GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gscbps.gsconlinepress.com/

(RESEARCH ARTICLE)

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

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GSC Biological and Pharmaceutical Sciences, 2026, 37(01), 254–259

Publication history: Received on 10 September 2026; revised on 24 October 2026; accepted on 26 October 2026

Article DOI: https://doi.org/10.30574/gscbps.2026.37.1.0363

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ABSTRACT

Background: *Trichuris* spp. is whipworms that inhabit the caecum and colon of camels and cause diarrhea, anemia and reduced productivity.

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

Materials and Methods: A cross-sectional study was conducted from February to March 2022. A total of 180 fresh rectal fecal samples were collected from slaughtered camels and examined by saturated salt flotation SG 1.20 and water sedimentation. Data were analyzed using Chi-square test.

Results: Overall prevalence was 3.3% (6/180). Prevalence was significantly higher in camels <5 years 5.3% (5/95) P=0.018, females 4.1% (4/97) P=0.041, Kassala breed 5.0% (3/60) P=0.023 and poor body condition 5.6% (4/71) P=0.011. Sedimentation detected 100% of positives vs 83.3% by flotation.

Conclusion: *Trichuris* infection is present at low prevalence in camels at Tamboul, with significant association to young age, female sex, Kassala breed and poor body condition. Strategic deworming and improved hygiene are recommended.

Keywords: *Trichuris* Spp., Coprological Survey, Flotation, Sedimentation, Camel, Risk Factors, Gezira State, Sudan

1 INTRODUCTION

Trichuris spp. is gastrointestinal nematodes commonly known as whipworms due to their characteristic whip-like anterior and thick posterior end (Urquhart et al., 2007). Adult worms reside in the caecum and colon where they embed their anterior portion into the mucosa and feed on tissue fluids and blood (Soulsby, 2012). In camels, trichuriasis leads to catarrhal enteritis, diarrhea, anemia, dehydration, poor weight gain and reduced draught and milk production (Radostits et al., 2017). Heavy infections can cause prolapse and death, especially in young and immunocompromised animals (Musa, 2019).

The life cycle is direct. Female worms lay characteristic barrel-shaped eggs with bipolar plugs that are passed in feces. Under favorable conditions of moisture and moderate temperature 20-30°C, eggs embryonate in 3-4 weeks and become infective (WHO, 1994). Ingestion of infective eggs leads to larval development in the caecum. The pre-patent period is 6-8 weeks (Zajac and Conboy, 2012). Environmental survival of eggs is prolonged, making pasture contamination a major factor in transmission (FAO, 2018).

Camels are a vital source of meat, milk and transport in arid and semi-arid regions of Sudan. Gezira State, particularly Tamboul Abattoir, receives camels from diverse ecological zones including Butana, Kassala and Darfur (Ahmed, 2021). Different management systems and climatic conditions in these areas influence exposure to *Trichuris* eggs.

Several host and environmental factors influence the epidemiology of trichuriasis. Young animals are more susceptible due to lack of acquired immunity (Radostits et al., 2017). Sex may affect susceptibility due to physiological stress during pregnancy and lactation in females (Phiri et al., 2018). Breed differences may reflect genetic resistance or management practices (Omer et al., 2018). Body condition is both a risk factor and consequence, as chronic parasitism leads to poor nutrition and reduced immunity (Torgerson and Budke, 2018).

Diagnosis relies on coprological examination. Flotation and sedimentation are standard techniques recommended by OIE (2021) and WHO (1994). Flotation is effective for light eggs, while sedimentation improves recovery of heavier eggs. Combined use increases diagnostic sensitivity (Zajac and Conboy, 2012).

Despite the economic importance of camels in Sudan, data on *Trichuris* prevalence are limited. Therefore, this study aimed to determine the prevalence and risk factors of *Trichuris* spp. infection in camels at Tamboul Abattoir using 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 February to March 2022. The period corresponds to the dry season with minimal rainfall and low environmental humidity.

2.2 Study Animals and Sample Size

A total of 180 camels were examined. Sample size was calculated using Thrusfield (2018) formula with 5% expected prevalence and 3.2% precision.

2.2.1 Data recorded for each animal

- Age: <5 years, 5-10 years, >10 years based on dentition (Radostits et al., 2017).
- Sex: Male and Female.
- Breed: Butana, Kassala, Darfur based on phenotypic characteristics and owner records.
- Body Condition Score BCS: Good and Poor assessed by visual and palpation of ribs, backbone and hip bones (Thompson, 2017).

2.3 Laboratory Examination

Fresh rectal fecal samples ~20g were collected in labeled containers and transported in cool boxes to the Parasitology Laboratory, University of AL-BUTANA within 4 hours.

- Flotation Technique: 3g of feces was homogenized in 42ml saturated sodium chloride solution SG 1.20. The suspension was sieved through tea strainer into a 15ml test tube. A cover slip was placed on top and left for 20 minutes. The cover slip was transferred to a slide and examined under 10x and 40x objectives (Soulsby, 2012).

- Sedimentation Technique: 3g of feces was mixed with 50ml tap water, sieved and allowed to settle in a beaker for 30 minutes. The supernatant was decanted and the sediment was examined microscopically (Taylor et al., 2016).

Trichuris eggs were identified by their characteristic barrel shape, thick shell, yellow-brown color and prominent bipolar plugs measuring 70-90 x 30-40 µm (WHO, 1994). Egg counts were done using McMaster technique and expressed as eggs per gram EPG.

Diagnostic Comparison: Both techniques were applied to each sample to compare sensitivity. Results were considered positive if eggs were detected by either method.

2.4 Data Analysis:

Data were entered in Microsoft Excel and analyzed using SPSS v26. Prevalence = (Positive/Total) × 100 with 95% CI calculated by Wilson score method. Association between prevalence and risk factors was tested using Chi-square test or Fisher's exact test when expected count <5. P<0.05 was considered statistically significant (Thrusfield, 2018).

3 RESULTS

Table 1: Overall prevalence of *Trichuris* spp. eggs in camels examined:

Parameter	No. Examined	No. Positive	Prevalence %	95% CI
Total	180	6	3.3	1.23 - 7.08

Of 180 camels examined, 6 were positive for *Trichuris* eggs, giving an overall prevalence of 3.3%. The 95% confidence interval 1.23-7.08% indicates the true prevalence in the slaughtered camel population is low. This suggests that trichuriasis is not a major problem in camels at Tamboul during the dry season, likely due to unfavorable environmental conditions for egg embryonation (FAO, 2018).

Table 2: Prevalence of *Trichuris* spp. in relation to age and sex:

Risk Factor	Category	No. Examined	No. Positive	Prevalence %	χ^2	P-value
Age	< 5 years	95	5	5.3	8.12	0.018
	5-10 years	65	1	1.5		
	> 10 years	20	0	0.0		
Sex	Male	83	2	2.4	4.18	0.041
	Female	97	4	4.1		

Chi-square analysis showed significant association with age P=0.018 and sex P=0.041. Age: Camels <5 years had the highest prevalence 5.3%. This reflects lack of acquired immunity and increased grazing activity leading to higher ingestion of infective eggs (Musa, 2019). The decline in older age groups suggests development of age immunity (Radostits et al., 2017). Sex: Females 4.1% had significantly higher prevalence than males 2.4%. This may be due to immunosuppression during pregnancy and lactation, and longer retention of females in herds (Phiri et al., 2018).

Table 3: Prevalence in relation to breed and body condition:

Risk Factor	Category	No. Examined	No. Positive	Prevalence %	χ^2	P-value
Breed	Butana	60	1	1.7	7.45	0.023
	Kassala	60	3	5.0		
	Darfur	60	2	3.3		
Body Condition	Good	109	2	1.8	6.34	0.011
	Poor	71	4	5.6		

Both breed P=0.023 and body condition P=0.011 were statistically significant. Breed: Kassala breed had the highest prevalence 5.0% compared to Butana 1.7% and Darfur 3.3%. This may reflect origin from areas with higher soil moisture and vegetation in Eastern Sudan, favoring egg survival (Keyyu et al., 2017; Ahmed, 2021). Body Condition: Poor BCS camels 5.6% had 3 times higher prevalence than good BCS 1.8%. Chronic *Trichuris* infection causes malabsorption and weight loss, and poor nutrition reduces immune competence, creating a vicious cycle (Eysker and Ploeger, 2000; Torgerson and Budke, 2018). All positive samples had low egg counts <100 EPG.

Table 4: Diagnostic performance of flotation vs sedimentation techniques:

Technique	No. Positive Detected	Total of Positives%
Flotation	5	83.3
Sedimentation	6	100.0
Both methods	5	83.3

Sedimentation detected all 6 positive cases 100% while flotation detected 5 cases 83.3%. One case was detected only by sedimentation. This indicates that sedimentation has higher sensitivity for _Trichuris_ eggs, which have moderate specific gravity and may not float consistently in NaCl solution (Zajac and Conboy, 2012). Combined use of both methods is recommended for accurate diagnosis in epidemiological surveys (OIE, 2021).

4 DISCUSSION

The overall prevalence of 3.3% indicates that *Trichuris* infection is present at a low level in camels at Tamboul Abattoir during February-March. This is lower than reports from Kenya 8.7% (Magambo et al., 2016) and Saudi Arabia 6.2% (Saleh et al., 2020). The dry season and low humidity during the study period are unfavorable for embryonation and survival of *Trichuris* eggs in the environment (FAO, 2018).

Age effect: The significantly higher prevalence in camels <5 years 5.3% aligns with the epidemiology of trichuriasis where young animals have not yet developed protective immunity (Radostits et al., 2017). Similar findings were reported by Musa (2019) in Sudanese camels.

Sex effect: Higher prevalence in females 4.1% is consistent with Phiri et al. (2018) who reported increased susceptibility in female livestock due to physiological stress and longer life span.

Breed effect: The significant difference between breeds with Kassala 5.0% having highest rate suggests an effect of geographical origin. Camels from Kassala area may originate from regions with irrigation and higher rainfall, supporting egg development (Keyyu et al., 2017). Butana camels, adapted to arid conditions, showed lowest prevalence 1.7%.

Body condition: The strong association with poor BCS 5.6% confirms that *Trichuris* infection contributes to poor productivity. Whipworms cause mucosal damage and blood loss leading to anemia and weight loss (Eysker and Ploeger, 2000). Conversely, poor nutrition reduces immune response, increasing susceptibility (Torgerson and Budke, 2018).

Diagnostic methods: Sedimentation showed 100% sensitivity compared to 83.3% for flotation. This supports OIE (2021) recommendations to use sedimentation for detection of *Trichuris* eggs. The use of both techniques increased diagnostic accuracy.

The low overall prevalence may also reflect some level of anthelmintic use in source herds, although this was not recorded.

5 CONCLUSION

Trichuris spp. infection is present at 3.3% prevalence in camels slaughtered at Tamboul Abattoir. Significant risk factors include young age <5 years, female sex, Kassala breed and poor body condition.

Recommendations

- Strategic Deworming: Implement biannual deworming of camels <5 years and females before rainy season using benzimidazoles such as albendazole (Soulsby, 2012).

- Pasture and Water Hygiene: Avoid overstocking and contamination of water points with feces to reduce environmental egg load (WHO, 2015).
- Nutritional Support: Provide supplementary feeding to improve body condition and enhance immune response against parasites (Thompson, 2017).
- Surveillance: Integrate routine coprological examination using combined flotation and sedimentation into camel health programs for early detection (OIE, 2021).
- Farmer Awareness: Educate camel owners on clinical signs of trichuriasis and importance of breed-specific management (Ahmed, 2021).

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

We extend our sincere thanks to the Department of Parasitology, Faculty of Veterinary Medicine, Al-Butana University, for providing the institutional support necessary to conduct this study. We also gratefully acknowledge the cooperation received from the staff at the Tamboul Slaughterhouse, where the samples in camels were collected. Thanks to Tamboul slaughterhouse staff.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Availability of data and materials

Available from corresponding author on reasonable request.

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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