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Prevalence and Risk Factors of *Haemonchus contortus* in Sheep in Khartoum State, the Sudan

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Abstract: *A cross sectional study was conducted from June to August 2013 in Khartoum state to estimate the prevalence of Haemonchus contortus eggs in sheep feces and to investigate potential risk factors associated with them. Floatation technique, modified McMaster technique, and fecal incubation were used for identification of the egg of the parasite, egg count, and larval identification. The overall prevalence of H. contortus eggs was 12.1% with a 95% CI ranging from 7.97 to 16.23 while by risk factor category a prevalence that ranged from 3.7% to 22.2% (95% CI from -1.33 to 41.40) was reported. Furthermore, no significant statistical variances were observed at p-value ≤0.05 among the different categories of the risk factor except amid the different age groups, animals that produced normal and soft feces, and the animals that were given anthelmintics and that were not. Breed (x^2=11.2, p-value=0.004), age group (x^2=15.7, p-value=0.001), feces consistency (x^2=27.1, p-value=0.001), way of raising (x^2=6.7, p-value=0.009), and use of anthelmintics (x^2 =12.2, p-value=0.001) were associated with detection of H. contortus eggs in the univariate analysis. All these factor were also significant in the multivariate analysis with odds of being Floatation test-positive for H. contortus eggs. It can be concluded that this bloodsucker parasite was prevalent in a low percentage in Khartoum and use of anthelmintics was a protective factor. Therefore, the use anthelmintics by sheep farmers from period to period is recommended as a prophylactic measure.*

Keywords: *Prevalence, risk factors, Haemonchus contortus, sheep, the Sudan*

I. Introduction

The Sudan has a very huge wealth of animal resources that has been estimated to be around 143 million head of animals; of which 95 million are small ruminants [24, 25]. The livestock sector is a very important sector in the Sudan, as the exports of livestock and livestock products are currently among the top sources of foreign exchange [26]. Furthermore, this sector contributes by 46% to the Gross Domestic Product (GDP), 27% to Foreign Exchange Earnings (FEE) [24, 25, 26].

Parasitic diseases are significant obstacle that faces livestock farmers, especially small ruminants owners and/or herders. These diseases are often encountered from the environment or transmitted by vectors [7, 27]. *Haemonchus contortus* is a nematode that causes Haemonchosis in small ruminant. It lives in the abomasums of ruminants and its eggs are shed with feces of the host [3, 4]. It is a common blood sucker that results in either deaths in heavily infested animals due to anemia or dramatically diminishes the productivity. A single worm sucks about 0.05 ml of blood per day and the female can lay up to 10.000 eggs per day also [27]. It causes excessive economic losses in sheep and goats in tropical areas where it is endemic [1, 4, 5]. Clinically, the disease is more severe in lambs than in adult animals and it occurs in three forms: per-acute or acute or chronic. For many years, anthelmintics have extensively been used to control this endoparasites [9, 18, 38].

The Sudanese desert sheep are raised under different management and husbandry systems as dedicated by the ecological conditions [3, 24]. Prevalence of *H. contortus* in small ruminant has been reported previously from these different ecological settings in the Sudan but associated risk factors were poorly addressed [3]. Accordingly, this study was carried out to estimate the prevalence of *H. contortus* eggs in sheep feces in Khartoum state and to investigate potential risk factors associated with them.

II. Materials And Methods

Study Area

The study was carried out in Khartoum state, which is located in central Sudan, in the semi-arid zone between the latitude 15.08ºN and 16.39ºN and longitude 31.36ºE and 34.25ºE (Fig. 1). Khartoum state receives little infrequent rain with an average of less than 300 mm per year. Diurnal and annual temperature variations are very wide. The highest mean maxima is between March and May, ranging from 35 to 43ºC and the lowest mean minima is between December and February ranging from 15 to 28ºC. Semi-intensive animal production system prevails in Khartoum relying on the natural range in the vicinity of the villages and the town outskirts [24].

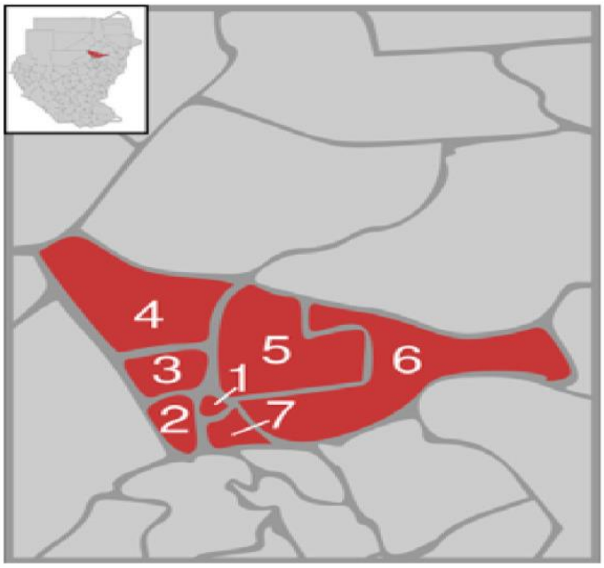

Fig. 1: Map of study area showing the selected localities (1=Khartoum, 2=Um Badda, 3= Omdurman, and 6=East Nile). Adopted from Nurelhuda *et al*. [41]

Study Design and Sampling Strategy

A cross sectional survey was conducted from June to August 2013 using a multistage random sampling strategy. Out of the 7 localities of Khartoum state, 4 were conveniently selected including Khartoum, Um Badda, Omdurman, and East Nile (Fig. 1). Within the selected localities, smaller administrative units and/or villages and some sheep markets were further conveniently selected as follow: Soug Elzreiba, Elsoug Elshabei, and Soug Elmowielh in Omdurman locality and Elredwan, Soug Elmashia, and Soug Elsalam in Um Badda. While in East Nile locality samples were taken from Hilat Kuku, Elshigela, Elkeryab, Zrayeb Elnasr, Eid babiker and Soba Sharig and from Elremailah and Soug Elsahafa in Khartoum locality. Sheep flocks and individual animals were randomly and/or conveniently selected [13].

The sample size was calculated according to Martin *et al.* [13] and Thrusfield [23] using the following formula:

$n= 1.96^2(P^\wedge) (Q^\wedge) / L^2$

Where:

n	= sample size
1.96^2	= constant
P^	= expected prevalence
Q^	= 1-P^
L	= precision level

Accordingly, n was 120 and was multiplied by 2 to increase accuracy and reliability [23.

Samples Collection and Laboratory

Fecal Sample Collection:

Fecal samples were collected directly from the rectum in plastic containers as described by Solusby [21], labeled, stored in an ice box and transported immediately for diagnosis at the Parasitology Laboratory of the College of Veterinary Medicine, Sudan University of Science and Technology, Khartoum North, the Sudan.

Floatation Technique, Egg Count and Larval Identification:

Detection and identification of *H. contortus* egg using saturated NaCl solution and egg count by modified McMaster technique were carried out as described by Shah-Fischer and Say [19], Maposa [12], and Chaney [28] while the larvae cultures and identification were conducted as per the method explained by Hansen [8], Lynda *et al*. [11], Solusby [21], and Coles *et al*. [29].

Questionnaire Survey

Questionnaires were administered and discussed with owners and herders of sheep. Data concerning herd size and whether mixed with other animals, season, housing, source of new animals, way of raising, use of anthelmintics, and if animal suffers other diseases were collected.

Data Analyses

All collected data were entered, cleaned, coded, and stored electronically in a Microsoft® Excel for Windows® 2007 database. The Statistical Package for Social Sciences (SPSS) for Windows® version 18.0 (SPSS Inc., Chicago, Illinois) was used for all appropriate statistical analyses. Descriptive statistics of the variables were obtained. Hypotheses of differences of the variables of the risk factors between floatation test-positive and floatation test-negative animals were first tested by univariate analysis by means of the 2-tailed chi-square test. Furthermore, a logistic regression model was used to assess the combined effect of the risk factors with $p \leq 0.25$ in the univariate analysis.

III. Results

Prevalence of *Haemonchus contortus* eggs

An overall prevalence of *H. contortus* eggs of 12.1% (n= 29; 95% CI from 7.97 to 16.23) was recorded and more than two thirds (86.2%, 25/29) of the incubated samples developed *H. contortus* larvae.
The prevalence of *H. contortus* eggs by risk factor category, ranged from 3.7% to 22.2% (95% CI from -1.33 to 41.40) with no significant statistical variances observed at p-value ≤0.05 except among the different age groups, animals that produced normal and soft feces (feces consistency), and among the animals that were given anthelmintics and that were not.

Association of the Risk Factors with *Haemonchus contortus* eggs

As Table 1 and 2 depicted, breed (x^2=11.2, *p-value*=0.004), age group (x^2=15.7, *p-value*=0.001), feces consistency (x^2=27.1, *p-value*=0.001), way of raising (x^2=6.7, *p-value*=0.009), and use of anthelmintics (x^2 =12.2, *p-value*=0.001) were associated with detection of *H. contortus* eggs in univariate analysis while the other individual and management risk factors were not.

Some risk factors were associated with the detection of *H. contortus* eggs in the multivariate analysis (Table 3). Ashgar (OR=2.82, 95% CI from 1.35 to 22.2, *p-value*=0.031) and Kabashi (OR=8.03, 95% CI from 4.89 to 72.2, *p-value*=0.016) breeds, animals >1-3 years old (OR=3.50, 95% CI from 2.01 to 7.50, *p-value*=0.044) and animals >3 years old (OR=4.60, 95% CI from 1.02 to 20.8, *p-value*=0.028), soft feces consistency (OR=5.22, 95% CI from 5.30 to 21.4, *p-value*=0.047), semi-nomadic way of raising (OR=3.30, 95% CI from 1.80 to 25.0, *p-value*=0.019) and animals where anthelmintics were not used (OR=3.43, 95% CI from 1.40 to 29.4, *p-value*=0.011) were more susceptible to disease in comparison to the reference category of the same risk factor.

IV. Discussion

Sheep are one of the most important animals that provide farmers with food and wool. One of the most noteworthy antagonistic factors to sheep farming is parasitic diseases, especially those caused by nematodes [30]. Results of this study indicated that *H. contortus* is prevalent in sheep of Khartoum state, the Sudan. The overall prevalence was lower than the slaughterhouse-based prevalences reported by Mubarak [14], Fayza *et al.* [3] and Almalaik *et al*. [31] in North Kordofan state, Omdurman, Khartoum state, and Tulus locality, South Darfur state which were 36.4%, 32% and 53.4%. It was also lower than the prevalences reported from other countries which were 47.7%, 71.03%, 56.3% and 72.5% in Ethiopia [2, 15, 20, 32], 55.56% in Benin [34], 37.2%, 35.4%,77.7%, and 80.6% in Pakistan [17, 22, 33, 38], 82.0% and 94.0% in Togo and Guinea in West Africa [35, 36]. However, it was higher than that reported in Iran which was 9.3% [39]. These noticed diverse prevalences of the bloodsucking parasite could be due to variations in management system adopted in the investigated areas.

There was a significant association between breed, age group, and feces consistency and *H. contortus* eggs in this study. Chuadary *et al*. [1] and Taswar *et al*. [22] came to the same conclusion the breed influenced the prevalence of the bloodsucker parasite, while Gerdaghi [6] could not establish any relation. Some indigenous breeds of sheep and goats are known with their resistance to endoparasites infestation including round worms. Genetic variations could possibly lead to such noticed differences in susceptibility [3]. The observed connection between age group and the parasite herein, confirmed the findings of Tasawar *et al*. [22] in Punjab, Pakistan, and Gerdaghi [6] in Behshar, Iran, but contradicted with the findings of Lateef *et al*. [10] in Pakistan, and Nganga *et al*. [16] in Kenya. Other dissimilar findings were those of Qamer *et al*. [17] in Pakistan, and Sissay [20], Nagasi *et al*. [15] and Dagnachew *et al*. [2] in Ethiopia. *H. contortus* afflicts young animals more than old ones and results in high case fatality rates but persists in the adult, and hence, the higher chance of detection of eggs in the fecal materials of the old ones [3]. The prevalence of *H. contortus* eggs was different relying on feces consistency with 32.0% of animals that produced soft feces and 6.3% that produced normal feces being positive. Soft feces indicates GIT disturbances disorders including those caused by this bloodsucker endoparasite. In this study, way of raising was investigated as a risk factor and it did influence the prevalence of the round worm eggs in feces. The percentage of samples harboring eggs was higher in sedentary animals that do not graze at all as compared with animals that graze sometimes. When a sedentary animal, being reared in a farm and/or a pen, gets infested with this worm, the number of eggs shed per meter square would probably increases and consequently increases the risk to in-contact susceptible animals. There was a statistically significant difference between the percentage of the detection of the endoparasite in the animals that were given anthelmintics and the animals that were not given. Sheep that were animals given anthelmintics were less infested. Furthermore, use of anthelmintics had a positive association in the univariate analysis with detection of eggs and was obviously a protective risk factor. This finding was in agreement with the findings of a study carried out in North Kordofan state, the Sudan [14].

Contrary to the findings of this study and the findings of Fayza *et al*. [3] and Sissay [20], some studies like Qamar *et al*. [17] and Tahrani *et al*. [39] have shown that this disease was more prevalent during the season of rainfall than during other seasons of the year. It has been proved that high humidity, at least in the microclimate of the feces and the herbage is essential for larval development and their survival [17]. This could presumably be explained by the fact that the high biotic potential of *H. contortus* results in rapid dominance at times when environmental conditions on pasture are favorable for the development and survival of the free-living stages. Qamar *et al*. [17] indicated that the prevalence showed a definite seasonal sequence that corresponded with the rainfall pattern in their study area. In both sheep and goats, counts of *Haemonchus*-eggs increased with rains and peak levels of egg counts as well [39]. Additionally, several factors i.e., warmer and wetter grazing seasons, the greater time animals spend on pasture, ineffective de-worming practices or the development of anthelmintic resistance would likely contribute to the occurrence of the disease in small ruminants [40].

V. Conclusions And Recommendations

It can be concluded that the bloodsucker parasite, *H. contortus*, was prevalent in a low percentage in Khartoum. Breed, age group, and feces consistency were associated with the disease in the univariate analysis while use of anthelmintics was a protective factor. Therefore, the use anthelmintics by sheep farmers from period to period is recommended as a prophylactic measure but also how to correctly use these chemicals and the hazards that might possibly arise to animals and consumers if not appropriately used should be explained.

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Table 1: Prevalences of *Haemonchus contortus* eggs in sheep by individual animal risk factors in Khartoum state and univariate analysis (from June to August 2013)

Risk factors	No. tested	No. positive	%	95% CI	df	χ^2	*p-value*
Locality							
Omdurman	40	3	7.50	-0.66 - 15.66[a]	3	3.2	0.360
Khartoum	17	1	5.00	-5.36 - 15.36[a]			
Um Badda	18	4	22.2	3.00 - 41.40[a]			
East Nile	165	21	12.7	7.62 - 17.78[a]			
Sex							
male	113	11	9.70	4.24 - 15.16[a]	1	1.1	0.292
female	127	18	14.2	8.13 - 20.27[a]			
Breed							
Ashgar	105	10	9.50	3.89 - 15.11[a]	2	11.2	0.004
Hamari	90	7	8.00	2.40 - 13.60[a]			
Kabashi	45	12	26.7	13.8 - 39.63[a]			
Age							
≤1	54	2	3.70	-1.33 - 8.730[a]	2	15.7	0.001
>1-3	124	11	8.90	3.89 - 13.90[a]			
>3	62	16	25.8	14.91 - 36.8[b]			
Body condition							
good	151	17	11.3	6.25 - 16.35[a]	2	2.8	0.247
moderate	90	12	13.3	5.59 - 19.41[a]			
Feces consistency							
normal	189	12	6.30	2.84 - 9.760[a]	2	27.1	0.001
soft	50	16	32.0	19.1 - 44.90[b]			
Season							
dry	185	19	10.3	5.92 - 14.70[a]	1	2.4	0.114
wet	55	10	18.2	8.00 - 28.40[a]			

different superscripts indicate significant difference at $p \leq 0.05$, * = risk factor with variable that has expected count less than 5 or with constant variable thus no chi square was calculated

Table 2: Prevalences of *Haemonchus contortus* eggs in sheep by herd management risk factors in Khartoum state and univariate analysis (from June to August 2013)

Risk factors	No. tested	No. positive	%	95% CI	df	χ^2	*p-value*
Herd size							
1-35	62	9	14.5	5.74 - 23.26[a]	2	0.81	0.667
36-70	123	15	12.2	6.42 - 17.98[a]			
>70	55	5	9.10	1.50 - 16.70[a]			
Housing type							
indoor	93	12	12.9	6.09 - 19.71[a]	1	0.09	0.757
outdoor	147	17	11.6	6.42 - 16.78[a]			
Source of new animals							
in-breeding	187	20	10.7	6.27 - 15.13[a]	2	1.9	0.379
from other farms	28	4	14.3	1.33 - 27.27[a]			
from markets	25	5	20.0	4.32 - 35.68[a]			
Way of raising							
zero grazing	81	16	19.7	11.0 - 28.36[a]	1	6.7	0.009
semi-nomadic	159	13	8.20	3.94 - 12.46[a]			
Use of anthelmintic							
yes	153	10	6.50	2.59 - 10.41[a]	1	12.2	0.001
no	87	19	21.8	13.1 - 30.48[b]			
Other disease							
yes	20	4	20.0	2.47 - 37.5[a]	1	1.2	0.257
no	220	25	11.4	7.20 - 15.6[a]			
Other animal							
yes	41	8	19.5	7.37 - 31.63[a]	1	2.5	0.109
no	199	21	10.6	6.32 - 14.88[a]			

different superscripts indicate significant difference at $p \leq 0.05$, * = risk factor with variable that has expected count less than 5 or with constant variable thus no chi square was calculated

Table 3: Multivariate associations of risk factors with *Haemonchus contortus* eggs in sheep in Khartoum state (from June to August 2013)

Risk factors	No. tested	No. positive	%	Exp(B)	95% CI	*p-value*
Breed						
Hamari	105	10	9.50	Ref		
Ashgar	90	7	8.00	2.82	1.35-22.2	0.031
Kabashi	45	12	26.7	8.03	4.89-72.2	0.016
Age						
≤1	54	2	3.70	Ref		
>1-3	124	11	8.90	3.50	2.01-07.5	0.044
>3	62	16	25.8	4.60	1.02-20.8	0.028
Feces consistency						
normal	189	12	6.30	Ref		
soft	52	17	32.7	5.22	5.30-21.4	0.047
Way of raising						
zero grazing	81	13	8.20	Ref		
semi-nomadic	159	16	19.7	3.30	1.80-25.0	0.019
Use of Anthelmintics						
yes	153	10	6.50	Ref		
no	87	19	21.8	3.43	1.40-29.4	0.011