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Gastrointestinal Parasitic Infections of Ruminants in Pastoral Communities of Ondo State, Nigeria

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ABSTRACT

Livestock are important for food production and agricultural systems; however, helminth infections are a major constraint on their productivity and value. The present study aimed to investigate the prevalence and associated risk factors for helminth infections in four pastoral communities in Ondo State, Nigeria. A total of 1,165 fecal samples from livestock in four pastoral rural/peri-urban communities (Akungba, Ikare, Oka, and Supare) in the Akoko area of Ondo State were screened for gastrointestinal parasitic infections via the sedimentation technique. The overall prevalence of parasitic infections was 67.7%, with sheep having the highest prevalence of infection (72.8%). The prevalence of parasitic infection was significantly associated with the breed of livestock. Important parasites of public health, including *Fasciola* species, *Strongyloides* species, *Trichuris* species, hookworms, *Schistosoma* species, *Trichostrongylus* species, and *Fasciola* species, which are the most common, were isolated in the current study. Two-thirds (75.5%) of the observed prevalence was due to infection with a single helminth species, whereas the remaining one-third (24.5%) comprised infections with two or three species of helminths. Among multiple infections, *Fasciola* species plus *Strongyloides* species coinfection had the highest prevalence (46%). The present findings suggest the need for regular epidemiological surveillance and treatment of infected ruminants with gastrointestinal helminths.

Keywords: Helminth, Infection, Livestock, Prevalence, Ruminant

INTRODUCTION

Livestock farming and trading are sources of income in rural communities across Nigeria, especially among subsistence farmers and pastoralists, contributing approximately 1.7% of the national gross domestic product (GDP) and approximately 9% of the agricultural value added (FAO, 2019). Over the years, parasitic infections have remained a major challenge to productivity in livestock farming in Nigeria, with helminth infections accounting for up to 79.92% of infections (Karshima et al., 2018; Ola-Fadunsin et al., 2020).

The extensive system of animal husbandry commonly practiced across the country contributes to the incidence of parasitic infections. Although the effects of these infections are difficult to measure, they result in economic losses reflected in poor growth rates and reduced production of meat, milk, wool, and carcass quality (Strydom et al., 2023). The intestinal parasites of ruminants and their prevalence have been documented in studies from different parts of Nigeria; however, the majority of the studies are from northern Nigeria, as livestock farming is a predominant occupation in this region (Karshima et al., 2018).

Numerous factors, including host-related factors (host species, the animal's sex, age, bodily condition, and breed/genotype), and environmental factors (the degree of infection across different strata), influence the abundance and distribution of parasitic infections in livestock ruminants (Kołodziej-Sobocińska, 2019). As the global population increases continuously, livestock production needs to be more efficient to sustain food security, especially meat and dairy products (Morgan et al., 2013). Therefore, there is a need for constant epidemiological surveys to understand the pattern of infections and the various risk factors in different regions. However, previous studies on parasitic infections among livestock in Nigeria were conducted in abattoirs, possibly due to the ease of sample collection compared with the challenges of locating herders in rural areas (Elelu and Eisler, 2018; Karshima et al., 2018). Despite being well known for having several pastoral communities, studies on gastrointestinal diseases in cattle in the Akoko area of Ondo State are rare (Akinmoladun and Olafare, 2014).

Thus, the present study aimed to provide baseline epidemiological data on parasitic infection in cattle, sheep, and goats in four pastoral communities in the Akoko area of Ondo State, Nigeria.

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MATERIALS AND METHODS

Ethical approval

Ethical approval was obtained from the ethical review board of Adekunle Ajasin University, Akungba Akoko, and oral consent was secured from individual traders and herdsmen. All applicable national and institutional guidelines for the care and use of animals were followed.

Study location

The Akoko subgroup comprises forty small rural to peri-urban settlements spread across four local government areas of Ondo State, Nigeria. The present study was carried out in four of the major settlements: Ikare (7.5248° N, 5.7669° E), Akungba (7.4740° N, 5.7379° E), Oka (7.4570° N, 5.8011° E), and Supare (7.3812° N, 5.6248° E) (Figure 1). The area has rocky terrain characterized by rainforest vegetation with an annual rainfall of 1500 mm, a relative humidity of 75% to 95%, and an average temperature of 24°C. The population is mixed, comprising people from different tribes involved in various occupations, of which farming and/or pastoralism is predominant. The area hosts various agricultural markets and is a collection point for crops and animals.

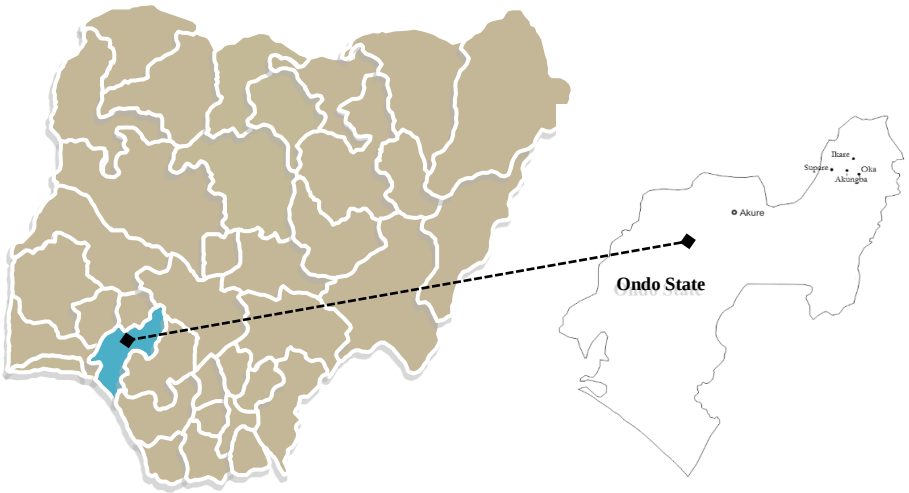

Figure 1. Map of Nigeria showing the study location

Sample collection and processing

The sample size (n = 369) was determined based on the 60% regional prevalence of helminths in ruminants in Nigeria (Karshima et al., 2018), 95% confidence level, Z score = 1.96, and 5% absolute precision. At the four study sites (three rural and one peri-urban), 1165 livestock, comprising 391 cattle, 384 goats, and 390 sheep, from 2 months to 8 years were selected via simple random sampling. Fresh fecal samples were collected directly from the rectums of the animals or ground immediately after they were voided into properly well-labeled sterile containers and were taken to the laboratory for microscopic examination. The fluke finder, a commercially available tool, was used for the isolation of parasite eggs from fecal samples. This kit has a single unit made of two 2-inch-wide sieves of approximately 125 nm and 30 nm mesh, and parasite ova/cysts are isolated via differential filtration followed by differential sedimentation (Zárate-Rendón et al., 2019). Approximately 2 g of feces was mixed with water and poured into the upper part of the fluke finder unit. This mixture was washed several times with water, and the larger material that was retained was discarded. The material that was left in the small diameter sieve was drained into a beaker, where it settled for a few minutes before the supernatant was removed. The process was repeated until the residue was clear. The sediment was then poured into a 2-inch Petri dish. A pipette was used to place a small amount of sample on the slide, which was stained with three drops of methylene blue and covered with a cover glass. The slides were examined systematically under x10 and x40 magnifications via a light microscope (Olympus, Japan) for larvae, helminth eggs, and cysts. The ova and larvae of the parasites were identified based on their morphological characteristics according to the methods of Cheesbrough (2005) and WHO (2019).

Statistical analysis

The data were analyzed via Microsoft Excel, version 2407 (2024), and R software, version 4.4.1 (2024). The variables (sex, age, breed, and location) were examined for their associations with the incidence of parasites via chi-square ($\chi 2$) tests. The p-value was regarded as statistically significant if it was less than 0.05 at the 95% confidence level.

RESULTS

Among the 1,165 livestock examined for gastrointestinal infections, the overall prevalence of infection was 67.7%, with sheep having the highest prevalence of infection (72.8%), followed by goats (66.7%) and cattle (63.7%, Table 1). In the populations that were sampled, there were more female animals (51.9%) than male animals (48.1%), and most of the animals were either under one-year-old (38.4%) or more than two years old (40.6%). The West African dwarf breed made up a relatively large portion of the animals. Except for the Dalgae breed, all age groups were represented in the samples of male and female animals throughout the breeds. There were slightly more infected female animals (68.6%) and animals more than two years old (69.8%) than male animals (66.8%) and animals younger than two years of age (67.6% and 64.1%), despite the proportion of infection based on the sex and age of the animals being similar (Table 2). The age- and sex-related variations were statistically insignificant ($p = 0.302$, $p = 0.509$). Among the breeds, the Gbokono and West African breeds had higher infection rates (70.5% and 69.8%), whereas the Dalgae and Yakana breeds had lower infection rates (44% and 65.4%, respectively). The difference in infection rates among the breeds was statistically significant ($p = 0.002$). The prevalence of infection among the study sites was similar, ranging between 65.5% and 68.9%, and statistically insignificant ($p = 0.762$). Multiple regression analysis of risk factors revealed a significant relationship between infection rates and breeds of livestock ($p = 0.001$).

Table 1. The overall prevalence of gastrointestinal helminths in livestock in the Akoko area of Ondo State, Nigeria, in 2021

Animal	Total	No positive	Percentage
Cattle	391	249	63.7
Goat	384	256	66.7
Sheep	390	284	72.8
Total	1165	789	67.7

Table 2. Demographic characteristics of infected livestock and odds ratios of the risk of infection in the Akoko area of Ondo State, Nigeria, in 2021

Characteristic	Overall (%), N = 1,165[1]	Number positive (%), N = 789[1]	OR[2]	95% CI[2]	P value
Sex					
Female	605	415 (68.6%)[a]	Ref.	Ref.	
Male	560	374 (66.8%)[a]	18	0.83, 1.41	0.6
Age group					
<1	447	302 (67.6%)[a]	Ref.	Ref.	
1-2	245	157 (64.1%)[a]	0.96	0.68, 1.35	0.8
>2	473	330 (69.8%)[a]	1.16	0.86, 1.57	0.3
Breed					
Dalgae	50	22 (44.0%)[a]	Ref.	Ref.	
Gbokono	78	55 (70.5%)[b]	3.51	1.54, 8.11	0.003
West African Dwarf	774	540 (69.8%)[c]	3.34	1.72, 6.58	< 0.001
Yakana	263	172 (65.4%)[d]	2.58	1.31, 5.12	0.006
Location					
Akungba	380	262 (68.9%)[a]	Ref.	Ref.	
Ikare	410	281 (68.5%)[a]	0.98	0.72, 1.33	0.9
Oka	123	81 (65.9%)[a]	0.82	0.52, 1.28	0.4
Supare	252	165 (65.5%)[a]	18	0.74, 1.58	0.7

[1] n (%), [2] OR: Odds ratio, CI: Confidence interval, Ref: Reference. [a-d] Different superscript letters in the same row indicate statistical significance at $p < 0.05$.

Among the 789 animals infected, 24.5% had multiple gastrointestinal helminth infections, while the remaining animals (75.5%) were infected with a single species. Among the livestock, goats (30.9%) had the highest rate of multiple infections, followed by sheep (22.2%) and cattle (20.5%). However, for single infections, cattle (79.5%) had the highest rate of infection, followed by sheep (77.8%) and goats (69.1%). Concerning the sex of the animals, both sexes had similar infection rates of single and multiple infections ($p = 0.400$). The prevalence of single and multiple infections also

varied insignificantly across the different age categories of livestock (p = 0.700). A higher rate of multiple infections was observed in Gbokono (29.1%), followed by the West African Dwarf breed (26.3%) and Yakana (20.3%), whereas the Dalgae breed had no multiple infections (Table 3). There were significant differences between the type of infection and the species and breed of the animals (p = 0.016). The frequencies of single (71.9%-79.8%) and multiple (20.3%-29.1%) infections were comparable across the different study sites (p = 0.200).

The eggs of the different parasites identified in the present study were *Fasciola* species (77%), *Strongyloides* species (14%), *Trichuris* species (6.6%), hookworms (1.5%), *Schistosoma* species (0.9%), and *Trichostrongylus* species (0.4%, Figure 2). Multiple infections were observed, with *Fasciola* species plus *Strongyloides* species (46%) having the highest prevalence among all the samples. In multiple infections with three helminths, coinfections with hookworm plus *Fasciola* species plus *Strongyloides* species (2.7%) and *Fasciola* species plus *Strongyloides* species plus *Trichostrongylus* species (1.4%) were observed (Figure 3).

Table 3. Types of infections according to the demographic characteristics of livestock in the Akoko area of Ondo State, Nigeria, in 2021

Characteristic	Overall, N = 789[1]	Multiple infections, N = 193[1] (%)	Single infection, N = 596[1] (%)	P value[2]
Animal				0.014
Cattle	249	51 (20.5%)[a]	198 (79.5%)	
Goat	256	79 (30.9%)[a]	177 (69.1%)[a]	
Sheep	284	63 (22.2%)[a]	221 (77.8%)[a]	
Sex				0.4
Female	415	96 (23.1%)[a]	319 (76.9%)[a]	
Male	374	97 (25.9%)[a]	277 (74.1%)[a]	
Age group				07
<1	302	83 (27.5%)[a]	219 (72.5%)[a]	
1-2	157	43 (27.4%)[a]	114 (72.6%)[a]	
>2	330	67 (20.3%)[a]	263 (79.7%)[a]	
Breed				0.016
Dalgae	22	0 (0%)[a]	22 (100.0%)[a]	
Gbokono	55	16 (29.1%)[b]	39 (70.9%)[b]	
West African dwarf	540	142 (26.3%)[c]	398 (73.7%)[c]	
Yakana	172	35 (20.3%)[d]	137 (79.7%)[d]	
Location				0.2
Akungba	262	53 (20.2%)[a]	209 (79.8%)[a]	
Ikare	281	79 (28.1%)[a]	202 (71.9%)[a]	
Oka	81	20 (24.7%)[a]	61 (75.3%)[a]	
Supare	165	41 (24.8%)[a]	124 (75.2%)[a]	

[1] n (%): Number and percentages in brackets. [2] Pearson's chi-square test; [a-d] Different superscript letters in the same row indicate statistical significance at p < 0.05.

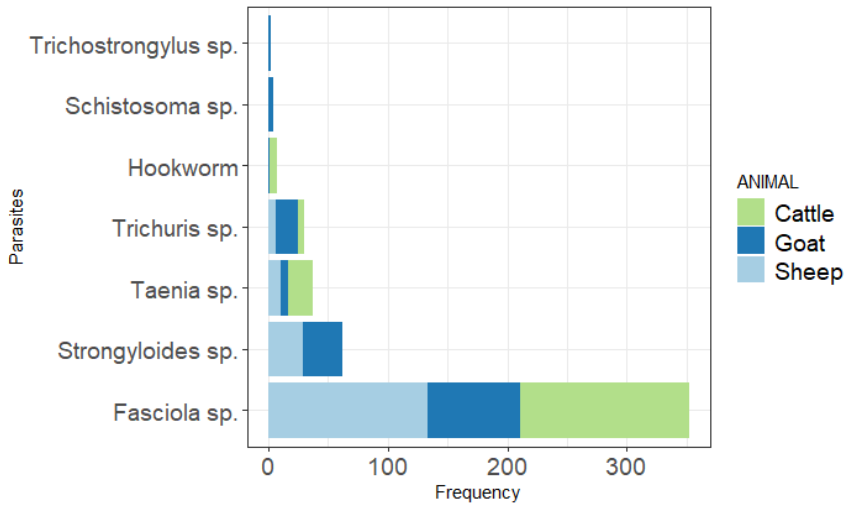

Figure 2. Frequency of single parasitic infections in livestock in the Akoko area of Ondo State, Nigeria, in 2021.

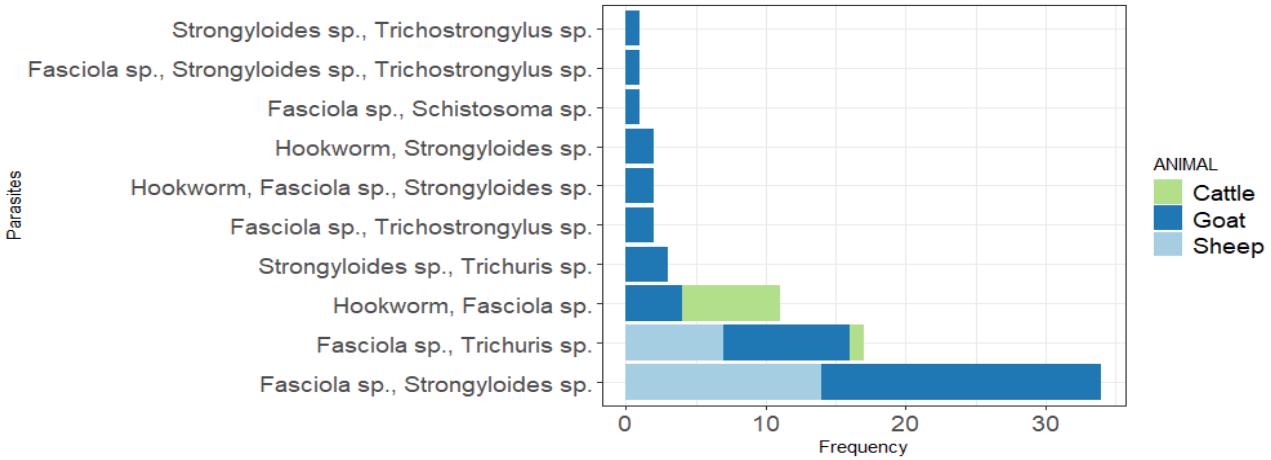

Figure 3. Frequency of multiple parasitic infections in livestock in the Akoko area of Ondo State, Nigeria, in 2021.

DISCUSSION

The high overall prevalence (67.7%) observed in the current study is suggestive of high transmission of gastrointestinal helminths among livestock in the area, with potential impacts on livestock productivity and human health (Table 1). The high rates of infection recorded among the animals exceeded the Southwest regional prevalence of 49.18% reported in a study by Karshima et al. (2018). The high prevalence is consistent with previous studies within the southwestern part of the country (Unigwe et al., 2016; Bolaji et al., 2023; Jonathan et al., 2023).

The high rate of infection recorded in cattle (63.7%) and goats (66.7%) in the present study exceeded the prevalence reported in previous studies in Ondo State from abattoir surveys (Omoleye et al., 2013; Afolabi and Olususi, 2016; Dada and Jegede, 2019; Simon-Oke and Awosolu, 2021).

The West African dwarf is a native goat and sheep breed that predominates in the southwestern region of Nigeria, while the White Fulani is the most common breed of cattle (Kubkomawa, 2017). In the present study, three breeds of cattle from the White Fulani group, as well as goats and sheep from the West African dwarf type, were examined. The age and sex patterns of infections observed in the present study are similar to those reported by Sylvia et al. (2015), Jegede et al. (2015), and Yuguda et al. (2018), with females and older animals being more infected. A commonly reported pattern of increased infection in young animals was similarly observed in the present study; however, a contrasting pattern was observed in older animals. This observation suggests that the interplay of different host and management factors, such as immunity, diet, grazing system, and veterinary care, might have played a role in the observed pattern of infection across the different age groups. The differences in sex prevalence have been attributed to possible variations in immunology and adaptivity to infection between sexes, and reproduction in female animals is also believed to play a role in infection, as it lowers the resistance of female animals to infection (Jegede et al., 2015). Although the susceptibility of animals to gastrointestinal helminth infection could be influenced by a variety of host factors, including age, sex, and breed, only the breed of the animal was significantly associated with the rate of infection in the present study, similar to the findings of Ola-Fadunsin (2017) and Ola-Fadunsin et al. (2020). Breeding has been reported to be an important factor in the epidemiology of parasitic infections in livestock, with local cattle breeds at greater risk of infection than imported cattle breeds (Ola-Fadunsin et al., 2020). The odds of infection with helminths were two times greater in the Yakana breed (OR = 2.58, $p = 0.006$) and three times greater in the Gbokono and West African Dwarf breeds (OR = 3.51, $p = 0.003$, OR = 3.34, $p < 0.05$) than in the Dalgae breed (Table 2). On the other hand, some other studies have found no appreciable variations in the relationship between animal breed and infection (Adedipe et al., 2014; Jegede et al., 2015; Sylvia et al., 2015). Several factors, including the animal rearing system, the frequency of treatment, and the physiological and nutritional health of the animals, are important contributors to the prevalence of helminth infections in various breeds of ruminants (Ola-Fadunsin et al., 2020). There was no significant difference in the pattern of infection across the different study sites. This is expected, as the settlements are close to each other and share the same ecological and environmental factors.

Approximately one-third of the infections reported in the present study were multiple infections comprising two to three helminths (Table 3 and Figure 3). This observation is similar to that of Yuguda et al. (2018) and Ola-Fadunsin et al. (2020), who reported multiple infections in livestock in Bauchi and Ilorin, respectively. The occurrence of multiple infections in livestock in the current study could be attributed to the nomadic system of management, which allows the

animals to access a wide range of habitats and possibly encounter diverse parasites with a relatively high risk of infection. Host-ranging patterns have been proposed to have a major influence on parasite diversity (Bordes et al., 2009). The presence of mixed infections has been linked to morbidity and poor productivity in cattle (Kumsa et al., 2011). Multiple infections suppress the immune system of hosts and increase their vulnerability to other illnesses or parasites (Hananeh et al., 2022).

The different parasites encountered in the present study (Figure 2) have been commonly reported across the country, as described in a review by Karshima et al. (2018). Some of the species encountered are emerging as important zoonoses of great public health concern, especially in developing countries (Robinson and Dalton, 2009; Mathison and Pritt, 2018; Majewska et al., 2021). Fasciolosis, formerly regarded as a livestock disease, has now been recognized as an emerging zoonotic disease with an increasing number of human infections (Robinson and Dalton, 2009). The impact of schistosomiasis on livestock has received less attention than that of human infections; however, current reports on hybridization between human and animal species with evidence of possible transmission of zoonotic schistosomiasis have resulted in renewed attention because of its potential impact on public health (Webster et al., 2013). Similarly, hybridization has also been reported in other helminths, such as Fasciola (Webster et al., 2016; Easton et al., 2020). Recently, the subtle impact of hookworm infection has been recognized, with the disease being linked to severe iron deficiency anemia (IDA) and potential effects on cognitive development in children (Brooker et al., 2004). Helminth infection, in addition to being transmitted to humans, sometimes results in unquantifiable direct and indirect economic losses due to reduced productivity in livestock. Increasing interactions between humans and animals, climate change, migration, and changes in the human diet are some of the factors that have been linked to the increasing emergence of zoonotic potential in parasites of animal origin (McCarthy and Moore, 2000; Keiser and Utzinger, 2005; Majewska et al., 2021).

CONCLUSION

The high prevalence of gastrointestinal helminth infection recorded in the study areas suggests ongoing transmission of parasites between different animal species and the environment, possibly due to the congregation of livestock in the region. The high rates of gastrointestinal infection in livestock in the present study cannot be ignored because of its possible impacts on livestock productivity as well as the potential risk to human health through food consumption and environmental contamination. There is a need for improvements in the animal management and treatment of infected animals in the study area.

DECLARATIONS

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The authors did not receive any funding for this work.

Availability of data and materials

This manuscript includes all the data generated or analyzed during the study.

Authors' contributions

Ajakaye Oluwaremilekun Grace conceptualized the study and conducted fieldwork, laboratory experiments, and data analysis. Adejuyigbe Aderotimi carried out the fieldwork and laboratory experiments. Ajakaye Oluwaremilekun Grace drafted the manuscript, and both authors read and approved the final manuscript.

Competing interests

The authors declare that they have no conflicts of interest.

Ethical considerations

The authors confirm that all the authors have reviewed and submitted the manuscript to this journal for the first time.

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