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Seroprevalence of *Toxoplasma gondii* in Farm Animals in West Kordofan, and Blue Nile states, Sudan

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ABSTRACT

Considering the veterinary and public health significance of *T. gondii* infection and absence of epidemiological data in West Kordofan, and Blue Nile states in Sudan, a total of 392 serum samples from camel, cattle, sheep and goats in West Kordofan, and Blue Nile states were examined for *T. gondii* antibodies using Latex agglutination test. The overall seroprevalence was 22.4% (88/392). The seropositivity rate was 13.3% (6/45), 44% (33/75), 61% (22/36), 15.4% (21/136), 6% (6/100) in camels, cattle, sheep and goats and donkeys, respectively. Animal species was the only risk factor of *T. gondii* seropositivity. The significant higher seroprevalence of *T. gondii* in sheep and cattle indicates their potential role in the transmission of human toxoplasmosis in Sudan and the widespread contamination of the rural environment in Sudan with *Toxoplasma* oocysts. Further epidemiological studies, as well as special awareness and educational programs for toxoplasmosis are strongly suggested.

Keywords: Camel; Cattle; Goats; Seroprevalence; Sheep; Sudan; *Toxoplasma gondii*

INTRODUCTION

According to the official reports, the livestock population of Sudan was estimated at about 109 million heads, comprising about 4.9 million camels, 40 million sheep, 32 million goats, and 31 million cattle (FAO, 2020). The Sudanese livestock sector plays a crucial role in the national economy and welfare of the entire population via provision of essential food, cash from export earnings, means of transport and manure for soil fertility (IGAD, 2013). In spite of their significant contribution to the national economy, the livestock receive little

attention from the government and are influenced by a multitude of diseases, including toxoplasmosis (Wilson, 2018).

Toxoplasmosis is a neglected zoonosis caused by a cosmopolite protozoon, *Toxoplasma gondii*. This parasite is one of the ubiquitous parasites among humans and warm-blooded animals. Up to One-third of the world population was found to be infected with toxoplasmosis (Tenter et al., 2000). *T. gondii* infection can be acquired via ingestion of contaminated food, water or dust with sporulated oocysts, containing sporozoites, consumption of undercooked meat containing tissue cysts, and by transplacental transmission of tachyzoites from mother to fetus (Dubey et al., 2010). Despite, toxoplasmosis in humans is generally asymptomatic; it can have deleterious effects on immunocompromised patients and pregnant women (Weiss and Dubey, 2009). Toxoplasmosis is also responsible for economic and reproductive problems in livestock especially sheep and goats, resulting in stillbirth, neonatal deaths and abortion (Buxton, 1998).

In Sudan, few reports investigated the seroprevalence of *T. gondii* in farm animals (Camel, cattle, sheep and goats) and the prevalence ranged between 6.2% to 76% (Elamin et al., 1992; Khalil and Elrayah, 2011; El-Basheir et al., 2012; Elfahal et al., 2013; Medani and Kamil, 2014; Atail et al., 2017; Jomaa et al., 2017; Lazim et al., 2018). Despite the impact of *T. gondii* on animal industry, the epidemiological situation of this parasite in several states in Sudan, such as West Kordofan and Blue Nile states is unknown. Therefore, the present study aimed to determine the prevalence of *T. gondii* infection in camel, cattle, sheep and goats and the associated risk factors in West Kordofan and Blue Nile states.

MATERIALS AND METHODS

Ethical approval and consent to participate

Permission was obtained according to the standards of animal experimentation and Ethics committee of Obihiro University of Agriculture and Veterinary Medicine (Approval No. 19–19).

Study area and sample collection

The current study was performed in two states located in the south of Sudan; West Kordofan (12°0'N 28°9'E) and Blue Nile (11°16' N 34°4'E). Camels, cattle, sheep, and goats are owned by nomadic tribes and reared in a free-range breeding. Both states selection was due to lack of epidemiological screening of *T. gondii* in farm animals.

A total of 292 serum samples were collected after obtaining oral consent from the owners in West Kordofan State ($n = 151$; 45 camel, 34 cattle, and 72 goats) and Blue Nile State ($n = 141$; 41 cattle, 36 sheep, and 64 goats). Samples were collected with jugular venipuncture into plain vacutainer tubes. Serum was separated and stored at -20°C until analysis.

Latex agglutination test (LAT)

Serum samples were tested for the presence of *T. gondii* antibodies, via Latex agglutination test, Toxocheck-MT (Eiken chemical Co., Tokyo, Japan) according to the

manufacturer instructions. Screening of each serum sample was conducted at two-fold dilution starting from 1:8 to 1:1,024. Samples that showed agglutination at 1:32 were regarded positive.

Statistical analysis

To analyze the impact of animal species, gender and location as risk factors on the distribution of *T. gondii* in Sudan, Fisher’s exact test in GraphPad Prism 6.0 software was performed (GraphPad Software, Inc., La Jolla, CA, USA). Odds ratio (OR) and 95% confidence intervals (CI) were calculated. $P < 0.0001$ was regarded statistically significant.

RESULTS

Out of 292 animal sera surveyed for *T. gondii* antibodies among, 82 (28%) were seroreactive; being 13%, 41%, 22% in camels, cattle and goats, respectively in West Kordofan state while that in Blue Nile state was 46%, 61%, 7.8% in cattle, sheep and goats, respectively (Table 1).

Table 1. Seroprevalence of *Toxoplasma gondii* in different farm animals in West Kordofan and Blue Nile states and the titer of antibodies.

Location	Species	Total	No. of positive (%)	Antibody titers					
				1:32	1:64	1:125	1:256	1:512	1:1024
West Kordofan	Camel	45	6 (13)	5	0	0	1	0	0
	Cattle	34	14 (41)	8	2	1	1	0	2
	Goats	72	16 (22)	2	3	6	4	0	1
	Total	151	36 (23.8)						
Blue Nile	Cattle	41	19 (46)	12	3	1	3	0	0
	sheep	36	22 (61)	3	6	10	2	1	0
	Goats	64	5 (7.8)	0	0	1	0	1	3
	Total	141	46 (32.6)						
Total		292	82 (28)	30	14	19	11	2	6

Table 1 shows also the distribution of *T. gondii* antibodies among camel, cattle, sheep and goats in West Kordofan and Blue Nile states and the titer of antibodies. The antibody titration results were as follows: 30 (1:32), 14 (1:64), 19 (1:125), 11 (1:256), 2 (1:512), 6 (1:1,024). At a dilution of 1:32 and 1:125, higher rate of seropositivity was observed.

Overall prevalence in different animal species was 44%, 13.3%, 61.1%, and 15.4% in cattle, camel, sheep and goats, respectively. Infection rate was 23.8%, and 32.6%, in West Kordofan and Blue Nile states, respectively (Table 2).

To examine the associated risk factors for *T. gondii* seropositivity, geographic location, gender and animal species were examined. The seroprevalence was significantly higher ($P < 0.0001$) in sheep (OR (95% CI) = 0.12, 0.05 - 0.3) and cattle (OR = 0.23, 0.1 -

0.4) in comparison with goats (Table 2). Nonetheless, no significant difference was discerned in relation to the gender ($P = 0.8$) and location ($P = 0.1$) (Table 2) and *Toxoplasma* seropositivity.

Table 2. Analysis of the effect of animal species, gender and location on the distribution of *T.gondii* in Sudan.

Factor	Number of tested	Seroprevalence		Odds ratio (95% confidence interval)	p-value
		Positive number (%)	Negative number (%)		
Species					
Goats	136	21 (15.4)	115 (84.6)	Reference	
Sheep	36	22 (61.1)	14 (38.9)	0.12 (0.05 - 0.3)	< 0.0001
Camel	45	6 (13.3)	39 (86.7)	1.19 (0.5 - 3.2)	0.8
Cattle	75	33 (44)	42 (56)	0.23 (0.1-0.4)	< 0.0001
Gender					
Female	260	74 (28.5)	186 (71.5)	Reference	
Male	32	8 (25)	24 (75)	1.19 (0.5-2.8)	0.8
Location					
West Kordofan	151	36 (23.8)	115 (76.2)	Reference	
Blue Nile	141	46 (32.6)	95 (67.4)	0.65 (0.4 -1.1)	0.1

DISCUSSION

The absence of epidemiological data concerning toxoplasmosis in West Kordofan and Blue Nile states warranted more investigation. Our survey showed a *T. gondii* seropositivity of 13.3%, 44%, 61.1%, and 15.4% in the examined camel, cattle, sheep and goats, respectively. This is the first report about toxoplasmosis in farm animals in West Kordofan and Blue Nile states, Sudan and the results are comparable with other states in Sudan. By comparison, the current seropositivity of *T. gondii* in camels (13.3%) was relatively similar to that in a previous serosurvey conducted in Gedarif state in which seropositivity was 14.6% (Jomaa et al. 2017). Our seroprevalence results in camel were lower than those reported with other investigators who showed prevalence in camels was 76% in Butana plains, 44% in Khartoum and 20% in Butana plains (Elamin et al. 1992; Khalil and Elrayah, 2011; El-Bashier et al. 2012), respectively.

Conversely, the infection rate of *T. gondii* in cattle in the current study (44%) was higher than those reported in River Nile (6.2%), Gazira (14.9%) and Khartoum states (12.7%, 32%, 11.9%) (Lazim et al., 2018; Elfahal et al., 2013; Khalil and Elrayah, 2011; Medani and Kamil, 2014), respectively.

In sheep, our results demonstrated a prevalence of 61.1%, which was relatively close to that in previous two reports where the prevalence of toxoplasmosis in sheep was 57.5% in Khartoum and El-Gadarif states (Khalil and Elrayah, 2011; Atail et al., 2017). In addition, our results were higher than those observed in previous investigations; 40.9% at Khartoum

state, and 26.5% at River Nile state (Medani and Kamil, 2014; Lazim et al., 2018), respectively. Our results in goats showed that seroreactivity was 15.4% which were lower than those reported by previous studies; 46.5% at El-Gadarif state and 27.9% in River Nile state (Atail et al., 2017; Lazim et al., 2018), respectively.

The above-mentioned differences in *T. gondii* infection rates may be because of variations in geographical locations, serologic assays utilized, climatic conditions, animal species, sample size and sampling time (Fereig et al., 2016; Zhang et al., 2016; Abdelbaset et al., 2020).

Among the analyzed risk factors, the animal species represented the only associated risk factor for *T. gondii* seropositivity. Seroprevalence was significantly higher in sheep and cattle compared to the goats. These results were in the same line with previous reports that revealed sheep have a high susceptibility to *Toxoplasma* infection (Khalil and Elrayah, 2011; Fereig et al., 2016). These results also point out the importance of sheep and cattle in the transmission of human toxoplasmosis in Sudan, particularly when considering the Sudanese people's habit of consumption of partially cooked meat, liver, and viscera or unpasteurized milk (El-Hassan et al., 1991). Regarding the gender and geographical location, no statistical significance was observed. These findings were similar to other reports in which no significant relationship was noticed between these risk factors and *T. gondii* seropositivity (Elfahal et al., 2013; Fereig et al., 2016).

In a conclusion, this is the first report investigating the prevalence of *T. gondii* infection in camel, cattle, sheep and goats in west Kordofan and Blue Nile states in Sudan. The remarkable high prevalence of *T. gondii* antibodies in sheep and cattle suggests their potential role in the transmission of human toxoplasmosis in Sudan. Further epidemiological studies, as well as special awareness and educational programs for toxoplasmosis are urgently needed. Additional studies may determine the overall impact of toxoplasmosis on the livestock economy

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

SUBMISSION DECLARATION AND VERIFICATION

The authors declare that the work described has not been published previously and that it is not under consideration for publication elsewhere. All the authors approve the publication of this manuscript and that, if accepted, it will not be published elsewhere in the same form, in English or any other language, including electronically without the written consent of the copyright holder.

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