The Survival of Foot-and-Mouth Disease Virus in Raw and Pasteurized Milk and Milk Products*

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ABSTRACT

The Foot-and-Mouth Disease virus (FMDV) is not a public health threat, but it is highly contagious to cloven-footed animals. The virus is shed into milk up to 33 h before there are apparent signs of the disease in dairy cows, and, in extreme cases, signs of disease may not appear for up to 14 d. During this time, raw milk can serve as a vector for spread of the disease both at the farm and during transport to the processing plant by milk tanker. Raw milk and milk products fed to animals have the potential to cause infection, but the potential for pasteurized milk products to cause infection is largely unknown.

Current minimum pasteurization standards may not be adequate to eliminate FMDV in milk completely. The purpose of this paper is to assess the literature on the thermal resistance of FMDV in milk and milk products, to identify the risks associated with ingestion of pasteurized products by animals, and to lay a strategy to prevent the spread of FMDV from contaminated milk.

(Key words: milk, milk products, Foot-and-Mouth Disease, pasteurization)

Abbreviation key: FMDV = Foot-and-Mouth Disease virus, ID = infectious dose, PFT = plaque-forming units, SAT = Southern African Territories.

INTRODUCTION

Characteristics

Foot-and-Mouth Disease virus (FMDV) is not a public health threat, but is highly contagious to cattle and

other cloven-footed animals (Callis et al., 1968). There are 7 serotypes (A, O, C, Asia 1, and Southern African Territories [SAT] 1, 2, and 3) and more than 60 subtypes of FMDV. The small non-enveloped virus is a member of the *Picornaviridae* family, which also includes rhinoviruses and enteroviruses. Foot-and-Mouth Disease virus leaves mature animals debilitated and is sometimes fatal to the young. The virus is characterized by fever and blister-like lesions followed by erosions on the tongue and lips, in the mouth, on the teats, and between the hooves. It reduces the commercial value of dairy cattle by reducing milk yield. It may be spread by aerosol, direct contact with infected animals, or ingestion of contaminated milk or meat products or it may be transmitted by fomites, such as shoes, truck tires, and other inanimate objects in contact with the virus; birds; and rodents (APHIS, 2001).

Transmission and Quantity of the Virus in Raw Milk

Foot-and-Mouth Disease virus is shed into the milk, blood, pharynx, vagina, and rectum before onset of clinical manifestations of the disease in infected cows. Foot-and-Mouth Disease virus appeared in the milk of animals exposed to it by contact with infected animals an average of 2.2 d before clinical signs of the disease appeared (Burrows, 1968). Experiments inoculating the udder with FMDV showed that it is highly capable of producing large amounts of the virus (Burrows et al., 1971). Blackwell et al. (1981) confirmed that FMDV replicates in the mammary gland after exposure of uninfected cows to pigs with the virus and proposed that three virus-release mechanisms operate in infected mammary gland secretory cells. Shed virus incorporated into the CN micelles and fat droplets would afford the virus protection from environmental inactivants.

Milk handling at the farm and during transport from farm to farm by milk tankers has been implicated as an important source for spread of the disease (Dawson, 1970; Donaldson, 1973). Without a viable method to prevent spread of the virus, this presents a potential source for infection of the milk supply.

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Hedger and Dawson (1970) obtained samples of milk from farm premises during the FMDV epidemic in the West Midlands, England, from 1967 to 1968. Foot-and-Mouth Disease virus was found in milk bulk tanks and bulk tankers at least 33 h before onset of symptoms in infected animals. Titters as high as $10^{4.0}$ minimum infectious doses (ID)₅₀/mL were reported for a retail bottle of milk and in a bulk tanker. However, Donaldson et al. (1982) showed that titers in bulk tanks are more likely to average $10^{2.2}$ plaque-forming units (PFU)/mL. Milk transported directly to the processing plant from infected premises was not associated with spread of the disease, although it was reported that 3 outbreaks at pig farms resulted from the feeding of infected milk delivered by one bulk tanker (Donaldson, 1997).

Sellers (1971) compiled tables of the amount of various types of FMDV required to set up infection in animals through various routes. It was shown that just 1 mL of milk with $10^{5.0}$ ID₅₀ of FMDV contained the infective dose for ingestion by pigs and that a daily intake of milk of 0.5 L with $10^{2.3}$ ID₅₀/mL is sufficient to set up infection. Although data for setting up infection in calves were not reported, it was hypothesized that for calves requiring $10^{6.0}$ ID₅₀ by ingestion, a virus concentration in the range from $10^{3.3}$ to $10^{2.05}$ ID₅₀/mL is required to set up infection if 0.5 to 9 L/d of milk are consumed. Sellers (1971) also showed that a 2000-gallon bulk tanker with $10^{4.0}$ ID₅₀/mL of milk would contain 10^6 infective doses for pigs and 10^5 infective doses for calves by ingestion.

Transmission and Quantity of FMDV in Pasteurized Milk

Simulated high-temperature, short-time pasteurization studies of FMDV-containing milk.

High-temperature, short-time heating is the most common method of pasteurization used today for fluid milk. Milk is usually heated in a plate heat exchanger to a specified temperature followed by holding at that temperature in a pipe for a specified period of time. Current Pasteurized Milk Ordinance (PMO, 2001) standards for HTST heating of milk require heating to a minimum of 71.7°C and a holding time of at least 15 s.

Many studies have been conducted to determine survival of FMDV in milk and milk products after heating of milk artificially infected with FMDV or using milk from FMDV-infected animals. High-temperature, short-time heating was simulated by immersing tubes or bottles filled with the infected milk in a water bath and heating to the desired temperature for a specified period of time. The tubes were then immediately chilled. However, these studies do not truly simulate HTST pasteurization because the flow conditions and

temperature profiles encountered in commercial pasteurizers are not simulated.

Sellers (1969) determined the inactivation rate of FMDV (British Field Strain 1860 Type O₁) in inoculated whole milk at various temperatures and pH using simulated HTST. Virus was assayed using cell culture. Results indicated that a longer holding time is required to inactivate the virus for milk with higher pH. For milk at pH 6.7, 99.999% inactivation of the virus (5 log₁₀ reduction) was achieved in 17 s at 72°C. At pH 7.6, FMDV was inactivated in 55 s at 72°C. A biphasic inactivation curve was noted with initially rapid virus inactivation followed by a longer inactivation period. It was concluded that virus in naturally infected milk may be in the form of free virus or virus in cells, and that virus in infected cells may survive longer.

A series of studies to determine the effectiveness of pasteurization on elimination of FMDV in naturally infected milk and milk products was carried out at the Plum Island Animal Disease Center, USDA, in Greenport, New York. In most experiments, a suspension containing Type A, subtype 3 (A₃), strain Mecklenburg was inoculated into dairy cows to infect them. Samples heated by simulated HTST pasteurization were tested for infectivity in cell culture and were also inoculated into steers; 2.0 mL of sample were inoculated intradermally, and 35 mL were inoculated i.m. to test for FMDV. If steers remained free of clinical signs of FMDV for 14 d, they were then challenged by intradermal inoculation. Inoculation of steers was shown as the most sensitive test for detecting trace amounts of the virus compared with cell culture (Blackwell and Hyde, 1976).

To simulate HTST pasteurization, whole or skim milk and cream were heated to either 72 or 80°C and held for 15 to 17 s or were heated at 72°C and held for times up to 5 min and then immersed immediately in an ice bath (Hyde et al., 1975; Blackwell and Hyde, 1976). Milk obtained from infected cows had a mean pH of 7.15, confirming Sellers' (1969) observation that pH increased in animals infected with FMDV. Heating inactivated 99.999% of the virus. For skim milk heated at 72°C for 2 min, only 1 of 3 samples were infective for steers. Evaporated pasteurized samples showed no infectivity by cell culture, but all inoculated steers were positive for the virus. All cattle become infected with the virus after inoculation with the cream component (Table 1). Survival of FMDV after evaporation of whole milk heated for 30 s (but not skim milk receiving equivalent treatment) suggests that the fat component of whole milk protects the virus during heating more than the protein does.

In other studies, De Leeuw et al. (1980) obtained milk from cows infected intramammarily or intranasally

Table 1. Survival of Foot-and-Mouth Disease virus (FMDV) in heat-treated, whole or skim milk from infected cows. Survival of FMDV in the heated product was tested by inoculation in steers. Initial titer of FMDV in milk ranged from 5 to 7 log₁₀ plaque-forming units (PFU)/mL.

Milk type	Temperature/time	Method ¹	log ₁₀ PFU/mL reduction by cell culture ²	Inoculation results (no. steers positive/no. inoculated)	Reference
Skim milk	72°C/15 s	LP	5	6/6	Blackwell and Hyde (1976)
	72°C/15 s	LP, evaporation	N/A	1/3	
	72°C/30 s	LP	5	6/6	
	72°C/30 s	LP, evaporation	N/A		
	72°C/1 min	LP	5 to 6	6/6	
	72°C/2 min ³	LP	5 to 6	2/6	
	72°C/3 min	LP	5 to 6	NT ⁴	
	72°C/4 min	LP	5 to 6	NT	
Whole milk	72°C/15 s	LP followed by evaporation	3 to 5	1/1	Hyde et al. (1975)
	80°C/15 s	LP followed by evaporation	5	1/1	
	72°C/15 s	LP	5	NT	Blackwell and Hyde (1976)
	72°C/30 s	LP	5	6/6	
	72°C/1 min	LP	5	6/6	
	72°C/2 min	LP	5	6/6	
	72°C/3 min	LP	5	6/6	
	72°C/3 min	LP evaporation	N/A		
	72°C/4 min	LP	4 to 6	6/6	
	72°C/5 min	LP	5 to 6	6/6	
	72°C/5 min	LP	5 to 6	NT	
Whole milk	76, 80, and 85°C/15 to 20 s	Alfa-Laval plate pasteurizer	Not given	Inactivated	Khukhorov et al. (1975)
Whole milk	102°C, 2 to 3 s	UHT	6.1	Survived	Cunliffe et al (1979)
	123°C, 2 to 3 s	UHT	5.1 to 5.4	Survived in 2 of 3 runs	
	130°C	UHT	4.9 to 6.3	Survived	
	138°C	UHT	3.7 to 6.4	Survived at highest titer	
	148°C	UHT	4.4 to 5.2	Inactivated	

¹LP = Lab pasteurization; UHT = ultra-high temperature pasteurizer, lab continuous flow unit.

²Values are approximate.

³Only 1 of 3 samples infectious to cattle.

⁴NT = Not tested.

with FMDV. Interferons were detected in cows infected intramammarily, and virus titers were higher. Thermal inactivation curves for milk infected through the two methods were different with a slower rate of inactivation for the intramammarily infected cows. Differences in the inactivation curves were also noted if milk was stored at -70°C before heating; stored milk showed enhanced thermal inactivation. The use of milk for inactivation experiments obtained from cows infected intramammarily was questioned because of the higher titers and the unlikelihood that primary infection would occur through the mammary route. However, Walker et al. (1984) noted that milk obtained from intramammarily infected cows produces the most adverse conditions under which inactivation experiments can be carried out and provides a safety margin when regulations are based on these data.

To demonstrate that thermal resistance of FMDV is similar in milk obtained from intramammarily infected cows and from cows exposed to infected animals, Blackwell et al. (1982) infected dairy cows with FMDV by

exposing them to pigs. Foot-and-Mouth Disease virus was found in whole milk as well as its components—skim milk, cream, and cellular debris. The titer levels of the virus in milk from the cows infected in this manner were similar to those of intramammarily infected cows used in earlier experiments. Whole and skim milk heated to 72°C and held for 0.25 min exhibited thermal stability similar to that reported earlier for milk from cows that were infected intramammarily (Hyde et al., 1975; Blackwell and Hyde, 1976) as indicated by cell culture. The heated samples were not tested by inoculation in steers.

Blackwell (1976) studied the survival of FMDV in the manufacture of Cheddar, Mozzarella, and Camembert cheeses prepared from milk of infected cows. Samples were inoculated in steers to detect FMDV both after preparation and at various stages of aging. Cheddar cheese was prepared from raw or subpasteurized milk. Foot-and-Mouth Disease virus survived at the final curd pH of 5.1. Foot-and-Mouth Disease virus did not survive in Mozzarella, possibly because of the combina-

tion of the acidic environment (pH 5.1) and heating of the curd in hot water before kneading and stretching. Foot-and-Mouth Disease virus was detected in Camembert cheese after processing at pH of 5.2 and after a 21-d ripening period, but was not detected after 35 d.

Cunliffe and Blackwell (1977) prepared CN from the milk of infected cows. Foot-and-Mouth Disease virus survived the temperature and acid treatment of CN preparation. Foot-and-Mouth Disease virus also persisted throughout sodium caseinate manufacture (Cunliffe et al., 1978). Only 1 of 4 batches that was infectious to steers after 1 d in storage remained infectious at 42 d of storage. The researchers attributed this discrepancy to minor deviations in technique.

Gaggino et al. (1977) investigated survival of FMDV Type C₃ in CN prepared from milk obtained from infected cows. Lactic acid-producing bacteria was used to lower pH to 4.6. Milk was not pasteurized, but temperature was held at 43°C during processing. Dried CN was inoculated into steers and FMDV was shown to be inactivated.

Foot-and-Mouth Disease virus was detected in sweet whey obtained from a preparation of Cheddar and Camembert cheeses made from infected milk (Blackwell, 1976) but not in the acid whey from CN preparation (Cunliffe and Blackwell, 1977). The whey components, α -LA, β -LG, and lactose, isolated from sweet whey (Blackwell, 1978a) showed no evidence of the virus when inoculated into steers.

Foot-and Mouth Disease virus persisted in butter stored for up to 30 d and in butter oil stored for 45 d at 4°C when obtained from pasteurized cream (Blackwell, 1978b). The cream fractions were positive for the virus.

HTST pasteurization in flow systems. Khukhorov et al. (1975) showed inactivation of FMDV, Type A₂₂, in milk from infected cows by pasteurization of 20-L samples of milk at 76, 80, and 85°C for 15 to 20 s in an Alfa-Laval plate pasteurizer. Calves, piglets, and mice inoculated with the pasteurized milk did not show symptoms of FMDV.

Bohm et al. (1979) pasteurized whole milk, artificially infected with Type O₁ FMDV, in a tubular pasteurizer. Milk was heated to temperatures ranging from 66 to 78°C and held for 40 s. Cattle did not show symptoms of FMDV when inoculated with the sample heated to 66°C.

Bohm (1982) obtained milk from cows intranasally infected with Type O₁ FMDV. The infected milk was blended with whole and skim milk and then pasteurized at 73°C for 40 s (or 63°C for 40 s for a hard cheese) in a tubular pasteurizer prior to making a variety of milk products. Foot-and-Mouth Disease virus was not detected in skim milk, CN, or whey after processing or drying when tested by cell culture or inoculation in

baby mice and steers. Camembert, Edam, and hard cheeses were free of virus when tested in steers. It was concluded that a 40-s hold time was required to ensure inactivation of FMDV in milk.

It is unknown how well the flow studies reported here simulated commercial HTST used in the US. Flow rates and dimensions of the experimental apparatus were not given to determine whether the pasteurizers were operated under laminar or turbulent flow conditions.

UHT processing. Cunliffe et al. (1979) showed inactivation of FMDV Type A₃, strain Mecklenburg, in milk using UHT processing (Table 1). Flow rate of the milk was 0.4 L/s. Foot-and-Mouth Disease virus was inactivated in milk when held at 148°C for 3 s or longer.

In the event of an outbreak, Cunliffe et al. (1979) recommended construction of mobile UHT units for attaching to on-farm bulk milk processing equipment for safe disposal of infected milk on infected premises.

Even though UHT pasteurization inactivated FMDV in milk, Douglas et al. (1981) showed that interactions between CN and whey proteins occur, CN solubility is reduced at neutral pH and below, and 56% of the whey proteins in skim milk are denatured.

Walker et al. (1984) treated FMDV-infected whole and skim milk to construct a thermal death curve. Average pre-treatment titer of milk was 10^{5.9} PFU/mL. Foot-and-Mouth Disease virus in the infected milk was inactivated at times >20 min at 100°C and 2.5 s at 148°C. No differences in virus inactivation were noted in skim or whole milk.

The thermal death curve is shown in Figure 1. If the data are extrapolated to 72°C, the corresponding time for virus inactivation is approximately 230 min. Using the definitions of D and z from microbiology, where D is a measure of the heat resistance of a microorganism defined as the time in minutes to kill 90% of the organism, and z is defined as the temperature change needed to reduce the D value 10-fold, the value of z is approximately 20°C. This value is greater than that for the thermal resistance of alkaline phosphatase (z = 4.8°C) used to indicate proper pasteurization of skimmed or whole milks and is greater than the value for the most heat-resistant of the non-spore-forming pathogens found in milk (Sullivan et al., 1971; Larkin, 1983).

Survival of FMDV in other dairy products. Studies on the survival of FMDV in fermented products, such as yogurt, have not been reported. However, the low pH, lower than that encountered in CN production, and higher temperatures may be sufficient to inactivate FMDV. The impact of membrane technologies, such as ultrafiltration, used in production of whey protein concentrates, or microfiltration, used to clarify or concentrate milk and remove bacteria, on removal of the virus from milk or whey have not been investigated. Also,

Figure 1. Thermal death time curve for Foot-and-Mouth Disease virus (FMDV) in skim or whole milk from infected cows. Data points obtained at the Central Veterinary Institute, Lelystad, The Netherlands. ● = FMDV inactivated; ○ = FMDV survived. Data points obtained at Plum Island Animal Disease Center (Greenport, NY): ▲ = FMDV inactivated; △ = FMDV survived. Points with large open circles were used to hand-fit the data. Reprinted from Walker et al., "The thermal death time curve for foot-and-mouth disease virus contained in primarily infected milk." 1984. *BIOLOGICALS* (formerly *J. Biological Standardization*) 12:185–189 with permission from Elsevier.

the survival of the virus in processed cheese has not been investigated.

DISCUSSION

Because FMDV is shed into milk before dairy cattle show clinical signs of the disease, there is opportunity for raw milk to spread the virus on the farm and from farm to farm.

At the farm, animals may become infected if fed raw milk from an infected cow (Sellers, 1971). Biosecurity measures for handling of waste milk fed to animals at the farm should consider use of an on-farm pasteurizer followed by careful handling to prevent recontamination. This would significantly reduce virus that might be present in milk and lower the risk of setting up infection in animals (Sellers, 1971). Pasteurization of colostrum prior to feeding to calves or use of a commercially available pasteurized product is also recommended.

Biosecurity measures that prevent spread of milk from leaky hose fittings in the milking parlors and around milk bulk storage tanks, for example, would also do much to prevent spread of the virus to animals through the possible route of inhalation of aerosol droplets, although the risk would be very low, or by drinking spills (Donaldson, 1997).

Milk tankers used to transport milk from farm to farm or directly to the processing plant are potential vectors for transmission of FMDV. Ports are typically opened on tankers when pumping milk from the bulk milk tanker at the farm, when pumping milk to bulk storage at the processing plant, and when milk is sampled at the processing plant. The ports have inserts with baffles that should remain in place when the ports are opened. Ports without inserts should not be opened if the tanker is carrying milk. Milk spillage when connecting hoses and at hose fittings should immediately be cleaned up and the area sanitized. Drivers should not enter barns or come in contact with livestock.

In the event of an outbreak of FMDV, the titer of virus in milk in the bulk storage tank may be much lower than that found in the milk from a single infected cow because infected milk is mixed with that from non-infected cows. This milk is further diluted in the milk tanker truck if the tanker collects from more than one farm and is further diluted in the storage tanks at the processing plant, which, depending on the size of the processing facility, may range in size from 25,000 to 50,000 gallons. The amount of virus in milk would be diluted accordingly.

Lab pasteurization of milk, whether artificially or naturally infected with FMDV, ensures inactivation of the virus on the order of 5 to 7 log₁₀ PFU/mL as detected by cell culture (Sellers, 1969; Hyde et al., 1975; Blackwell and Hyde, 1976), but samples were still infective when inoculated into steers. These samples contained only 0 to 10 PFU/mL of FMDV. Milk products such as CN, sodium caseinate, cheese, acid and sweet whey, whey products, and butter made on the lab-scale from naturally infected, then pasteurized milk were also infective to steers (Blackwell, 1976; Cunliffe and Blackwell, 1977; Cunliffe et al., 1978; Blackwell, 1978b). With the exception of acid whey, whey products, and some of the cheeses (Cunliffe and Blackwell, 1977), inoculation of samples of the products into steers caused infection, indicating that post-pasteurization processing steps did not lessen infectivity. Acid whey, with a pH of 4.8 and low solids content, contrasts the other products with their high fat and protein (mostly CN) contents, which may offer protective effects to the virus during processing. These results show that even though processing reduces virus titer significantly, the biphasic nature of the inactivation curve (Sellers, 1969) indi-

cates that a small fraction may require additional time to inactivate or harsher treatment. Only UHT processing of milk (Cunliffe et al., 1979) showed complete inactivation of the virus when treated samples were inoculated in steers.

The data reported above were obtained using laboratory or batch methods that do not simulate conditions encountered in commercial HTST processing plants and may over- or under-predict the lethal effects of the process (Franklin, 1965). In HTST processing, an additional variable, flow, and its impact on improving virus reduction must be considered. Commercial HTST are normally run using plate or tubular heat exchangers to heat the milk followed by a tube to hold the milk. Flow conditions, as defined in the PMO (2001), are such that all particles of milk are held for the same length of time in the holding tube (minimum of 15 s) at a temperature of at least 72°C; no particle leaves the tube before the prescribed holding time.

Khukhorov et al. (1975) and Bohm (1982) reported complete inactivation of the virus in milk, CN, or various cheeses when commercial practice or continuous flow processing methods simulating commercial HTST processing were used. Khukhorov et al. (1975) used calves, mice, and piglets to detect virus, but it is unknown if these animals have the same sensitivity to the virus as steers. Bohm (1982) indicated that steers were used to detect very small quantities of the virus, but the protocol for steer inoculation was not given in detail. Also, by using a blend of infected and noninfected milk in experiments, pH of milk, which is elevated in infected milk as shown by Blackwell and Hyde (1976), was lowered. This may decrease the thermal resistance of the virus (Sellers, 1969) when heating, but may simulate the realistic scenario in an FMDV outbreak in which milk from an infected farm is blended with milk from a noninfected farm at the dairy.

Several countries have issued contingency plans for use by animal health officials in the event of an FMDV outbreak. These plans provide guidelines on the prevention, diagnosis, and eradication of the disease at the farm and special instructions for handling of milk and milk products (APHIS, 2001; AUSVETPLAN, 1996; DEFRA, 2001). Currently, most plans follow the International Animal Health Code recommendations (OIE, 2003) that milk be treated according to the protocol established in Figure 2 in the event of an outbreak. The AUSVETPLAN (1996) recommends that products such as cottage cheese, yogurt, acid CN, and acid whey are defined as treated if they are subject to a processing pH <5 or pH >11 for a minimum of 30 min.

Double pasteurization is difficult to implement in commercial HTST plants. The benefits of an additional heating and holding time to eliminate virus are not

1. Milk or cream for human consumption (article 3.6.2.6)
 - a) Ultra-high temperature (UHT) (UHT = minimum temperature of 132°C for at least 1 s)
 - b) If the milk has a pH <7, simple HTST
 - c) If the milk has a pH >7 or over, double HTST
2. Milk for animal consumption (article 3.6.2.6)
 - a) Double HTST pasteurization (72°C for at least 15 s)
 - b) HTST combined with other physical treatment; e.g., maintaining a pH <6 for at least 1 h or additional heating to at least 72°C combined with desiccation
 - c) UHT combined with another physical treatment referred to in b)

Figure 2. Protocol established for the treatment of milk in the event of an outbreak of Foot-and-Mouth Disease virus following the International Animal Health Code recommendations (OIE, 2003).

reported in current literature. However, Donaldson (1997) reports that in the 1982 Denmark FMDV outbreak, milk fed to animals was subjected to two heat treatments, one at 72°C for 15 s and one at 80°C for 3 s followed by acidification to <4.5. Outbreaks of FMDV were not reported for domestic animals fed this milk.

Modern processing plants utilize a homogenization step between the regeneration and heating steps that breaks down the milk fat globules and may be useful in exposing virus encapsulated in milk fat and cells, thereby enhancing virus reduction. Also, prior to pasteurization, milk is clarified, which removes some virus in debris (Blackwell and Hyde, 1976).

The risks of pigs or calves contracting FMDV from infected raw milk are high, but Donaldson (1997) concluded that the risk of infection is low if they are fed pasteurized milk or a dairy product derived from it. Donaldson (1997) reports that for a high probability of infection, a calf would have to consume 1250 to 12,500 L of milk to obtain an infective dose of virus, a physical impossibility. He further concludes that if the dairy product was treated by HTST followed by another treatment or UHT, the risk for transmission of FMDV by the product is remote.

CONCLUSIONS

Biosecurity measures should be implemented to prevent spread of FMDV by raw milk in the event of an outbreak caused by either naturally occurring or deliberate contamination. These measures include feeding animals only pasteurized milk and dairy products, careful handling of raw milk on the farm in the milking parlor and at the bulk tank, and careful handling of milk during pick up and delivery.

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