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Research Article

Prevalence and Infection Intensity of *Haemonchus contortus* in Sheep and Goats Slaughtered during the Late Dry Season in Zaria, Nigeria

***Isah I., Oloche M. and Yusuf K. H.**

Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria
****Corresponding Author's email*: iisah007@yahoo.com; Phone: +2348036030186**

ABSTRACT
Haemonchosis remains one of the most economically important helminth infections limiting small ruminant productivity in tropical and subtropical regions. This study determined the prevalence and intensity of *Haemonchus contortus* infection in sheep and goats slaughtered during the late dry season in Zaria, Kaduna State, Nigeria. A cross-sectional abattoir-based design was employed, involving 196 small ruminants comprising 98 sheep and 98 goats. Abomasa were collected immediately after slaughter, and adult worms were recovered using standard post-mortem worm count techniques. Identification was based on morphological features, and worm burdens were categorized into light, moderate, and heavy infections. Data were analysed using descriptive statistics and Chi-square tests to compare infection patterns between species. Findings revealed that light infection was the predominant category in both sheep (78.6%) and goats (70.4%), while moderate infection occurred at low levels in sheep (6.1%) and goats (3.1%). No heavy infections were recorded in either species. A higher proportion of goats (26.5%) were uninfected compared to sheep (15.3%). Statistical analysis indicated no significant difference in infection distribution between sheep and goats ($p > 0.05$). The overall pattern suggests widespread exposure to *H. contortus* but with relatively low worm burdens during the late dry season. The absence of heavy infections may reflect seasonal constraints on larval survival and transmission dynamics. These findings highlight the importance of season-specific parasite control strategies and provide baseline epidemiological data for the improvement of helminth management in small ruminants in northern Nigeria.

Keywords: Dry season; *Haemonchus contortus*; Infection intensity; Prevalence; Small ruminants

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INTRODUCTION

Gastrointestinal helminth infections continue to pose a major constraint to small ruminant production worldwide, particularly in tropical and subtropical regions where environmental conditions favour parasite development and transmission (Yusuf and Asefa, 2023). Among these parasites, *Haemonchus contortus*, commonly referred to as the barber's pole worm, is one of the most pathogenic nematodes affecting sheep and goats. It inhabits the abomasum, where it feeds on blood, leading to anaemia, reduced productivity, and in severe cases, mortality (Adduci *et al*., 2022; Ayana, 2024). The economic implications of haemonchosis are substantial, and these encompass decreased weight gain, poor reproductive performance, and increased costs of treatment and control (Arsenopoulos *et al*., 2021; Regassa *et al*., 2024; Demessie *et al*., 2025).

The epidemiology of *H. contortus* is strongly influenced by climatic factors such as temperature, humidity, and rainfall, which determine the development and survival of infective larvae on pasture (Rashid and Irshadullah, 2018; Flay *et al*., 2022). In the Northern Guinea savannah zone of

Nigeria, seasonal variations play a critical role in shaping infection dynamics. The rainy season typically supports higher transmission due to favourable moisture conditions, while the dry season is often associated with reduced larval availability (Fakae, 1990; Josiah *et al*., 2015). However, the persistence of infection during the dry season, particularly in abattoir animals sourced from diverse ecological backgrounds, remains an important area of investigation. Given the favourable conditions for larval development and survival, haemonchosis is often more common during the rainy season in northern Nigeria; nonetheless, infections that survive into the late dry season continue to be economically and epidemiologically significant. When the next rainy season begins, animals that retain adult *H. contortus* during the dry season may act as significant reservoirs of infection, promoting pasture contamination and quick transmission. Furthermore, even in cases when infection levels are relatively low, physiological stress brought on by feed scarcity and poor nutritional status during the dry season may worsen the pathogenic effects of haemonchosis. Consequently, understanding the prevalence and infection intensity of *H. contortus* during the late dry season is essential for improving strategic parasite control and timing of anthelmintic interventions in endemic areas.

In Nigeria, sheep and goats constitute an important component of rural livelihoods and food security, making the control of parasitic diseases such as haemonchosis essential for sustainable livestock production. Sheep and goats differ in their grazing and browsing behaviours, which may influence their exposure to infective larvae. Sheep, being grazers, are more likely to ingest larvae from contaminated pasture, whereas goats, as browsers, tend to feed above ground level and may have relatively lower exposure (Mohammed *et al*., 2020; Cellier *et al*., 2022). Despite these differences, both species are susceptible to *H. contortus*, and comparative studies are essential to understand species-specific infection patterns and inform targeted control strategies.

Abattoir-based studies provide valuable insights into the true burden of parasitic infections, as they allow direct recovery and enumeration of adult worms (Rizwan *et al*., 2025). Unlike faecal-based diagnostic methods, post-mortem worm counts offer a more accurate assessment of infection intensity and parasite distribution. Such studies are particularly useful in endemic regions where subclinical infections may go unnoticed but still contribute to production losses (Regassa *et al*., 2024).

It was hypothesized that *Haemonchus contortus* infection persists in sheep and goats during the late dry season in Zaria, with differences in prevalence and infection intensity occurring between host species. Therefore, given the importance of *H. contortus* and the limited data on its dry-season dynamics in northern Nigeria, this study was designed to determine the prevalence and intensity of infection in sheep and goats slaughtered in Zaria. The findings are expected to contribute to a better understanding of seasonal parasite epidemiology and support the development of effective, evidence-based helminth control programmes in the region.

MATERIALS AND METHODS

Study Area

The study was conducted at Dogarawa slaughter slab in Zaria, Kaduna State, Nigeria, located opposite the Sabon Gari Local Government Secretariat. Zaria lies within the Northern Guinea savannah zone and experiences a tropical climate characterized by two distinct seasons: a rainy season (May–October) and a dry season (November–April) (Ibrahim *et al*., 2020). The study was carried out in March 2020, corresponding to the late dry season.

Small ruminants slaughtered at the facility were sourced from Zaria metropolis, surrounding peri-urban settlements, and nearby rural communities. The predominant sheep breed encountered was Yankasa, while goats were mainly Red Sokoto.

Study Design

A cross-sectional abattoir-based study was conducted to determine the prevalence and intensity of *Haemonchus contortus* infection in sheep and goats during the late dry season.

Sample size determination

The sample size was calculated using the formula described by Thrusfield (2018) for estimating proportions at a 95% confidence level and 5% precision:

$n = Z^2 \times P \times (1-P) / L^2$

Where:

n = required sample size

Z = standard normal deviate at 95% confidence (1.96)

P = expected prevalence (0.85) based on previous findings (Junaidu *et al*., 2014)

L = desired precision (0.05)

This yielded a minimum sample size of approximately 196 animals.

Sample collection and handling

A total of 196 small ruminants comprising 98 sheep and 98 goats were randomly sampled immediately after slaughter. Abomasa were carefully removed,

and their contents along with mucosal washings were collected. Samples from sheep and goats were kept separately in labeled sterile polythene bags to ensure proper identification. All samples were transported promptly to the Helminthology Laboratory, Department of Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria. Prior to analysis, samples were stored under refrigeration to preserve parasite integrity.

Recovery and identification of *Haemonchus contortus*

Adult worms were recovered using standard post-mortem worm count techniques as described by Hansen and Perry (1994). Briefly, the abomasal contents and washings were emptied into a deep tray and diluted with clean water. The mixture was thoroughly homogenized and transferred into a wash bottle. Repeated washing and decanting procedures were carried out until most debris and fecal material were removed, resulting in a relatively clear suspension. Aliquots of the suspension were subsequently poured into Petri dishes and examined under illumination using a light box. Adult worms observed in the dishes were carefully recovered with a Pasteur pipette and preserved in 10% formalin for subsequent identification and counting.

Identification of *Haemonchus contortus* was carried out using a light microscope based on characteristic morphological features described in standard parasitological keys. Female worms were identified by the characteristic "barber's pole" appearance formed by the white ovaries spirally coiled around the blood-filled intestine or the vulval flap, while males were identified by the presence of a well-developed copulatory bursa and associated spicules (Hansen and Perry, 1994). Following identification, the total number of *H. contortus* worms recovered from each animal was recorded.

Classification of infection intensity

Recovered worm burdens were categorized into infection intensity levels (light, moderate, and heavy) based on established parasitological thresholds. Animals with no recovered worms were classified as uninfected.

Data analysis

Data generated were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to compute prevalence as percentages. Differences in prevalence between sheep and goats, as well as infection categories, were evaluated using the Chi-square (χ^2) test. Statistical significance was set at $P < 0.05$. Results were presented using tables, means, and standard deviations where appropriate.

Ethical considerations

Permission for sample collection was obtained from abattoir authorities and animal owners (butchers). All procedures were conducted in line with standard ethical guidelines for the use of animal tissues in research, and these ensured minimal disruption to routine slaughter operations.

RESULTS

Representative morphological features used for the identification of *Haemonchus contortus* were observed in the recovered adult worms under light microscopy. Female worms showed the characteristic vulval flap, while male worms possessed a well-developed copulatory bursa with visible spicules. These diagnostic features confirmed the identity of the recovered nematodes as *H. contortus* (Plate I).

In sheep (Table 1), *Haemonchus contortus* infection was predominantly observed at the light intensity level, with 78.6% (77/98) of animals affected. Moderate infection occurred in 6.1% (6/98) of sheep, while no cases of heavy infection were recorded. A proportion of 15 animals (15.3%) showed no infection. The mean values across categories were relatively close, with light infection having a mean of 1.29 ± 0.57, moderate infection 1.00 ± 0.54, and uninfected animals 1.27 ± 0.42.

In goats (Table 2), light infection was also the most frequent, occurring in 70.4% (69/98) of animals. Moderate infection was recorded in 3.1% (3/98) of goats, while no heavy infections were observed. A proportion of 26 (26.5%) goats were uninfected. The mean values showed slight variation across categories, with light infection at 1.35 ± 0.56, moderate infection at 1.20 ± 0.41, and uninfected animals at 1.33 ± 0.52.

In the combined comparison (Table 3), light infection remained the most prevalent category in both species, occurring in 78.6% of sheep and 70.4% of goats. The proportion of uninfected animals was higher in goats (26.5%) compared to sheep (15.3%), while moderate infection was slightly higher in sheep (6.1%) than in goats (3.1%). The mean values across infection categories were comparable between sheep and goats. Statistical analysis showed no significant difference in the distribution of infection between the two species ($\chi^2 = 1.415$, $p = 0.842$)

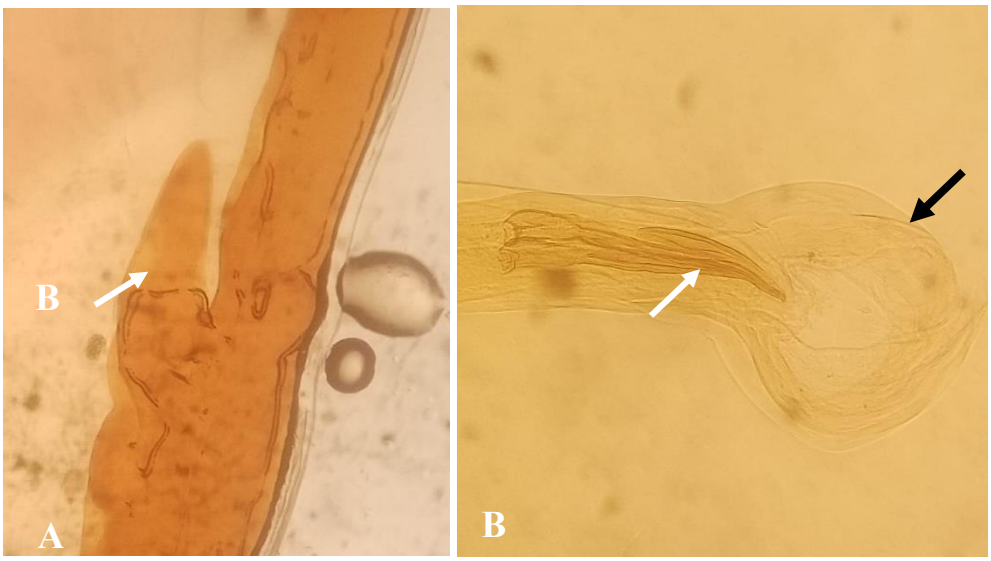

Plate I: Representative morphological features of *Haemonchus contortus* recovered from sheep and goats slaughtered during the late dry season in Zaria, Nigeria

A: Vulval flap of female *H. contortus*

B: Copulatory bursa (black arrow) and spicules (white arrow) of male *H. contortus*

Table 1: Prevalence and intensity distribution of *Haemonchus contortus* infection in sheep slaughtered during the late dry season in Zaria, Nigeria

Degree of infection	Frequency	Prevalence (%)	Mean/Std. Deviation
Light	77	78.6	1.29 ± 0.57
Moderate	6	6.1	1.00 ± 0.54
Heavy	0	0	0
None	15	15.3	1.27 ± 0.42

Table 2: Prevalence and intensity distribution of *Haemonchus contortus* infection in goats slaughtered during the late dry season in Zaria, Nigeria

Degree of Infection	Frequency	Prevalence (%)	Mean /Std Deviation
Light	69	70.4	1.35 ± 0.56
Moderate	3	3.1	1.20 ± 0.41
Heavy	0	0.0	0
None	26	26.5	1.33 ± 0.52

Table 3: Comparative prevalence and intensity distribution of *Haemonchus contortus* infection between sheep and goats slaughtered in the late dry season in Zaria, Nigeria

	Sheep		Goat			
Degree of infection	**Prevalence (%)**	**Mean**	**Prevalence (%)**	**Mean**	**p-value**	**Chi-square**
Light	78.6	1.29	70.4	1.35	0.842	1.415
None	15.3	1.27	26.5	1.20		
Moderate	6.1	1.00	3.1	1.33		

DISCUSSION

The findings of this study align with reports from other investigations, which indicated that *H. contortus* infections persist during the dry season but occurred at low to moderate intensities (Jacquiet *et al*., 1995; Arsenopoulos *et al*., 2021; Kandil *et al*., 2025; Magdálek *et al*., 2025). Studies in Ethiopia and other sub-Saharan regions have documented decreased worm burdens during dry periods, despite continued parasite presence (Regassa *et al*., 2024; Demessie *et al*., 2025). This consistency may suggest that seasonal environmental constraints do not eliminate transmission but rather suppress its intensity, thus, allowing a background level of

infection to persist within small ruminant populations.

The predominance of low-intensity infections is comparable to findings reported by Arsenopoulos *et al*. (2021) and Flay *et al*. (2022), who described subclinical haemonchosis as a common feature in endemic systems. Such patterns are often attributed to partial host immunity developed through repeated exposure, especially in adult animals. This is because immunological responses can limit parasite establishment and fecundity without completely preventing infection (Alba-Hurtado and Muñoz-Guzmán, 2013; Albuquerque *et al*., 2019), thereby could explain why infections remained widespread but generally mild in intensity. This phenomenon is particularly relevant in traditionally managed flocks where continuous exposure to infective larvae occurs.

The absence of heavy infections contrasts with studies conducted during wetter seasons, where higher burdens were frequently reported due to enhanced larval survival on pasture (Rashid and Irshadullah, 2018; Flay *et al*., 2022). The late dry season conditions in northern Nigeria, characterized by high temperatures and low humidity, are unfavourable for the development and migration of infective third-stage larvae. These environmental limitations might have likely reduce pasture contamination levels, interrupt transmission cycles, and consequently prevent the accumulation of heavy worm burdens.

Comparative observations between sheep and goats in similar ecological settings have produced mixed results, though many studies suggested slightly higher susceptibility in sheep due to their grazing behaviour (Mohammed *et al*., 2020; Cellier *et al*., 2022). The similarity in infection patterns between the two species in the present study supports findings from Demessie *et al*. (2025), where no significant interspecies difference was observed under shared management conditions. This convergence may be explained by overlapping feeding habits in semi-intensive or extensive systems, where goats may graze more frequently than expected, thereby increasing their exposure to infective larvae.

The relatively higher proportion of uninfected animals observed in goats is in agreement with previous reports which showed the adaptive feeding strategy of goats as browsers, which in turn reduces their ingestion of infective larvae from pasture (Cellier *et al*., 2022). However, this advantage may be diminished in environments where browse resources are scarce, such as during the dry season, thus, forcing goats to adopt grazing behaviours similar to sheep. This behavioural shift could explain the relatively close infection distribution between the two species despite their inherent ecological differences.

Findings from this study also corroborate the notion that abattoir-based worm recovery techniques provide more accurate estimates of infection intensity compared to faecal egg count methods. These similar methodological advantages were emphasised by Rizwan *et al*. (2025), who demonstrated that post-mortem examinations tend to reveal hidden parasite burdens that might not be detectable through indirect diagnostic approaches. This therefore, emphasises the importance of such studies in generating reliable epidemiological data for parasite control planning.

From a production perspective, the persistence of low-level infections carries important implications. Although clinical disease may be absent, subclinical haemonchosis can still result in reduced feed efficiency, impaired weight gain, and diminished reproductive performance (Arsenopoulos *et al*., 2021; Adduci *et al*., 2022). These subtle losses often go unnoticed by farmers but cumulatively contribute to significant economic inefficiencies in small ruminant production systems.

The observed infection pattern further suggests that dry-season transmission, though limited, may serve as a reservoir for subsequent outbreaks during the rainy season. Residual worm populations in infected animals can rapidly amplify once environmental conditions become favourable, leading to increased pasture contamination. This therefore shows the strategic importance of implementing targeted anthelmintic treatments during the late dry season to reduce carry-over infections and minimize the risk of seasonal disease escalation.

Another important implication relates to the growing concern of anthelmintic resistance, which has been widely reported in *H. contortus* populations globally (Adduci *et al*., 2022). The predominance of low worm burdens may suggest an opportunity to adopt targeted selective treatment (TST) approaches, where only heavily infected or clinically affected animals are treated. Such strategies help preserve refugia and decrease the development of resistance while maintaining effective parasite control.

CONCLUSION

The study demonstrates that *Haemonchus contortus* infection persists during the late dry season in Zaria, predominantly at low intensity with no heavy

burdens. This pattern reflects seasonal environmental constraints on parasite transmission and highlights the role of subclinical infections in maintenance of endemicity. Hence, strategic dry-season control measures, particularly targeted selective treatment, are essential to reduce infection reservoirs and improve small ruminant productivity in the region.

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