Potential quality defects in milk as a result of high SCC from cows infected by FMD

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Introduction

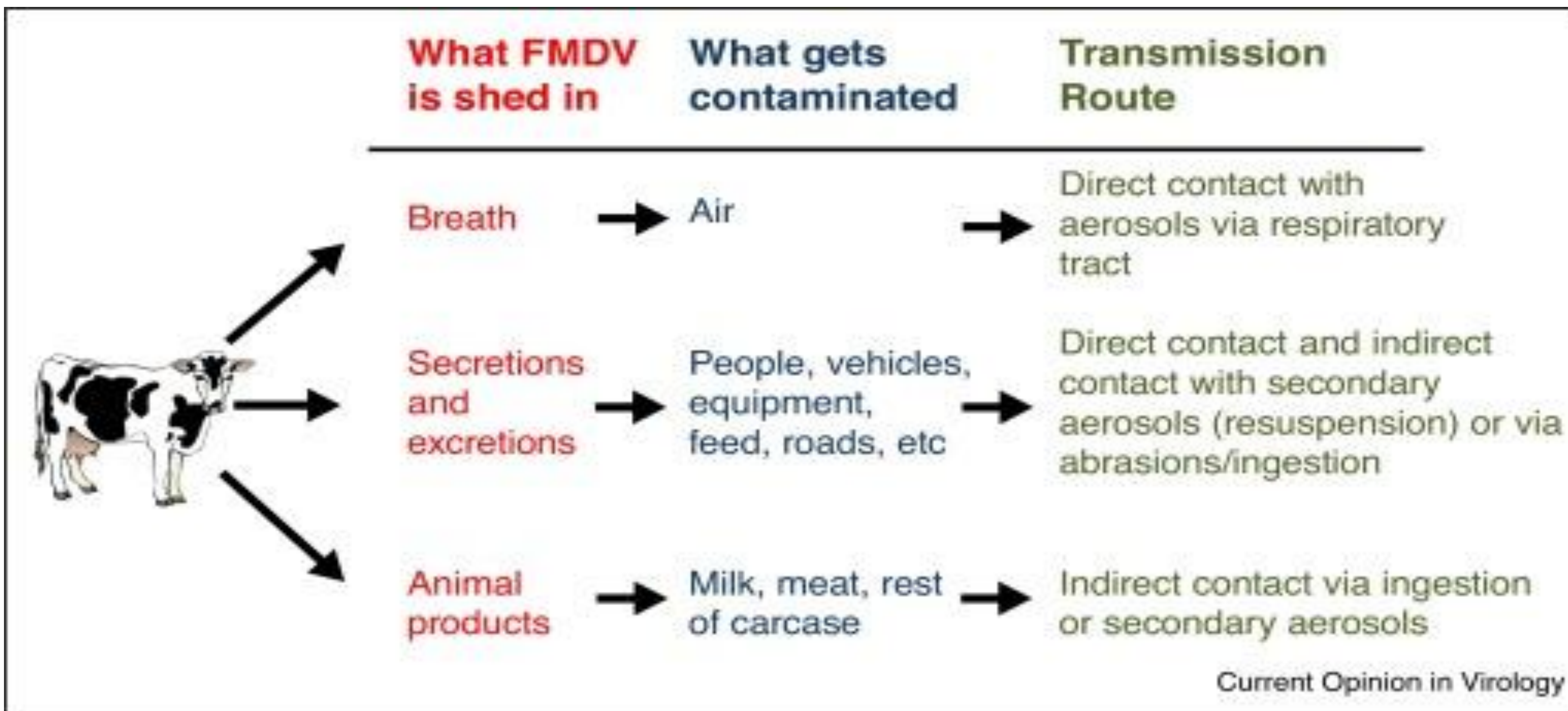
- Foot-and-mouth disease (FMD) is a highly transmissible disease caused by infection with an Aphthovirus, a member of the family Picornaviridae.
- There are 7 serotypes of the virus, termed: A, O, C, Asia 1, and SAT (Southern African Territories) 1, 2, and 3. Further diversity is found between strains within each serotype.
- The virus primarily affects cloven-hoofed animals and hosts include cattle, pigs, sheep, and goats.

Severity

- Outbreaks can severely disrupt livestock production and require significant resources to control, as in the 2001 UK outbreak.
- This outbreak, which lasted for approximately 8 months, is estimated to have cost about USD 10 billion.
- In nonendemic countries, a major part of the cost of outbreaks is because of lost trade and the large numbers of animals culled to limit spread of the disease, not direct effects of the disease on infected animals' performance.

Epidemiology and Transmission of Foot-and-Mouth Disease in Animals

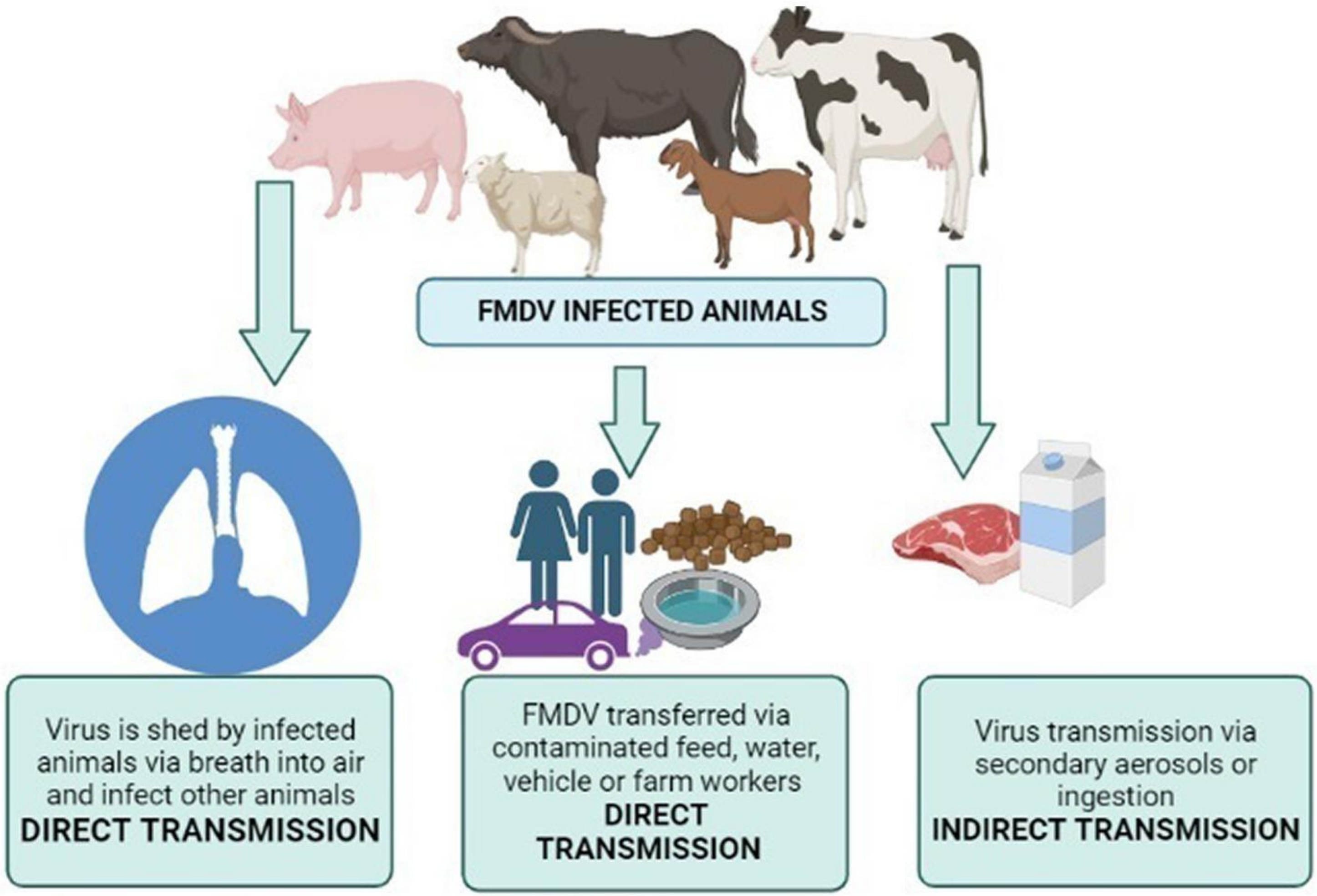
- The FMD virus is transmitted via direct contact with infected animals or indirect contact with secretions or excretions (including semen and **milk**) from infected animals or by mechanical vectors (**people, horses, dogs, cats, birds, vehicles) or air movement over land or water.**
- The virus can enter the host via inhalation, ingestion, or through skin wounds and mucous membranes.



Disease transmission

- FMD has high destruction potential because of its infectivity, high transmissibility through wind and by fomites (such as splinters, barbed wire or farmyard surfaces, including soil, feeding troughs or barn beams, have been implicated as sources of virus).
- People can act as mechanical vectors of FMD by carrying the virus on clothing or skin.
- However, FMD is not considered a public health problem.

Disease transmission



FMD virus resistance

- FMD virus is environmentally resistant but can be easily inactivated outside the pH range 6–9 and by desiccation(moisture loss) and at temperatures >56°C.
- It is resistant to lipid solvents such as ether and chloroform, but sodium hydroxide (caustic soda), sodium carbonate (soda ash), citric acid, and acetic acid (vinegar) are effective disinfectants.
- Iodophors(Iodine containing solutions), quaternary ammonium compounds, hypochlorite, and phenols are less-effective disinfectants, especially in the presence of organic matter.

Heat treatment of Contaminated milk and survival of FMD virus

- FMD virus is shed into milk in dairy cows before clinical signs develop, so there is opportunity for virus to spread from farm to farm and from cow to calf via raw milk.
- FMD virus may survive pasteurization depending on the method (HTST) as the lipid component of milk protects virus during heating.
- FMD virus can survive for up to 20 weeks on hay or straw bedding, in dry faecal matter for up to 14 days in summer, in faecal slurry for up to 6 months in winter, in urine for 39 days, and in soil for 3 (summer) to 28 (winter) days.
- The extent of virus survival in these materials is dependent on the initial level of contamination.

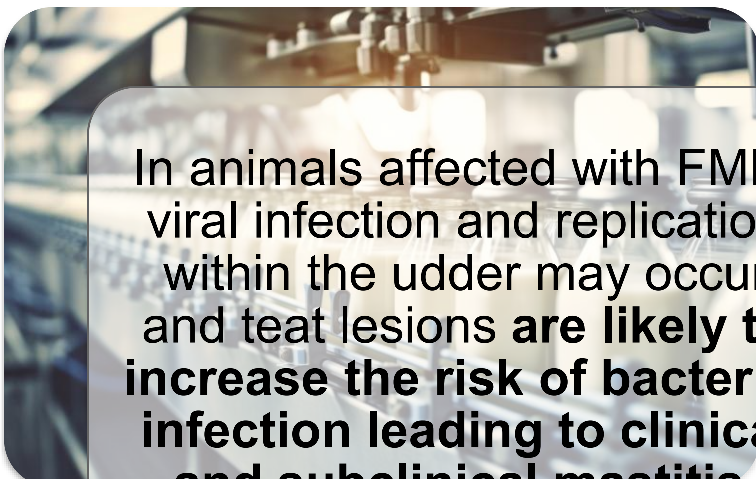
FMD virus incubation period

- The incubation period of FMD is variable and depends on the host, environment, route of exposure, and virus strain.
- After infection with FMD virus, the average incubation for cattle is 2–14 days.
- It is important to be aware that animals can transmit the virus before the appearance of clinical signs because animals have the virus in the pharynx (muscular tubular passage) and in the blood before the disease is observed.

Pathology

- Foot-and-mouth disease (FMD) being a viral condition of ruminants is characterised by initial pyrexia (temperature increase) followed by the development of vesicles on the tongue, hard palate, coronary band and interdigital region.
- **Lesions are also common on the teats in lactating cows** and a sudden milk drop is typically seen**.**

Effect of FMD on milk Production and processing



In animals affected with FMD, viral infection and replication within the udder may occur and teat lesions **are likely to increase the risk of bacterial infection leading to clinical and subclinical mastitis**.

High differential SCC as a result of mastitis poses direct and indirect problems during further processing

Effect of somatic cell on pasteurized milk

- High SCC has an influence on the casein fractions of pasteurized milk, especially low-fat products.
- The most important consequence of the changes in casein fractions of pasteurized milk during storage is the enzymatic hydrolysis of casein associated with SCC.
- Certain significant sensory modifications in milk is found mainly in the bitter taste due to peptides release, which originating mostly from the β-casein.

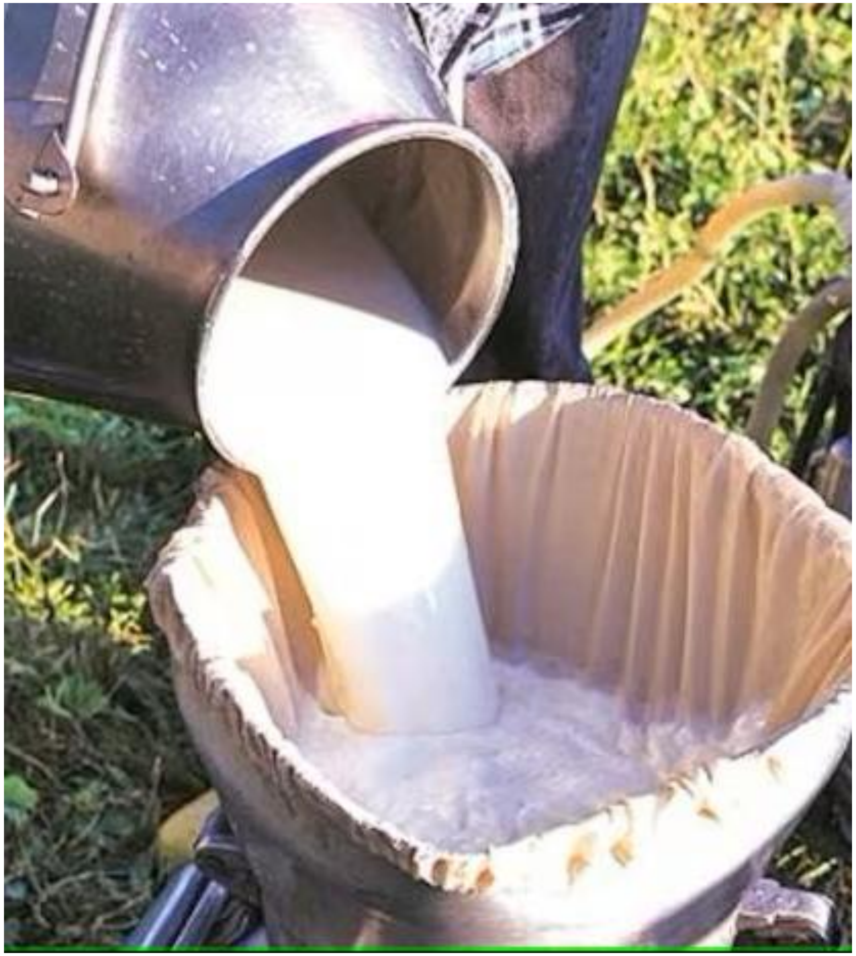
Effect of somatic cell on pasteurized milk (cont)

- Rancid off flavour has also been described as having a soapy, bitter, unclean taste and lingering aftertaste
- Bitterness has been associated with high levels of short-chain fatty acids
- Milk rancidity has been described as a major quality defect associated with market milk.
- Decreased CN (casein nitrogen) during cold storage of milk, especially in high SCC milk, indicates that significant levels of proteolytic activity remained after pasteurization.

(caseins, whey proteins and non-protein nitrogen(NPN) make up the nitrogen content of milk (76%, 18% and 6% respectively).

Effect of somatic cell on pasteurized milk (cont)

- High SCC raw milk has been shown to have high concentrations of plasmin, plasminogen and proteases of somatic cell origin.
- Plasmin is heat stable with large percentages surviving minimum pasteurization (72°C for15 sec).
- Even after UHT treatment, 30 to 40% of plasmin activity can still remain.



Effect of somatic cell on pasteurized milk (cont)

- Extensive proteolysis in milk can result in the accumulation of small hydrophobic peptides, causing bitterness and astringency. (During processing and digestion, milk proteins are disassembled into functional peptides).
- The high SCC milk has significantly higher tendency for bitter and astringent flavours at 21 d than low SCC milks.
- Bitterness becomes a problem when levels of heat-resistant plasmin are high, as is the case during mastitis.
- Proteolysis is a more significant problem in extended shelf life of refrigerated fluid milks.

Effect of somatic cell on cheese

- The production of dairy products from milk with elevated SCC has been characterized by reduced product yield, reduced yield efficiency, increased losses in the production of cheese (e.g. whey) and reduced product quality (Auldist et al., 1996; O'Brien et al., 2004).
- As SCC increases the fat in whey increases, moisture in cheese increases and protein in cheese decreases.
- Protein and fat recovery are found to considerably reduced as milk SCs increased.

Effect of somatic cell on cheese (cont)

The reduction in the recoveries of fat and protein in cheese with elevated SCC may be due to impaired rennet coagulation and cheese making properties or increased proteolysis and lipolysis in high SCC milk.

Elevated SCC may trigger a slow, weak congealing largely due to altered milk protein composition, mineral disproportion and an increased milk pH.

As milk SCC increased, the protein content of cheese significantly decreased.

Effect of somatic cell on cheese (cont)

- Decrease in protein is largely due to reduction in casein as a percentage of total protein, since it is commonly casein that is adjusted into the curd, while the whey is expelled during syneresis.
- Research found that the negative effects on the organoleptic properties of cheese were testified for milk with SCC as low as 100,000 cells/ml.
- Even a small increase in SCC can negatively impact cheese processing. Recommended that cheese manufacturers keep SCC <200,000 cells/ml.
- The loss in cheese is 318g per 100 kg milk when the somatic cell count increases from 240.000 to 640.000, equal to 3.26%.

Effect of somatic cell on ultra-high temperature (UHT)

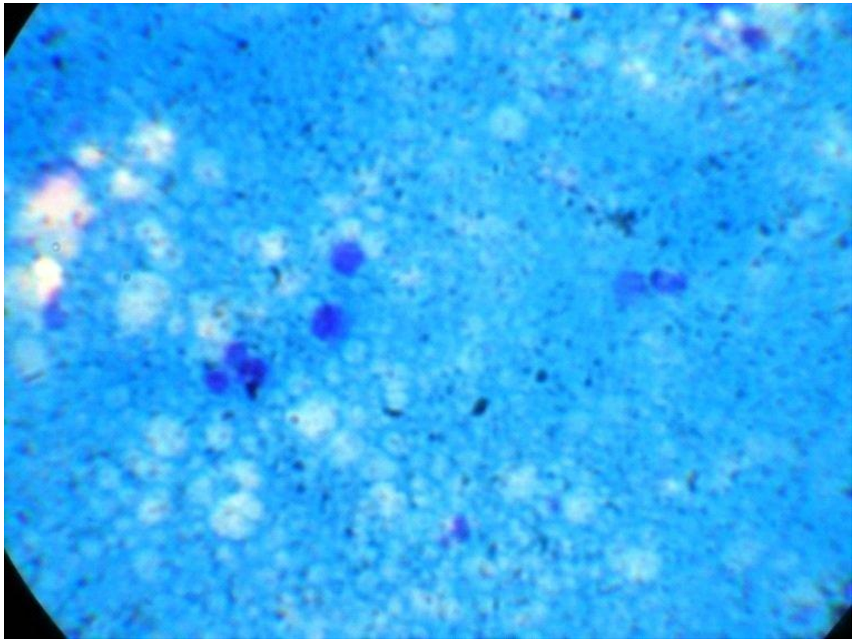
- Research found that UHT milk produced from raw milk with a high SCC tended to gel faster than low-SCC milk.
- Gelation of UHT milk during storage (age gelation) is a major factor limiting its shelf-life. The gel which forms in UHT milk is a three-dimensional protein matrix formed by the whey proteins, particularly b-lactoglobulin, interacting with casein, k-casein, of the casein micelle. The major proteinaceous linkages which develop during the heat treatment result in formation of b-lactoglobulin—k-casein complexes.
- The following factors which influence the quality of milk have an effect on the gelation behaviour of UHT milk.
  - *Gelation during storage of UHT milk has been associated with proteolysis of caseins in several studies. The proteolysis has been attributed to both the natural milk proteinase and proteinases produced by psychrotrophic bacterial contaminants of raw milk.*
  - *It has been reported that proteolysis of casein caused by milk proteinase is responsible for gelation of UHT milk during storage.*
  - *Proteolysis in milk may be caused by SCC proteases, native proteases (primarily plasmin) and proteases produced by psychrotrophic bacteria during storage of raw milk.*
  - *Plasmin is generated from plasminogen and this conversion is more pronounced in milks with high SCC (Verdi and Barbano et al., 1991). Although, previous reports have showed that plasminogen is continually converted to plasmin in UHT milk during storage (Magboul et al., 2001), which could explain the proteolytic activity found in the UHT milks*
  - *They concluded that low levels of plasmin, arising from activation of plasminogen by an elevated level of plasminogen activator in the high-SCC milks, were responsible for this enhanced gelation.*

Effect of somatic cell on Ultra-high temperature (UHT) (cont)

- Mastitic milk (i.e. with high somatic cell count) subjected to UHT treatment is more susceptible to gelation than normal milk (Swartling, 1968).
- This has been attributed to increased proteolytic activity resulting from an elevated level of plasmin (Bastian and Brown, 1996; Saeman et al., 1988).
- Auldist et al. (1996) showed that, during storage at 20°C, UHT-treated high-SCC milk showed more proteolysis than low-SCC milk - the milks with the highest SCC gelled fastest.

High SCC UHT milk and food safety

- The relationship of high SCC milk with the presence of pathogenic organisms and toxins offers insight into the potential increase in safety risk factors to consumers when high SCC milk is marketed.
- Scientific studies however have not shown that the ingestion of large numbers of bovine leukocytes is harmful to humans.



Handling of milk during FMD outbreak

- Milk from infected animals should at best be destroyed at point of source.
- Destruction by means of disposing milk in trenches and addition of souring agents to below pH 5 and covering with topsoil (30 days) soil survival.
- No spraying of milk on pastures and farmland.
- Heat treatment of milk for the purpose of animal feed to be avoided.
- Maintain biosafety measures at all times.

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Thank you/Dankie