Prevalence of Simbu serogroup viruses antibodies in cattle in Sudan

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Abstract

Background

Simbu serogroup are arbo-viruses which are mainly transmitted by *Culicoides*. It is one of the largest serogroups within the genus *Orthobunyavirus* of the family *Peribunyaviridae*, includes at least 24 antigenically diverse, albeit serologically related viruses. Meager information is available on Simbu serogroup viruses infection in ruminants outside of Europe. Therefore, in this study, serological surveillance of Simbu serogroup viruses in cattle in seven States in Sudan was conducted during the period May, 2015 – March, 2016.

Results

Using a cross-sectional design, 184 cattle sera were collected and tested by a commercial SBV ELISA kit which enables the detection of antibodies against various Simbu serogroup viruses. The results showed an overall 86.4% prevalence of Simbu serogroup viruses antibodies in cattle in Sudan. Univariate analysis showed significant association (p= 0.007) between ELISA seropositivity and state where samples were collected.

Conclusion

This is study suggests that Simbu serogroup viruses infection can be present in cattle in Sudan. Further epizootiological investigations on Simbu serogroup viruses infection are warranted.

Background

The Simbu serogroup viruses, is one of the serogroups that belongs to the Orthobunyavirus genus of the family Peribunyaviridae. Virus members such as Akabane virus (AKAV), Aino virus (AINV), Sathuperi virus (SATV), Schmallenberg virus (SBV) and Shamonda virus (SHUV) cause similar symptoms and are prevalent in Oceania, Australia, Africa and Asia [1].

Simbu serogroup viruses are transmitted mainly by Culicoides biting midges [2, 3]. Several Simbu serogroup viruses have been shown to cross the placenta and result in outbreaks of abortion, stillbirth and malformations [49]. The congenital malformations seen at birth are recognized as arthrogryposis hydranencephaly syndrome and related to the pregnancy stage at which the dam is infected. In cattle, severe brain deformities may happen if the dam is infected between 76 and 106 days of pregnancy [2, 4].

In Sudan Simbu serogroup viruses such as Akabane virus (AKAV) was reported based on serological evidence in sheep, goats, and cattle in different ecological zones [10, 11].

Owing to the meager data available on Simbu serogroup viruses infection in ruminants in countries outside of Europe, this survey was carried out to detect anti-Simbu serogroup viruses IgG antibodies in cattle sera samples obtained in seven States in Sudan during the period May, 2015 – March, 2016.

Methods

Study area

The survey was conducted during the period from May, 2015 – March, 2016 in seven States in Sudan (Blue Nile, El Gezira, Kassala, Khartoum, North Darfur, River Nile and Sennar States) aimed to cover most of the country. Selection of these locations was based on them being the main potential areas for livestock rearing. Selection of farms was made randomly and the formal mechanism used was lottery. In each area, samples were collected from at least four groups of dairy cattle that were kept apart.

Study design and sample collection

A cross-sectional survey that included seven states of Sudan. Sample size estimation was calculated using the formula $n = 4PQ/L2$ [12] where n is the required number of animals to be examined; P is a known or estimated prevalence; $Q = (1 - P)$; L is the allowable error. The number of animals estimated using this formula assuming 29.40% prevalence rate [11] was 332. The sample size was decreased to 184 due to financial, technical, logistical and social obstacles and difficulties that faced the researcher. Collection of animal samples was reviewed and in accordance with the animal welfare code of Sudan. Five ml of blood samples were collected from 184 adult, apparently healthy dairy cattle in seven States in Sudan (Blue Nile, El Gezira, Kassala, Khartoum, North Darfur, River Nile and Sennar States) during the period May, 2015 – March, 2016 (Fig. 1). Sera were obtained by centrifugation at 1500 rpm/min. for 10 minutes and kept at -20^{o}C until tested.

Serological assay

Simbu serogroup enzyme-linked immunosorbent assay (ELISA)

Commercial SBV ELISA kit (IDEXX Laboratories, USA) which enables the detection of antibodies against various Simbu serogroup viruses were used to detect anti- Simbu serogroup viruses in diluted sera samples (1/10) according to the manufacturer's instructions. The specificity and sensitivity of the ELISA kit is 99.5%, 98.1%, respectively [13]. The sample optical densities (OD) were measured by a microplate ELISA reader (Asys Expert Plus, Austria) at 450 nm. The sample to positive control ratio (S/P ratio) was then determined using the formula:

$$100 \times \frac{\text{OD Sample} - \text{OD Negative}}{\text{OD Positive} - \text{OD negative}}$$

The cutoff value of antibody titer is ≥ 40% i.e. all samples which have S/P ratio ≥ 40 are considered positive as indicated in the kit literature.

Statistical analysis

Risk factor with more than two categorical levels such as state was tested individually using univariate logistic regression. Differences in Simbu serogroup antibody seroprevalence between cattle and state where samples were collected were evaluated using Chi-square ($\chi 2$) test. Statistical differences between all possible pairs of groups were defined at $P < 0.05$. Statistical analysis was performed using SPSS version 20 (SPSS Inc., Chicago, U.S.A.).

Results

Simbu serogroup viruses antibodies were detected in cattle in all areas tested with varying prevalences. The seroprevalence rates in cattle ranged from 69.2% in North Darfur to 100% in Kassala and Sennar States. The prevalence rates were highest in Kassala and Sennar States (100%) and River Nile (88%), Blue Nile (85.7%) and El Gezira (83.3%) moderate in Khartoum (76.9%) and North Darfur (69.2%) States with an overall prevalence of 86.4%. Univariable logistic regression revealed significant association ($p = 0.007$) between ELISA seropositivity and state where samples were collected (Table 1).

Table 1 Univariate analysis for the association of origin of collected samples (State) and seropositivity for Simbu serogroup viruses in cattle in seven States in Sudan during the period May, 2015 – March, 2016.

State	No of tested cattle	No positive	Prevalence rate in cattle (%)	P value
Blue Nile	21	18	85.7	
El Gezira	30	25	83.3	
Kassala	30	30	100	
Khartoum	26	20	76.9	*0.007**
North Darfur	26	18	69.2	
River Nile	25	22	88	
Sennar	26	26	100	
Total	**184**	**159**	**86.4**	

*Significantly different

Discussion

The present study indicates that cattle are commonly exposed to Simbu serogroup viruses in Sudan with an overall seropositivity of 86.4%. A high Simbu serogroup viruses seroprevalence in cattle was reported in different European countries. Seroprevalence of Shmallengberg virus (SBV) within-herd was up to 100% and 70–100% in Germany and Netherlands, respectively [14, 15].

In the current study, the overall seropositivity of Simbu serogroup virsuses detected in cattle (86.4%) in accordance with estimated overall seropositivity (91.2%) of Simbu serogroup viruses in Nigeria [16] and it was higher than that reported in cattle in Tanzania [1]. It is also similar to overall seropositivity of Shmallenberg virus in Europe: 79–94% in France [17], 90.8% in Belgium [18] and 72.5% in Netherlands [15]. In Africa, serological screening suggests presence of SBV in cattle, sheep and goats in Mozambique with an overall 100% prevalence rate in cattle. [19].

The differences in prevalence rates between the States herein reported may be attributed to local ecological factors, type of management and practices, flock or herd size, insect vector activity……. etc. that might influence the rates of transmission and infection with Simbu serogroup viruses. However, the high prevalence noted in all states suggests that the vector (s) of Simbu serogroup viruses is abundant and widespread in Sudan. These results also corporate the high prevalence of Akabane virus (AKAV) (29.4%) that has previously been reported in Sudanese dairy cattle [11].

In Sudan, the concerned veterinary authorities and other private companies import bulls or semen for genetic improvement from Europe. Unfortunately, no test that confirms semen freedom from sexually-transmitted diseases (STDs) is practiced. Since Simbu serogroup viruses such as SBV was detected in semen of infected bulls [20] and non-specific clinical signs that are associated with disease were Furthermore, additional Simbu viruses, including Shamonda and Sathuperi are considered potential teratogenic agents in ruminants [3, 4, 21]. These facts dictate that testing of imported ruminants semen for simbu serogroup viruses is required in Sudan to prevent introductions of new viruses into the country.

Conclusions

The findings of the current study reveal that Simbu serogroup viruses are circulating in Sudan which suggesting that activity of competent insect vectors is extensive in the country. Finally, further epizootiological investigations on Simbu serogroup viruses infection in cattle and other farm animals at the country level are important to identify the actual virus spp. from the vertebrate and invertebrate hosts and to determine its genetic relationships with the Simbu serogroup viruses circulating in Europe and Africa. Also, the data obtained in the current study is considered an important first step towards the establishment of tighter control on imported animals or their germ lines for genetic improvement.

Abbreviations

AINV: Aino virus; AKAV: Akabane virus; ELISA: enzyme-linked immunosorbent assay; IgG: Immunoglobulin G; OD: Optical density; SATV: Sathuperi virus; SBV: Schmallenberg virus; SHAV: Shamonda virus; STDs: sexually-transmitted diseases.

Declarations

Acknowledgement

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Availability of data and materials

Data and materials are available upon request by the corresponding author.

Authors' contributions

MOH, SHA and RAG carried out the ELISA assays and drafted the manuscript. MOH conducted the statistical analysis. KAE, AME and KMT did the samples and data collection. AME contributed to the conception and design of the study and revised the manuscript. All authors have read and approved the final version of this manuscript.

Ethics approval and consent to participate

Collection of blood from cattle was performed by qualified veterinarians following proper physical restraint of animals to ensure both personnel and animal safety. Animal owners were explained the study purposes before procedures and upon agreeing to participate, they provided a written consent prior to study procedures and blood collection from their animals. The study received ethical clearance from the ethical committee of the Central Veterinary Research Laboratory (CVRL), Animal Resources Research Corporation (ARRC). Sample collection was carried out according to the animal welfare code of Sudan.

Conflict of interest: The authors declare that they have no conflict of interest.

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Figures

Figure 1

Map of Sudan showing states where samples were collected.