Akabane virus: serological survey of antibodies in livestock in the Sudan

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Key words

Cattle - Sheep - Goat - Cow - Calf - Akabane virus - Neutralization test - Blood serum - Antibody - Sudan.

Summary

An investigation was conducted to assess the prevalence of Akabane virus antibodies in domestic ruminants from different ecological zones of Sudan. Neutralizing antibodies were demonstrated in sheep, goats and cattle sampled between 1979 and 1980 from El Obeid, Nyala, Kassala, Jonglei and Sennar. The highest prevalence was in Jonglei where 27 % of six sheep, 36 % of eleven goats and 47 % of 90 cattle had antibodies to the virus. Although antibodies were demonstrated in 8 % of 79 dams and 15 % of 70 dams of two sentinel calf herds in Central Sudan at Shambat and Um Benein, respectively, none of their sentinel calves sampled between 1981 and 1983 had antibodies. Antibodies were subsequently detected in 8 (14 %) out of 57 calves from Shambat and 5 (12 %) out 40 from Um Benein of the random samples collected during 1985 from 1-3 year old calves. The implications of these results are discussed.

■ INTRODUCTION

Akabane virus, an arbovirus in the Simbu serogroup of the family *Bunyaviridae*, causes premature birth, still birth and congenital arthrogryposis hydranencephaly in cattle, sheep and goats (5, 7, 9). Major epizootics have occurred in Israel (7, 16), Japan (11) and Australia (4). The virus does not apparently produce ill effects in cattle, sheep and goats infected after birth (6, 12) and attempts to recover it from bull semen have been unsuccessful (13).

In Africa, outbreaks of congenital defects due to Akabane virus have been reported in South Africa (2, 19). The virus has also been isolated from a pool of about 100 *Culicoides* midges in that country by Theodoridis *et al.* (18), who also detected antibodies to the virus in cattle. In Kenya, Akabane virus was isolated from *Anopheles funestus* (8) and antibodies were detected both in domestic and wild ruminants, but without any evidence of congenital malformations (3). Al-Busaidy *et al.* (1) reported antibodies to Akabane virus in the sera of wildlife from two African countries South of the Sahara showing the wide geographical distribution of the virus in this continent.

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To date no information is available concerning Akabane virus in the Sudan. The aim of the present work was therefore to investigate the epidemiology of this virus in domestic ruminants in the Sudan.

■ MATERIALS AND METHODS

Virus

The virus used was the JaGAr 39 strain of Akabane virus originally supplied by Dr. Y. Inaba of the National Institute of Animal Health, Tokyo, Japan, at the 19th passage in suckling mouse brain. The 6th passage in BHK-21 cells was used in the serum neutralization test.

Test sera

Field sera

Serum samples were collected during 1979 and 1980 from various domestic species from Nyala, El Obeid, Sennar, Kassala and Jonglei. The origins of the sera were related to different ecological zones of Sudan (figure 1).

Sentinel herds' sera

Between October 1980 and September 1983 sentinel calf herds were established at Khartoum University Farm, Shambat, Kartoum

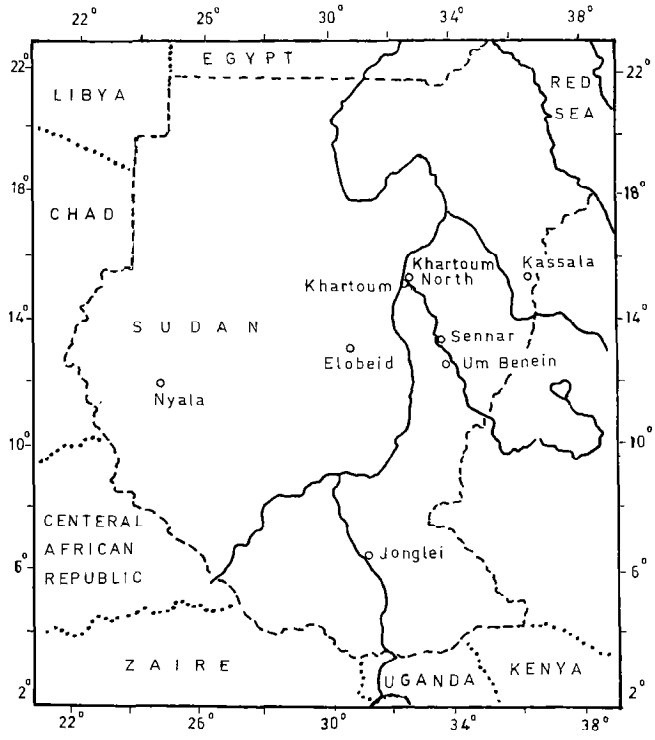

Figure 1 *: map of the Sudan showing the locations of the two sentinel herds and areas from which sera were collected.*

North and at Um Benein Animal Production Research Station, about 250 miles South of Khartoum on the Blue Nile. The purpose was to monitor the activity of some arboviruses of animals in these areas (10). Initial sera were obtained from the sentinel calves during the first month of life and thereafter at monthly intervals for one year or more. Monthly serum samples collected between July and December from 37 calves in 1981 and 53 calves in 1982, in addition to sera from 37 calves sampled between June and September 1983, were selected from the sentinel herd at Shambat for the purpose of the present investigation. From the sentinel herd at Um Benein sera collected from 45 calves in 1981, 27 calves in 1982 and 24 calves in 1983 during the same months as for Shambat were available for examination. Sera from 79 dams at Shambat and from 70 dams at Um Benein were also used. In addition, sera collected at random from 57 calves (one to three years old) at Shambat and from 40 calves at Um Benein during January and February 1985 were included in this investigation.

Serum neutralization test

The test was performed in disposable flat bottomed tissue culture microtitre plates as previously described (1). Controls carried out with each test included titration of the virus and known negative and positive sera.

■ RESULTS

The results of neutralization tests in field sera from sheep, goats and cattle are shown in table I. Serum neutralizing antibodies to Akabane virus were found in all three species examined and in all five locations. The highest proportion of animals with antibodies were from Jonglei, where 27.3 % of sheep, 36.3 % of goats and 47.8 % of cattle were positive. Among all three species cattle seemed to be the preferred feeding host for the vector in the Sudan.

The results of serum neutralization tests carried out on serum samples from Shambat and Um Benein sentinel calf herds and their dams between 1980 and 1983, together with the results obtained with sera collected from the calves sampled in 1985, are shown in table II. Neutralizing antibodies against Akabane virus were not detected in serum samples collected between 1981 and 1983 from either sentinel calf herd. Nevertheless, neutralizing antibodies were detected in seven dams from Shambat (8.8 %) and in 11 dams from Um Benein (15.7 %). Neutralizing antibodies were also detected in eight out of 57 calves from Shambat and in five out of 40 calves from Um Benein sampled during 1985.

■ DISCUSSION

In the present study sera were only considered positive for Akabane when titres were 80 or above as it has been suggested by Al-Busaidy *et al.* (1) that titres below this value may be due to non specific inhibitors of viral growth in the test sera. The results presented in table I indicated that antibodies to Akabane were detected in domestic animals in five ecological zones of Sudan. The highest proportion of animals with antibodies to Akabane virus were those from Jonglei. Cattle from this area showed the highest percentage of neutralizing antibodies of any groups tested. It is evident that a significant epizootic of Akabane virus had occurred in Jonglei during the years before those samples were collected in 1980. In this region, the White Nile spreads out and gives rise to large swampy areas. During the dry months and when the water level is low, these swampy areas are favourite grazing grounds for cattle and other livestock. They also provide ideal breeding sites for a huge variety of biting insects. This may explain why the number of animals with antibodies to Akabane virus in Jonglei was so much higher than in any other part of the Sudan and may support the hypothesis of Davies and Jesset (3) that Akabane virus is endemic in those areas of Sub-Saharan Africa which share ecological characteristics with parts of Kenya of known endemicity.

Table II shows that Akabane virus infections of sentinel calves at Shambat and Um Benein had not occurred between July and December of 1981 and 1982 and between June and September 1983.

The fact that most animals were examined at least twice (i.e. in two successive years) and in some cases in all three years without the detection of antibodies, eliminates the possibility that infection could have occurred between the sampling periods. However, antibodies were detected in dams from both Shambat and Um Benein indicating that these animals had been infected with Akabane virus at some stage during their life (table II). The absence of neutralizing antibodies from the sera of sentinel calves in Shambat and Um Benein between July 1981 and September 1983 and the subsequent detection of antibodies in 15 calves sampled from these two areas in 1985 indicate that Akabane virus was active in both areas some time between October 1983 and January 1985.

Infection of animals with either bluetongue virus (BTV) or bluetongue-related orbiviruses in both Shambat and Um Benein sentinel calves has previously been shown to occur each year between July and December (10). From the data presented here and the variability observed in the Akabane virus it seems likely that infection of animals with Akabane virus in Shambat and Um Benein is not an annual event but has a more sporadic occurrence. This view is supported by the observations made with other arbovirus diseases such as bovine ephemeral fever where major

Tableau I

Prevalence of neutralizing antibodies against Akabane virus in sera of sheep, goats and cattle from five regions in the Sudan

Location	Year and origin of samples	Sheep Num. positive/ Num. sampled (%)	Goats Num. positive)/ Num. sampled (%)	Cattle Num. positive/ Num. sampled (%)
El Obeid	1979 (abattoir)	12/114 (10.5)	-	14/98 (14.3)
Nyala	1980 (abattoir)	6/27 (22.2)	1/14 (7.1)	3/11 (27.3)
Kassala	1980 (field)	4/69 (5.8)	0/54	-
Jonglei	1980 (field)	6/22 (27.3)	4/11 (36.3)	43/90 (47.8)
Sennar	1980 (field)	16/101 (15.8)	-	5/47 (10.6)

Table II

Prevalence of antibodies against Akabane virus in bovine sera from Shambat and Um Benein

Location	Origin of samples	Date collected	Num. positive/ Num. sampled (%)
Shambat	Sentinel calves		
	8 months to 1 year old	July-December 1981	0/37
	(1-2 years old)	July-December 1982	0/53
	(up to 3 years old)	June-September 1983	0/37
	Mothers (age unknown, > 4 years)	October 1980 to September 1982	7/79 (8.8)
	Random samples (1-3 year old calves)	February 1985	8/57 (14.0)
Um Benein	Sentinel calves		
	(8 months to 1 year old)	July-December 1981	0/45
	(1-2 years old)	July-December 1982	0/27
	(up to 3 years old)	June-December 1983	0/24
	Mothers (age unknown, > 4 years)	November 1980 to March 1982	11/70 (15.7)
	Random samples (1-3 year old calves)	January 1985	5/40 (12.5)

epizootics occur after a number of years with either few or no cases in the interepizootic years (17). The epidemiology of Akabane virus in Central Sudan is therefore different from that of BTV and BTV-related orbiviruses. This difference may mean that Akabane virus is transmitted either less efficiently than bluetongue and other related orbiviruses or by different vectors. Unless major epizootics of Akabane disease occur, leading to noticeable outbreaks of abortion and foetal malformation, this disease may pass undetected. Even in the event of such outbreaks, agents other than Akabane virus which cause similar clinical signs usually have to be eliminated before Akabane virus is suspected (14).

In a study carried out by Sato *et al.* (15), it was shown that the sensitivity of the neutralization test for bovine antibodies against Akabane virus had been improved by incubation of virus-serum mixtures at 4°C for 48 h, followed by incubation with complement at 37°C for 30 min as compared with incubation at 37°C for 60 min in the absence of complement. The authors showed that sera collected from nine animals four weeks after vaccination with live virus gave negative results by the traditional neutralization test, but recorded neutralizing antibody titres of 8-128 by the new method. It is therefore possible that some animals considered negative in the present study might have been positive if examined by the method of Sato *et al.* (15).

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REFERENCES

1. AL-BUSAIDY S., HAMBLIN C., TAYLOR W.P., 1987. Neutralizing antibodies to Akabane virus in free-living wild animals in Africa. *Trop. Anim. Health Prod.*, **19**: 197-202.

2. BARNARD B.J.H., 1977. Akabane virus in South Africa. *J. South Afr. Vet. Assoc.*, **48**: 161.

3. DAVIES F.G., JESSET D.M.A., 1985. A study of the host range and distribution of antibodies to Akabane virus (genus Bunyavirus, family Bunyaviridae) in Kenya. *J. Hyg.*, **95**: 95-196.

4. DELLA-PORTA A.J., MURRAY M.D., CYBINISKY D.H., 1976. Congenital bovine epizootic arthrogryposis and hydranencephaly in Australia. *Austr. vet. J.*, **52**: 594-595.

5. INABA Y., KUROGI H., OMORI T., 1975. Akabane disease: epizootic abortion, premature birth, stillbirth and congenital arthrogryposis-hydranencephaly in cattle, sheep and goats caused by Akabane virus. *Aust. vet. J.*, **51**: 584-585.

6. KUROGI H., INABA Y., TAKAHASHI E., SATO K., SATODA T., GOTO Y., OMORI T., MATUMOTO M., 1977. Congenital abnormalities in newborn calves after inoculation of pregnant cows with Akabane virus. *Infect. Immun.*, **17**: 338-343.

7. MARKUSFELD O., MAYER E., 1971. An arthrogryposis and hydranencephaly syndrome in calves in Israel 1969/70 - epidemiological and clinical aspects. *Refuah Vet.*, **28**: 51-61.

8. METSELLAR D., ROBIN Y., 1976. Akabane virus isolated in Kenya. *Vet. Rec.*, **99**: 86.

9. MIURA Y., HAYASHI S., ISHIHARA T., INABA Y., OMORI T., MATUMOTO M., 1974. Neutralizing antibody against Akabane virus in precolostral sera from calves with congenital arthrogryposis-hydranencephaly syndrome: brief-report. *Arch. Gesamte Virusforsch.*, **46**: 377-380.

10. MOHAMED M.E.H., TAYLOR W.P., 1987. Infection with bluetongue and related orbiviruses in the Sudan detected by the study of sentinel calf herds. *Epidem. Infect.*, **99**: 533-545.

11. OMORI T., INABA Y., KUROGI H., MIURA Y., NOBUTO K., OHASHI Y., MATSUMOTO M., 1974. Viral abortion, arthrogryposis-hydranencephaly syndrome in cattle in Japan 1972-1974. *Bull. Off. int. Epizoot.*, **81** : 447-458.

12. PARSONSON I.M., DELLA-PORTA A.J., SNOWDON W.A., 1977. Congenital abnormalities in newborn lambs after infection of pregnant sheep with Akabane virus. *Infect. Immun.*, **15**: 254-262.

13. PARSONSON I.M., DELLA-PORTA A.J., SNOWDON W.A., O'HALLORAN M.L., 1981. Experimental infection of bulls with Akabane virus. *Res. vet. Sci.*, **31**: 157-160.

14. PORTERFIELD J.S., DELLA-PORTA A.J., 1981. Bunyaviridae: infection and diagnosis. In: Kurstak E., Kurstak C. eds., Comparative diagnosis of viral diseases, Vol. 4. London, United Kingdom, Academic Press, p. 479-508.

15. SATO K., TANAKA Y., TOKUHISA S., INABA Y., FUSHIKI T., MATUMOTO M., 1987. Appearance of slow-reacting and complement requiring neutralizing antibody in cattle infected with Akabane virus. *Vet. Microbiol.*, **14**: 183-189.

16. SHIMSHONY S., 1980. An epizootic of Akabane disease in bovines, ovines and caprines in Israel 1969/1970: epidemiological assessment. *Acta Morphol. Acad. Sci. Hungar.*, **28**: 197-200.

17. St GEORGE T.D., STANDFAST H.A., CHRISTIE D.G., KNOTT S.G., MORGAN I.R., 1977. The epizootiology of bovine ephemeral fever in Australia and Papua-New Guinea. *Aust. vet. J.*, **53**: 17-28.

18. THEODORIDIS A., NEVILL E.M., ELS H.J., BOSHOFF S.T., 1979. Viruses isolated from *Culicoides* midges in South Africa during unsuccessful attempts to isolate bovine ephemeral fever virus. *Onderstepport J. vet. Res.*, **46**: 191-198.

19. ZUMPT G.F., BRYSON R.W., ANDREOU S., 1978. Hydranencephaly in calves in Natal region (correspondence). *J. S. Afr. vet. Assoc.*, **49**: 32.

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Résumé

Mohamed M.E.H., Mellor P.S., Taylor W.P. Virus Akabane: enquête sérologique des anticorps chez les animaux d'élevage au Soudan

Cette étude porte sur une évaluation de la fréquence des anticorps antivirus Akabane chez les ruminants domestiques dans différentes zones écologiques au Soudan. Les anticorps neutralisants ont été détectés chez les moutons, les chèvres et les bovins. Les sérums de ces animaux ont été récoltés entre 1979 et 1980 à El Obeid, Nyala, Kassala, Sennar et Jonglei. C'est dans cette dernière région qu'ont été trouvés les plus forts taux de présence d'anticorps antivirus dans les sérums analysés : respectivement 27 p. 100, 36 p. 100 et 47 p. 100 chez les moutons (6), les chèvres (11) et les bovins (90). Bien que les anticorps aient été détectés chez 8 p. 100 des 79 vaches et chez 15 p. 100 des 70 vaches dans deux troupeaux sentinelles au Centre du Soudan, respectivement à Shambat et Um Benein, aucun des veaux suivis dans ces élevages entre 1981 et 1983 ne s'est révélé positif. Par la suite, des sérums d'échantillons aléatoires prélevés en 1985 sur des animaux âgés de 1 à 3 ans ont montré la présence d'anticorps chez 8 veaux sur 57 (14 p. 100) à Shambat et 5 veaux sur 40 (12 p. 100) à Um Benein. Les implications de ces résultats sont discutées.

Mots-clés : Bovin - Ovin - Caprin - Vache - Veau - Virus Akabane - Réaction de neutralisation - Sérum sanguin - Anticorps - Soudan.

Resumen

Mohamed M.E.H., Mellor P.S., Taylor W.P. Virus Akabane: encuesta serológica de los anticuerpos en los animales domésticos de Sudán

Se llevó a cabo una investigación para confirmar la prevalencia de anticuerpos del virus Akabane en los rumiantes domésticos de diferentes zonas ecológicas de Sudán. Los anticuerpos neutralizantes se encontraron en ovejas, cabras y bovinos, cuyas muestras se recolectaron entre 1979 y 1980 en El Obeid, Nyala, Kassala, Jonglei y Sennar. La prevalencia más elevada se encontró en Jonglei, donde 27 p. 100 de seis ovejas, 36 p. 100 de once cabras y 47 p. 100 de 90 bovinos presentaron anticuerpos al virus. A pesar de que los anticuerpos se encontraron en 8 p. 100 de las 79 hembras y 15 p. 100 de las 70 hembras pertenecientes a dos hatos control de bovinos, en el Sudán Central en Shambat y Um Benein, respectivamente, ninguno de los terneros control examinados entre 1981 y 1983 presentaron anticuerpos. Los anticuerpos fueron luego detectados en 8 (14 p. 100) de los 57 terneros de Shambat y 5 (12 p. 100) de los 40 de Um Benein, examinados en 1985, con edades de 1 a 3 años. Se discuten las implicaciones de estos resultados.

Palabras clave: Ganado bovino - Ovino - Caprino - Vaca - Ternero - Virus Akabane - Reacción de neutralización - Suero sanguíneo - Anticuerpo - Sudán.