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Incidence and prevalence of tick-borne haemoparasites infecting sheep and goats in Sennar state, Sudan

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Abstract

Sudan possess more than ninety million head of sheep and goats. However, rare was reported regarding Babesiosis, Anaplasmosis and Theileriosis in sheep and goats. In the present study the prevalence of Babesia, Theileria and Anaplasma, the causative agents for sheep and goats piroplasmosis were investigated in Sennar state, Sudan, through a crosssectional study carried out based on Giemsa staining assay from November 2014 to October 2015. The study was performed in five locations namely Sennar, Singa, El Mazmum, Abu Na'ama and El Dinder. Of 1415 sheep and goats examined, 31.66% of the Sheep and 18.62% of the goats were positive for different Piroplasma species. Apparently, sheep had higher rate of Piroplasma species infection compared with goats. Additionally, in both animals the overall prevalence was higher in Babesia species followed by Theileria spp and then Anaplasma spp. Risk factor analysis showed that location and season were associated to sheep and goats piroplasmosis. Such results were discussed accordingly and recommendations were suggested to undertake the socio-economic importance, prevention and control of such diseases.

Keywords: sheep, goats, piroplasma species, sennar state, Sudan

Introduction

Sudan possess around 140 million livestock population. The Ministry of Animal Wealth estimates the sheep and goats population at 48.0 and 42.0 million heads, respectively [1]. Such asset is endangered by different endemic diseases, which collectively causes significant economic losses to the pastoral community. In Sudan unpredictable weather, sometime drought and scarcity of fodders oblige the pastoralists to move with their animals. However, diseased animals normally have less ability for movement, less feeding ability, less feed conversion ratio and hence, light weight less reproduction and more susceptibility for diseases infection. Additionally, such diseases impose economic losses by causing morbidity and mortality and harming the internal and international livestock trade. Furthermore, the management of such diseases also augment the cost. Trying to avoid such costs, light or no healthcare practices could result in endemicity of such diseases and the diseased animals become reservoir and ultimately leads to more incidences [2, 3]. Moreover, livestock and humans emerging and re-emerging zoonotic diseases are nowadays spread tremendously and has potential of crossing continental boundaries. In Sudan, detection of emerging diseases like Crimean-Congo hemorrhagic fever, a tick-borne virus, was also reported as a result of eating raw sheep meet [4]. The tick-borne diseases cause important economic losses particularly in developing countries [5]. Babesiosis, Anaplasmosis and Theileriosis are among the most important tick-transmitted diseases affecting animals in sub-Saharan Africa [6, 7]. In fact, literature survey revealed few reports about such diseases in sheep and goats in Sudan. Tick vectors are different throughout the worldwide. For instance, *Rhipicephalus evertsi* and *Rhipicephalus (Boophilus) decoloratus* were reported as competent Babesiosis tick vectors in livestock in Angola [8]. However, in Sudan, such parasites were reported in small ruminants without relations as vectors to such tick species [9-16]. Therefore, the relation of such diseases to vectors is not understood. Additionally, some other factors might play important roles in such circulation of infection. For instance, climatic stress (e.g. fluctuation of raining) and hence, less weeds that leads to movement of animals in addition to possibility of acquiring other infection with other diseases such as trypanosomosis will lead to malnutrition beside the inadequate and poor veterinary service. Furthermore, the favorability of the such climate for tick survival and the availability of ticks on such hosts and lack of vaccination [17]. As a consequence, the basic information about current epidemiological status of such diseases in livestock is lacking. Therefore, as a contribution to increase the knowledge on presence and distribution of such diseases and vectors, the present work is considered as a step in a frame of broader and precise developmental research project.

Materials and Methods

Study area and Study animals

Sennar state is a plane area bordered by Gezira state in the north, Gadaref state in the east, Blue Nile state in the west and Ethiopian international border in the south. These included Sennar town (13°33' N, 33°37' E), Singa (13°09' N, 33°57' E), Dinder (13°44' N, 34°12 E), and Abu Naama (12°44' N, 34°08' E). Sheep and goats blood specimens were collected from around 5 cities: Sennar, Singa, Muzmum, Abu Na'ama and Dindir (Map 1).

Blood Samples Collection and Estimation of Parasitemias

Blood samples were collected from 717 sheep and 698 goats. For blood samples collection, around fifty animals (25 Watish sheep and 25 Nubian goats), were randomly selected from each of the aforementioned 5 locations every 2 month, year round from November 2014 to October 2015 during three seasons: Winter (November to February), Summer (March to June) and Autumn (July to October). Blood smears were prepared from the sheep and goats' jugular vein blood and examined using Giemsa method and observed at 1000× magnification as described [18, 19].

Statistical Analysis

Descriptive statistics using software STATISTIX-8 was used.

Results and Discussion

In Sudan, few PCR-based techniques were reported for research purpose, however, such techniques are not yet been documented for field application to diagnose small ruminant piroplasmosis [16]. Additionally, for limited budget, in the current work, only blood smear examination was used. Such blood smear diagnostic observations were considered therefore, as a step to be followed by molecular techniques reassessments that would provide more informative diagnosis. Bearing in mind the microscopy was the gold standard diagnosis method used in the present study, such a high prevalence encourages scientists to be confirmed by most sensitive methods in both animals' blood and tick species to explained the biological transmission. Additionally, among the tick species found in the present study (in process for publication), some were reported elsewhere as competent vector ticks for bovine babesiosis such as *Rhipicephalus evertsi*, *R. sanguineus* and *R. (Boophilus) decoloratus* [8, 20, 21]. Furthermore, Theileriosis is a disease caused by species of the genus *Theileria*, and transmitted by tick genera such as *Rhipicephalus* [22]. Moreover, it worth noting that such diseases prevalence could also be due to mechanical transmission by biting flies and also by vertical transmission [23].

Of 1415 sheep and goats examined, 31.66% of the Sheep and 18.62% of the goats were positive for different Piroplasma species (Table 1). Apparently, sheep had higher rate of Piroplasma species infection compared with goats. Additionally, in both animals the overall prevalence was higher in Babesia species followed by Therileria spp and then Anaplasma spp. Risk factor analysis showed that location and season were associated to sheep and goats piroplasmosis. The present results provide important information that could be beneficial for better understanding, prevention and control of such diseases.

Table (2) shows the percentages of Babesia, Anaplasma and Therileria [total 227 infected sheep out of 717 examined animal (31.66%)] in sheep blood year-round (3 seasons) in Sennar state. The positives were breakdown as: Babesia spp. 106 infected sheep (46.70%) predominated followed by Theileria spp 76(33.48%) and then, Anaplasma spp 45(19.82%). Regarding the effect of location in Babesia infection, the prevalence percentage is in descending order as follows: Sennar, Singa, Mazmum, Dindir and Abu Na'ama. With regard to Theileria, it was higher in Singa, followed by Dindir, Mazmum, Sennar and then, Abu Na'ama. However, the Anaplasma prevalence percentage was in descending order as: Singa, Dindir, Mazmum, Abu Na'ama and then, Sennar. The higher prevalence was in winter, then summer and autumn.

Table 1: Total percentage prevalence of the different *Piroplasma spp.* in sheep and goats in Sennar state, Sudan from November 2014 to October 2015

	Babesia	Therileria	Anaplasma	Total
Sheep	106	76	45	227
(717)	46.70%	33.48%	19.82%	31.66%
Goats	79	37	14	130
(698)	60.77%	28.46%	10.77%	18.62%

Table 2: Effect of location and season on the prevalence of Babesia, Therileria and Anaplasma spp. in sheep blood at Sennar state, Sudan November 2014 to October 2015

Location	Babesia spp.			Anaplasma spp.			Therileria spp.		
	Winter 1	Summer	Autumn	Winter	Summer	Autumn	Winter	Summer	Autumn
Sennar	30.4	12.0	10.2	2.2	0.0	0.0	6.5	14.0	10.2
Singa	14.9	22.0	12.2	4.3	0.0	4.1	14.9	10.0	12.2
Mazmum	15.7	24.1	6.3	35.3	7.4	2.1	5.9	20.4	6.3
Abu Na'ama	8.3	4.1	19.2	16.7	4.1	5.8	4.2	8.2	7.7
Dindir	14.6	11.8	16.0	6.3	2.0	0.0	12.5	17.6	4.0

As in sheep, in goats (Table 3), 130 goats out of 698 (18.62%) were found infected. Babesia spp was most predominated 79(60.77%) followed by Theileria spp 37(28.46%) and then Anaplasma spp 14(10.77%). Babesia proportional distribution was in descending order as follows: Singa, Sennar, Abu Na'ama, Dindir and then Mazmum. While Babesia spp seasonal distribution in winter and autumn was more higher than summer. However, the prevalence of Theileria spp was higher in Singa, less in Abu Na'ama, then, Sennar and no infection was detected in both Mazmum and Dindir. The Theileria spp seasonal distribution seems as a slight normal distribution curve: winter raised up in summer and descended in autumn. Regarding the Anaplasma, the lesser parasites of the three in both sheep and goats. It was most predominated in Singa followed by Mazmum, Dindir, Sennar and non in Abu Na'ama. The Anaplasma spp seasonal prevalence was higher in winter then, summer and far less in autumn.

Apparently, such diseases cause serious economic losses due to mortality and reduction of meat and milk yield. Moreover, the international trade and global animal enterprise would be menaced [24-26]. Unfortunately, few research among Sudanese pastoralists or agro-pastoralists to challenge such problems was performed [27]. In Sudan, piroplasmosis epidemiological aspects are rarely reported in sheep [12, 28] and, goats [29]. Using Reverse Line Blot (RLB) hybridization assay, it was examined apparently healthy sheep (n=219) from six different geographical localities in Sudan [16]. They scored *Theileria ovis*, *T. separata*, *T. lestoquardi* and *T. annulata* and stated that *T. ovis* and *T. separata* were reported for the first time in sheep in Sudan. However, there is no Babesia species detected in all examined samples and that could be due to the use of 15 oligonucleotide probes that could be unspecific for Babesia species. Moreover, such prevalence of *Anaplasma* in sheep and goat herds in Sudan as part of the sub-Saharan Africa is not a surprise [30]. Additionally, despite the presence of the three aforementioned blood parasites, prevalence and genetic diversity of Babesia and Anaplasma species in cattle in Sudan was reported [31].

Table 3: Effect of location and season on the prevalence of *Babesia, Therileria* and *Anaplasma spp*. in goats' blood at Sennar State, Sudan November 2014 to October 2015

Location	Babesia spp.			Anaplasma spp.			Therileria spp.		
	Winter	Summer	Autumn	Winter	Summer	Autumn	Winter	Summer	Autumn
Sennar	19.1	13.6	3.9	0	2.3	0	8.5	9.1	3.9
Singa	14.3	13.7	34.6	4.1	0	14	14.3	11.8	1.9
Mazmum	8.9	0	4.1	2.2	0	2	0	0	0
Abu Na'ama	15.9	6.3	10.4	0	0	0	0	10.4	16.7
Dindir	9.8	6	4	0	4	0	0	0	0

In fact, in the present project, ten tick species were found in sheep and goats (data in process for publication). It was reported that the immature stages of tick can obtain the disease by feeding on the infected animal and transmit it trans-stadially. Additionally, the infected female adult tick can spread such diseases up to 32 generations via a transovarial route [32]. Furthermore, such parasites new genotypes were reported [33]. It is therefore, would be valuable should an elaborative study on the genetic diversity of such parasites and routes of transmission in Sudan is considered to fill the gap of such an overlooked areas. Generally, for better understanding of the ecology of a certain disease in a certain geographical region, in a certain animal species and animal breed, precise evaluation should be planned regarding the parasites and the vectors. Therefore, further study including precise parasites diagnosis methods in both animal serum and ticks beside close monitoring of distribution of tick vectors should be carried out to clarify present and recent epidemiological threats, estimate the most imperiled areas by such haemoparasites and best management program to reduce the economic losses in Sudan. Furthermore, such tropical diseases are one of the major hurdles of animal production. There are several risk factor lead to the occurrence and augmenting the harm of such diseases. For instance, climate changes and raining, expansion of cultivating land, deforestation in benefit of farming, effect on vectors, lack of public awareness, the close contact between livestock and owners and labors and emergence of new pathogens' serotype that facilitate them to escape from present control measures. That in addition to the effect of the indigenous animal breeds vs. crossed ones and the intensity of the cross-breeding programs and quality of vaccination [34, 35].

It is therefore a fundamental requirement to establish a synchronized monitoring and surveillance of such diseases, including geographical information system (GIS) [36] and rapid and confirmatory diagnosis throughout the country. Additionally, because Sennar state borders Ethiopia, such steps would be crucial for the management, control and eradication of endemic and trans-boundary diseases of livestock. Such measures lead to improve quality and quantity of livestock products hence, compete in the international market [37]. Therefore, the involvement of the political decision makers would be crucial for avoiding hiding of the disease outbreaks, quarantine of diseased animals and implementation of national and regional collaboration, transport of clinical materials for diagnosis and vaccines. The aforementioned efforts could help providing effective management and therefore, sustainable livestock production.

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