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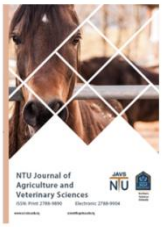

Detection of Gastrointestinal Worm Infection in Small Ruminants in Ogbomoso, Nigeria

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Article Informations

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A B S T R A C T

This cross-sectional study examined the prevalence and risk factors associated with gastrointestinal worm infections in sheep and goats in Ogbomoso, Nigeria. A total of 280 faecal samples were collected using a simple random sampling technique from 140 sheep and 140 goats. The samples were examined using simple floatation and formalin-ethyl acetate concentration techniques. The overall infection rate was 81.79%, with rates of 82.14% in sheep and 81.43% in goats. All three helminth classes were detected in both sheep and goats. A total of 11 helminth species were identified in sheep, mainly nematodes, with *Haemonchus* spp. (72.14%) being the most prevalent, and *Paramphistomum* spp. (0.71%) being the least prevalent. Thirteen helminths were identified in goats, where *Haemonchus* spp. (71.43%) had the highest occurrence, while *Cooperia*, *Marshallagia*, and *Trichuris* spp. (0.71%) had the lowest. Infection rates were not significantly influenced by sex, age, or breed ($p > 0.05$). This study confirms a high prevalence of a diverse range of gastrointestinal worms in sheep and goats in Ogbomoso, Nigeria.

Introduction

The livestock sector represents a key component of the agricultural industry in developing countries. It contributes significantly to the agricultural gross domestic product (GDP) of Nigeria, with ruminants representing an essential source of animal protein [1]. With a population of about 84 million goats, 47 million sheep, and 20 million cattle, they supply a great amount of daily meat and dairy products across the country while representing family wealth in some traditional settings [2]. Ruminant production has a wide range of other economic significance [3, 4]. Feed shortage, nutrition, limited knowledge of farmers in livestock production, and parasitic diseases remain key challenges to ruminants' productivity despite their established benefits [5].

Worms are ubiquitous however, their greatest impact is observed in sub-Saharan Africa, where favourable agroecological conditions have led to varying levels of infection being reported [1, 3]. Signs such as reduced feed intake, stunted growth, diarrhoea, weight loss, anaemia in some cases, and death in severe infections are associated with gastrointestinal helminth infections [1]. Consequently, these infections lead to reduced meat and milk production, decreased capacity of the animal, high control costs, condemnation of affected parts during meat inspection, and in some instances, zoonotic infections [1, 6]. Climate, pasture management, the number of infective eggs and larvae, the presence of intermediate hosts, grazing habits, health status, and age of the animal are established factors influencing the severity of gastrointestinal helminth infections [7].

Only a limited number of studies within Ogbomoso have investigated gastrointestinal helminths in small ruminants. These studies were based on small sample sizes, provided limited host-specific infection rates, and reported a narrow range of worm species. Additionally, no study has examined the potential risk factors of gastrointestinal worm infections in small ruminants in this area. This study aimed to determine the infection rate, diversity and risk factors of gastrointestinal helminth infections in sheep and goats in Ogbomoso, Nigeria. The findings will contribute new epidemiological insights for developing and improving parasite prevention and control strategies.

Materials and Methods

Study Area

The study took place in Ogbomoso, Oyo State, Nigeria. This town is located between 4°15' East of Greenwich Meridian and latitude 8°15' Northeast of the equator. It is bordered by Oyo, Ilorin, Osogbo, and Ikoyi. Ogbomoso has a mean annual rainfall of 1216mm. The mean annual temperature is estimated to be 26.2°C, while the vegetation is derived savannah [8]. The main slaughter slab, markets, farms, and households were visited during the study.

Ethical Approval

All samples were collected according to the guidelines laid down by the International Animal Ethics Committee and the Department of Animal Production and Health Animal Ethics Committee, Ladoke Akintola University of Technology (Approval number: APH/24/194624UG).

Study Design and Sample Size

The study was cross-sectional and was conducted from May to July 2024. With an estimated prevalence of 79.92% [1], the sample size was determined using the Thrusfield formula.

Sample size= $Z^2 \times P\ (1\text{-}P)/d^2$

Z is the 95% confidence interval (1.96), P is the expected prevalence (79.92%), and d is the desired absolute precision (5%). A total of 246.6 sample size was obtained and rounded up to 280. This was equally divided between the study population (sheep and goats).

Sample Collection

The sheep and goats at the various sampling sites were selected using a simple random sampling technique. Parameters such as the breed, age, and sex of the animals were recorded. The faecal samples were collected directly from the rectum of each apparently healthy sheep and goat into well-labelled airtight plastic bags. The samples were immediately transported to the Veterinary Parasitology Laboratory in transport boxes containing ice packs for processing. All samples were analysed within 24 hours of collection.

Sample Handling

Simple floatation and formalin-ethyl acetate concentration techniques were used to analyse the faecal samples.

Simple floatation technique:

1. About 2g of the faeces (individual) was mixed thoroughly with 10 ml of saturated sodium chloride solution.
2. The mixture was sieved to the brim of a test tube, a coverslip was placed on it, and it was allowed to stand for about 15 minutes.
3. The coverslip was carefully transferred to a clean glass slide.
4. The slide was examined for helminth eggs under a microscope at 10× and 40× magnification [1].

Formalin-ethyl acetate concentration technique:

1. The faeces (2g) was dissolved in 10% formalin.
2. The mixture (7 ml) was sieved into a test tube, to which 3 ml of ethyl acetate was added.

3. After shaking the tube vigorously by hand for one minute, it was centrifuged for 5 minutes at 3000 rpm.
4. The supernatant was decanted, and the sediment was placed on a clean glass slide.
5. It was stained with iodine and examined under a microscope at 10× and 40× magnification [9].

Based on their morphological features, the helminth eggs observed were identified as described by Taylor *et al*. [10] and Soulsby *et al*. [11].

Statistical Analysis

Data obtained were subjected to descriptive statistics using the Statistical Package for the Social Sciences (SPSS Version 20). Chi-square tests and binomial logistic regression were used to determine the association between each potential risk factor and gastrointestinal helminth infection status using The Jamovi Project (2024) [12]. Odds ratios were derived with respect to the designated reference category shown in each table. P-value of < 0.05 was considered statistically significant. The results were presented in tables and figures.

Results

The study screened a total of 280 faecal samples from small ruminants, resulting in an overall helminth infection rate of 81.79% as shown in Table 1, where 115 sheep (82.14%) and 114 goats (81.43%) were infected with one or more gastrointestinal helminth eggs across the different locations. Of the 140 sheep sampled, infection rates were highest (64.29%) in those sampled from markets. Similarly, of the 140 goats sampled, the highest infection rate (62.86%) was also recorded in goats from markets.

A total of 11 helminths, including nine nematodes, one cestode, and one trematode, were observed in sheep (Table 2). The highest infection rate was recorded for *Haemonchus* spp. (72.14%) in sheep, while *Paramphistomum* spp. (0.71%) had the least. Thirteen helminth species were recovered from goats, including eleven nematodes, one cestode, and a trematode (Table 3). *Haemonchus* spp. (71.43%) had the highest infection rate in goats, while *Cooperia*, *Marshallagia*, and *Trichuris* spp. (0.71%) were the lowest.

A total of 43 and 44 distinct gastrointestinal helminth combinations were identified in goats and sheep, respectively. These combinations were grouped into broader categories based on whether the infection was single or mixed. From the 115 sheep infected with gastrointestinal worms, coinfection patterns ranged from one to five, with the highest being three helminth coinfections recorded in 48 sheep (41.74%) (Figure 1). The Chi-square goodness-of-fit test showed that the distribution of coinfection patterns in sheep differed significantly from an equal distribution ($\chi^2 = 39.65$, $p < 0.001$). Similarly, up to five helminth coinfection patterns were observed in the 114 infected goats. Three helminth coinfection patterns were also the highest, which were recorded in 44 goats (38.59%) (Figure 2). The distribution of coinfection patterns in goats also differed significantly from an equal distribution ($\chi^2 = 40.65$, $p < 0.001$).

As shown in Table 4, male sheep had higher odds of infection than female sheep, though this difference was not statistically significant (OR = 1.51, 95% CI = 0.61-3.70, p = 0.40). Similarly, younger sheep showed a higher prevalence of infection than adults and were 2.16 times more likely to have infections with gastrointestinal helminths. This difference was also not significant ($\chi^2 = 0.45$, $p = 0.44$). Male goats had a higher prevalence than females, the difference was not statistically significant ($p < 0.05$), with males being 1.42 times more likely to be infected (OR = 1.42, 95% CI = 0.55-0.47, p = 0.89). Young goats had a higher prevalence rate and higher odds (OR = 1.62) of infection compared to adults, this difference was also not statistically significant ($\chi^2 = 0.21$, $p = 0.54$). West African Dwarf (WAD) goats had a higher infection rate (83.74%) than Red Sokoto goats (64.71%) and were three times more likely to be infected (Table 5), but was not significant ($\chi^2 = 3.58$, $p = 0.06$).

Discussion

This study confirmed that 81.79% of small ruminants in Ogbomoso, Nigeria, were infected with at least one gastrointestinal worm, with infection rates of 82.14% in sheep and 81.43% in goats. This relatively high infection rate aligns with findings from several studies within and outside Nigeria. For instance, Eke *et al*. [13] reported an infection rate of 78.54% in sheep and goats in North Central, Nigeria. Similarly, infection rates of 78.8% in Osun State [14], 77.5% in Lafia [15], 70.91% in Ibadan [16], and 75% in Niger State [17] have been documented. Beyond Nigeria, studies have reported infection rates of 88% in Thailand [18], 74.41% in Ethiopia [19], and 100% in Southern Italy [20]. However, some studies in Nigeria have recorded lower infection rates ranging from 24.35% to 49.36% [13, 21, 22], which contradicts the findings of this present study. Variations in the infection rates may be influenced by factors like geographical location, climatic conditions, worm control measures, presence or absence of intermediate hosts, differences in sample size and diagnostic techniques and management systems.

Eleven distinct helminth species were identified in sheep, while thirteen were recovered from goats in this study, which falls within the range of 6-13 species documented in previous studies from Nigeria and other parts of the world [13, 15, 16, 21, 23]. Notably, all worms identified in this study are being reported for the first time in sheep and goats in Ogbomoso. Several studies have

established nematodes as the most prevalent gastrointestinal helminth. This present study has also confirmed nematodes as the most abundant species in sheep and goats in Ogbomoso, Nigeria. One possible explanation for this dominance is the direct lifecycle most nematodes have, eliminating the need for intermediate hosts. Trematodes and cestodes have been reported as the most frequent gastrointestinal helminths of small ruminants in Jos, Nigeria [21], a finding that contrasts with the results of this study. *Haemonchus* and *Trichostrongylus* species were the most dominant nematodes in both ruminant species in this study. Some studies have also confirmed the high infection rates of *Haemonchus* spp. in goats in Nigeria [13, 17] and Rwanda [24]. The larval development of *Haemonchus* spp. occurs optimally at high temperatures and humidity, making the climate of Nigeria particularly suitable for its survival [24]. Similarly, the eggs and infective larvae of *Trichostrongylus* spp. are known to survive under adverse environmental conditions, facilitating their survival and year-round transmission [1].

Sheep had a higher infection rate of gastrointestinal helminths than goats, although the difference was minimal. This finding aligns with Ola-Fadunsin and Ibitoye [14], Sebro *et al*. [19], Yohanna *et al*. [21], and Mushonga *et al*. [24], among others, who also observed a higher prevalence in sheep. Sheep typically graze closer to the ground, increasing their risk of ingesting infective larvae. In contrast, goats are more selective browsers and tend to feed on shrubs and leaves, reducing their direct exposure to contaminated pastures. However, the high prevalence in sheep observed in this study is not consistent with the findings of Eke *et al*. [13], Aliyu *et al*. [15], Eke *et al*. [17], and Cai *et al*. [23], who reported higher infection rates in goats in other regions of Nigeria.

The relationship between sex and infection in both sheep and goats showed no statistically significant difference. However, infection rates were higher in males (sheep and goats), which could be attributed to the voracious feeding nature of males, where they consume larger amounts of forage and graze more extensively. Similar findings have been reported by Eke *et al*. [13], Eke *et al*. [17], all of whom concluded that sex did not influence the prevalence of gastrointestinal helminths in small ruminants, implying that both males and females had equal chances of infection. Conversely, sex had a significant influence on infection rates [15], with females exhibiting a higher burden of infection compared to males. This study further revealed that younger sheep and goats had higher infections than adult sheep and goats. There was no statistically significant variation ($p > 0.05$), aligning with the findings of Ola-Fadunsin *et al*. [1]. Young animals are more susceptible to infections as compared to adults that may have developed some level of partial immunity through repeated exposure [22]. Contrarily, Yohanna *et al*. [21] confirmed that age significantly ($p < 0.05$) influenced the prevalence of helminth infections in ruminants, with adults being more affected. Cai *et al*. [23] reported a higher prevalence of gastrointestinal parasite infection in adults than in young ruminants. The West African Dwarf breed of goats had a higher infection rate than the Red Sokoto breed in this study. The relation between breed and infection was not statistically significant ($p > 0.05$), suggesting both breeds had an equal likelihood of infection. The WAD breed also had a higher prevalence of worms as reported by Aliyu *et al*. [15] in Lafia, Nigeria.

Conclusion

This study confirms a very high infection rate of gastrointestinal worms in sheep and goats within Ogbomoso, Nigeria. To the best of our knowledge, it represents the first reports of a broad and diverse range of worm species in both host species within this region. All classes of helminths were detected in the sheep and goats, with nematodes being the most frequent in both. The findings suggest that small ruminants in the area are widely predisposed to gastrointestinal helminths, regardless of sex, age, or breed.

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The authors have no acknowledgements to declare.

Competing Interests

The authors declare that there are no conflicts of interest regarding this manuscript.

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Table 1. Total Infection Rates of Gastrointestinal Worms in Sheep and Goats in Ogbomoso, Nigeria

Location	Number Examined	Number Infected	Infection Rate (%)	Total Infection Rate (%)
Sheep				82.14
Slaughter Slab	---	---	---	
Households	17	10	7.14	
Markets	102	90	64.29	
Farms	21	15	10.71	
Goats				81.43
Slaughter Slab	10	7	5.00	
Households	22	12	8.57	
Markets	96	88	62.86	
Farms	12	7	5.00	
Total	280	229		81.79

Table 2. Infection Rate of Gastrointestinal Worms in Sheep (n = 140) in Ogbomoso, Nigeria

Helminths	Number Infected	Infection Rate (%)	95% Confidence Interval	Total Infection Rate (%)
Toxocara spp.	7	5.00	1.29-8.61	82.14
Nematodirus spp.	8	5.71	1.75-9.56	
Bunostomum spp.	17	12.14	6.37-17.55	
Oesophagostomum spp.	35	25.00	16.72-32.17	
Cooperia spp.	12	8.57	3.72-13.21	
Trichostrongylus spp.	86	61.43	48.45-69.49	
Haemonchus spp.	101	72.14	58.07-79.57	
Strongyloides spp.	37	26.43	17.91-33.73	
Moniezia spp.	14	10.00	4.76-14.97	
Chabertia spp.	2	1.43	-0.55-3.39	
Paramphistomum spp.	1	0.71	-0.69-2.11	
No parasite seen	25	---		

Table 3. Infection Rate of Gastrointestinal Worms in Goats (n = 140) in Ogbomoso, Nigeria

Helminths	Number Infected	Infection Rate (%)	95% Confidence Interval	Total Infection Rate (%)
Toxocara spp.	7	5.00	1.29-8.61	81.43
Bunostomum spp.	10	7.14	2.72-11.41	
Oesophagostomum spp.	38	27.14	18.51-34.51	
Cooperia spp.	1	0.71	-0.69-2.11	
Trichostrongylus spp.	79	56.43	43.99-64.64	
Haemonchus spp.	100	71.43	57.43-78.92	
Strongyloides spp.	49	35.00	25.20-42.90	
Moniezia spp.	26	18.57	11.43-25.01	
Paramphistomum spp.	2	1.43	-0.55-3.39	
Chabertia spp.	2	1.43	-0.55-3.39	
Nematodirus spp.	4	2.86	0.06-5.62	
Marshallagia spp.	1	0.71	-0.69-2.11	
Trichuris spp.	1	0.71	-0.69-2.11	
No parasite seen	26	---		

Table 4. Relationship between Sex and Age and Gastrointestinal Worm Infections in Sheep in Ogbomoso, Nigeria

Variable	Number Examined	Number Infected	Infection Rate (%)	Odds Ratio (95% CI)	χ^2	P Value
Sex						
Male	61	52	85.25	1.51 (0.61-3.70)	0.71	0.40
Female*	79	63	79.75	1.00		
Age						
Young (< 1 year)	10	9	90	2.16 (0.26-18.03)	0.45	0.44
Adult* (> 1 year)	130	106	81.54	1.00		

*Reference Category; CI: Confidence Interval

Table 5. Relationship between Sex, Age, and Breed and Gastrointestinal Worm Infections in Goats in Ogbomoso, Nigeria

Variable	Number Examined	Number Infected	Infection Rate (%)	Odds Ratio (95% CI)	χ^2	P Value
Sex						
Male	61	50	81.97	1.42 (0.55-3.68)	0.02	0.89
Female*	79	64	81.01	1.00		
Age						
Young (< 1 year)	8	7	87.50	1.62 (0.19-14.11)	0.21	0.54
Adult* (> 1 year)	132	107	81.06	1.00		
Breed						
WAD	123	103	83.74	3.31 (0.99-10.99)	3.58	0.06
Red Sokoto*	17	11	64.71	1.00		

*Reference Category; CI: Confidence Interval; WAD: West African Dwarf

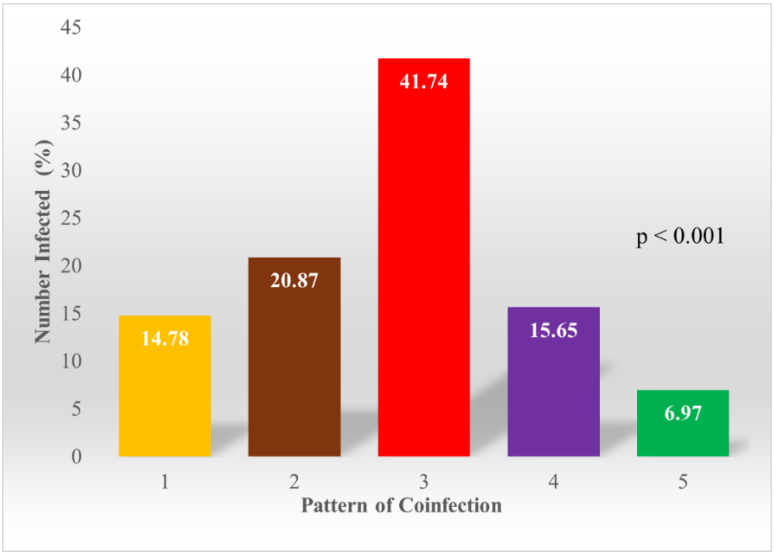

Figure 1. Patterns of Gastrointestinal Worm Coinfections Observed in Sheep in Ogbomoso, Nigeria

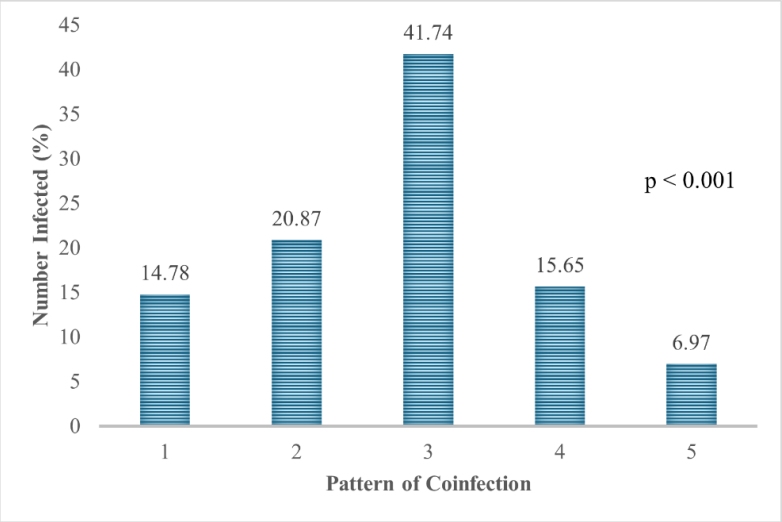

Figure 2. Patterns of Gastrointestinal Worm Coinfections Observed in Goats in Ogbomoso, Nigeria