German Federal Institute for Risk Assessment

FAQ

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STEC/EHEC infections through food: identifying and preventing risks

→ Changes compared to the version dated 2 September 2024: Revision and update; addition of information on the possible bacterial contamination of sprouts and sprout seeds such as fenugreek seeds, update of the reading material.

STEC stands for Shiga toxin-producing *Escherichia* (*E.*) *coli*. These are mainly transmitted through contaminated/impure food. STEC contain the Shiga toxin (formerly termed verotoxin), a strong cell toxin that can cause serious illness in humans. These include (bloody) diarrhoea and haemolytic uraemic syndrome (HUS), which can lead to kidney failure. STEC are often referred to as enterohaemorrhagic *E. coli* (EHEC).

The best-known representative of STEC is serotype O157:H7. On a global scale, this is the serotype most frequently associated with severe disease and outbreaks affecting large numbers of people. However, detection of other STEC serotypes in cases of severe infection are increasing. STEC are difficult to detect because their general properties do not differ from those of common *E. coli* bacteria found in the intestinal flora. Identifying STEC entails determining Shiga toxins and, if necessary, other virulence characteristics that cause disease in specialised laboratories.

What are STEC?

STEC are *E.* coli bacteria that produce certain poisonous substances (toxins). These Shiga toxins (formerly termed verotoxins) are powerful cell toxins that can cause serious illness in humans. To test, for example, food for STEC bacteria, the corresponding toxin genes (*stx* genes) are detected in the laboratory.

What is the difference between STEC, VTEC and EHEC?

Historically, the bacteria were called verotoxin-producing *E. coli* (VTEC) because the effect of the toxin produced by these bacteria can be detected in cell culture tests using what are

termed Vero cells (kidney cells from African green monkeys). As the toxin is very similar in structure to the toxin produced by *Shigella dysenteriae*, the name "Shiga-like toxin" was also used interchangeably. Today, the term Shiga toxin is primarily used, referring to Shiga toxin-producing E. *coli* (STEC). STEC found in humans are usually referred to as enterohaemorrhagic E. *coli* (EHEC) and reported as EHEC infection.

Where do STEC normally occur?

STEC occur naturally in the intestines of ruminants such as cattle, goats or sheep and are excreted in the animals' faeces. They can be transmitted directly or indirectly (through contaminated food or water) from animals to humans and cause disease.

How long is the incubation period for a STEC infection?

It takes an average of three to four days from consuming food contaminated with STEC to the onset of illness. However, the incubation period ranges between two and ten days.

How do humans become infected with STEC?

Humans become infected with STEC via the oral route. The most common route of infection is via the consumption of contaminated food, mainly raw milk and meat products. STEC is common in livestock (cattle, sheep, goats, less commonly pigs) without the animals becoming ill. The pathogens are excreted from the animals' intestinal flora into the environment as well as into animal food products (e.g. milk and meat). These food products can become contaminated with STEC at almost any point in the production chain, all the way up to the consumer. Only a few bacteria are needed to cause infection in humans: with STEC serotype O157:H7, people can become ill after ingesting just 10 to 100 bacteria. Raw animal food products should therefore be heated sufficiently before consumption.

Other important routes of infection include contact with STEC shedders (sick humans and healthy livestock/zoo animals that shed these pathogens) and infections from STEC-contaminated environments (e.g. surface water and soil). Some of the pathogens can survive in the environment for many weeks. Contaminated water and fertilisation with contaminated excrement can also contaminate vegetables, grains and fruit with STEC. If these are inadequately cleaned and then consumed raw, they can be a source of infection for humans. See the BfR FAQ on E. *coli* in flour and dough.

The Robert Koch Institute regularly publishes current figures on cases on its website (RKI - Publications and data).

Why can fruit and vegetables be contaminated with STEC?

Fruit and vegetables can be contaminated with the pathogen through STEC-contaminated water or natural fertilisers. In addition, the pathogen can also be transmitted during food preparation through cross contamination. This occurs when bacteria from contaminated (usually raw) food (e.g. meat) is transferred to another (usually ready-to-eat) food (e.g. salad). The bacteria can be transmitted during food preparation through direct contact with the food. However, indirect transmission via hands, equipment, work surfaces, knives or

other kitchen utensils is also possible. Cross contamination is possible, for example, if contaminated raw meat is processed first and then salad is cut with the same knife.

Can sprouts be a source of STEC/EHEC?

Sprouts are grown industrially in germination chambers in a very moist and warm environment. These are ideal conditions for the extremely rapid growth of bacteria that accidentally come into contact with the sprout seeds or water, for example due to poor hygiene. If contamination with pathogenic bacteria such as STEC occurs, a bacterial count that exceeds the necessary infection dose is quickly reached.

Fresh sprouts are therefore among the most perishable foods. Even when stored in a cool place, there is a risk of rapid microbial spoilage and food-borne infection with pathogenic bacteria such as *E. coli*, *Listeria*, *Salmonella* or viruses such as noroviruses or hepatitis A viruses.

Even low germ counts can increase rapidly within a few days due to germ multiplication in pre-packaged sprouts. As a result, the germ load can be very high once the use-by date is reached. The BfR recommends that these foods should only be consumed after thorough heating.

If the sprouts are served raw, they should be washed thoroughly before consumption and eaten as quickly as possible to reduce the bacterial load. People with weakened immune systems should avoid eating raw sprouts.

This recommendation also applies to sprouts grown at home.

Can STEC also be found in plants if the seeds were already contaminated with the pathogen?

For wheat seeds and various sprout seeds, it has been shown that contamination of the seeds can lead to contamination of the seedlings. Other experimental studies have also shown that some STEC strains can, for instance through the soil, be internalized into the roots of plants (e.g. lamb's lettuce, lettuce, spinach) and, in isolated cases, end up in the plant itself.

In experiments involving contamination of alfalfa sprouts with STEC, the intake of bacteria into the interior of the plants was detected in isolated cases.

How safe are home-grown vegetables?

When you grow your own vegetables, you can trace the entire production process. However, it cannot be ruled out that the vegetables are contaminated with STEC (or other bacteria). Hygiene rules for the cultivation, storage and preparation of food should therefore also be observed here.

How can STEC infection through food be avoided?

In general, observing general hygiene rules reduces the risk of infection:

- Wash your hands thoroughly with soap and water and dry them carefully before preparing food as well as after contact with raw meat.
- Store and prepare raw meat separately from other foods (e.g. vegetables), including when barbecuing (use separate cutting boards, plates, and tongs).
- Vegetables, fruit and other foods that have come into contact with suspicious products (e.g. contaminated vegetables) should also not be eaten raw. Such contact can occur, for example, when products are stored next to each other.
- Surfaces and objects that have come into contact with raw meat, its packaging or defrosting water should be cleaned thoroughly with washing-up liquid and warm water and then dried immediately.
- Replace cloths and towels after preparing raw meat and wash them at a minimum temperature of 60°C.
- Wash raw fruit and vegetables thoroughly before eating (rub vigorously for at least 30 seconds, using warm water if possible) and peel if necessary. Washing and peeling reduces the number of bacteria and lowers the risk of infection. However, neither method completely eliminates bacteria.

Certain foods are particularly often associated with STEC/EHEC outbreaks (e.g. raw milk and beef) or have been identified as the cause of particularly critical outbreaks (e.g. sprouts and seeds from which sprouts are grown). Additional measures must be observed when handling these foods.

For example, particularly vulnerable individuals (children under five years of age as well as elderly or immunocompromised individuals) are generally advised not to consume raw milk and raw milk products (e.g. raw milk cheese).

Seeds for sprouts are sometimes also used as additives in other foods; for example, fenugreek seeds are found in herbal teas, cheese and mustard varieties, breastfeeding teas, food supplements and curry mixes. However, there is currently no evidence that foods made from fenugreek seeds other than sprouts cause EHEC infections.

Tea bags containing fenugreek seeds should be infused with boiling water like any other herbal tea and left to steep for at least 5 minutes. As herbal teas can be contaminated with pathogens, the BfR does not consider water from hot water dispensers to be suitable for preparing herbal teas.

Ground fenugreek seeds are used to make spice mixtures, especially curry powder. Fenugreek seeds are a common ingredient in Indian curry spice mixtures in particular. In the industrial production of spices, thermal processes such as hot water steam treatment are commonly used to reduce pathogens. These treatments are also effective against STEC bacteria.

Homemade spice mixes made from fenugreek seeds are safe if the seeds have been heated thoroughly, for example by roasting them in a pan or boiling them.

How can STEC bacteria be killed?

Heating processes such as boiling, frying, roasting and braising kill STEC. This requires that a temperature of 70 °C or higher be reached at all points of the food for at least two minutes. (For foods with low water content, such as flour and sprout seeds, this temperature-time

combination may not be sufficient.) However, these bacteria are relatively insensitive to other environmental influences, such as an acidic environment, cold or dehydration. Deep-freezing food does not usually kill STEC bacteria either.

Can STEC also occur in processed foods and canned foods?

Whether STEC occurs in processed or packaged foods depends on the type of processing. Products that no longer contain raw food generally do not pose a risk of bacterial transmission.

The pathogen does not survive the usual heating processes used in the production of canned foods. The temperatures used for pasteurising milk and producing cooked sausages are also sufficient to kill STEC. In products such as pickled gherkins, the low pH value and salt content generally ensure adequate preservation.

Unheated, merely washed plant-based foods such as bagged salad may contain STEC or other pathogens and should be washed thoroughly before consumption.

Can a STEC infection be transmitted to infants via breast milk during breastfeeding?

The BfR points out that STEC is not transmitted to infants via breast milk.

Is it advisable to disinfect food with tablets intended for water disinfection or with other substances to protect against STEC infection?

Tablets for water disinfection are not suitable for disinfecting food. The prescribed concentration for use is only suitable for sterilising water. Increasing the concentration without prior efficacy testing could, in the worst case, lead to health impairments due to residues being left on the food.

In Germany, there are currently no products approved and widely available for disinfecting food. Disinfectants approved for use in the food sector are intended exclusively for killing germs on everyday objects, surfaces or floors.

Can pets also become infected with STEC?

Pets can also come into contact with STEC, for example when fed raw meat, and become infected. Such infections are usually milder than in humans. However, it is possible for pets to in turn infect humans via smear infection if adequate hygiene is not observed.

Is there a link between STEC in game animals, game meat and STEC diseases in humans?

The German federal states ("Laender") regularly collect data on the prevalence of STEC in wild animals and game meat samples as part of their zoonosis monitoring. This data shows a high STEC prevalence (occurrence) of 40% in roe deer and approximately 30% in roe deer meat samples. In comparison, STEC-positive samples are found in approximately 20 to 25% of calves and cattle raised for meat production, while STEC is detected in approximately 2 to

3% of beef samples. The significantly lower prevalence of STEC in beef compared to game meat is attributed to differences in the slaughtering process.

STEC infections or outbreaks caused by the consumption of game meat are reported rather rarely, probably for a variety of reasons (different STEC types, frequency of consumption, form of consumption, distribution range).

As STEC is frequently detected in wild ruminants, good hand hygiene should be observed immediately after visiting petting zoos or petting enclosures in wildlife parks.

What was the cause of the largest STEC/EHEC outbreak in Germany to date?

An *E. coli* strain of serotype O104:H4 was clearly identified as the cause of the STEC/EHEC outbreak caused by sprouts in Germany in 2011. Genetic analysis of the strain revealed that it is very similar to enteroaggregative E. *coli* (EAEC or EAggEC) but still produces Shiga toxins.

EAEC are another group of pathogenic *E. coli*. They attach in a specific way to the intestinal wall and cause watery diarrhoea. EAEC can be transmitted from person to person via smear infections.

STEC/EHEC can typically be clearly distinguished from EAEC. While STEC bacteria live in the intestines of ruminants, EAEC have so far mainly been detected in humans, not in animals. Like STEC, EAEC cause (severe) diarrhoea. Unlike STEC, however, EAEC do not normally produce Shiga toxins, which can cause particularly severe illness in humans, such as the haemolytic uraemic syndrome (HUS), which is characterized by damaged small blood vessels, destruction of red blood cells and acute kidney failure. The EHEC outbreak in Germany in 2011, with more than 3,800 ill people and 53 dead, showed that new combinations of different *E. coli* types can sometimes emerge, posing new challenges.

What is being done to protect consumers from STEC?

Reference laboratories at the BfR and the Robert Koch Institute detect, characterise and assess the risk posed by STEC. At the BfR, *E. coli* from food sent in by the regional authorities of the German federal states ("Laender") are characterized in order to identify STEC that are pathogenic to humans, i.e. that cause illness. The determination of STEC types and their virulence characteristics – i.e. the characteristics that cause them to make people ill – is necessary in order to identify whether human infections are attributable to the consumption of STEC-contaminated food. The aim is to detect and contain outbreaks of disease as quickly as possible. Whole genome sequencing is used to characterise STEC strains in detail and compare samples isolated from food and humans. These genome sequences provide information about the relationship between individual strains and indicate possible infection events. They also provide an overview of the prevalence and variability of STEC in general or of specific subtypes in Germany. When it comes to comparing strains, the BfR works closely with the competent authorities of the German federal states ("Laender"), the German Federal Office of Consumer Protection and Food Safety and the Robert Koch Institute to protect consumers from outbreaks caused by STEC-contaminated food.

Further information on STEC/EHEC infections through food on the BfR website:

BfR FAQ "**Escherichia coli in flour and dough – What is important for enjoyment without remorse?**"
https://www.bfr.bund.de/en/service/frequently-asked-questions/topic/escherichia-coli-in-flour-and-dough-what-is-important-for-enjoyment-without-remorse/

BfR FAQ "**Preparing (green) smoothies: what should be considered**"
https://www.bfr.bund.de/en/service/frequently-asked-questions/topic/preparing-green-smoothies-what-should-be-considered/

BfR FAQ "**Avoiding infections – What should be considered when consuming raw milk?**"
https://www.bfr.bund.de/en/service/frequently-asked-questions/topic/avoiding-infections-what-should-be-considered-when-consuming-raw-milk/

BfR opinion "**Tempered hot water dispensers not suitable for herbal tea infusions**" (in German)
https://www.bfr.bund.de/stellungnahme/temperierte-heisswasserspender-fuer-kraeuterteeaufguesse-nicht-geeignet/

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH). It protects people's health preventively in the fields of public health and veterinary public health. The BfR provides advice to the Federal Government as well as the Federal States ('Laender') on questions related to food, feed, chemical and product safety. The BfR conducts its own research on topics closely related to its assessment tasks.

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