The impact of importation of live ruminants on the epizootiology of foot and mouth disease in Saudi Arabia

This paper (No. 29112016-00086-EN) has been peer-reviewed, accepted, edited, and corrected by authors. It has not yet been formatted for printing. It will be published in December 2016 in issue **35** (3) of the *Scientific and Technical Review*

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Summary

Approximately five million live ruminants are imported annually into Saudi Arabia. The majority of these animals are imported shortly before the pilgrimage season from Sudan and the Horn of Africa, where foot and mouth disease (FMD) is known to be enzootic. This study was designed to investigate the impact of the importation of these live ruminants on the epizootiology of FMD in Saudi Arabia. The authors carried out antibody testing on a total of 480 sheep and 233 cattle from the sacrificial livestock yards of the Saudi Project for Utilization of Hajj Meat, which performs ritual slaughter on behalf of pilgrims in the Holy city of Makkah. The results revealed that 136 (28.3%) of the 480 sheep tested were serologically positive for FMD, using an indirect enzyme-linked immunosorbent assay (ELISA) (3ABC FMD ELISA). This included 17.7% of Sawakani sheep (imported from Sudan) and 40.9% of Barbari sheep (imported from the Horn of Africa). Among the cattle, 120 (51.5%) of 233 animals tested positive for FMD virus (FMDV) antibodies. The 120 seropositive cattle included all clinically suspected cattle and 62 (35.4%) symptom-free, in-contact cattle. The findings highlight the risks associated with the annual importation of live ruminants from FMD enzootic areas. The risks include the possible introduction of new exotic FMDV serotypes, particularly when potential carriers or subclinically infected animals are considered. An understanding of the epidemiology of different strains and the ability to track their movement between geographical regions is essential for the development of efficient control strategies for the disease. Therefore, genotyping of FMDV strains isolated from imported and local animals is recommended.

Keywords

Epidemiology – Foot and mouth disease – Importation – Live ruminants – Makkah – Pilgrimage season – Saudi Arabia – Seroprevalence.

Introduction

International trade in animals and their products has been recognised as a primary determinant of the global epidemiology of transboundary diseases such as foot and mouth disease (FMD) (1). Saudi Arabia imports several million live ruminants for slaughter annually. The majority of these animals are imported from countries where FMD virus (FMDV) is enzootic. Particular emphasis has been placed on the possibility of importing either carrier animals, which may act as a potential source of infection, or subclinically infected animals which may actively excrete FMDV (2). Serotypes of FMDV that are not incorporated in the vaccine currently used in Saudi Arabia (e.g. SAT1 and SAT2) are prevalent in some of these exporting countries. Moreover, in some other exporting countries, the prevalent FMDV serotypes are not routinely typed (3).

Over a period of five years, from July 1999 to June 2004, five outbreaks of FMD serotype O and one outbreak of FMD serotype SAT2 were reported among livestock in Saudi Arabia. Four of these outbreaks were limited to cattle, while the other two involved all livestock species, including cattle, sheep and goats. With regard to distribution, the two extensive outbreaks of FMD virus serotype O were recorded in the five regions of the country (central, eastern, western, northern and southern) in February to April 2001 and August to November 2001, while two of the three limited outbreaks involving FMDV serotype O occurred only in the central region during October and November 1999 and in March and April 2000. The last serotype O outbreak was reported in the southern region (Jizan) in June 2004. Infection with FMDV serotype SAT 2 was reported for the first time in Saudi Arabia during an outbreak of FMDV serotype O in the central region (Al-Karj, Riyadh) from March to April 2000 (4).

Between November 1989 and October 1991, neutralising antibodies against FMDV serotypes O, A and/or Asia 1 were detected in serum samples collected from some non-vaccinated indigenous ruminants raised in different regions of Saudi Arabia (3). The importance of investigating the current epizootiological status of FMD in Saudi

Arabia, in order to aid planning to improve national control measures, has been clearly demonstrated (5).

Small ruminants play an important role in the epidemiology and transmission of FMDV because the clinical signs of FMD in adult sheep and goats are frequently mild or inapparent (6, 7, 8). Sheep have often been implicated as disseminators of FMDV, both between and within countries. Moreover, sheep and goats may act as carriers: infected herds kept by owners who practise transhumance methods or are nomadic can spread the infection to other herds long before the diagnosis of the disease is established. Shipping and trade involving live sheep and goats is much more common worldwide than trade in other FMD susceptible species. Lack of registration of all sheep and goat herds (especially of small hobby herds) and lack of individual identification (ear tags) may result in incomplete control of an FMD outbreak (9).

There is evidence that recurrent FMDV outbreaks in Saudi Arabia may be attributed to importation of ruminants from countries where FMD is enzootic, particularly during the Hajj season. Such imported animals may be FMDV carriers or subclinical cases, or may show suspicious FMD lesions, as recorded during the Hajj season of 1432 H (2011) (10). This study aimed to record the FMD seroprevalence among imported live ruminants and to describe the impact on the epizootiology of the disease in the kingdom of Saudi Arabia, especially in Makkah, where about one million of these imported animals are slaughtered annually during the Hajj season. Furthermore, prevention and control strategies for FMD in Saudi Arabia, particularly in Makkah and during Hajj seasons, are discussed.

Materials and methods

Sample population

A total of 713 sacrificial animals (233 cattle and 480 sheep) were selected from the sacrificial livestock yards of the Saudi Project for Utilization of Hajj Meat (ADAHI), in the Holy city of Makkah, during the pilgrimage season 1433 H (24–29 October 2012). The Project was established in 1983 (1403 H) as a means of assisting pilgrims by performing the ritual of Odhiya and Sadaqa on their behalf. Meat is distributed among the poor in Makkah and excess quantities are exported to eligible beneficiaries in several countries. The ADAHI complex consists of eight slaughterhouses, seven of which (Moaisem 1, Moaisem 2, Moaisem 3, Unit B, Unit D, Unit E and Unit F) are for small ruminants and one (Moaisem 4) for camels and cattle. Annually, about one million ruminants, most of them sheep and goats, are slaughtered in these slaughterhouses within a four-day period during the time of the religious festival Eid al-Adha, which begins on the tenth day of Dhu Al-Hijjah (the last month of the Islamic calendar) and ends on the thirteenth day (in the international calendar the dates vary slightly from year to year).

All of the 233 cattle tested were of African origin; 58 of them were chosen from among animals showing clinical signs of FMD and no legal importation certificates were associated with them. The remaining 175 animals were chosen from cattle not exhibiting clinical signs of FMD. Sheep were randomly selected and showed no clinical signs of FMD. The selected sheep included 260 of the Sawakani breed (imported from Sudan) and 220 of the Barbari breed (imported from the Horn of Africa). Both Sawakani and Barbari sheep were imported shortly before the Hajj season through the Djibouti livestock quarantine centre and Jeddah Islamic port.

Blood samples were collected from the jugular veins of all animals. The sera were harvested from blood samples on the day of collection and kept at –80°C until the time of serological testing.

Serological surveillance of foot and mouth disease among sacrificial animals

An enzyme-linked immunosorbent assay, the 3ABC FMD ELISA (IDEXX Laboratories, Inc., USA, Part Number: FBT1139T), was used for serological testing of both bovine and ovine sera. The test detects antibodies to the non-structural FMDV protein 3ABC. The test accurately detects infection while differentiating infected from marker vaccinated animals. The serological assay was carried out as recommended by the manufacturer in the microbiology laboratory of the Environmental and Health Research Department of the Custodian of the Two Holy Mosques Institute for Hajj and Umrah Research at Umm Al-Qura University in Makkah, Saudi Arabia.

Results

Epizootiological aspects

Approximately five million live ruminants are imported annually into Saudi Arabia for slaughter. The majority of these animals are imported from Sudan and the Horn of Africa, where FMD is enzootic. Importation occurs through sea transportation from the animal quarantine centre in Djibouti to Jeddah Islamic port (Fig. 1).

Most of the imported ruminants are sheep and goats. About one million of them are used as sacrificial animals for slaughter in Makkah around the time of Eid al-Adha. Two sheep breeds are usually imported, the Sawakani breed (imported from Sudan) and the Barbari breed (mainly imported from the Horn of Africa). The sheep included in the study were of known origin and were accompanied by legal importation certificates.

The African cattle in the study were of unknown sources and no legal importation certificates were associated with them. They were illegally transported from the southern region of Saudi Arabia (Jizan region) into Makkah (the western region) shortly before the Hajj season of 1433 H. Fifty-eight of the 233 cattle (24.9%) showed classical clinical signs of FMD. Importation of infected African cattle increases the risk of introduction of exotic FMDV serotypes into Saudi Arabia. Illegal movement of diseased cattle increases the risk of FMDV dissemination. In addition, open housing of these cattle in the livestock yards of the ADAHI complex may spread infection to all sacrificial animals.

Clinical examination

Thorough clinical examinations revealed that about one-quarter (24.9%) of the investigated cattle were FMD suspect cases. The reported clinical signs included high fever (40–41.5°C), depression, dullness and loss of appetite. Affected cattle were weak and emaciated. Inflammation around the nostrils was a common sign (Fig. 2). Some of the diseased cattle had vesicles (Fig. 3) with the consequent ropy salivation (Fig. 4). Vesicles in the interdigital space (Fig. 5) with lameness were also observed. These animals suffered pain in the standing position and were reluctant to move. No clinical signs of the disease were noticed in the sheep.

Seroprevalence of foot and mouth disease among sacrificial animals

The results of the serological investigations revealed serological evidence of FMD infection in 256 (35.9%) of the 713 sacrificial animals. This included 136 (28.3%) of 480 sheep and 120 (51.5%) of 233 cattle (Table I). In sheep, 17.7% of the Sawakni breed (46/260) (imported from Sudan) and 40.9% of the Barbari breed (90/220) (imported from the Horn of Africa) were serologically positive for FMD. All clinically suspected cattle were seropositive, while 35.4% of apparently healthy in-contact cattle (62/175) were serologically positive.

Discussion

Outbreaks of FMD are a primary animal health concern worldwide because the disease is highly contagious and causes productivity losses among infected animals (11). In Saudi Arabia, approximately five million live ruminants are imported annually, mostly from FMD-enzootic African countries. Moreover, the intensified importation of at least two million of these animals shortly before the pilgrimage season every year for sacrifice represents a great potential risk for the introduction of new FMDV serotypes, especially into the Holy city of Makkah (4), with subsequent possible outbreaks. The importation of animals is also a risk factor for FMD introduction in many other countries, e.g. it was reported that the importation of Irish veal calves into the Netherlands via an FMD-contaminated staging point in France was the most likely route of transmission of the 2001 FMD outbreak (12). Moreover, an exotic SAT2 FMDV of topotype VII was characterised in Egypt as the cause of the widespread field outbreaks seen during February and March 2012 (13). These newly emerged viruses were genetically closely related to strains isolated from Saudi Arabia, Sudan, Eritrea and Cameroon between 2000 and 2010, suggesting the dominant nature of this virus and underscoring the need for worldwide intensive surveillance to avoid devastating consequences (14).

Foot and mouth disease in adult sheep and goats is frequently mild or inapparent, with no distinct clinical signs, and therefore the diagnosis can easily be missed (15, 16). Several cases have been reported in the past where small ruminants were held responsible for the introduction of FMD into previously disease-free countries (8). The reasons for considering small ruminants as a risk factor that could play an important role in the epidemiology and transmission of FMD include the fact that sheep and goats are the usual carriers of the disease (9) and the fact that FMD is difficult to diagnose clinically in these animals. Such unrecognised FMDV infection in sheep may represent a potential risk for the spread of the disease (17). In Saudi Arabia, most of the imported live ruminants are sheep and goats, and these represent the majority of the sacrificial animals in Makkah during the pilgrimage season. Most of these animals are imported from FMD-enzootic African countries with poor quarantine measures. In this study, none of the sheep and goats showed clinical signs of FMD. The inapparent nature of FMD in sheep and goats represents a high risk for the introduction of new exotic FMDV topotypes from Africa into Saudi Arabia.

In cattle, FMD is usually clinically obvious, especially in the unvaccinated herds of countries in which the disease occurs only occasionally (18). This study reported FMD in African cattle in Makkah with obvious clinical signs of the disease. Typical FMD clinical signs, including inflammation around the nostrils, vesicles, ropy salivation and lameness, were reported. Clinical FMD infections, under certain climatic and epidemiological conditions, can be transmitted by a variety of mechanisms, including windborne spread (19). In this study, the reported open housing system for the diseased cattle in the livestock yards represents another important risk factor for the disease epizootiology in Makkah, leading to the possibility of rapid spread of the infection, not only to all the sacrificial ruminants in Makkah, but also to other susceptible animals in the western region of Saudi Arabia.

Unlike animals which are carriers of FMD, subclinically infected animals may be highly contagious. The spread of FMD in the United Kingdom in 2001 and the subsequent spread of the disease to other countries show that subclinical infections make trade in animals or animal products a potential hazard for importing countries. The importation of subclinically infected animals has serious implications for the control of FMD, because such animals are likely to disseminate the disease when in contact with susceptible livestock (1). In Saudi Arabia, illegal movement of cattle of African origin from the southern region (Jizan region) into the western region (Makkah region) shortly before the Hajj season of 1433 H represented a high potential risk for FMDV dissemination. Control of animal movements is one of the most important measures for a successful FMD eradication strategy (20).

The detection of antibody to non-structural proteins (NSPs) of FMDV can be used to identify past or present infection with any of the seven serotypes of the virus, whether or not the animal has also been vaccinated. Therefore the tests can be used to confirm suspected cases of FMD and to detect viral activity or substantiate freedom from infection on a population basis. For certifying animals for trade, the tests have an advantage over structural protein (SP) methods, because the serotype of the virus does not have to be known (21). Antibodies to the polyproteins 3AB or 3ABC are generally considered to be the most reliable indicators of infection (22). In this study, the FMD 3ABC test was used for accurate detection of infection, differentiating infected from marker-vaccinated animals. The detection of antibodies to NSPs of FMDV is the preferred diagnostic method to distinguish virus-infected carrier animals from vaccinated animals (23, 24, 25). Serological tests, such as those for antibodies to NSPs or specific immunoglobulin A (IgA), provide increased security by reducing the likelihood of trading carrier animals and can be used to help define the limits of an outbreak (26). It has been demonstrated that the 3ABC ELISA is able to detect antibodies indicative of infection with FMDV in asymptomatic sheep under field conditions (17).

In the current study, laboratory investigations revealed serological evidence of FMD infection in 256 (35.9%) of 713 sacrificial animals. In the previous year, during the pilgrimage season of 1432 H (4–9 November 2011) in Makkah, 14 (0.78%) suspected cases of FMDV were recorded among 1,800 inspected cattle (11). A serological survey for FMD among vaccinated indigenous ruminants raised in different regions of Saudi Arabia was carried out by Hafez *et al.* (3). Among serum samples from 5,985 sheep, 1,371 goats, 1,052 cattle and 694 ruminants of unspecified species, precipitating antibodies against FMDV were detected in 1,209 (20%), 127 (9%), 172 (16%) and 38 (5%) samples, respectively.

In the current study, 46 (17.7%) of 260 Sawakni sheep (imported from Sudan) and 90 (40.9%) of 220 Barbari sheep (imported from the Horn of Africa) were serologically positive for FMD. None of these sheep showed clinical signs of FMD. On the other hand, all cattle that showed suspected clinical signs of FMD were serologically positive for FMDV antibodies, while 62 (35.4%) of 175 apparently healthy in-contact cattle also showed serological evidence of FMD infection. Hafez *et al.* (3) concluded that the high percentage of positive serological test results in sheep and goats in many regions of Saudi Arabia, in the absence of clinical FMD among these species, indicates the importance of these range animals in transmitting FMDV between regions within the country.

The most appropriate approach to FMD control would be to prevent infected animals from entering the principal trading routes for susceptible animals (27). The *Terrestrial Animal Health Code* (*Terrestrial Code*) of the World Organisation for Animal Health (OIE) makes recommendations for international movements of live animals and animal products with regard to a possible generic risk of FMD for these different commodities (28, 29). The current study suggests that the recommendations of the *Terrestrial Code* for international movements of live animals should be strictly applied during importation of live animals into Saudi Arabia.

Molecular epidemiological studies on FMD in Saudi Arabia are needed. In Egypt, during the 2006 outbreak, the results of molecular typing suggested a relationship between strains of Egyptian and East African origin. The molecular typing confirmed only that, through the trade in live cattle, an East African type A strain had been introduced which was not contained at the quarantine station. The origin of the infection was unclear, because the animals in quarantine may have acquired infection at various points during shipment, including on board the ship (possibly from contaminated pens or other animals), at the port before loading, or in transit from Ethiopia to the port of loading (30). Therefore, isolation and genotyping of FMDV serotypes is recommended and will be considered in the authors' future work.

Any country experiencing an outbreak of FMD can expect questions or trade restrictions from regular trading partners (31). The need for approximately one million sheep and goats for slaughter within a very short time (four days) during the Hajj season every year requires Saudi Arabia to import ruminant animals from Africa, although FMD is a constant threat to animal agriculture worldwide and must always be considered when defining policies concerning the trade of live animals and animal products (32). Six of the seven serotypes of FMDV (all but Asia 1) are prevalent in Africa (33). In addition, the FMD diagnostic capacity in eastern Africa is still inadequate (34).

Foot and mouth disease control should increasingly be considered from a global perspective (35, 36). The disease affects livestock throughout the world, particularly those in poorer countries. In many places little is done to control FMD, largely due to a lack of resources and a failure to recognise the benefits that control brings. In many countries, FMD prevents agricultural development and reduces food security; it may also cause major losses due to control costs and in some cases by limiting access to export markets (37). For control of FMD in the Middle East and North Africa, coordinated epidemiological studies leading to a common control policy should be implemented and supported by the international community (38). An international aid programme for control of FMD in poorer African countries will help these countries to export live animals and subsequently will increase development opportunities.

Conclusions and recommendations

There is evidence that the introduction of several exotic or other serotypes of FMDV into Saudi Arabia has occurred through the intensive importation of live ruminants from Sudan and the Horn of Africa, where FMD is enzootic, particularly shortly before Hajj seasons. Imported animals, especially sheep, may be FMDV carriers or have subclinical infections.

This study suggests the following recommendations that may contribute to decreasing the risk of importation of exotic FMDV serotypes into Saudi Arabia:

– prohibition of the importation of live ruminants from African countries where FMD is enzootic

– serological screening of the live ruminant animals at the Djibouti quarantine station before exportation, for exclusion of all seropositive (infected or carrier) cases

– improvement of import controls, including quarantine, at Jeddah Islamic port

– vaccination of uninfected and non-carrier ruminants in the country of origin at least three weeks before export to Saudi Arabia, using a polyvalent vaccine incorporating FMDV strains which can stimulate protection against Saudi field strains

– serological testing of random and representative samples at Jeddah Islamic port quarantine facilities to verify vaccination of the imported live animals

– establishment of a national project for the intensive production of sheep as an alternative to importation, with a production capacity of about one to two million head per year

– application of all recommendations of the OIE *Terrestrial Code* for international movements of live animals (30)

– further studies for typing and characterisation of any FMDV exotic topotypes and annual reporting of FMD molecular epidemiology in Saudi Arabia.

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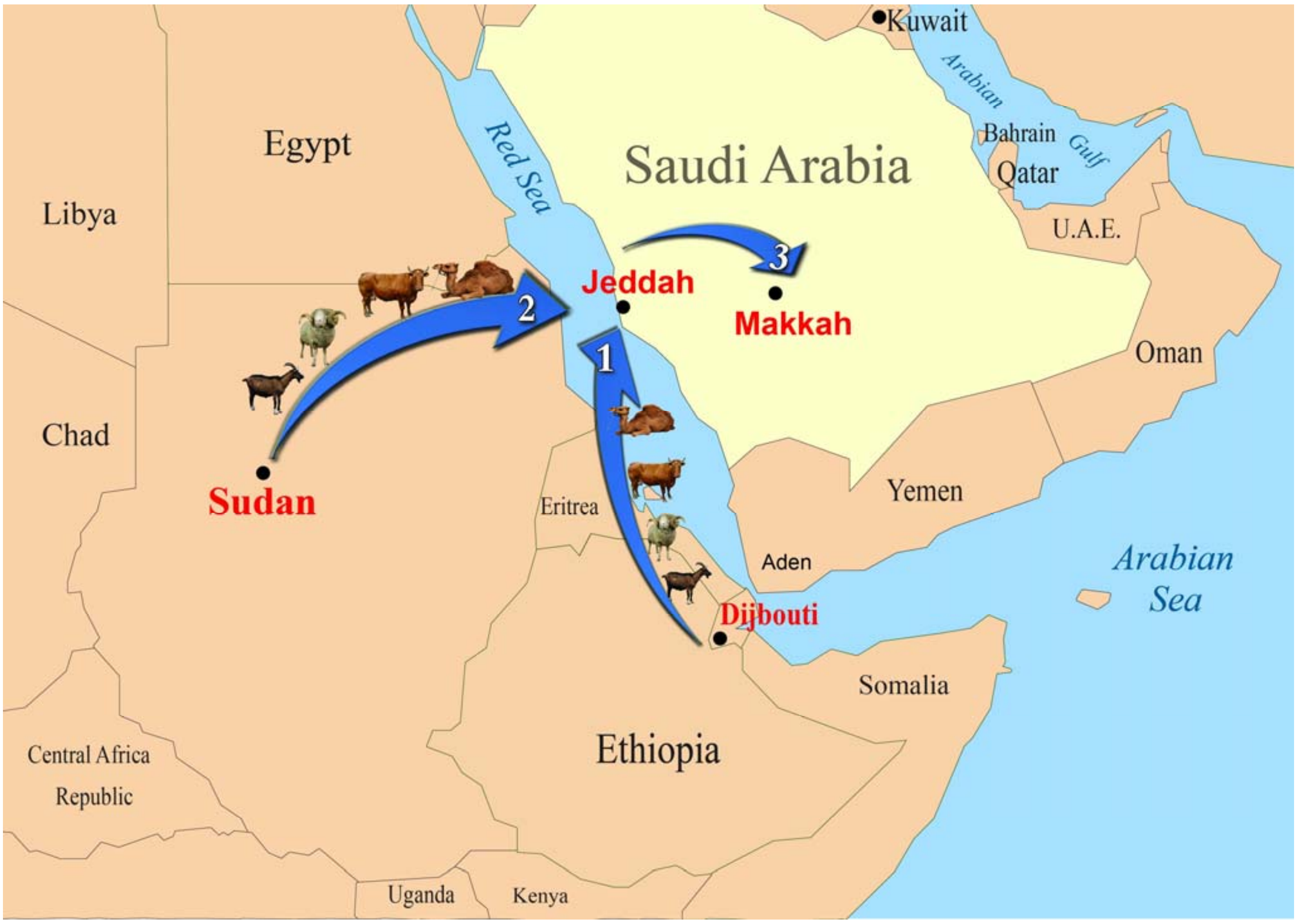
Table I
Seropositive foot and mouth disease cases among animals imported for sacrifice

Investigated animals	No. of animals	Seropositive cases	
		No.	%
Cattle with clinical signs	58	58	100
Cattle without clinical signs	175	62	35.4
Subtotal (cattle)	233	120	51.5
Sawakani sheep (from Sudan)	260	46	17.7
Barbati sheep (from the Horn of Africa)	220	90	40.9
Subtotal (sheep)	480	136	28.3
Total (cattle and sheep)	713	256	35.9

Fig. 1

Importation of live ruminant animals into Saudi Arabia



1) From the Horn of Africa through Djibouti

2) From Sudan into Saudi Arabia

3) From Jeddah to Makkah

Fig. 2
Inflammation around the nostrils

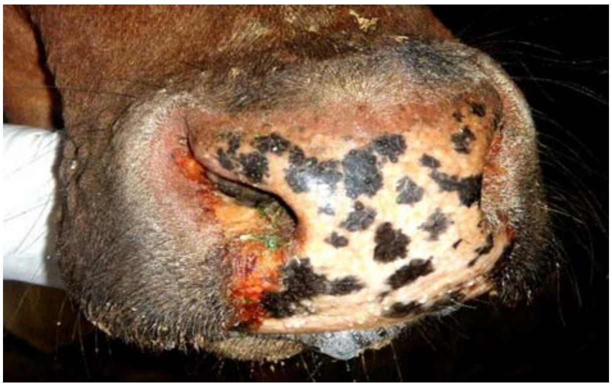


Fig. 3
Ruptured vesicles on the hard palate (vesicular stomatitis)

Fig. 4
Ropy salivation

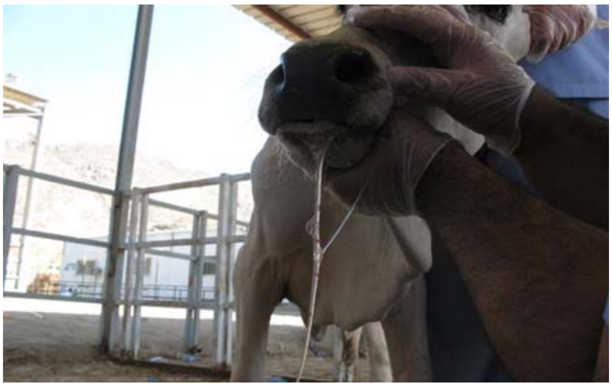


Fig. 5

Inflammation and vesicles in the interdigital space