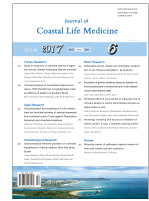


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## Gastrointestinal helminth parasites of ruminants slaughtered in Shendi abattoir, River Nile State, Sudan

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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* sp., *Ostertagia* sp., *Ascaris* spp., *Nematodirus* spp., and *Dictyocaulus* sp.); and 3 cestodes (*Moniezia* sp., *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 ruminants with large annual losses by causing acute illnesses and mortality in the 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, *Cysticercus bovis*, *Haemonchus contortus*, *Neascaris* and *Moniezia*[10,13,14]. In Western Sudan, *Fasciola gigantica*, *Paramphistomum* spp., *Schistosoma bovis*, *Cysticercus bovis*, *Nematodirus* spp., *Oesophagostomum radiatum*, *Haemonchus* sp., *Trichostrongylus* spp., *Cooperia* spp., *Strongyloides* spp., *Oxyuris* spp., *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 Gedarif State, the common helminth parasites that infect cattle are *Oesophagostomum*

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*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 upto 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. Part of the top surface layer of the filtrate (fecal suspension) was transferred using a Pasteur pipette into a McMaster counting chamber and was allowed to stand for 5 min, after which it was examined under a binocular microscope at 10 × 10 and 10 × 40 magnifications. Parasites were identified on the basis of egg color, shape, contents, and size using the keys given by Foreyt[21], and photographic records were made using a digital camera. The eggs were counted and each count was multiplied by 50 to obtain the total number of eggs per gram of fecal matter (epg)[22].

#### 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 microscope 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 ( $\chi^2$ ). 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., *Trichostrongylus* sp., *Ostertagia* sp., *Ascaris* spp., *Nematodirus* spp., and *Dictyocaulus* sp.); 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 *Trichostrongylus* 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 ( $n = 687$ ).

Variables		Cattle			Sheep			Goats		
		No. exam.	P (%)	Mean inten.	No. e.xam.	P (%)	Mean inten.	No. exam.	P (%)	Mean inten.
Age	Young	60	60.0*	1306.8*	62	61.3	506.5*	150	64.7	624.2
	Adult	75	21.3	598.3	165	61.8	431.4	175	69.7	459.8
Sex	Male	97	39.2	650.4	148	62.8*	444.6	134	67.9	650.4*
	Female	38	36.8	675.0	79	59.5	465.9	191	67.0	508.9

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

Variable		Cattle			Sheep			Goats		
		No. exam.	P (%)	Mean inten.	No. exam.	P (%)	Mean inten.	No. exam.	P (%)	Mean inten.
Place of source	River Nile	86	33.7	710.3	168	55.4	423.7	290	65.2	550.7
	White Nile	4	75.0	1666.7	0	0.0	0.0	0	0.0	0.0
	Blue Nile	0	0.0	0.0	18	94.4	482.4	7	100	364.3
	West Sudan	35	40.0	1207.1	41	73.2	436.7	28	82.1	432.6
	East Sudan	10	60.0	925.0	0	0.0	0.0	0	0.0	0.0
Season	Rainy	70	41.4	586.2*	127	70.1*	359.6*	100	78.0*	412.2
	Dry	65	35.4	1241.3	100	51.0	612.7	225	62.7	635.1

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 ( $n = 687$ ).

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

## 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 parasite 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 *Strongyloides* 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 *Strongyloides* 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* spp. 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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### References

- [1] Mulugete T, Batu G, Bitew M. Prevalence of gastrointestinal parasites of sheep and goats in and around Bedelle, South-Western Ethiopia. *Int J Vet Med* 2011; **8**: 14-25.
- [2] Borji H, Azizzadeh M, Kamelli M. A retrospective study of abattoir condemnation due to parasitic infections: economic importance in Ahwaz, Southwestern Iran. *J Parasitol* 2012; **98**: 954-7.
- [3] Turner WC, Versfeld WD, Kilian JW, Getz WM. Synergistic effects of seasonal rainfall, parasites and demography on fluctuations in springbok body condition. *J Anim Ecol* 2012; **81**: 58-69.
- [4] Thumbi SM, de Bronsvort BM, Poole EJ, Kiara H, Toye P, Ndila M, et al. Parasite co-infections show synergistic and antagonistic interactions on growth performance of East African zebu cattle under one year. *Parasitology* 2013; **140**: 1789-98.
- [5] Charlier J, van der Voort M, Kenyon F, Skuce P, Vercruysse J. Chasing helminths and their economic impact on farmed ruminants. *Trends Parasitol* 2014; **30**: 361-7.
- [6] Raza MA, Younas M, Schlecht E. Prevalence of gastrointestinal helminths in pastoral sheep and goat flocks in the Cholistan desert of Pakistan. *J Anim Plant Sci* 2014; **24**: 127-34.
- [7] Tariq K, Chishti M, Ahmad F. Gastro-intestinal nematode infections in goats relative to season, host sex and age from the Kashmir valley, India. *J Helminthol* 2010; **84**: 93-7.
- [8] Dagnachew S, Amanute A, Temesgen WC. Epidemiology and gastrointestinal helminthiasis of small ruminants in selected site of North Gondar zone, Northwest Ethiopia. *Ethiop Vet J* 2011; **15**: 57-68.
- [9] Ratanapob N, Arunvipas P, Kasemsuwan S, Phimpraphai W, Panneum S. Prevalence and risk factors for intestinal parasite infection in goats raised



- in Nakhon Pathom province, Thailand. *Trop Anim Health Prod* 2012; **44**: 741-5.
- [10] Eisa AM, Mustafa AA, Soliman KN. Preliminary report on cysticercosis and hydatidosis in Southern Sudan. *Sudan J Vet Sci Anim Husb* 1962; **3**: 97-108.
- [11] El Badawi ES, El Khawad S, Eisa AM, Ibrahim AM, Slepnev NK, El Gezuli AY. Incidence of helminth parasites in ruminants slaughtered in western provinces of the Sudan. *Sudan J Vet Sci Anim Husb* 1978; **19**: 58-65.
- [12] Atta El Mannan AM. Investigations on gastrointestinal parasites in sheep and goats in Sennar District, Sudan. *Sudan J Vet Res* 1983; **5**: 69-73.
- [13] Eisa AM. Normal worm burden of cattle in Upper Nile Province, Sudan. *Sudan J Vet Sci Anim Husb* 1963; **2**: 63-70.
- [14] El Badawi ES, Slepnev NK, Eisa AM. A survey of helminth parasites of cattle, sheep and goats in the southern region of the Sudan. *Sudan J Vet Sci Anim Husb* 1976; **17**: 86-90.
- [15] Kheir SM, Kheir HM. Gastrointestinal nematodes of equines in Southern Darfur region of the Sudan. *Sudan J Vet Res* 1981; **3**: 53-7.
- [16] Abdalla SH. Effect of endoparasites on the growth rate of Sudanese sheep and cattle. *Trop Anim Health Prod* 1989; **21**: 3.
- [17] Mohammed AA, El Malik KH. The epidemiology of cystic echinococcosis in Nyala, Southern Darfur State, Sudan. *Sudan J Vet Res* 2000; **16**: 49-53.
- [18] Mohammed AS, Atta El Mannan AM. The gastro-intestinal parasites of some domestic animal species in Damzin District, Blue Nile State, Sudan. *Sudan J Vet Res* 2003; **18**: 99-103.
- [19] Mohamed IM, Ahmed GA, Siham E, Iman AM, Abdalla MA. Endoparasites of cattle in Gedarif State, Sudan. *Sudan J Vet Res* 2013; **28**: 11-3.
- [20] El-Doush ME. Some studies on liver and gastrointestinal parasites of cattle at Atbara, Northern State [Thesis]. Khartoum: University of Khartoum; 1995.
- [21] Foreyt WJ. *Veterinary parasitology*. Iowa: Blackwell Publishers; 2001.
- [22] Hansen JW, Perry BD. *The epidemiology, diagnosis and control of helminth parasites of ruminants*. 2nd ed. Nairobi: International Laboratory for Research on Animal Diseases; 1994.
- [23] Ahmed AS. Investigation of diseases in dairy cows in the White Nile and Gezira states. Sudan [Thesis]. Khartoum: University of Khartoum; 2004.
- [24] Elmahdi IE, Ali QM, Magzoub MA, Ibrahim AM, Saad MB, Romig T. Cystic echinococcosis of livestock and humans in central Sudan. *Ann Trop Med Parasitol* 2004; **98**: 473-9.
- [25] Darien KM. Ante-mortem and post-mortem causes of condemnation of meat in Ghanawa Slaughterhouse in Khartoum State [Thesis]. Khartoum: University of Khartoum; 2008.
- [26] Alkareem IB, Abdelgadir AE, Elmalik KH. Study on prevalence of parasitic diseases in cattle in Abyei area, Sudan. *J Cell Anim Biol* 2012; **6**: 88-98.
- [27] Khan MN, Sajid MS, Iqbal Z, Hussain ZA. Gastrointestinal helminthiasis: prevalence and associated determinants in domestic ruminants of district Toba Tek Singh, Punjab, Pakistan. *Parasitol Res* 2010; **107**: 787-94.
- [28] Badaso T, Addis M. Small ruminants haemonchosis: prevalence and associated risk factors in Arsi Negelle municipal abattoir, Ethiopia. *Glob Vet* 2015; **15**: 315-20.
- [29] Bansal DK, Agrawal V, Haque M. A slaughter house study on prevalence of gastrointestinal helminths among small ruminants at Mhow, Indore. *J Parasit Dis* 2015; **39**: 773-6.
- [30] Blackie S. A review of the epidemiology of gastrointestinal nematode infections in sheep and goats in Ghana. *J Agric Sci* 2014; **6**: 109-18.
- [31] Islam KS, Taimur MA. Helminthic and protozoan internal parasitic infections in free ranging small ruminants of Bangladesh. *Slov Vet Res* 2008; **45**: 67-72.
- [32] Awraris T, Bogale B, Chanie M. Occurrence of gastrointestinal nematodes of cattle in and around Gondar Town, Amhara Regional State, Ethiopia. *Acta Parasitol Glob* 2012; **3**: 28-33.
- [33] Shitta KB, James-Rugu NN. Prevalence of gastro-intestinal helminthes of slaughtered cattle at Wukari abattoir Taraba State, North-Eastern Nigeria. *Niger J Parasitol* 2013; **34**: 55-9.
- [34] Maharana BR, Kumar B, Sudhakar NR, Behera SK, Patbandha TK. Prevalence of gastrointestinal parasites in bovines in and around Junagadh (Gujarat). *J Parasit Dis* 2016; **40**: 1174-8.
- [35] Ploeger HW, Kloosterman A, Rietveld WB, Hilderson H, Hollanders W. Quantitative estimation of the level of exposure to gastro intestinal nematode infection in first-year calves. *Vet Parasitol* 1994; **55**: 258-315.
- [36] Radostits AM, Blood DC, Gay C. *Veterinary medicine*. 10th ed. London: WS Saunders Company LTD; 2010.
- [37] Fikru R, Teshale S, Reta D, Yosef K. Epidemiology of gastrointestinal parasites of ruminants in western Oromia. Ethiopia. *Int J Appl Res Vet Med* 2006; **4**: 51-7.
- [38] Bilal MQ, Hameed A, Ahmad T. Prevalence of gastrointestinal parasites in buffalo and cow calves in rural areas of Toba Tek Singh, Pakistan. *J Anim Plant Sci* 2009; **19**: 67-70.
- [39] Coelho WD, Talamini do Amarante AF, Bresciani KS. Occurrence of gastrointestinal parasites in goat kids. *Rev Bras Parasitol Vet Jaboticabal* 2012; **21**: 65-7.
- [40] Yohanna JA, Maisae RD, Nwibari BW, Njoku CI. Gastrointestinal helminthes among slaughtered cattle at Jos abattoir, Plateau State, Nigeria. *Nig J Parasitol* 2012; **33**: 141-4.
- [41] Ibrahim N, Tefera M, Bekele M, Alemu S. Prevalence of gastrointestinal parasites of small ruminants in and around Jimma Town, Western Ethiopia. *Acta Parasitol Glob* 2014; **5**: 12-8.
- [42] Velusamy R, Rani N, Ponnudurai G, Anbarasi P. Prevalence of intestinal and haemoprotozoan parasites of small ruminants in Tamil Nadu, India. *Vet World* 2015; **8**: 1205-9.
- [43] Richard S, Cabaret J, Cabourg C. Genetic and environmental factors associated with nematode infection in dairy goats in Northwestern France. *Vet Parasitol* 1990; **36**: 237-43.
- [44] Vlassoff A, Bisset SA, McMurtry LW. Faecal egg counts in Angora goats following natural or experimental challenge with nematode parasites within flock variability and repeatabilities. *Vet Parasitol* 1999; **84**: 113-23.
- [45] Ohaeri CC. The parasitic helminths of cattle slaughtered in abattoir in Umuahia South Local Governme Area, Abia State, Nigeria. *Int J Appl Res Technol* 2012; **1**: 85-9.
- [46] O'Connor LJ, Walkden-Brown SW, Kahn LP. Ecology of the free-living stages of major trichostrongylid parasites of sheep. *Vet Parasitol* 2006; **142**: 1-15.
- [47] Villalba JJ, Miller J, Ungar ED, Landau SY, Glendinning J. Ruminant self-medication against gastrointestinal nematodes: evidence, mechanism, and origins. *Parasite* 2014; **21**: 31.
- [48] Zinsstag J, Ankers P, Ndao M, Bonfoh B, Pfister K. Multiparasitism, production and economics in domestic animals in sub Saharan West Africa. *Parasitol Today* 1998; **14**: 46-9.
- [49] Romero CG, Gruner L. Effect of temperature and humidity on gastrointestinal infections of cattle pastures. *Ann Rech Vet* 1984; **15**: 65-74.
- [50] Tesfaheywet Z. Helminthosis of sheep and goats in and around Haramaya, Southeastern Ethiopia. *J Vet Med Anim Health* 2012; **4**: 48-55.
- [51] Miran MB, Kasuku AA, Swai ES. Prevalence of echinococcosis and *Taenia hydatigena* cysticercosis in slaughtered small ruminants at the livestock-wildlife interface areas of Ngorongoro, Tanzania. *Vet World* 2017; **10**: 411-7.
- [52] Sissay MM, Uggla A, Waller PJ. Epidemiology and seasonal dynamics of gastrointestinal nematode infections of sheep in a semi-arid region of eastern Ethiopia. *Vet Parasitol* 2007; **143**: 311-21.
- [53] Qamar MF, Maqbool A, Khan MS, Ahmad N, Muneer MA. Epidemiology of haemonchosis in sheep and goats under different managemental conditions. *Vet World* 2009; **2**: 413-7.
- [54] Javed MS, Iqbal Z, Hayat B. Prevalence and economics of haemonchosis in sheep and goats. *Pak Vet J* 1992; **12**: 36-8.