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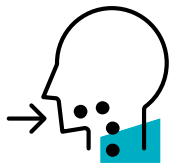
Foot-and-mouth disease - No health risk expected when consuming pasteurised milk and dairy produce

In brief

- Following the outbreak of foot-and-mouth disease (FMD) in Germany, the German Federal Institute for Risk Assessment has examined whether the consumption of milk from infected animals poses a health risk to humans.
- According to the current assessment, the consumption of heat-treated (pasteurised) milk poses no health risk, even if the milk comes from animals infected with the foot-and-mouth disease (FMD) virus. Products made from pasteurised milk such as yoghurt, milk powder or infant formula and other products made from it also pose no risk to human health according to the current state of knowledge.
- The heat treatment of milk (pasteurisation) leads to a significant reduction in the amount of viruses in the milk. Corresponding thermal processes are also used in the production of the aforementioned dairy produce.
- Overall, the scientific findings to date suggest that only the intake of very high amounts of virus (through intensive, direct contact with infected animals or through repeated consumption of highly contaminated, non-pasteurised milk) leads to human disease in individual cases.
- Between 1921 and 1997, only around 40 cases of human infection with the FMD virus were reported worldwide. In contrast to infected animals, human infections with the FMD virus are mild with complete recovery.

How does the foot-and-mouth disease virus enter the body via milk and dairy produce?

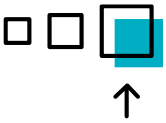


The foot-and-mouth disease virus is excreted by infected animals via vesicle contents in the mouth and claw area as well as body secretions and faeces, including milk. The virus can then be ingested **orally** by humans when consuming milk and dairy produce that has not been sufficiently heated.

Is there a health risk?

According to current knowledge, the consumption of pasteurised milk from animals infected with foot-and-mouth disease and the consumption of dairy produce made from it is safe for human health.

How high in quality is the data?



The quality of the data is **high**. The reduction of virus levels in milk through heat treatment (pasteurisation) has been proven in various studies. In the production of milk powder, infant formula or whey powder, a thermal inactivation process such as pasteurisation is also used at the beginning of the process. Specific laboratory tests for further virus reduction in the production of these dairy products are not available to the BfR. However, as drying processes with high temperatures are used, a further slight reduction in the amount of virus can be assumed.

1 Subject of the assessment

The German Federal Institute for Risk Assessment (BfR) issues a statement on possible health risks from the consumption of pasteurised milk and products with corresponding heat treatment (e.g. milk powder, infant milk formula) and products made from these (e.g. confectionery with whey powder) with regard to human diseases caused by infection with the foot-and-mouth disease (FMD) virus. The background to this is the outbreak of FMD in Germany, in which the FMD virus was detected in a herd of water buffalo in Brandenburg.

2 Result

The consumption of pasteurised milk and products with corresponding heat treatment (e.g. milk powder, infant milk formula) as well as products made from these (e.g. confectionery with whey powder) is safe for human health according to the current state of knowledge, even if the milk is derived from FMD-infected animals. In general, human infections with the FMD virus are extremely rare, show mild courses and were the result of direct and intensive contact with diseased animals. Only after a self-experiment with repeated ingestion of highly contaminated raw milk were symptoms of disease described. Infections and illnesses in humans through the consumption of pasteurised milk and milk products are not known.

The amount of foot-and-mouth disease virus is greatly reduced by heat treatment. When milk is pasteurised, the amount of infectious virus decreases by 4-5 $\log_{10}$ levels (10,000-100,000-fold) at a temperature of 72 °C for 15 seconds (s). A thermal inactivation process such as pasteurisation is also generally used at the beginning of the process in the manufacture of dairy produce, including dried products such as skimmed milk powder, whey protein concentrate or infant formula. Data on the inactivation of foot-and-mouth disease virus during the further production of these dairy products is not available, but it can be assumed that the drying steps used here result in a further slight reduction in infectivity. The manufacturing process of pasteurised milk and products with appropriate heat treatment thus significantly reduces the amount of virus, which is why a health risk to humans from the consumption of these products is not to be expected with a high degree of certainty.

3 Rationale

3.1 Assessment of the risk to human health from the consumption of pasteurised milk and products with appropriate heat treatment with regard to foot-and-mouth disease virus

3.1.1 Hazard identification

The foot-and-mouth disease (FMD) virus belongs to the family Picornaviridae, genus Aphtovirus, and comprises the seven serotypes O, A, C, SAT1, SAT2, SAT3 and Asia 1 (Rahman et al., 2025). The FMD virus is currently endemic in Turkey, the Middle East and Africa, in many Asian countries and in parts of South America (FLI, 2025). On 10 January 2025, FMD was detected in a water buffalo farm in the district of Märkisch-Oderland (Brandenburg). This is the first case of FMD in Germany since 1988.

The disease caused by the virus is foot-and-mouth disease. It is a highly contagious viral disease for all cloven-hoofed animals such as cattle, sheep, goats and pigs as well as various zoo and wild animals. Affected animals often show high fever and painful blistering in the mouth and claw area (Rahman et al., 2025).

The foot-and-mouth disease virus is excreted by infected animals via body secretions and faeces. Fluid-filled vesicles in particular contain high levels of foot-and-mouth disease virus. However, the virus is also excreted via the mammary glands. Here, the foot-and-mouth disease virus can be detected even before the onset of clinical symptoms, with virus quantities of up to $10^{6,6}$ KID_{50}/millilitre (ml) (infectious dose determined by inoculation of cell cultures) (Donaldson et al., 1997).

The foot and mouth disease virus has a high tenacity against drying, cold and high salt concentrations. In raw milk, frozen and cured meat such as pork, the virus can remain infectious for months under suitable conditions. In contrast, the virus is rapidly inactivated at pH values below 6.0 (Bachrach et al., 1957).

3.1.2 Hazard characterisation

Diseases caused by the FMD virus in humans are extremely rare and are generally mild with complete recovery (ECDC, 2012). Between 1921 and 1997, there were only about 40 known cases of human infection with the FMD virus worldwide (Bauer, 1997). Even during a major FMD outbreak in the UK in 2001 with over 2,000 outbreaks in livestock, humans were not

infected, despite increased surveillance (Pempeh et al., 2001). In this respect, this disease is not to be regarded as a classical zoonosis.

In the cases observed, a mild febrile general illness developed with subsequent vesicle formation in the mouth, finger and toe areas. The blisters subsequently healed completely within a few days.

The diseases were mainly caused by direct and intensive contact with diseased animals in animal husbandry or during slaughter, or during vaccine production. Furthermore, Hertwig (1824, cited in Bauer, 1997) describes a self-experiment in which three veterinarians each drank 250 ml of highly contaminated raw milk from cows suffering from foot-and-mouth disease on four consecutive days and then fell ill. There are no known cases of illness following the consumption of pasteurised milk or other foods.

3.1.3 Exposure estimation

The minimum infectious dose for humans is not known for the foot-and-mouth disease virus, and the few cases of disease described were exclusively due to intensive direct contact with infected animals. Only a targeted repeated ingestion of highly contaminated raw milk in a self-experiment could trigger an illness. It can therefore be assumed that only the intake of very high quantities of virus leads to human disease in individual cases.

Virus quantities of up to 10^4 ID_{50}/ml (infectious dose determined by inoculation of animals) or $10^{2.2}$ PFU/ml (infectious dose determined by inoculation of cell cultures) were found in raw milk tanks from farms with FMD (Tomasula and Konstanze, 2004).

Heat can inactivate the foot-and-mouth disease virus. In "high temperature - short time" (HTST) pasteurisation, milk is heated to a minimum of 72 °C for at least 15 s. Heat treatment of milk from experimentally infected cows reduced the amount of infectious virus at 72 °C for 15 s by 4-5 log_{10} levels (10,000-100,000-fold, measured in cell cultures), but residual infectious virus could still be identified by inoculation into cattle (Blackwell et al., 1976). The effect of pasteurisation was also investigated in a short heating system with plate heat exchanger and hot holding tube (Tomasula et al., 2007). Milk with up to 10^4 PFU/ml from experimentally infected cows was tested. After heat treatment in the temperature range between 72 °C and 95 °C with a heat holding time of 18 s or 36 s, no infectious virus could be detected in cell culture experiments, although residual infectious virus was still detected in individual samples in animal experiments (Tomasula et al., 2007). Relevant animal health regulations (EU, 2019) consider pasteurisation at 72 °C for 15 s to be sufficient to ensure safety for dairy produce with regard to FMD transmission.

In the production of dairy produce, including dried products such as skimmed milk powder, whey protein concentrate or infant formula, a thermal inactivation process is generally used at the beginning of the process, so that the effect of pasteurisation already significantly reduces the amount of virus (International Dairy Federation, 2022). The BfR does not have any data on the further reduction of foot-and-mouth disease virus in the production of milk powder, infant formula or whey powder. In the manufacture of these products, the milk or whey is converted into powder by spray drying at high temperatures. The drying process is assumed to reduce the FMD virus by around 1 log level, although there are no specific laboratory tests on this (Centre for Food Security and Public Health, 2014).

The fact that no human infections or illnesses have been reported to date through the consumption of pasteurised milk and dairy products indicates that pasteurisation reduces the amount of virus far below the minimum infectious dose for humans.

3.1.4 Risk characterisation

FMD is a highly infectious viral disease for cloven-hoofed animals. During the illness of the animals, the FMD virus can enter the milk and remain infectious in raw milk. Infections and diseases in humans caused by the foot-and-mouth disease virus are extremely rare, generally with a mild course and complete recovery. Almost all human cases are due to close contact with infected animals. It has also been shown that under the extreme conditions of self-experimentation with ingestion of highly contaminated raw milk, human disease can be triggered. Overall, human disease caused by the foot-and-mouth disease virus therefore appears to be a very rare event that can be attributed to contact with very high levels of the virus.

The pasteurisation of milk greatly reduces the amount of virus over several log levels, so that the virus is either completely inactivated or only a very small amount of residual virus must be assumed in pasteurised milk. A significant reduction in the amount of virus must also be assumed in the production of milk powder, infant milk formula or whey powder, as a thermal inactivation process such as pasteurisation is always used at the beginning of the process and a further slight reduction in infectivity can be assumed due to the drying steps used thereafter. The fact that no human infections or illnesses have been described to date through the consumption of pasteurised milk and dairy products also indicates that these products are safe for human consumption.

Overall, it can therefore be concluded that the consumption of pasteurised milk and products with corresponding heat treatment (e.g. milk powder, infant milk formula) as well as products made from these (e.g. confectionery with whey powder) is safe for human health according to the current state of knowledge.

Further information on the BfR website on foot-and-mouth disease

Foot-and-mouth disease /(FMD): questions and answers
https://www.bfr.bund.de/en/foot_and_mouth_disease__fmd___questions_and_answers-318720.html

BfR communication: Foot-and-mouth disease in cloven-hoofed animals: No hazard to humans through food consumption
https://www.bfr.bund.de/cm/349/foot-and-mouth-disease-in-cloven-hoofed-animals-no-hazard-to-humans-through-food-consumption.pdf

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About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the Federal Ministry of Food and Agriculture (BMEL) in Germany. The BfR advises the Federal Government and the States ('Laender') on questions of food, chemicals and product safety. The BfR conducts independent research on topics that are closely linked to its assessment tasks.

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Publisher:
German Federal Institute for Risk Assessment
Max-Dohrn-Straße 8-10
10589 Berlin, Germany
T +49 30 18412-0
F +49 30 18412-99099
bfr@bfr.bund.de
bfr.bund.de/en

Institution under public law
Represented by the president Professor Dr Dr Dr h. c. Andreas Hensel
Supervisory Authority: Federal Ministry of Food and Agriculture
VAT ID No. DE 165 893 448
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