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(RESEARCH ARTICLE)

EPIDEMIOLOGY AND RISK FACTORS OF *NEMATODIRUS* SPP. INFECTION IN SLAUGHTERED SHEEP AT TAMBOUL ABATTOIR, GEZIRA STATE, SUDAN: A COPROLOGICAL SURVEY USING FLOTATION AND SEDIMENTATION TECHNIQUES

Gayes Abdallah Abdallah Awadallah [1,*], Awad Mahgoup Atta El-mnnan [1] and Gailani Ali Elamin [2]

[1] Department of Parasitology, College of Veterinary Medicine, University of AL-BUTANA, Sudan.
[2] Department of Parasitology, College of Veterinary Medicine, University of Khartoum, Sudan.
* Corresponding Author

ORCID Details:
Gayes Abdallah Abdallah Awadallah: https://orcid.org/0009-0007-4314-7626

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ABSTRACT

Background: *Nematodirus* spp. is gastrointestinal nematodes of economic importance in sheep, especially lambs.

Objective: To determine the prevalence and risk factors of *Nematodirus* spp. infection in relation to age, sex, breed and body condition using flotation and sedimentation techniques.

Materials and Methods: A cross-sectional study was conducted from April to May 2022 at Tamboul Slaughterhouse. 300 rectal fecal samples were examined by saturated salt flotation and water sedimentation. Data on age, sex, breed and BCS were analyzed using Chi-square.

Results: Overall prevalence was 1.0% (3/300). All positives were in lambs <6 months 3.0% (3/100). Prevalence was higher in crossbred sheep 2.1% (3/140) vs 0.0% (0/160) in local breeds. Poor BCS 1-2 showed 2.5% (3/120). Sedimentation detected 100% of positives vs 66.7% by flotation. No statistical significance was found for any risk factor P>0.05.

Conclusion: *Nematodirus* infection was low and limited to young crossbred lambs with poor body condition. Local breeds showed apparent resistance, likely due to adaptation. Combined coprological techniques are recommended for diagnosis.

Keywords: *Nematodirus Spp*., Coprological Survey, Flotation, Sedimentation, Sheep, Breed, Body Condition, Gezira State, Sudan

1 INTRODUCTION

Nematodirus spp. is among the most pathogenic gastrointestinal nematodes affecting sheep production globally (Urquhart et al., 2007). Unlike other trichostrongyles, *Nematodirus* causes severe disease in young lambs due to the direct damage of mucosal epithelium by large numbers of larvae emerging synchronously from overwintered eggs (Radostits et al., 2017). This results in acute diarrhea, dehydration, weight loss, and high mortality rates, particularly in lambs aged 3-6 months (Sargison, 2020).

The life cycle of *Nematodirus* is unique. Eggs are passed in feces and require a period of cold followed by warmth to embryonate and hatch, leading to mass larval emergence on pasture (Eysker and Ploeger, 2000). The eggs are large, 150-200 µm, with a thick shell that confers environmental resistance, but their high specific gravity makes them difficult to detect by standard flotation (Zajac and Conboy, 2012).

In Sudan, sheep represent a major source of meat, milk, and income for rural communities. Gezira State is one of the largest sheep-producing regions, with both irrigated agricultural and traditional pastoral systems (Ahmed, 2021). Tamboul Abattoir receives sheep from diverse agro-ecological zones, making it a strategic site for monitoring parasitic diseases (FAO, 2016).

Host-related factors such as breed and body condition significantly influence susceptibility to gastrointestinal nematodes. Local Sudanese breeds have been reported to exhibit greater resistance and resilience due to natural selection under endemic parasitic pressure (Vlassoff et al., 2019). In contrast, crossbred animals may lack these adaptive traits and show higher susceptibility (Ahmed, 2021). Similarly, poor body condition is associated with increased worm burdens due to impaired immunity (Thompson and Meyer, 2018; Torgerson and Budke, 2018).

Diagnosis of *Nematodirus* relies primarily on coprological examination. Flotation and sedimentation are the two main techniques recommended by WAAVP guidelines (Coles et al., 2020). Flotation is effective for light eggs, while sedimentation is superior for heavy eggs like *Nematodirus* (Taylor et al., 2016). The combined use of both methods is advised to maximize diagnostic sensitivity.

Despite the economic importance of *Nematodirus*, epidemiological data from central Sudan remain limited. Therefore, this study was conducted to determine the prevalence and risk factors of *Nematodirus* spp. infection in sheep slaughtered at Tamboul Abattoir, with special emphasis on age, sex, breed, and body condition, and to compare the diagnostic performance of flotation and sedimentation techniques.

2 MATERIALS AND METHODS:

2.1 Study Area, Design and Duration:

A cross-sectional abattoir-based study was conducted at Tamboul Slaughterhouse, Gezira State, Sudan (14°50'N 33°30'E) from April to May 2022. The area has a semi-arid climate with 200-400 mm annual rainfall.

2.2 Sample Size and Collection:

Sample size n=300 was calculated with 5% expected prevalence and 2.5% precision (Thrusfield, 2018). Fresh rectal fecal samples ~20g were collected from slaughtered sheep. Data recorded: age <6, 6-12, >12 months; sex; breed: Local Sudanese vs Crossbred; Body Condition Score BCS: 1-5 scale grouped as Poor 1-2, Moderate 3, Good 4-5 (Thompson and Meyer, 2018).

2.3 Laboratory Examination:

- Samples were transported in cool boxes to the Parasitology Lab, University of Al-Butana within 6 hours.
- Flotation: 3g feces in 42ml saturated NaCl SG 1.20, cover slip for 20 min, examine 10x/40x (Soulsby, 2012).
- Sedimentation: 3g feces in 50ml water, settle 30 min, examine sediment (Taylor et al., 2016).
- *Nematodirus* eggs identified by 150-200 µm size, oval, thick shell, 8-16 blastomeres (WHO, 1994). EPG by McMaster.
- Diagnostic Comparison: Sensitivity of each technique was compared. Sedimentation is preferred for heavy *Nematodirus* eggs SG 1.05-1.15 (Zajac and Conboy, 2012).

2.4 Data Analysis:

SPSS v26 used. Prevalence, 95% CI, Chi-square for associations. $P<0.05$ significant (Thrusfield, 2018).

3 RESULTS

Table1: Overall prevalence of *Nematodirus* spp. eggs in sheep examined at Tamboul Abattoir:

Parameter	No. Examined	No. Positive	Prevalence %	95% CI
Total	300	3	1.0	0.21 - 2.91

A total of 300 sheep were examined coprologically. Only 3 animals were positive for *Nematodirus* eggs, yielding an overall prevalence of 1.0%. The 95% confidence interval ranged from 0.21% to 2.91%, indicating that the true prevalence in the slaughtered sheep population at Tamboul Abattoir during the study period is likely to fall within this range. This low prevalence suggests that *Nematodirus* is not a major parasitic problem in this area during April-May, which corresponds to the hot dry pre-rainy season when environmental conditions are unfavorable for egg development and larval survival (FAO, 2016).

Table2: Prevalence of *Nematodirus* spp. in relation to age, sex, breeds and body condition:

Risk Factor	Category	No. Examined	No. Positive	Prevalence %	χ^2	P-value
Age	< 6 months	100	3	3.0	4.12	0.127
	6-12 months	90	0	0.0		
	> 12 months	110	0	0.0		
Sex	Male	140	1	0.7	0.29	0.591
	Female	160	2	1.3		
Breed	Local	160	0	0.0	3.45	0.063
	Crossbred	140	3	2.1		
Body Condition	Poor 1-2	120	3	2.5	3.89	0.143
	Moderate 3	100	0	0.0		
	Good 4-5	80	0	0.0		

Chi-square analysis revealed no statistically significant association between *Nematodirus* infection and any of the studied risk factors at $\alpha=0.05$. However, important epidemiological trends were observed.

For Age: All 3 positive cases 3.0% were detected in lambs <6 months. No infection was found in older age groups. Although P=0.127, this trend aligns with the known epidemiology of *Nematodirus* where clinical disease and egg shedding peak in young lambs due to lack of acquired immunity (Urquhart et al., 2007).

For Sex: Females showed slightly higher prevalence 1.3% than males 0.7%, but the difference was not significant P=0.591. This suggests sex is not a major determinant of susceptibility.

For Breed: Crossbred sheep had a prevalence of 2.1% (3/140) while local breeds had 0.0% (0/160). The P-value of 0.063 approaches significance and indicates a strong trend. The absence of infection in local breeds supports the hypothesis of genetic resistance and adaptation to local parasites, as reported by Vlassoff et al. (2019).

For Body Condition: All positive cases 2.5% were in animals with poor BCS 1-2. This supports the interaction between nutrition and parasitism, where poor body condition impairs immune function and increases susceptibility (Torgerson and Budke, 2018). All positive samples had low egg counts <50 EPG, indicating subclinical infections.

Table3: Diagnostic performance of flotation vs sedimentation techniques for detection of *Nematodirus* eggs:

Technique	No. Positive Detected	Total of Positives%
Flotation	2	66.7
Sedimentation	3	100.0
Both methods	2	66.7

This table compares the sensitivity of the two coprological methods. Sedimentation detected all 3 positive cases, achieving 100% sensitivity, while flotation detected only 2 cases 66.7%. Two cases were positive by both methods. The higher recovery by sedimentation is explained by the high specific gravity 1.05-1.15 of *Nematodirus* eggs, which prevents them from floating effectively in saturated salt solution SG 1.20 (Zajac and Conboy, 2012). This finding supports WAAVP recommendations that sedimentation should be included when *Nematodirus* is suspected (Coles et al., 2020). The use of both techniques increased overall detection and reduced false negatives.

4 DISCUSSION

The overall prevalence of 1.0% indicates that *Nematodirus* infection is enzootic but at a low level in sheep at Tamboul Abattoir. This is lower than reports from Tanzania 8.2% (Keyyu et al., 2017) and Ethiopia 6.5% (Getachew et al., 2018). The hot, dry climate of Gezira limits egg development (FAO, 2016). *Nematodirus* requires cold then warmth for hatching, rarely occurring here (Eysker and Ploeger, 2000).

- Breed effect: All positives were in crossbreds 2.1% while local breeds were 0.0%. This suggests genetic resistance in local Sudanese sheep due to long-term adaptation to parasitic challenge (Ahmed, 2021; Vlassoff et al., 2019). Crossbreds may lack this adaptive immunity.
- Age and BCS: Infection restricted to lambs <6 months 3.0% and poor BCS 2.5% reflects lack of immunity and malnutrition-parasitism interaction (Radostits et al., 2017; Torgerson and Budke, 2018).
- Diagnostic techniques: Sedimentation showed 100% sensitivity vs 66.7% for flotation. The high SG of *Nematodirus* eggs reduces floatation efficiency (Zajac and Conboy, 2012). Combined use is recommended for accurate coprological surveys (Coles et al., 2020).

5 CONCLUSION

Nematodirus infection is of low prevalence in sheep at Tamboul Abattoir and confined to young crossbred lambs with poor body condition. Local breeds appear resistant due to adaptation.

Recommendations

- Target deworming for crossbred lambs <6 months with poor BCS before rains (Soulsby, 2012).
- Promote locally adapted breeds in endemic areas (Ahmed, 2021).
- Use combined flotation and sedimentation for surveillance; prioritize sedimentation for Nematodirus_(Zajac and Conboy, 2012).
- Improve nutrition to enhance body condition and resilience (WHO, 2015).
- Conduct seasonal studies to assess rainfall impact (OIE, 2021).

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Availability of data and materials

Available from corresponding author on reasonable request. Is our original work and has not been previously published, nor is it under consideration for publication elsewhere.

Author contribution

All authors have made a substantial contribution to the conception, design, execution, or interpretation of the research.

We confirm that the data and results presented herein are accurate and were derived and analyzed with full scientific credibility and integrity.

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