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A serological evaluation of 1979–1982 Kenyan foot-and-mouth disease type SAT 2 viruses

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SUMMARY

Serological evaluations of foot-and-mouth disease type SAT 2 viruses isolated in Kenya between 1979 and 1982 were performed using the two-dimensional microneutralization test. Nine field isolates of epizootiological significance were compared with four vaccine viruses. The results obtained identified Tan 5/68 as the most appropriate reference vaccine virus strain since it had the broadest serological spectrum. Potent Tan 5/68 vaccines would be expected to provide adequate protection against the contemporary SAT 2 field viruses. In the case of K183/74, which also was shown to have a broad spectrum with viruses isolated in Kenya, the results show that the 1982 isolate from central Kenya was significantly divergent ($r < 1{\cdot}00$ at $P = 0{\cdot}01$) and warranted tactical revaccination for its control. The study highlighted the fact that strain R1215 which had been isolated from the oesophageal-pharyngeal swabs of asymptomatic carrier cattle had a narrow serological spectrum suggesting that such viruses could be unsuitable as vaccine for the national campaign.

INTRODUCTION

The history of confirmed foot-and-mouth disease (FMD) in Kenya dates back to 1932 when A and O types were first characterized. There was no documentation in the next 20 years. However, in 1952 and 1955 severe type O outbreaks led to the first vaccination scheme using European type O vaccine from Holland. In 1960, the Wellcome Institute for Research on Foot and Mouth Disease (WIRFMD) was opened at Embakasi to undertake laboratory diagnosis of FMD and to conduct research on all local problems including vaccines. Initially attenuated vaccines were used to control a severe type SAT 2 outbreak which occurred in north eastern Kenya during 1960–1. Three years later the WIRFMD was expanded to include a Vaccine Production Laboratory which by 1968 was producing inactivated vaccines against types O, A, SAT 2 and C (Crees, 1982).

Type SAT 2 outbreaks became prominent in 1968 when a SAT 2 epizootic

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covered Tanzania and southern Kenya (Rweyemamu, 1970; Chema & Rweyemamu, 1978). Ken 3/57 virus was shown to be serologically inappropriate for this outbreak and as a result the Tan 5/68 strain was adopted for vaccine production in 1970. During the next 4 years the SAT 2 vaccine used in southern Kenya comprised the SAT 2 Tan 5/68 strain and that for central and northern Kenya the Ken 3/57 strain. During 1973–4, however, most of the SAT 2 vaccine used in Kenya comprised the Ken 3/57 strain only. In 1974–5 another SAT 2 epizootic was experienced in southern Kenya and as it was shown that the new strain represented by K183/74 was broad, covering both the northern (Ken 3/57) and southern Kenya strains (Tan 5/68), it was decided to adopt this strain as the sole vaccine virus. Vaccines prepared from K183/74 were used between 1970–80 (Chema & Rweyemamu, 1978). However, since low antibody titres were observed even in animals which were immune to challenge with virulent virus, it was difficult to monitor the efficacy of these vaccines under field conditions. During 1980–2 an apparently thermostable virus, strain R1215 (Anderson, Doughty & Spooner, 1982), was adopted as the vaccine virus. This strain had been derived from the oropharynx of a symptomless carrier animal. Its serological specificity, however, was not ascertained prior to its adoption as the SAT 2 vaccine virus. This report summarizes a study of the antigenic evolution of SAT 2 viruses in Kenya and the relationship of the most recent isolates with vaccine viruses.

MATERIALS AND METHODS

Viruses

The nine field isolates of SAT 2 FMD virus used in this study were obtained from WIRFMD, Embakasi, after adaptation to either calf thyroid (CTY) or baby hamster kidney (BHK 21) cells. They were selected from the 1979–82 outbreak and each isolate was chosen on the basis of its epidemiological significance (Table 1). The additional four viruses were vaccine strains.

Antisera

Pooled antisera were taken 10 days after revaccination from groups of guinea pigs vaccinated with inactivated purified 140S antigen emulsified in incomplete Freund's adjuvant. Three of the antisera were against the established vaccine viruses; K183/74, Tan 5/68 and R1215 and their corresponding serum numbers were As 486, As 470 and As 978. The other three antisera were against more recent virus isolates, two of which were from Kenya K49/80 (As 1177) and K21/81 (As 1175), and the other one from Zambia, Zam 3/81 (As 1074). In our experience guinea-pig and cattle sera have similar virus strain specificities provided inactivated virus is used as the inoculum for both species.

Virus strain differentiation

The serological comparison of virus strains was carried out using the two-dimensional microneutralization test performed in matched pairs (Rweyemamu *et al.* 1978).

Mean titres of two or more replicates tested were used for the calculation of 'r' values, defined as the ratio in serum titre to heterologous and homologous viruses.

Table 1. *Details of viruses used in the study of* 1979–82 *SAT* 2 *outbreaks in Kenya*

Strain designation	Year of isolation	Passage history†	Area of isolation	Comments
Tan 5/68	1968	BHK 9, suspension 10, BHK 1	Northern Tanzania	Past vaccine virus, Kenya
K183/74	1974	BHK 2, suspension 12, BHK 3	Southern Kenya	Current vaccine virus Kenya
R1215	1976	BHK 8, suspension 16, BHK 1	Southern Kenya 'Carrier' virus‡	Past vaccine virus, originally isolated from a carrier animal
K16/79	1979	CTY 3, BHK 8	Rift valley (Naivasha), Kenya	Outbreak virus
K49/80	1980	CTY 5, BHK 1, E/T, BHK 5	Southern Kenya (Kajiado)	Holding ground cattle, showing tongue but no foot lesions
K21/81	1981	CTY 3, E/T, BHK 5	Rift valley (Naivasha), Kenya	Isolated outbreak
K38/81	1981	CTY 3, E/T, BHK 5	Rift valley (Nyandarua), Kenya	Minor epizootic
K15/81	1981	CTY 3, E/T, BHK 8	Laikipia, north eastern Kenya	Extensive outbreak
K89/81	1981	CTY 3, BHK 3, E/T, BHK 3	Southern Kenya, Kajiado	Isolated outbreak
K126/81	1981	CTY 1, BHK 2, E/T, BHK 9	North Eastern Kenya, Garissa	Isolated outbreak
K41/82	1982	CTY 3, BHK 3, E/T, BHK 3	North Eastern Kenya, Laikipia	Extensive outbreak
K65/82	1982	CTY 3, BHK 3, E/T, BHK 3	Central Kenya (Kiambu)	Extensive outbreak
Zambia 3/81	1981	E/T, CK, BHK 7, suspension 3, BHK 1, suspension 3	Southern Zambia, Monze	Current vaccine strain Pirbright

† For example BHK 9, suspension 10, BHK 1 denotes 9 pasages in BHK monolayers followed by 10 in BHK suspension cultures followed by one in a BHK monolayer. CTY denotes calf thyroid and CK calf kidney cells. E/T denotes ether-treated.

‡ i.e. one isolated from an oesophageal–pharyngeal swab of asymptotic cattle.

Table 2. *Serological evaluation of Kenyan SAT 2 viruses (r values obtained in two-dimensional microneutralization tests)*

Virus...	Rift valley			Southern		North-eastern			Central	Zambia
Serum	K16/79 Naivasa	K21/81 Naivasha	K38/81 Nyandarua	K49/80 Kajiado	K89/81 Kajiado	K15/81 Laikipia	K126/81 Garissa	K41/82 Laikipia	K65/82 Kiambu	ZAM 3/81
SAT 2 K183/74 AS 486	0·34	0·20*	0·71	0·58	0·33	0·45	0·48	0·89	0·13**	0·25*
SAT 2 TAN 5/68 AS 470	0·59	0·28*	0·31	0·65	0·68	0·31	0·59	0·62	0·49	0·32
SAT 2 R1215 AS 978	0·13**	0·05**	0·05**	0·28*	0·17**	0·08**	0·09**	0·16**	0·07**	0·04**
SAT 2 K21/81 AS 1175	0·89	1·00	> 1·00	> 1·00	0·13**	0·13**	0·36	> 1·00	0·20*	0·07**
SAT 2 K 49/80 AS 1177	0·08**	0·12**	0·19*	1·00	0·06**	0·04**	0·19*	0·18*	0·06**	0·02**
SAT 2 Zambia 3/81 AS 1074	0·22**	0·26*	> 1·00	> 1·00	0·14**	0·13**	0·59	0·58	0·32*	1·00

* $r = < 1{\cdot}00$ at $P = 0{\cdot}05$.
** $r = < 1{\cdot}00$ at $P = 0{\cdot}01$.

Interpretation of the r value was based on the probability of the value obtained being significantly less than 1·00. A pooled variance of 0·106 was used to indicate values of r significantly less than 1·00 at probability levels of $P = 0·05$ and $P = 0·01$ (Rweyemamu, 1983).

RESULTS

The 'r' values obtained in this study of the Kenya SAT 2 viruses with the various antisera are shown in Table 2. It was evident that the vaccine viruses Tan 5/68 and K183/74 are still largely relevant to recent field outbreak viruses, although the outbreak virus in central Kenya (K65/82) was significantly divergent from K183/74 ($r < 1·00$ at $P = 0·01$). The outbreak was associated with an immunity break 3 months after vaccination. Serum to R1215 was observed to have a very narrow serological spectrum (eight out of nine Kenyan isolates giving values of $r < 1·00$ at $P = 0·01$). Serum prepared from the more recent isolate K21/81 was effective against other virus isolates in the areas peripheral to its origin. However two out of nine isolates had r values significantly divergent from 1·00 at $P = 0·01$ in contrast to Tan 5/68 where no values of r were found to be significantly divergent at this level, and K183/74 with only one value of $r < 1·00$ at $P = 0·01$. The serological spectrum of the other recent isolate K49/80 was very narrow.

Serum to Zambia 3/81 reacted poorly ($r < 1·00$ at $P = 0·01$) with three out of nine Kenyan isolates tested demonstrating that this strain, which has previously been shown to be serologically appropriate for southern and western Africa, is not suitable for eastern Africa.

DISCUSSION

The results obtained in this study indicate a consolidated broad spectrum for Tan 5/68 virus which was the Kenyan SAT 2 vaccine virus between 1970 and 1974 (Chema & Rweyemamu, 1978; Fig. 1). Strain R1215 had a narrow serological spectrum and the experience gained in the field suggests that this strain has been inappropriate in many areas. The current vaccine virus is the K183/74, which was originally introduced in 1976. This strain seems to provide adequate cover for all the viruses isolated prior to 1982. It is apparent, however, that the 1982 virus originating from central Kenya was divergent from K183/74, suggesting continuing antigenic drift in this area. Such drift is not unexpected since the area is not compulsorily vaccinated and the sporadic vaccination cover is less than adequate. In the circumstances it could be speculated that low antibody titres may have contributed to the emergence of an antigenically divergent strain, as represented by K65/82. This hypothesis is strengthened by the fact that a virus, K41/82, from an isolated, non-spreading outbreak in an area of compulsory vaccination in north-eastern Kenya does not appear to be different from K183/74. To control localized divergent strains, such as K65/82, it is suggested that immediate revaccination with K183/74 vaccine and/or supplementation of vaccines with Tan 5/68 would be appropriate. Confirmation of this is given by the demonstration that a SAT 2 K183/74 vaccine inoculated twice into susceptible cattle at Pirbright (UK) and Embakasi (Kenya) protected cattle fully against challenge with K65/82 virus and, in contrast to the report by Anderson *et al.* (1982), a high neutralizing

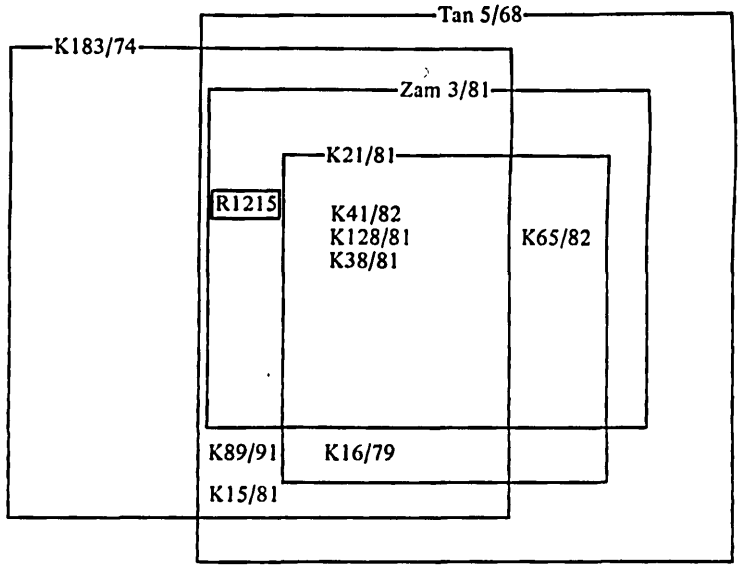

Fig. 1. Interrelationships amongst type SAT 2 viruses at $r < 1{\cdot}00$ at $P = 0{\cdot}01$.

antibody response (mean log serum titre at time of challenge was 2·45 SN_{50}) was obtained in the cattle that were so vaccinated (unpublished data). Alternatively, Tan 5/68 could be adopted as a baseline vaccine virus to which the other strains may need to be added from time to time since it still has the widest serological spectrum. This situation is comparable to that observed in A_{22} viruses Rweyemamu *et al.* (1983, in preparation).

It is suggested from the results of this study that the emergence of significantly divergent strains as a result of continuous antigenic drift could be halted in Kenya by the continuous field monitoring and proper use of either K183/74 or Tan 5/68 as the reference vaccine virus strain, which if necessary could be supplemented tactically (Ouldridge *et al.* 1982; Ndeti *et al.* 1982).

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