Gastrointestinal helminth parasites of ruminants slaughtered in Shendi abattoir, River Nile State, Sudan

Yassir Sulieman1*, Shaza Osman Ibrahim1, Randa Elsir Eltayeb1, Therakamol Pengsakul2, Azzam Afifi2, Mohamed Ahmed Zakaria3, Mudather Abdel Rahman Khairala4

1Department of Zoology, Faculty of Science and Technology, University of Shendi, Shendi, Sudan.
2Department of Zoology, Faculty of Science and Technology, Omdurman Islamic University, Omdurman, Sudan
3Department of Biology, Faculty of Education, University of Nyala, Nyala, Sudan
4Department of Biology, Faculty of Education, University of Kassala, Kassala, Sudan

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ABSTRACT

Objective: To evaluate the situation regarding gastrointestinal helminth parasites in ruminants (cattle, sheep and goats) slaughtered in the abattoir of Shendi, River Nile State, Sudan.

Methods: From September 2015 to October 2016, a total of 687 fecal samples were collected and analyzed by flotation and sedimentation techniques.

Results: A total of 411 ruminants examined were positive with one or more helminths, giving 59.8% overall prevalence with intensity of 548.23 eggs per gram feces. A total of 12 gastrointestinal helminth parasite genera were identified, including 2 trematodes (Fasciola spp. and Paramphistomum spp.); 7 nematodes (Haemonchus spp., Strongyloides spp., Trichostrongylus spp., Ostertagia spp., Ascaris spp., Nematodirus spp., and Dictyocaulus sp.); and 3 cestodes (Moniezia spp., Taenia spp., and Dipylidium sp.). Prevalence of Taenia spp. infection was the highest, whereas Trichostrongylus sp. and Dictyocaulus sp. infections had the lowest prevalences. Adult ruminants had higher infection prevalence than the younger ones, but this difference was not statistically significant (P > 0.05). On the other hand, male ruminants had significantly higher infection prevalence than the females (P < 0.05). Helminth prevalence was significantly higher during the rainy season than the dry season. The highest mean egg outputs were recorded for the young and the female ruminants. Likewise, the mean egg output of helminth was higher during the dry than the rainy season, with a significant difference (P < 0.05).

Conclusions: These results encourage implementation of effective preventive and control measures directed against the parasites of ruminants throughout the country.

1. Introduction

Gastrointestinal (GI) parasites are known to be widespread in many countries and they negatively impact the production of domestic animals[1-6]. The helminth infections of ruminants are mostly caused by nematodes, such as Ostertagia spp., Capillaria spp., Trichuris spp., Strongyloides spp., Trichostrongylus spp. and Cooperia spp.; cestodes such as Moniezia spp. and Taenia spp.; and trematodes such as Dicrocoelium spp., Fasciola spp., and amphistomes.

The prevalence of a parasitic infection varies greatly by area, depending on many factors such as level of agriculture, pasture management, micro- and macro-climate of the environment, immunological and nutritional status of the host, presence of intermediate hosts, vectors, and the numbers of infecting larvae and eggs in the environment[7-9].

In Sudan, GI parasites are known to be widespread, damaging the domestic animal production[10-12]. The internal helminth species reported in Southern Sudan are Fasciola gigantica, F. bovis, hydatid cyst, cysticer cus bovis, Haemonchus contortus, Neoascaris and Moniezia[10,13,14]. In Western Sudan, Fasciola gigantica, Paramphistomum spp., Schistosoma bovis, cysticer cus bovis, Nematodirus spp., Oesophagostomum radiatum, Haemonchus sp., Trichostrongylus sp., Cooperia sp., Strongyloides sp., Oxyuris sp., Parascaris sp., Trichuris sp. and Chabertia sp. have been reported[11,15,17]. Six genera of nematodes and two genera of trematodes were found in Damazin District[18]. In Gedaref State, the common helminth parasites that infect cattle are Oesophagostomum...
radiatum, Chabertia ovina, Ascaris spp. and Trichostrongylus spp.[19]. In the River Nile State, F. gigantica, Trichuris ovis and Strongyloides papillosus have been reported[20]. In general, numerous parasitic worm infections have been detected in cattle, sheep, and horses in Sudan, while goats and camels were found to have comparatively few parasitic infections at lower rates[12].

The objective of this study was to provide basic information on the GI helminth parasites of ruminants (cattle, sheep and goats) slaughtered at the abattoir of Shendi City, River Nile State, Sudan, from September 2015 to October 2016.

2. Materials and methods

2.1. Study area

The study was conducted in the local abattoir of Shendi, a city situated on the east bank of the River Nile, Northern Sudan, between 16°40’52” N and 33°25’7” E. The area has semi-arid climatic features with a very short rainy period in August (mean precipitation 29.3 mm), and temperatures within 28–41 °C. The vegetation is poor and sparse in the desert zones; it is virtually absent except in the area along the banks of River Nile and area nearby water sources where ephemeral herbs and grasses occur after the occasional rainfall.

2.2. Ethical considerations

Before initiation of the study, endorsements were obtained from the Ministry of Animal Resource of the River Nile State and the authority of Shendi city abattoir for sample collection.

2.3. Collection of fecal samples

Fecal samples were collected twice a week, from September 2015 to October 2016, from the rectum and small intestine of slaughtered ruminants at the abattoir of Shendi, in early mornings between 6:00 AM and 7:00 AM. The collected samples were kept separate in clean 60-mL plastic containers with lids, and were clearly labeled each with a specific reference number. With reference to that identifying number, data regarding the animal’s age, gender, origin of source area, and sampling time (month/year) were recorded. The samples were transferred to the Laboratory of Zoology, University of Shendi in ice-cooled boxes. They were immediately examined for helminth eggs and worms, or stored refrigerated (4 °C) for up to one day at the maximum before processing. The age of each animal was determined by dental inspection, whereby animals having temporary incisors (milk teeth) were classified as young, and those with permanent incisors were recorded as adults.

2.4. Fecal examination and count of helminth eggs

2.4.1. Flotation technique

The number of fecal nematode eggs was determined using McMaster technique, in which approximately 4 g of a feces sample were placed into a beaker with 56 mL of salt/sugar solution as the flotation fluid and mixed thoroughly. Thereafter the suspension was filtered through a fine strainer into a new clean beaker. The filtrate was poured into a test tube, which was allowed to stand in a test tube rack for 5 min. Then the supernatant was very carefully removed using a pipette and the sediment was re-suspended in 5 mL water and allowed to settle for 5 min. The supernatant was again carefully discarded using a pipette and the sediment was stained by adding one drop of methylene blue. Finally, the stained sediment was transferred to a McMaster counting chamber for microscopic examination.

All parasite eggs found were photographed using a digital camera. When preparing samples for microscopic observations during the experiments using the two techniques, all the adult or larval parasites recovered were washed thoroughly with saline and stored in 10% formalin in transparent plastic containers.

2.4.2. Sedimentation technique

The number of fecal trematode eggs was determined using a sedimentation technique, in which approximately 3 g of each feces sample were placed in a beaker with 40–50 mL clean tap water and mixed thoroughly with a stirrer. Thereafter the fecal suspension was filtered through a fine strainer into a new clean beaker. The filtrate was poured into a test tube, which was allowed to stand in a test tube rack for 5 min. Then the supernatant was very carefully removed using a pipette and the sediment was re-suspended in 5 mL water and allowed to settle for 5 min. The supernatant was again carefully discarded using a pipette and the sediment was stained by adding one drop of methylene blue. Finally, the stained sediment was transferred to a McMaster counting chamber for microscopic examination. All parasite eggs found were photographed using a digital camera. When preparing samples for microscopic observations during the experiments using the two techniques, all the adult or larval parasites recovered were washed thoroughly with saline and stored in 10% formalin in transparent plastic containers.

2.5. Data analysis

The prevalence of infection was calculated as a percentage of D/N, where D is the number of animals infected and N is the total number of animals examined. The association of the independent factors (age, sex, season, and source location of the host) to the continuous dependent variables, namely, number of eggs per gram or intensity of infection, was calculated using One-way ANOVA. The associations between the independent factors and the prevalence of various parasites were evaluated using the Chi-square test (χ²). The statistical software SPSS 16.0 for Windows (SPSS Inc., Chicago, IL., USA) was used to conduct the data analysis and values were considered significant when \( P < 0.05 \).

3. Results

3.1. Overall prevalence and intensity of GI helminth infection

Out of the 687 ruminants examined, 411 were found positive with one or more (GI) helminth parasites, giving 59.8% overall prevalence of infection (38.5%, 61.7% and 67.4% in cattle, sheep and goats, respectively); while the overall mean intensity of infection or egg counts per gram (epg) was 548.23 (970.2, 451.8 and 536.3 in cattle, sheep and goats, respectively). A total of 12 genera of GI helminth parasites were identified: 2 trematodes (Fasciola spp. and Paramphistomum spp.); 7 nematodes (Haemonchus spp., Strongyloides spp., Trichostongylus sp., Ostertagia sp., Ascaris spp., Nematodirus spp., and Dictyocaulus spp.); and 3 cestodes (Moniezia sp., Taenia spp., and Dipylidium sp.). It was observed that the prevalence of Taenia spp. infection was the highest, whereas the infection rates with Trichostongylus sp. and Dictyocaulus sp. were the lowest during the study period. Moreover, fecal sample examination showed that 6.6% of the examined animals had dual infection, mostly by Taenia spp. and Strongyloides spp.

3.2. Prevalence and intensity of infection according to the host age

The prevalence and intensity of GI helminth parasites in relation to the age of slaughtered ruminants are shown in Table 1. The adult goats had the highest prevalence of GI helminth parasites (69.7%), while the adult cattle had the lowest recorded prevalence (21.3%); however, there was no statistically significant difference \( (P > 0.05) \) between adult and young ruminants in their prevalence of infection. On the other hand, the highest intensity of infection was recorded among the young cattle (1306.8 epg), while the lowest was recorded...
for the adult sheep (431.4 epg). Overall, there was a significant difference (P < 0.05) in the fecal egg counts between adult and young ruminants.

### Table 1

Summary statistics on infections with GI helminth in relation to age and sex of the ruminants slaughtered in Shendi abattoir, September 2015 to October 2016 (n = 687).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. exam.</td>
<td>P (%)</td>
<td>Mean inten.</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young</td>
<td>60</td>
<td>60.0’</td>
<td>1306.8’</td>
</tr>
<tr>
<td>Adult</td>
<td>75</td>
<td>21.3’</td>
<td>689.3’</td>
</tr>
<tr>
<td>Sex</td>
<td>97</td>
<td>39.2’</td>
<td>650.4’</td>
</tr>
<tr>
<td>Female</td>
<td>38</td>
<td>36.8’</td>
<td>675.0’</td>
</tr>
</tbody>
</table>

P: Prevalence of infection; No. exam.: Number examined; inten.: Intensity: *: P < 0.05 compared with adult; †: P < 0.05 compared with female.

### 3.3. Prevalence and intensity of infection according to the host sex

The distribution of GI helminth parasites in the host according to sex is shown in Table 1. The results indicate that male goats had the highest prevalence of infection (67.9%), while the female cattle had the lowest (36.8%). There was a significant difference (P < 0.05) between males and females of the examined ruminants in total prevalence of infection. Female cattle had higher total helminth egg output, and there was a significant difference between males and females of the examined ruminants (P < 0.05).

### 3.4. Prevalence and intensity of infection according to source location of the host

Regional analysis indicates that goats from the River Nile, Blue Nile and West Sudan acquired more infections than the other ruminants examined. There were only cattle present in the White Nile and East Sudan; the sampling lacked sheep and goats from these source areas (Table 2). The prevalence of infections in the ruminants had statistically significant (P < 0.05) differences between source regions. There were significant differences (P < 0.05) in fecal egg counts among the examined ruminants between the source locations, and cattle from the White Nile had the highest intensity of egg output while goats from the Blue Nile had the lowest (Table 2).

### Table 2

Summary statistics on GI helminth infections in ruminants slaughtered in Shendi abattoir according to season and source location, September 2015–October 2016 (n = 687).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. exam.</td>
<td>P (%)</td>
<td>Mean inten.</td>
</tr>
<tr>
<td>Place of source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>River Nile</td>
<td>86</td>
<td>33.7’</td>
<td>710.3’</td>
</tr>
<tr>
<td>White Nile</td>
<td>4</td>
<td>75.0’</td>
<td>1666.7’</td>
</tr>
<tr>
<td>Blue Nile</td>
<td>0</td>
<td>0.0’</td>
<td>0.0’</td>
</tr>
<tr>
<td>West Sudan</td>
<td>35</td>
<td>40.0’</td>
<td>1207.1’</td>
</tr>
<tr>
<td>East Sudan</td>
<td>10</td>
<td>60.0’</td>
<td>925.0’</td>
</tr>
<tr>
<td>Season</td>
<td>70</td>
<td>41.5’</td>
<td>586.2’</td>
</tr>
<tr>
<td>Dry</td>
<td>65</td>
<td>35.4’</td>
<td>1241.3’</td>
</tr>
</tbody>
</table>

P: Prevalence of infection; No. exam.: Number examined; inten.: Intensity. *: P < 0.05 compared with dry season.

### 3.5. Prevalence and intensity of host infections by season

The results indicate higher prevalence of GI helminth infections in the ruminants slaughtered during the rainy season (August–October) (Table 2). The difference between the rainy and dry seasons in prevalence of infections was statistically significant (P < 0.05). The mean output of GI helminth eggs was higher during the dry season than in the rainy season (Table 2), and this difference was also statistically significant (P < 0.05).

### 3.6. Prevalence and intensity of infection by identified helminth species

The highest prevalence during the study period was recorded for the cestode, *Taenia* sp., while the nematodes, *Trichostrongylus* sp. and *Dictyocaulus* sp. had the lowest prevalences of infection. On the other hand, the nematode *Trichostrongylus* sp. had the highest mean intensity of egg output (Table 3).

### Table 3

Prevalence, mean intensity and intensity range of infections with GI helminth species in ruminants slaughtered at Shendi abattoir, September 2015–October 2016 (n = 687).

<table>
<thead>
<tr>
<th>Helminth species</th>
<th>Prevalence (%)</th>
<th>Mean intensity</th>
<th>Intensity range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasciola sp.</td>
<td>4.4</td>
<td>421.7</td>
<td>100–1200</td>
</tr>
<tr>
<td>Paramphistomum sp.</td>
<td>1.7</td>
<td>408.3</td>
<td>150–1200</td>
</tr>
<tr>
<td>Haemonchus sp.</td>
<td>1.2</td>
<td>331.3</td>
<td>150–450</td>
</tr>
<tr>
<td>Strongyloides sp.</td>
<td>14.8</td>
<td>567.2</td>
<td>100–2500</td>
</tr>
<tr>
<td>Trichostrongylus sp.</td>
<td>0.1</td>
<td>2000.0</td>
<td>2000</td>
</tr>
<tr>
<td>Ostertagia sp.</td>
<td>0.4</td>
<td>300.0</td>
<td>150–400</td>
</tr>
<tr>
<td>Ascaris sp.</td>
<td>3.3</td>
<td>582.6</td>
<td>100–2500</td>
</tr>
<tr>
<td>Nematodirus sp.</td>
<td>2.5</td>
<td>426.5</td>
<td>100–1200</td>
</tr>
<tr>
<td>Dictyocaulus sp.</td>
<td>0.1</td>
<td>150.0</td>
<td>150</td>
</tr>
<tr>
<td>Moniezia sp.</td>
<td>5.2</td>
<td>441.7</td>
<td>100–1500</td>
</tr>
<tr>
<td>Taenia sp.</td>
<td>25.3</td>
<td>613.4</td>
<td>100–3000</td>
</tr>
<tr>
<td>Dipylidium sp.</td>
<td>0.6</td>
<td>362.5</td>
<td>250–550</td>
</tr>
</tbody>
</table>

### 4. Discussion

Helminth infections or helminthosis refer to a complex of conditions caused by parasites of the Nematoda, Cestoda and Trematoda helminths. Results of the present study show that the ruminants slaughtered at Shendi abattoir from September 2015 to October 2016 were infected with a variety of GI helminth species. This confirms prior reports on the occurrence of GI helminth parasites in ruminants in Sudan[12,19,23-26]. Generally, there are many associated risk factors that influence the prevalence of GI helminth infections in ruminants, including age, sex, weather conditions and husbandry or management practices[27-30]. Moreover, the prevalence of an infectious disease in animals is dependent on further factors, including types of food and water, hygienic conditions, locations of pens, administration of drugs, and level of education and economic capacity of the farmers[29,31].

Although there was no statistically significant difference in the prevalence of infection between adult and young ruminants examined in this study, the slightly higher prevalence recorded in adults could be attributed to their longer exposure to parasites in pastures. This is not corroborated by the previous findings[32-34]. However, the young animals, having lower level of immunity, are more susceptible to infections than adults[35,36], which may effectively compensate for their shorter exposure.

The results of the present study show that male ruminants had significantly higher prevalence of GI helminths than their female counterparts. This is in contrast to many previous studies concluding no sex-related differences in the prevalence of GI helminths in ruminants, and especially in cattle[37-39]. However, some studies have shown significant differences in GI helminth infections between male and female goats or sheep[40,41], with higher infection rates in females, presumably because pregnancy lowered their immunity.

Regional analysis indicated that the non-local ruminants had higher prevalence of GI helminth infections than their local counterparts or the cases from the River Nile region. This could be due to differences inherent in the sampling (such as selection of...
animals to transport over a distance), the prevailing environmental conditions at source location of the host animal, animal husbandry practices, and availability of intermediate hosts. Analysis indicated that goats from the River Nile, the Blue Nile, and West Sudan had more infections than the other ruminants examined. Differences in prevalence of parasites may be partly due to variations in geographical and climatic conditions[8]. Moreover, the overstocking of animals may increase their infection rates as well as spreading rates of diseases.

The results of this study indicate that the prevalence of helminth infections was highest during the rainy season. This is likely due to the availability of a wide grazing area within the source location of the host animal, which increased the chance of picking up cysts, ova, larvae or intermediate hosts of these GI helminths in the pastures. In addition, temperature, humidity and rainfall in the grazing area and the grazing behavior of these hosts are also highly favorable for parasite transmission[9,42]. Moreover, susceptibility to infections is influenced by various factors like age, species, health status and previous exposure to parasites[43,44]. In contrast, the prevalence and intensity of various GI parasite infections is severely affected by drought conditions as the high temperatures cause desiccation of parasites eggs or larvae[8,22,45].

The results of this study showed that female cattle and sheep had higher total egg outputs than the males. It is well-known that the susceptibility of female ruminants to infections might be attributed to reduced immunity resulted from the stresses of pregnancy and lactation. However, this explanation seems not applicable when the studied animals are young.

There was a significant difference in fecal egg counts by age group of the ruminants studied in the present study, and the young had the highest intensities of infection while the adults had the lowest. The high worm burden in young ruminants may be due to their limited exposure and the immaturity of their immune system, so a large proportion of the ingested larvae develop into adults. In addition, the number of parasitic eggs varies according to the species of worm, the host species, and body condition and immune status of the host animal[46,47].

There were significant differences in the fecal egg counts by the source location of ruminant. Cattles from the White Nile were found to have the highest intensity of egg output, while goats from the Blue Nile had the lowest. As mentioned above, helminth infection rates often differ from region to region, and this relates mainly to the nature of the grazing lands along with the grazing behavior of the host animal.

The mean GI helminth egg output in the sampled ruminants was relatively higher during the dry season. This finding conflicts with a previous report on cattle from West Africa, according to which the worm numbers and egg excretion are seasonal and higher during the rainy season[48]. As a consequence, calves born during the rainy season are expected to be at a higher risk of infection with GI parasites than those born during the dry season. It has been reported that the maximum egg count and larval population of parasites are associated with the wet seasons[42,49].

The most prevalent GI helminth parasites detected in the present study were the cestode, Taenia spp. and the nematode Strongyloids spp. This corroborates some reported findings in Africa[50,51]. The high prevalence of strongyle nematodes may be due to their direct life cycle, (i.e. these nematodes do not require other animals to complete their life cycles) when favorable conditions are available upon pasture or at farms with poor hygienic conditions. On the other hand, the nematodes Trichostrongylus sp. and Dictyocaulus sp. were the least prevalent parasites. The highest prevalence of helminth infections overall (among the cattle, sheep and goats examined) was by the cestode Taenia spp., while the trematode Fasciola sp. caused the least infections in cattle, Haemonchus sp. caused the least infections in sheep, and both Trichostrongylus sp. and Dictyocaulus sp. caused the least infections in goats. The relatively low prevalence of Fasciola spp. among cattle may be due to the nature of the grazing lands that were source locations of these animals, as they may be unfavorable for the propagation through intermediate snail hosts. While Haemonchus spp. are more prevalent in the tropical and warmer temperate zones[52,53], their proportion in this study was very low. This finding is not consistent with a previous study in which sheep due to their ground grazing habit acquired more infections than goats[54].

On the other hand, the highest mean intensities of egg output were recorded for the trematodes Strongyloids spp. in cattle, and Paramphistomum sp. in sheep; while the nematode Trichostrongylus sp. had the highest mean egg output in goats. The high egg outputs of nematodes may be due to high fecundity, but the nematode Trichostrongylus sp. is less fecund in egg production[22]. Therefore, the high egg output observed in the current study may be due to high numbers of worms in the host intestine or abomasum.

In conclusion, this study showed that the GI helminth parasites are highly prevalent in the Sudanese ruminants, posing risks to human health. This calls for improved control and preventive measures, such as educating the farmers in the proper use of anthelmintic treatments.

**Conflict of interest statement**

We declare that we have no conflict of interest.

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