

## Seroprevalence of Foot and Mouth Disease in the Somali Eco-System in Kenya

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**Abstract:** The aim of this study was to document the prevalence of Foot and Mouth Disease (FMD) in the arid and semi-arid areas where the pastoral mode of livestock rearing is pre-dominant in Kenya especially in the Somali Eco-system. A cross-sectional sero-epidemiological study was conducted in the Somali Ecosystem (SES) in Kenya with 499 sera collected from January 2007 to December 2008 to determine the seroprevalence of Foot and Mouth Disease (FMD) in cattle in the SES. The samples were screened against the five serotypes of FMD known to be in circulation in Kenya i.e., FMD O, A, C, SAT1, SAT2 and measured by micro-neutralization assay. The overall sero-prevalence of FMD in the Somali-ecosystem was found to be 45.3% (95% CI = 40.96 to 49.66%). Twenty seven percent of all animals sampled tested positive for only one serotype while 17.6% tested positive for multiple serotypes. There was a high prevalence ( $p \leq 0.05$ ) in the circulation of serotype O (23 and 95% CI = 20.13-27.57%) as compared with the other serotypes, while the prevalence of serotype C was significantly lower ( $p \leq 0.05$ ) compared to the other four serotypes (1.6 and 95% CI = 0.82-3.12). Wajir district recorded the highest prevalence (24.8 and 95% CI = 16.71 to 27.54) while Garissa district recorded the least (6.2%). There was no significant sero-prevalence variation in relation to sex while older animals had higher sero-prevalences. The pastoral mode of livestock production, porous borders and wildlife inter-phase are significant factors that need consideration for effective control programmes.

**Key words:** Cattle, foot and mouth disease, Kenya, neutralization, somali eco-system

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### INTRODUCTION

Foot and Mouth Disease (FMD) is caused by a virus of the genus Aphthovirus, family Picornaviridae. There are 7 serotypes of the virus namely: A, O, C, SAT-1, SAT-2, SAT-3 and Asia type 1. Infection with one serotype does not confer immune protection against another. The disease is characterized by high fever, loss of appetite, salivation and vesicular eruptions on the feet, mouth and teats (Thomson, 1994). The disease has a high morbidity although mortality is rare in adult animals. FMD results in poverty impacts both from production losses caused directly by the disease and the implications of FMD for preventing opportunities for reducing risk and vulnerability (e.g., through access to new regional and domestic markets for livestock commodities) (Perry and Rich, 2007). Foot-and-Mouth Disease (FMD) is endemic in East Africa with six of the seven serotypes namely; O, A, C, SAT types 1, 2 and 3 reported to occur thus

complicating the epidemiology and control of the disease in the region. Serotype SAT3 has been recorded only in Uganda (Vosloo *et al.*, 2002). In Kenya outside the SES, from 2004-2006, circulating FMD serotypes in Kenya have included types O, A, C, SAT1 and SAT2 and recently the majority of the outbreaks outside the SES have been caused by serotypes O and SAT2. In Kenya, efforts to control the disease mainly consist of vaccination using a quadrivalent inactivated vaccine (with A, O SAT 1 and SAT 2) and restriction of animal movement in the affected areas. This works well in the highland areas where dairy cattle are reared, there are high population densities and a high level infrastructure. Although FMD prevalences have been well documented in these highland areas, there is lack of information on FMD in arid areas especially the SES which provide most of the cattle for beef. The SES is characterized by a pastoral mode of production, porous borders, poor infrastructure and vast areas where animal control

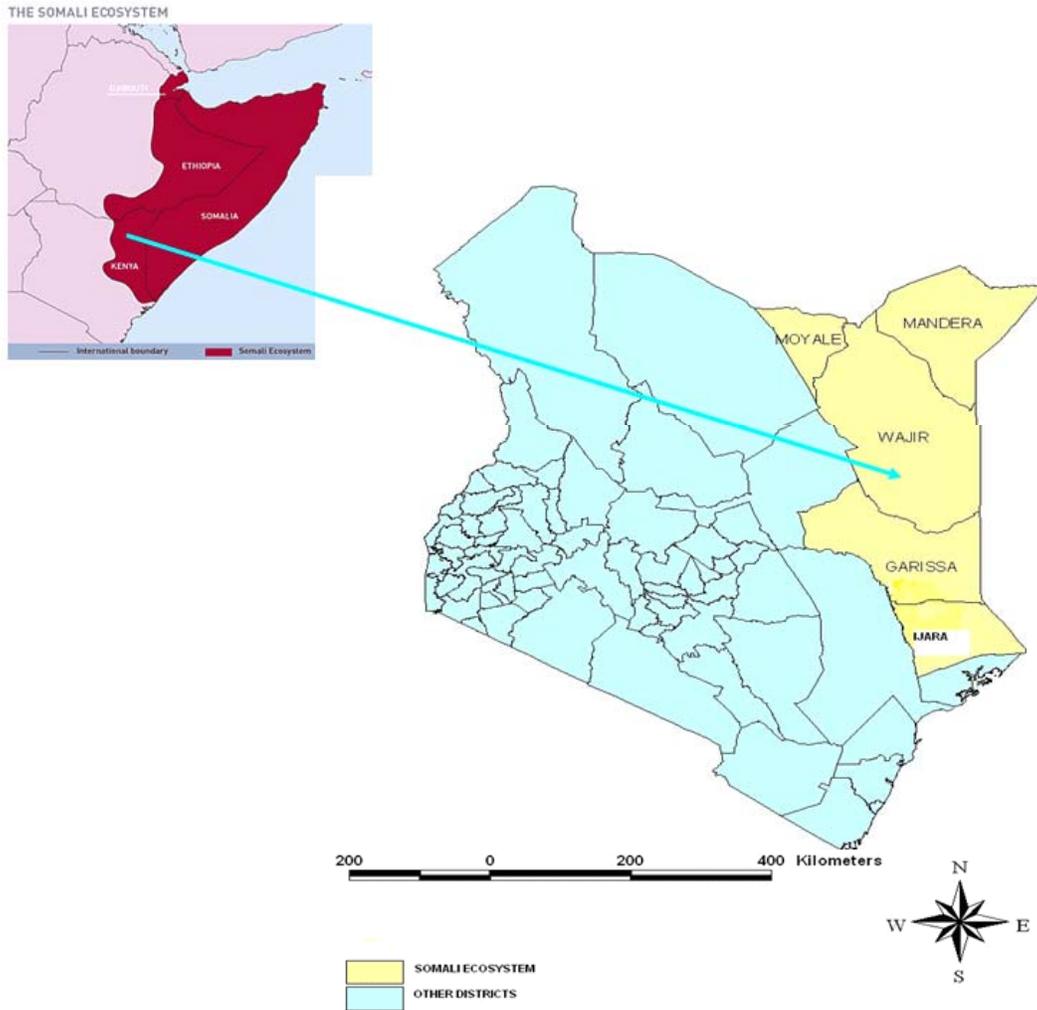


Fig. 1: Map showing the greater/Kenya somali-ecosystem

movement is impossible. Most of these beef cattle are marketed in open areas with free access to people and livestock. At a meeting of the FAO/AU-IBAR/PACE held in August 2006 in Nairobi, Kenya, it was suggested that FMD in the East African region exists and spreads in specific pastoralist ecosystems such as the Kagera Basin ecosystem on the Uganda/Rwanda/Tanzania border, the Maasai ecosystem on the Kenya-Tanzania border and the Somali ecosystem on the Kenya-Somalia border. The objective of this study was therefore to determine the sero-prevalence of FMD in the Somali Ecosystem in Kenya and the main serotypes in circulation in cattle in these arid areas where a pastoral mode of livestock production is practiced.

## MATERIALS AND METHODS

**Area of study:** The Somali ecosystem in Kenya is part of the greater Somali ecosystem whose other constituent

parts are South Eastern Ethiopia and Somalia, where the Somali ethnic group inhabit. The districts, which formed the focus of this study, are Mander, Wajir, Garissa, Ijara, Tana-River and Moyale as shown in Fig. 1. It lies within Agro-Ecological zones-IV to VI with a mean annual rainfall range of 300 to 700 mm per annum and a mean evapo-transpiration of 2600 mm. The area lies within an altitude range of 70 to 300 m above sea level.

Extensive farming and pastoral systems are practiced in this area with livestock production constituting the major economic activity of the zone. Six randomly selected villages from each of the six districts of the Somali ecosystem namely Moyale, Mander, Wajir, Garissa, Ijara, Tana River were chosen for serological analysis. Serum samples had been collected by the Somali Ecosystem Rinderpest Eradication Unit (SERECU) of AU-IBAR project between 2007 and 2008 from the SES for Rinderpest surveillance. That sera which remained after screening for Rinderpest was aliquoted and stored

in the Central Veterinary Laboratory sera bank. From each district between 80-90 samples were obtained and transported to Foot-and-Mouth Disease Laboratory with observation of the cold chain.

**Serological survey:** The minimum sample size for cross-sectional survey was calculated using the formula by Dohoo *et al.* (2003) with 95% confidence level and 5% absolute precision. The sample size was estimated by assuming a prevalence of 50% to get the minimum number required to determine the prevalence in simple random sampling. Accordingly the calculated sample size was 384. However, to improve precision, the sample size was increased to 499. A total of 499 sera were analyzed for FMD virus antibody detection by Virus Neutralization test at the Foot and Mouth Disease Laboratory, Kenya from February to June 2010. Each of the sera was screened sera against the five serotypes of FMD known to be in circulation in Kenya i.e., FMD O, A, C, SAT1, SAT2 using the strains for vaccine production namely 'A'K5/80, 'O'K77/78, 'C'K267/67, SAT T155/71, SAT 2K52/84, respectively and measured by micro neutralization assay as described in the OIE *Manual of Diagnostic Tests and Vaccines*. The cutoff for positivity with the VNT was a titer of 1/23 equivalent to 1.36 Log 10 (used in FMD Lab. Embakasi).

Quantitative Virus Neutralization micro test for FMD antibody was performed with BHK-21 cells in flat bottomed tissue culture microtitre plates. The sera was inactivated at 56°C for 30 min before testing. The standard control serum used was 21 day post vaccination sera collected during potency experiments at FMD Laboratory Embakasi. Virus Maintenance Media (VMM) was used with Eagle's complete medium.

Sera was diluted starting from 1/4 dilutions in a twofold series across the plate using two rows per serum leaving a volume of 50 µL per well. Previously titrated virus was added, each 50 µL unit volume which contained an estimated 100 TCID<sub>50</sub> with an accepted range of 32-320 TCID<sub>50</sub>. Controls were antiserum of known titre, negative serum, cell control and a virus titration used to calculate the actual virus titre used in the test.

The virus thus added to the titrated sera was incubated at 37°C for 1 h with plates covered with adhesive tape. A cell suspension of 50 µL was added at 10<sup>6</sup> cells/mL. This cell suspension had 10% bovine serum for cell growth. Plates were sealed again with pressure sensitive tape and incubated at 37°C for 2-3 days. They were then read after fixation using 0.05% methylene blue in 10% formalin for 30 min. Positive wells where there was virus neutralization remained intact and a blue sheet of cells was seen. Sera with titres ≥1.36 Log 10 were considered positive for FMD.

**Statistical analysis:** Serological data was subjected to statistical analysis using SPSS (version 13). The data was

imported to Ms Excel and graphs showing proportions of the serotypes were drawn for analysis. Chi Square Test was used to determine any association between age, sex and positive samples.

## RESULTS

The sero-prevalence of FMD in the Somali-ecosystem was 45.3% (95% CI = 40.96 to 49.66%). From the sera tested, 226 cattle out of 499 had antibodies to at least one serotype of the FMD virus. Some sera tested positive to more than one serotype (Table 1). Serotype O was significantly higher in circulation in the SES (Table 2) as compared to the other four FMD serotypes with a prevalence of 23% (118/499) whereas serotype C was the least with a prevalence of 1.6% (8/499). Serotype C appeared to be almost undetectable as the few positives titres were at the cutoff point of 1.36 log<sub>10</sub> except one sample out of 499 which had higher value of 1.51 log<sub>10</sub>.

The prevalence of serotype A (16.2%, 81/499) was fairly higher than that of SAT1 (14.8%, 74/499) and SAT2 (15.8%, 79/499) but the difference was not statistically significant. Three districts out of six under survey recorded serotype O as the most prevalent serotype i.e., Garissa (1.9%), Moyale (11.7% and Tana River (9.7%). Similarly one district (Mandera) had a higher prevalence rate of serotype A (6.4%) as compared to other serotypes. Only Wajir district differed from other districts in that SAT 1 (5.8%) and SAT 2 (7.8%) which were both significantly (p≤0.05) higher in prevalence compared to other serotypes (Table 3). Wajir District had the highest level of FMD seropositivity compared to other districts in the Somali ecosystem with an overall exposure rate of

Table 1: The frequency of the different serotypes in FMD seropositive cases

No. of serotypes	Seropositive cases	Seropositive %	95% CI%
5	1	0.2	(0.086-0.95)
4	11	2.2	(1.20-3.02)
3	21	4.2	(2.77-6.34)
2	55	11.0	(8.57-14.07)
1	138	27.7	(23.9-31.70)
Total seropositive	226	45.3	(40.97-49.67)
Total seronegative	273	54.7	(50.32-59.02)
Total	499	100.0	

Table 2: Frequency of the five FMD serotypes in cattle

Serotype	Frequency	Sero prevalence %	N	95% CI
Serotype O	118	23.6	499	20.13-27.57
Serotype A	81	6.2	499	13.26-19.72
Serotype C	8	1.6	499	0.82-3.12
SAT1	74	14.8	499	11.9-18.20
SAT2	79	15.8	499	12.89-19.29
Total	360	14.4	2495	13.10-15.86

X<sup>2</sup>: 103, 4df; p: 0.000

Table 3: The distribution of the five serotypes in the six districts

District	Serotype O (%)	Serotype A (%)	Serotype C (%)	SAT1 (%)	SAT2 (%)	Total (%)	CI %
TanaRiver	35.0 (9.7)	7.0 (1.9)	2.0 (0.6)	19.0 (5.3)	21.0 (5.8)	84.0 (23.3)	19.2-27.90
Wajir	17.0 (4.7)	18.0 (5)	1.0 (0.3)	21.0 (5.8)	28.0 (7.8)	85.0 (23.6)	19.5-28.20
Moyale	42.0 (11.7)	19.0 (5.3)	0.0 (0)	10.0 (2.8)	3.0 (0.8)	74.0 (20.6)	16.7-27.00
Garissa	7.0 (1.9)	4.0 (1.1)	0.0 (0)	5.0 (1.4)	2.0 (0.6)	18.0 (5.0)	3.19-7.76
Mandera	9.0 (2.5)	23.0 (6.4)	3.0 (0.8)	11.0 (3.1)	7.0 (1.9)	53.0 (14.7)	11.4-18.75
Ijara	8.0 (2.2)	10.0 (2.8)	2.0 (0.6)	8.0 (2.2)	18.0 (5)	46.0 (12.8)	9.7-16.60
Total	118.0 (32.8)	81.0 (22.5)	8.0 (2.2)	74.0 (20.6)	79.0 (21.9)	360.0 (100.0)	
CI	28.13-37.7	18.49-27.09	1.14-4.31	16.7-25.03	17.98-26.50		

Table 4: Seroprevalence of cattle FMD according to districts

District	Seropositivity count	Sero-prevalence	95% CI
Tanariver	46	20.4	15.10-25.60
Wajir	56	24.8	19.15-30.41
Moyale	50	22.1	16.71-27.54
Garissa	14	6.2	3.05-9.04
Mandera	32	14.2	9.61-18.70
Ijara	28	12.4	8.09-16.68
Total	226	100.0	

X<sup>2</sup>: 56.634, 5df; p: 0.000

Table 5: Seroprevalence of cattle FMD according to sex

Sex	Seropositive cases	Sero-prevalence (%)	95% CI
Male	74.00	33	26.8-39.1
Female	152.00	67	60.8-73.0
Total	226.00	100	

X<sup>2</sup>: 1.999, 5df; p: 0.945

Table 6: Seroprevalence of cattle FMD according to age

Animal age	No. of seropositive	Total	Seropositive %	CI%
3-4 years and above	8	10	80.0000000	51.21-98.47
2-3 years	107	199	53.7688442	46.84-60.70
1-2 years	111	290	38.2758621	32.68-43.87
Total	226	499	45.2905812	40.92-49.66

X<sup>2</sup>: 51.598, 10df; p: 0.00

24.8% (Table 4). This was followed closely by Moyale 22.1% and Tana River at 20.4%. The least exposure rates were noted in Garissa with a general exposure rate of 6.2%. The variations of individual level seroprevalence in districts were statistically significant (p<0.05).

**Test for associations:**

**Sex:** The total number of animals sampled was 499 of which the majority (67.7%, 338/499) were female while 32.3%, (161/499) were male. (46% (74/161)) of all male animals tested positive for at least one serotype while 45% (152/338) of all female animals were positive for at least one serotype. However, seropositivity was not statistically (p>0.05) associated with animal sex (Table 5).

**Age:** Seroprevalence varied significantly between ages (p≤0.05) with the older animals showing a higher risk of infection with FMD virus compared to younger animals. Out of all animals that tested positive for at least one

serotype, 1-2 year age bracket realized a prevalence of 38.2%, 2-3 year olds realized 54% while 3-4 year age bracket realized seroprevalence of 80% (Table 6).

**DISCUSSION**

The overall prevalence of FMD in the SES was found to be high at 45.3%. In comparison, a similar survey by Abdulahi *et al.* (2011) in the Somali region of eastern Ethiopia found a prevalence of 14.6%. The sero-positivity finding is higher than the overall sero-prevalence of 21, 26.5 and 8.18% reported by Shale *et al.* (2004), Rufael *et al.* (2008) and Molla *et al.* (2010) in Ethiopia, respectively. A higher prevalence of FMD in the Kenyan part of the SES could be attributable to the fact that there has been no recorded comprehensive vaccination campaign undertaken in the SES and that wildlife roam freely and commonly interact with livestock. The African Buffalo have been identified as the major carrier wildlife species of SAT serotypes in southern Africa and serological analyses suggest they are the major species infected in East Africa (Vosloo *et al.*, 2002). In addition, there is unrestricted high herd mobility, continuous contact and intermingling of different herds at water points and communal grazing areas. It is likely that clinical disease is underreported due to poor disease surveillance, communication and infrastructure.

The significantly (p≤0.05) higher sero-prevalence of FMD in adult animals than in calves observed in the current study is in agreement with the previous reports from Ethiopia of Rufael *et al.* (2008) in Borena pastoral area, Molla *et al.* (2010) in South Omo zone and Megersa *et al.* (2009) in Gamo gofa and Sidama zones, Ethiopia. This may be attributable to the fact that young cattle are herded in homestead areas and hence have less chance of exposure. In addition, the cattle herds follow seasonal patterns in search of good pasture and water and the herds are usually composed of adult males, non-lactating and non-pregnant female cows and hence more exposed to FMD than younger age group. On the other hand Esayas *et al.* (2009) who has done their research in Bench Maji zone of southern Ethiopia found no significant association between seropositivity of FMD and age of cattle.

While Mandera district had significant exposure to serotype A, 24% (34/90), very mild to SAT 2 and O (5-9%) and nil for serotype C, Moyale district had high circulation of serotype A (19%) and serotype O (12%), but only minimal exposure to SAT 1 and SAT 2 and no serotype C. Studies carried out by Tesfaye (2006) in the country of Ethiopia by ELISA tests found a high prevalence of serotype O (99.2%) followed by serotype A (95.8%). There is a lot of cross border animal movement in livestock between Kenya and Ethiopia by pastoralists in search of pastures during the dry seasons and it is not very surprising that the prominent serotypes near the border districts of Kenya of Mandera and Moyale are also the most common on the Ethiopian side of the border.

No significant difference ( $p>0.05$ ) was observed in the prevalence of FMD between female and male cattle in this study. This finding was consistent with the previous finding in the Borena pastoral area, Ethiopia reported by Rufael *et al.* (2008) and Esayas *et al.* (2009) in South Western Ethiopia and Abdulahi *et al.* (2011) in Somalia regional state, Eastern Ethiopia where there was no significant ( $p>0.05$ ) association between sex and seroprevalence. On the contrary, Hailu *et al.* (2010) in their report on the incidence of FMD among dairy cattle in northwest part of Ethiopia documented a higher rate of incidence in female (16.63%) cattle than that of male (1.37%) cattle.

Wajir district appears to be exposed to all four serotypes-O, A, SAT 1 and SAT 2 but no exposure to serotype C. Wajir district had the highest prevalence rates (23.6%) of FMD among the five districts. It is important to note that the district is the largest among five and borders Somalia to the West and Ethiopia to the North. In a European Union aided survey of foot and mouth in Somalia, serological tests showed exposure of the target unvaccinated cattle herds to FMD virus serotypes O, SAT1 A and SAT 2 (Jabra, 2010). In Ethiopia, a cross sectional sero-prevalence study of the Somali regional state, Western Ethiopia found a prevalence of 14% (Abdulahi *et al.*, 2011). The border areas are characterized by uncontrolled livestock and human movement where illegal trade and FMD transmission continues to be a risk. The role of the African Buffalo in the spread of SAT 1 and 2 in this district may need more investigation.

Garissa district had the lowest FMD seroprevalence prevalence at 6.2% as compared to the other districts with only low exposures to O, A SAT 2. The main market for cattle in the SES is located in the town of Garissa which is in the middle of the district. About 1500 to 4000 cattle from Somalia, Ethiopia, the SES and other parts of the region are sold every Wednesday and then trucked to Nairobi or Mombasa for the beef market. The fact that the cattle for markets do not interact with the local cattle may explain the low contact and therefore low prevalence rates. There is need to enforce this practice of preventing

interaction between market destined cattle with local cattle.

Overall, serotype O was the most prevalent serotype in the SES where it had prevalence rate of 23% followed by serotypes A (16.2%); SAT 2 (15.8%); SAT 1 (14.8%) while serotype C (1.6.5%) was almost negligible. Viruses of serotype C are said to be extremely rare; the last confirmed case was Kenya in 2005 and the Amazon region of Brazil in 2004 (FAO, 2005-6). The four serotypes are normally incorporated in the quadrivalent vaccine that is commonly used for control of FMD in East Africa. Due to the negligible circulation of type C in the SES and low nucleotide diversity of FMD type C reported (Sangula *et al.*, 2011) it may be necessary to exclude type C from the vaccine and reduce chances of field re-introduction. Unfortunately, in Kenya, as in other parts of Africa, the use of vaccines is sub-optimal in relation to the size of population and most of the FMD susceptible animal populations are at risk (FAO, 2005-6).

In conclusion the sero-prevalence of FMD was found to be high at 45% in the SES, an area which is dominated by pastoralists who practice a nomadic lifestyle in an area with extensive and porous borders. This is made worse by insecurity especially along the boundaries of Somalia which has not had a stable Government since 1991. It is recommended that sero-prevalence surveys be undertaken for wildlife and small stock so as to determine the role that these animals may play in the transmission of FMD in the SES. Such surveys should be part of a systematic disease surveillance and data collection. It is recommended that strategic vaccination programmes using quadrivalent vaccines in the SES would reduce the risk posed by cattle obtained from these areas and which are transported and marketed freely for beef production. It is also recommended that due to the vastness of the SES, poor infrastructure and pastoral mode of production, a more innovative approach to disease control is required. This may involve increased public awareness campaigns on the dangers posed by FMD in animals. In addition, recognition, analysis and adaptation of traditional disease control mechanism may increase the adoption of Government disease control regimes.

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