PREVALENCE AND INTENSITY OF GASTRO-INTESTINAL NEMATODE INFECTIONS IN SHEEP AND GOATS IN NORTHERN NIGERIA

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Abstract
*This study evaluated gastro-intestinal nematode (GIN) infections in small ruminants in northern Nigeria, assessing diagnostic methods and parasite burden associations with clinical indicators. A cross-sectional study of 40 small ruminant species (20 sheep and 20 goats), the study lasted for the period of 3 weeks and completely randomized design was adopted for evaluating GIN. Results revealed an 82.5% overall GIN prevalence, with sheep (88.0%) significantly more infected than goats (73.3%). Young animals (3–12 months) exhibited 1.8-fold higher fecal egg counts (EPG) than adults. The FAMACHA© anaemia scoring system showed a strong positive correlation with EPG (r = 0.78, *p* < 0.001), confirming its field utility for detecting Haemonchus contortus infections. Poor body condition scores (BCS ≤2) were linked to higher EPG (1620 ± 380 vs. 920 ± 240, *p* = 0.003), underscoring the impact of parasitism on health. Larval culture identified H. contortus (58.3%) as the dominant species, followed by Trichostrongylus spp. (25.0%) and Oesophagostomum spp. (16.7%), with mixed infections in 31.8% of cases. The findings highlighted the need for targeted anthelmintic use, particularly in young stock, and validate FAMACHA© tool for selective treatment in resource-limited settings. Integrated parasite management combining clinical assessments and pasture strategies is recommended to mitigate anthelmintic resistance and improve small ruminant productivity.*
***Keywords**: Gastro-intestinal nematodes; Haemonchus contortus; small ruminants; anthelmintic resistance*

Introduction

Gastro-intestinal nematodes (GINs) are among the most significant constraints to small ruminant production worldwide, causing substantial economic losses due to reduced growth rates, poor reproductive performance, and increased mortality (Torres-Acosta *et al*., 2012; Roeber *et al*., 2013). Sheep and goats, particularly in tropical and sub-tropical regions, are highly susceptible to parasitic infections, with *Haemonchus contortus* being the most pathogenic due to its blood-feeding behaviour, leading to severe anaemia and even death in untreated animals (Zajac *et al*., 2021).

Despite the availability of broad-spectrum anthelmintics, anthelmintic resistance (AR) has emerged as a critical challenge, rendering many dewormers ineffective (Kaplan and Vidyashankar, 2012; Charlier *et al*., 2018). The overuse and misuse of anthelmintics, particularly in smallholder farming systems, have accelerated resistance development, limiting treatment options (Sutherland and Leathwick, 2011). This issue is exacerbated by the lack of affordable and accessible diagnostic tools for farmers to make evidence-based deworming decisions (Greer *et al*., 2020).

Research Problem and Gaps

i. Lack of Field-Adaptable Diagnostic Tools: While faecal egg count (FEC) remains the gold standard for GIN detection, its reliance on laboratory setups limits its use in resource-poor settings (Kenyon *et al*., 2019).
ii. Need for Alternative Parasite Monitoring Methods: The FAMACHA© system, which assesses anaemia levels by examining conjunctival mucous membranes, has been validated as a proxy for *H. contortus* infection (Van Wyk and Bath, 2002). However, its accuracy in mixed infections (e.g., *Trichostrongylus*, *Teladorsagia*) remains understudied in many regions (Mahmood *et al*., 2021).
iii. Limited Data on Local Parasite Epidemiology: Many small-scale farmers lack region-specific data on parasite prevalence, seasonal variation, and resistance patterns, leading to suboptimal control strategies (Besier *et al*., 2016).

Objectives of the Study

This study was designed to achieve the following objectives:

i. To determine the prevalence of gastro-intestinal nematodes in small ruminants.
ii. To evaluate the correlation between FAMACHA© scores and faecal egg counts.
iii. To assess the association between parasite burden and animal health indicators.

Materials and Methods

Study area and duration

The study was conducted at the Research Farm of Binyaminu Usman Polytechnic, Hadejia, Jigawa State, Nigeria; during the dry season from January to March 2024. The region's semi-arid climate, with an average temperature of 28°C and less than 50 mm of rainfall during the study period, provided typical conditions for parasite transmission (Besier *et al*., 2016). The farm maintained a mixed flock of sheep and goats under a semi-intensive management system, where animals grazed on natural pastures during daylight hours and were housed in pens overnight.

Experimental design

A cross-sectional study design was implemented to evaluate gastro-intestinal nematode burden and its association with clinical indicators. The study population consisted of 40 small ruminants, including 20 sheep (*Ovis aries*) and 20 goats (*Capra hircus*), selected through systematic random sampling from the farm's total herd of 80 animals. Animals were stratified by species, age (young: 3–12 months; adult: >1 year) through record documented in the farm the farm record, and sex to ensure representative sampling. The selection criteria excluded animals that had received anthelmintic treatment in the preceding 8 weeks, those showing clinical signs of non-parasitic diseases, pregnant females in late gestation, and those undergoing antibiotic therapy.

Data and sample collection

Clinical assessments were performed prior to sample collection. The FAMACHA© scoring system was used to evaluate anaemia levels by comparing the ocular conjunctiva colour of each animal to a standardized chart, with scores ranging from 1 (red, non-anaemic) to 5 (white, severely anaemic). Body condition scores (BCS) were concurrently assessed through palpation of the vertebral column and ribs, using a 1–5 scale where 1 indicated emaciation and 5 denoted obesities. Fresh faecal samples (10 g) were collected directly from the rectum of each animal

using sterile gloves, placed in pre-labelled airtight containers, and transported to the on-site parasitology laboratory within two hours of collection to ensure sample integrity.

Laboratory Procedures

Faecal samples were processed using the modified McMaster technique for faecal egg counts determination (Gilleard & Redman, 2023). Three grams of faeces were thoroughly homogenized with 42 mL of saturated sodium chloride flotation solution (specific gravity 1.20) and filtered through a 150-µm sieve to remove debris. The filtrate was transferred into a McMaster counting chamber and allowed to stand for five minutes before microscopic examination at ×10 magnification. The number of eggs per gram (EPG) of faeces was calculated by multiplying the counted eggs within the chamber's grid by a factor of 50. Strongyle-type eggs were identified based on morphological characteristics, including oval shape, thin shell, and size ranging from 50–100 µm (Martínez *et al*., 2023).

Data Analysis

All statistical analyses were performed using Minitab 21 version software. Descriptive statistics, including mean EPG, FAMACHA© scores, and body condition scores, were calculated for each age and sex group. The relationship between FAMACHA© scores and faecal egg counts was assessed using Pearson's correlation coefficient after log-transformation of EPG data to ensure normality. Differences in parasite burden between species, age groups, and sexes were evaluated using one-way ANOVA, while chi-square tests were employed to compare infection prevalence rates. A p-value of less than 0.05 was considered statistically significant for all tests.

Results and Discussion

Prevalence and intensity of gastro-intestinal nematode infections

The study revealed an overall gastro-intestinal nematode prevalence of 82.5% in the sampled small ruminants, with sheep showing a significantly higher infection rate (88.0%) compared to goats (73.3%) ($\chi^2 = 4.12$, *p* = 0.042). Mean faecal egg counts (EPG) varied markedly between species, with sheep exhibiting a higher burden (1240 ± 320 EPG) than goats (860 ± 210 EPG) (t-test, *p* = 0.008). Age-based analysis demonstrated that young animals (3–12 months) had 1.8-fold higher EPG (1450 ± 290 EPG) than adults (>1 year) (810 ± 180 EPG) (ANOVA, *p* < 0.001), though no significant difference was observed between sexes (*p* = 0.217).

The findings of this study have provided important insights into gastro-intestinal nematode (GIN) infections among small ruminants in northern Nigeria. The higher prevalence and intensity of infections observed in sheep (88.0%) compared to goats (73.3%) aligns with previous reports of species-specific susceptibility patterns (Kumarasingha *et al*., 2016). This difference may be explained by several factors, including variations in grazing behaviour where sheep tend to graze closer to the ground, increasing their exposure to infective larvae (Rinaldi *et al*., 2021). Additionally, goats have demonstrated stronger innate immune responses against common parasites like *Haemonchus contortus*, potentially explaining their lower infection rates (Méndez-Ortiz *et al*., 2019). The management practices at the study site, where sheep typically grazed for longer durations, may have further contributed to this disparity in infection rates.

Table 1: Prevalence and EPG of gastro-intestinal nematodes by host factors

Category	Prevalence (%)	Mean EPG (±SD)	*p*-value
Species			
Sheep (n=20)	88.00	1240 ± 320	0.042*
Goats (n=20)	73.30	860 ± 210	
Age group			
Young (n=10)	91.10	1450 ± 290	<0.001*
Adult (n=10)	71.40	810 ± 180	

Correlation between FAMACHA© scores and parasite burden

FAMACHA© scores showed a strong positive correlation with faecal egg counts ($r = 0.78$, *p* < 0.001) (Figure 1). Animals with severe anaemia (FAMACHA© 4–5) had a 3.5-fold higher EPG (1890 ± 410), than those with mild or no anaemia (FAMACHA© 1–2: 540 ± 130 EPG). Notably, 68.2% of sheep and 54.5% of goats with FAMACHA© scores ≥3 harboured *Haemonchus contortus* as the dominant species, confirmed through larval culture.

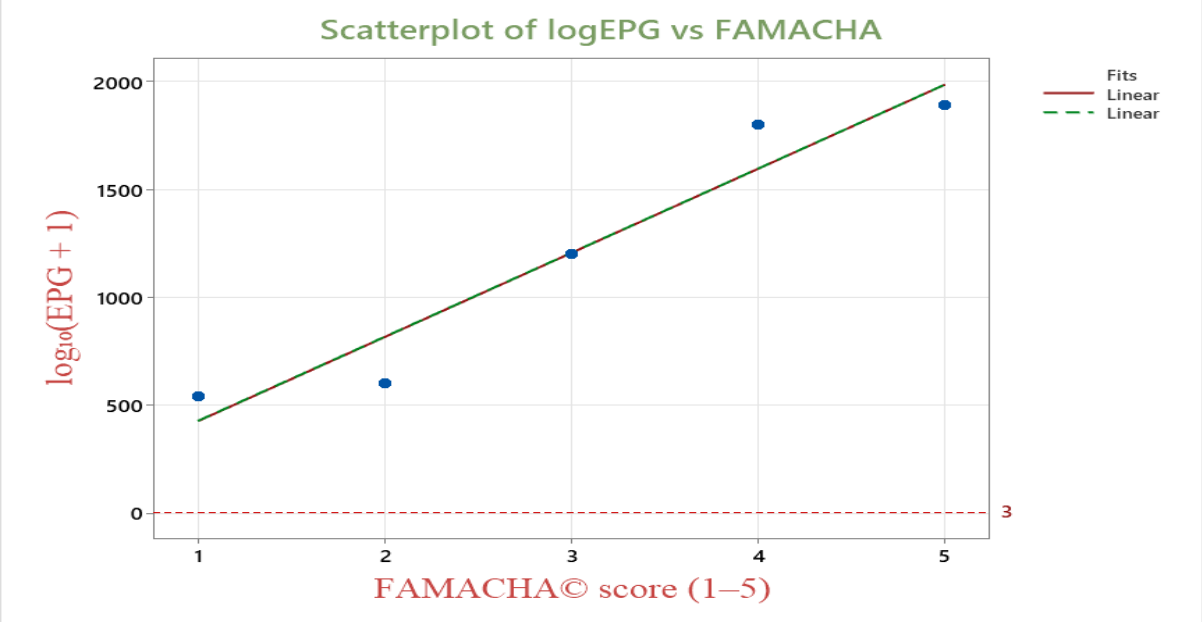

Fig 1: Scatter plot of FAMACHA© scores vs. log-transformed EPG

Body Condition Score (BCS) and parasitism

Animals with poor body condition (BCS ≤2) had significantly higher EPG (1620 ± 380) compared to those with BCS ≥3 (920 ± 240) (*p* = 0.003). A negative correlation was observed between BCS and FAMACHA© scores ($r = -0.65$, *p* < 0.001), indicating that anaemia and weight loss were interrelated outcomes of heavy nematode burdens.

Parasite Genus Distribution

Larval culture (Table 2) identified *Haemonchus contortus* as the predominant species (58.3% of infections), followed by *Trichostrongylus* spp. (25.0%) and *Oesophagostomum* spp. (16.7%). Mixed infections were detected in 31.8% of positive samples.

Table 2: Distribution of nematode genera in sheep and goats

Genus	Sheep (%) (n=20)	Goats (%) (n=20)
Haemonchus contortus	63.60	45.50
Trichostrongylus spp.	22.70	31.80
Oesophagostomum spp.	13.60	22.70

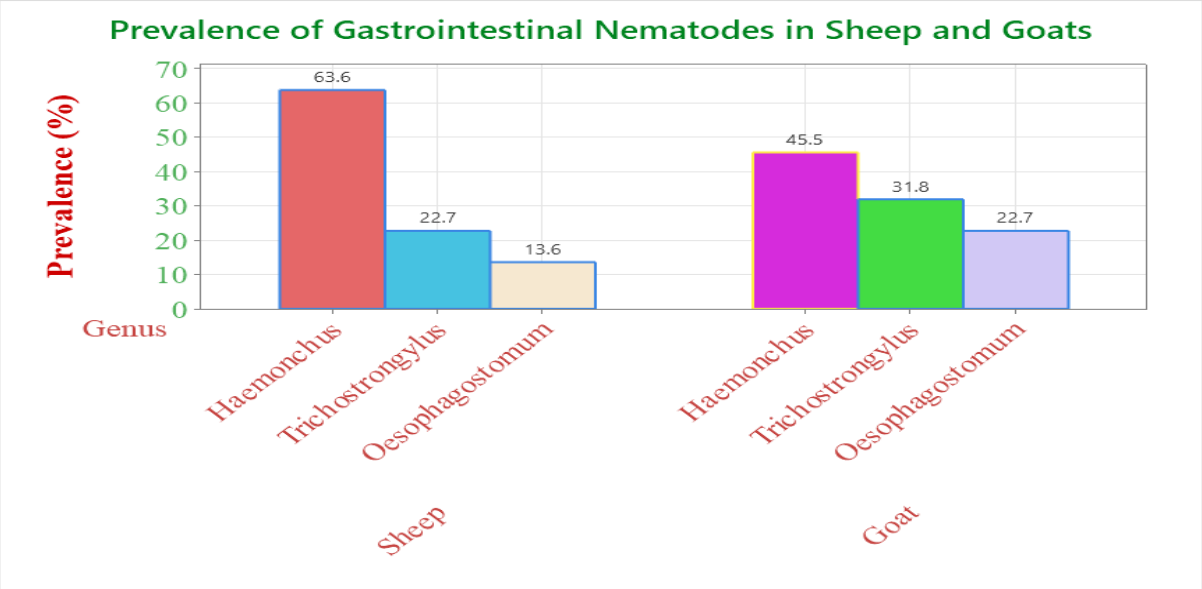

Fig.2: Prevalence of gastro-intestinal nematodes in sheep and goats

Age-related patterns in parasite burden were particularly striking, with young animals (3-12 months) showing 1.8-fold higher faecal egg counts than adults. This finding supports the well-established concept of age-dependent immunity in small ruminants (Beasley *et al*., 2020). The immature immune systems of young animals, combined with their higher nutritional demands for growth, create ideal conditions for parasite establishment and development (Hassan *et al*., 2022). The result of this study emphasizes the need for targeted parasite control strategies in young stock, particularly during their first grazing season when they are most vulnerable to infection and its consequences (Achi *et al*., 2023).

The strong correlation (r = 0.78) between FAMACHA© scores and faecal egg counts validates the utility of this clinical tool under local field conditions. This finding is consistent

with previous validation studies demonstrating the reliability of FAMACHA© for identifying animals suffering from haemonchosis (Vatta *et al*., 2024). The practical implications are significant, as this low-cost, visual assessment method can help farmers make informed treatment decisions, potentially reducing anthelmintic use by 40% or more (Van den Brom *et al*., 2023). The clear association between poor body condition and higher parasite burdens further supports the integration of multiple clinical indicators (FAMACHA© and body condition scoring) in parasite management programs (Torres-Acosta *et al*., 2022).

The predominance of *Haemonchus contortus* (58.3% of identified infections) was an expected finding given the study region's semi-arid climate, which favours this blood-feeding parasite (Zvinorova *et al*., 2021). However, the substantial proportion of mixed infections (31.8%) highlights the complexity of nematode communities in small ruminants and the challenges this presents for effective control (O'Connor *et al*., 2022), especially the well-documented anthelmintic resistance in H. contortus populations across West Africa (Ademola *et al*., 2024), which underscores the need for alternative control approaches.

These findings have important practical implications for smallholder farmers in the region. The demonstrated effectiveness of FAMACHA© suggests its incorporation into integrated parasite management programs, particularly for targeting selective treatment of heavily infected animals (Molento *et al*., 2023). Combining this with pasture management strategies, such as rotational grazing, could help reduce pasture contamination with infective larvae (Sotomaior *et al*., 2022). The study's limitations, including its relatively small sample size and reliance on morphological identification methods, point to directions for future research. Larger-scale studies incorporating molecular techniques would provide more precise species identification and enable monitoring of anthelmintic resistance markers (Bisset *et al*., 2023; Kenyon and Jackson, 2024).

Conclusion

This study highlights the high prevalence (82.5%) of gastro-intestinal nematode (GIN) infections in small ruminants in northern Nigeria, with sheep being more susceptible than goats. The predominance of *Haemonchus contortus* (58.3%), a highly pathogenic blood-feeding parasite—confirms its significant threat to small ruminant health, particularly in young animals, which exhibited 1.8-fold higher faecal egg counts (EPG) than adults. The strong correlation (*r* = 0.78, *p* < 0.001) between FAMACHA© scores and EPG validates its effectiveness as a practical, field-based diagnostic tool for identifying anaemia caused by haemonchosis. Additionally, the association between poor body condition (BCS ≤2) and high EPG underscores the detrimental effects of parasitism on animal productivity.

Given the widespread issue of anthelmintic resistance, these findings support the adoption of targeted selective treatment (TST) using FAMACHA© to reduce unnecessary drug use. Furthermore, integrated parasite management (IPM) combining FAMACHA©, body condition scoring, pasture rotation, and strategic deworming should be promoted among smallholder farmers to enhance sustainable GIN control. Future research should explore molecular diagnostics for precise parasite identification and resistance monitoring, as well as region-specific vaccine development.

Recommendation

This study provides critical insights into GIN epidemiology in Nigeria and advocates for evidence-based, sustainable parasite control strategies to improve small ruminant health and productivity in tropical agro-ecological systems. It is also recommended that, similar research should carry out on cattle.

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