

Tenacity (resistance) of noroviruses in strawberry compote

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On 19 September 2012, what has so far been the largest known foodborne outbreak of gastroenteritis in Germany broke out in various schools and childcare establishments in the federal states of Berlin, Brandenburg, Saxony, Saxony-Anhalt and Thuringia. A total of more than 11,000 children and youths suffered from diarrhoea and vomiting. Epidemiological studies conducted by the Robert Koch Institute and the task force set up at the Federal Office of Consumer Protection and Food Safety suggest that the pathogen and / or the pathogenic substance were transmitted through a batch of raw deep-frozen strawberries. Results from stool tests show that norovirus may have been the cause of the illness. The Federal Institute for Risk Assessment (BfR) has evaluated the tenacity, i.e. the resistance of noroviruses in strawberry compote which was produced in various ways in the kitchens implicated in the outbreak. Little is generally known about the tenacity of the human norovirus, because the infectiousness of these viruses cannot be measured due to a lack of cell culture systems. Nevertheless, according to the current state of knowledge, it is to be assumed that a high risk of infection is posed not only by raw but also by briefly heated dishes made from strawberries, if they are contaminated with noroviruses.

1 Subject of the Assessment

The Federal Institute for Risk Assessment (BfR) has scientifically assessed the tenacity of noroviruses in strawberry compote which was prepared in different ways in various industrial kitchens using deep-frozen strawberries. This assessment was conducted against the background of an outbreak of acute gastroenteritis among children and youths as well as caregivers in institutions in East Germany. At the end of September 2012, the majority of cases occurred in schools and kindergartens which in the relevant time period had been supplied with desserts by at least ten different kitchens. These desserts had been made from deep-frozen strawberries from a specific batch and without sufficient heating. In addition, studies of the Robert Koch Institute indicate a strong and statistically relevant connection between the consumption of these strawberry dishes and cases of diarrhoea with vomiting. With more than ten thousand cases, this outbreak is by far the largest known foodborne outbreak in Germany recorded so far. There is mounting evidence that deep-frozen strawberries contaminated with noroviruses caused the outbreak.

Investigations conducted by the affected catering company have found that the deep-frozen strawberries were prepared in different ways by the various kitchens. Several kitchens associated with the illness reported that they had only thawed and sugared the strawberries. Two kitchens stated that they had briefly heated the strawberries. One kitchen is said to have stirred the frozen strawberries into boiling water with sugar and a pinch of salt and then left them boiling for another two to three minutes before letting them brew for a while. According to information provided by the affected catering company, kitchens which have so far not been associated with the outbreak have almost exclusively served the strawberries in boiled form. The BfR has no information on what core temperatures were reached during these heating procedures.

2 Findings

Knowledge is generally scant about the tenacity of human noroviruses, because the infectiousness of these viruses cannot be measured due to a lack of cell culture systems. Heating human noroviruses for 30 minutes to 60 °C cannot completely inactivate the virus,

nor can lowering the pH value to 2.7 for three hours as has been proven by experiments with volunteers. No studies on noroviruses in strawberry compote or similar dishes are available. Overall, it can be concluded from the existing data that noroviruses tolerate a low pH value and that in a temperature range above 70 °C they lose infectivity in dependence of the holding time applied. Heating strawberry compote to core temperatures of above 90 °C and / or long holding times in the temperature range above 70 °C seem to be a suitable way to completely deactivate the virus. However, it is to be expected that stirring large quantities of deep-frozen strawberries into boiling water or the uneven heating resulting from brief boiling of a large quantity of compote cannot safely inactivate noroviruses present on the strawberries.

3 Statement of Reasons

Noroviruses are unenveloped viruses of the genus *Norovirus* in the family *Caliciviridae*. Several genogroups exist of which genogroups I and II are the most important in terms of human infections. Infection with noroviruses can lead to gastrointestinal illness which is characterised by diarrhoea and vomiting. This type of illness is found in all age groups. Infection experiments with volunteers led to the estimation of a minimal infectious dose of 10-100 virus particles. More recent analyses of these data show that the probability of a norovirus infection following ingestion of an infectious norovirus particle is 0.5. However, the probability of coming down with the symptoms increases with a higher infection dose from 0.1 (at 10^3 particles) to 0.7 (at 10^7 particles) (Teunis et al., 2008). The BfR is not aware of any studies on the differences in the dose-response relationship between children and adults. Infected persons can, with their stool, excrete up to 10^{11} virus particles per gram (Atmar et al., 2008).

Noroviruses are transmitted via the faecal-oral route. This can occur by direct contact with infected persons or indirectly via contaminated surfaces of foods. Infected persons can excrete very large quantities of norovirus with their stool. Food can also be contaminated through contact with norovirus-contaminated waste waters. Most likely, there is no reservoir for human noroviruses outside human beings.

Berries can be contaminated with noroviruses at different stages of the production process. The main concern in this context is improper watering and / or fertilisation with human excrements contaminated by norovirus. In addition, during the harvest or packaging persons infected with the norovirus can transfer the virus to the berries. In case of deep-frozen berries, norovirus can additionally get onto the berries via contaminated water which is added during the freezing process. In addition, the berries may also be contaminated during food preparation.

The BfR is not aware of any major outbreaks of illness in connection with strawberries contaminated with norovirus. However, there are numerous reports describing cases of illness through norovirus-contaminated raspberries. Deep-frozen raspberries are often mentioned in this context (Ponka et al., 1999; Falkenhorst et al., 2005; Cotterelle et al., 2005). A viral outbreak caused by deep-frozen strawberries contaminated with hepatitis A virus occurred in the United States in 1991 (Niu et al., 1992).

Little is generally known about the tenacity of human noroviruses, because the infectivity of these viruses cannot be measured due to a lack of cell culture systems. Studies with volunteers have shown that inactivation of noroviruses was insufficient after heating to 60 °C for 30 minutes (Dolin et al., 1972). Further insights into the tenacity of noroviruses have been obtained indirectly, through the use of surrogate viruses which are more or less closely

related to the human norovirus. Studies on the feline calicivirus (FCV) and canine calicivirus (CaCV) have shown that heating to 70 °C for 1 minute leads to a virus reduction of about 3 log (Duizer et al., 2004; Doultree et al., 1999). A virus reduction of 1 log means a decrease in the virus contamination by factor 10. FCV and murine norovirus (MNV) only show a minor decrease in infectivity amounting to 1 log following heating to 72 °C for 15 seconds (Cannon et al., 2006). Heating of FCV to 70 °C for 5 minutes or boiling for 1 minute leads to a strong reduction of 7.5 log (Cannon et al., 2006). If MNV is incubated at 80 °C for 2.5 minutes, it is deactivated by 6.5 log (Baert et al., 2008a).

Similar, little is known about the sensitivity of human noroviruses to pH value changes or additives. Exposed to a pH value of 2 for 30 minutes at 37 °C, the surrogate viruses FCV and CaCV show a strong fall in infectivity by 5 log (Duizer et al., 2004). Subjected to the same conditions, the surrogate virus MNV only shows a decrease of infectivity by less than 1 log, however (Cannon et al., 2006). This virus seems to be a more suitable surrogate for pH value studies, since early infection studies with human norovirus in volunteers had indicated that a pH value change to pH 2.7 for 3 hours did not destroy its infectivity (Dolin et al., 1972).

Investigations into the tenacity of human noroviruses in strawberries do not exist. A study was conducted with MNV which had been added to raspberry puree (Baert et al., 2008b). A treatment at 65 °C for 30 seconds resulted in a reduction of infectivity by 1.86 log. Heating to 75 °C for 15 seconds led to a decrease by 2.81 log.

4 References

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