematodes in Ruminants: The Parasite Burden, Associated Risk Factors and Anthelmintic Utilization Practices in Selected Districts of East and Western Hararghe, Ethiopia. J. Vet. Sci. Technol. 8: 433. doi: 10.4262/2157-7579.1000433

Calvete, C., L. Ferrer, D. Lacasta, R. Calavia, J. Ramos, M. Ruiz-de-Arkaute and J. Uriarte, 2014. Variability of the egg hatch assay to survey Benzimidazole resistancein nematodes of small ruminants under field conditions. Vet. Parasitol. 203 (1),102–113.

Foreit, W., 1999. Reference Manual of Veterinary Parasitology. 5th ed. Wiley Blackwell, New York, USA, Pp 22-26.

Fritsche, T., J. Kaufmann and K. Pfister, 1993. Parasite spectrum and seasonal epidemiology of gastro-intestinal nematodes of small ruminants in the Gambia. Vet. Parasitol. 49(2-4): 271-283.

Getachew, M., R. Tesfaye and E. Sisay, 2017. Prevalence and risk factors of gastrointestinal nematodes infections in small ruminants in Tullo District, Western Harerghe, Ethiopia. J. Vet. Sci. Technol.8:2.

Government of The Gambia (GoTG), 2012. The Gambia's second national communication under the United Nations Framework Convention on Climate Change. Ministry of Forestry and the Environment, Banjul, 113p.

Gupta, A., A.K. Dixit, P. Dixit and C. Mahajan, 2013. Prevalence of gastrointestinal parasites in mall ruminants in and around Jabalpur. India. J. Vet. Parasitol., 27(1): 59-60.

Hailelul, N., 2002. Study on prevalence of GIT helminthes of small ruminants in and around Wolayta Soddo, southern Ethiopia. DVM Thesis, Faculty of veterinary medicine, Addis Ababa university, Debre-Zeit. Ethiopia, p. 353.

Hansen J and B. Perry, 1994. The epidemiology, diagnosis and control of helminth parasites of ruminants. Kenya, A handbook, ILRAD.

Islam, M.S., M.S. Hossain, A.R. Dey, M.A. Alim, S. Akter and M.Z. Alam, 2017. Epidemiology of gastrointestinal parasites of small ruminants in Mymensingh, Bangladesh. JAVAR.4(4), 356-362.

Jaiteh, M.S. and B. Sarr, 2015. Climate change and development in The Gambia, Challenges to ecosystem goods and services. http://www.columbia.edu/~msj42/pdfs/ClimateChangeDevelopmentGambia_small.pdf. pdf retrieved 23/1/2022.

Kripali, K., S. Rajput, V. Jitendra, V. Shivan and G. Pritee, 2010. Prevalence of helminthes in small ruminants in Tarai region of Uttarakhand. Vet. World. 2: Pp: 265-266.

Lamy, E., S.V. Harten, E.S. Baptista, M. Manuela and M. Guerra, 2012. Factors Influencing Livestock Productivity. In: V. Sejian (Ed), Environmental Stress and Amelioration in Livestock Production: Springer-Verlag Berlin Heidelberg. Springer, pp: 19-34.

Ministry of Agriculture (MOA), 2016. The Gambia 2016 National Livestock Census.

Morgan, E., J. Charlier, G. Hendrickx, A. Biggeri, D. Catalan, G. von Samson-Himmelstjerna, J. Demeler, E. Müller, J. van Dijk, F. Kenyon, P. Skuce, J. Höglund, P. O'Kiely, B. van Ranst, T. de Waal, L. Rinaldi, G. Cringoli, H. Hertzberg, P. Torgerson, A.A. Wolstenholme and J. Vercruyss, 2013. Global Change and Helminth Infections in Grazing Ruminants in Europe: Impacts, Trends and Sustainable Solutions. Agriculture. 3: 484-502.

Muhammad, N.K., S.S. Mohammad, K.K. Mohammad and A.H. Zafar, 2010. Gastrointestinal heliminthiasis: Prevalence and associated determinants in domestic ruminants of district Toba Tek Singh, Punjab, Pakistan. J. Parasitol. Res.107: 787-794.

Muluneh, J., B. Bogale and M. Chanie, 2014. Major gastrointestinal nematodes of small ruminants in Dembia District, Northwest Ethiopia. Eur. J. Appl. Physiol.6 (2): 30-36.

Nardone, A., G. Zervas and B. Ronchi, 2004. Sustainability of small ruminant organic systems of production. Livest. 90(1), 27-39.

Odoi, A., J.M. Gathuma, C.K. Gachuiri and Omore, A. 2007. Risk factors of gastrointestinal nematode parasite infections in small ruminants kept in smallholder mixed farms in Kenya. BMC. Vet. Res.3(6): 1186-1746.

Oluwatayo, I.B. and T.B. Oluwatayo, 2012. Small ruminants as a source of financial security: a case study of women in rural Southwest Nigeria. *Institute for Money, Technology and Financial Inclusion (IMTFI), Working Paper, 1.*

Paddock, R., 2010. Breed, Age and Sex Wise Distribution of *Haemonchus contortus* in Sheep and Goats in and around Rawalpindi Region, Pakistan. J. Med. Vet.12: 60-63.

Perry, B.D., T.F. Randolph, J.J. McDermott, K.R. Sones and P.K. Thornton, 2002. Investing in animal health research to alleviate poverty. International Livestock Research Institute (ILRI), Nairobi, Kenya, p. 148.

Radostits, O.M., D.C. Blood and C.C. Gay, 1994. Veterinary Medicine. Bailliere Tindall, London.

Ratanapob, N., Arunvipas, P., Kasemsuwan, S., Phimpraphai, W. and Panneum, S. 2012. Prevalence and risk factors for intestinal parasite infection in goats raised in Nakhon Pathom Province, Thailand. Tropical Animal Health and Production, 44(4):741-5. doi: 10.1007/s11250-011-9954-6.

Ratanapob, N., P. Arunvipas, S. Kasemsuwan, W. Phimpraphai and S. Panneum, 2012. Prevalence and risk factors for intestinal parasite infection in goats raised in Nakhon Pathom Province, Thailand. Trop. Anim. Health Prod., 44(4):741-5. doi: 10.1007/s11250-011-9954-6.

Singh, E., P. Kaur, L.D. Singla and M.S. Bal, 2017. Prevalence of gastrointestinal parasitism in small ruminants in western zone of Punjab, India. Vet. World. 10: 61-66.

Urquhart, G.M., J. Armour, J.L. Duncan, A.M. Dunn and F.W. Jennings, 1996. Veterinary Parasitology. 2nd ed. Blackwell science, United Kingdom, pp: 307.

Watson, D.L., I.G. Colditiz, M. Andrew, H.S. Gill and K.G. Altmann, 1994. Age dependent immune response in merino sheep. Res. Vet. Sci. 57: 52-158.

Wodajo, H.D., B.A. Gemeda, W. Kinati, A.A. Mulem, A. van Eerdewijk, and B. Wieland, 2020. Contribution of small ruminants to food security for Ethiopian smallholder farmers. Small Rumin. Res.184, 106064.