

FAQ

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STEC/EHEC infections from food: recognising and preventing risks

The term STEC stands for Shiga toxin-producing *Escherichia (E.) coli*. These are mainly transmitted through contaminated food. STEC possess the eponymous Shiga toxin (formerly also known as Verocytotoxin). Shiga toxin is a powerful cytotoxin that can cause serious illness in humans. It can cause (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. This serotype is most frequently associated with severe courses of disease and outbreaks worldwide, affecting a large number of patients. However, other STEC serotypes are also increasingly being detected in severe infections. STEC are difficult to recognise as these bacteria do not differ in their general characteristics from *E. coli* bacteria in the intestinal flora. In order to be able to identify STEC, the presence of Shiga toxins and possibly other virulence characteristics must therefore be determined in specialised laboratories.

What is STEC?

STEC are *E. coli* bacteria that produce certain toxins. These so-called Shiga toxins (formerly also known as Verocytotoxins) are strong cytotoxins that can cause serious illness in humans. The corresponding toxin genes (*stx* genes) are detected in the laboratory to analyse food for STEC bacteria, for example.

What is the difference between STEC, VTEC and EHEC?

Historically, the bacteria were called verocytotoxin-producing *E. coli* (VTEC), as the effect of the toxin produced by these bacteria could be demonstrated in cell culture tests with so-called Vero cells (kidney cells of the African green monkey). As the toxin is very similar in structure to the toxin produced by *Shigella dysenteriae*, the name "Shiga-like toxin" was used equivalently. Nowadays, the term "Shiga toxin" is primarily used when discussing Shiga

toxin-producing *E. coli* (STEC). STEC found in humans are often referred to as enterohaemorrhagic *E. coli* (EHEC) and reported as EHEC infections.

Where do STEC normally occur?

STEC usually occur naturally in the intestine 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 can the incubation period for a STEC infection last?

On average, it takes three to four days from eating food contaminated with STEC to the outbreak of the disease. However, the incubation period can vary between two and 10 days.

How can humans become infected with STEC?

People become infected with STEC through oral intake. The most common route of infection is described as the consumption of contaminated food, mainly raw milk and meat products. In livestock (cattle, sheep, goats, less frequently pigs), STEC often occurs without the animals becoming ill. The pathogens enter the environment from the intestinal flora of the animals and are then transferred to animal foods (e.g. milk and meat). These foods can be contaminated with STEC at almost all points in the production chain right through to the consumer. Only a few bacteria are sufficient to cause an infection in humans: In the case of STEC O157:H7, people can fall ill after ingesting just 10 - 100 germs. Against this background, the relevance of heating these foods before consumption is emphasised once again.

Other important routes of infection are: Contact with STEC shedders (for example, infected humans and healthy farm animals/zoo animals that excrete these pathogens) and exposure from STEC-contaminated environments (e.g. surface water and soil). Some of the pathogens can survive in the environment for many weeks. Vegetables, cereals and fruit can also be contaminated with STEC via contaminated water and fertilisation with manure and slurry. If they are then inadequately cleaned and eaten raw, they can become a source of infection for humans. See also [FAQ on *E. coli* in flour and dough](#).

The Robert Koch Institute regularly publishes the latest figures on cases of the disease on its website (https://www.rki.de/DE/Content/Infekt/Jahrbuch/jahrbuch_node.html).

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 the preparation of food through so-called cross-contamination. In this case, the bacteria are transferred from one contaminated (usually raw) food (e.g. meat) to another (usually ready-to-eat) food (e.g. salad). However, indirect transmission via hands, utensils, work surfaces, knives or other kitchen utensils is also possible. Cross-contamination is possible, for example, if raw meat is processed first and then lettuce is cut with the same knife.

Can sprouts be a source of EHEC/STEC?

Sprouts are industrially germinated in drums in a very humid and warm environment. These are ideal conditions for the extremely rapid growth of bacteria that come into contact with the sprout seeds, the water or due to hygiene deficiencies. If contamination with pathogenic germs such as STEC occurs, a bacterial count is quickly reached that exceeds the infectious dose.

This is why fresh sprouts are perishable foods. Even if they are kept refrigerated, there is the possibility of rapid microbial spoilage and the risk of infection with pathogenic bacteria such as *E. coli*, *Listeria* and *Salmonella* or viruses such as noroviruses or hepatitis A viruses.

Even low bacterial counts in pre-packed sprouts can rise sharply within just a few days due to bacterial proliferation and have a very high bacterial load by the end of the recommended consumption period. The BfR therefore recommends that these foods should only be consumed thoroughly heated.

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

This recommendation also includes sprouts grown at home.

Can STEC also be found in plants if the seed was already contaminated with the pathogen?

For wheat seeds and various sprout seeds, it has been shown that contamination of the seed can lead to contamination of the seedling. It is also known from other experimental studies that some STEC strains were, for example, internalised from the soil into the roots of plants (e.g. lamb's lettuce, lettuce, spinach) and sporadically into the plant (lamb's lettuce).

When alfalfa sprouts were contaminated with STEC, the uptake of bacteria into the interior of the plants was observed in isolated experiments.

How safe are home-grown vegetables?

With home-grown vegetables, the entire production process can be traced. Nevertheless, it cannot be ruled out that the vegetables are contaminated with STEC (or other germs). Hygiene rules for growing, storing and preparing food should therefore also be applied here.

How can STEC infection through food be avoided?

As a general rule, observing general hygiene rules reduces the risk of infection.

- Wash hands thoroughly with soap and water before preparing food and after contact with raw meat, and dry them carefully.
- Store and prepare raw meat separately from other foods (e.g. vegetables), including when grilling (also use different cutting boards, plates and tongs).
- Vegetables, fruit and other foods that have come into contact with suspect products (e.g. contaminated vegetables) should also not be eaten raw. Such contact exists, for example, if the products are stored next to each other.

- After contact with raw meat, its packaging or any liquid produced during thawing, immediately clean surfaces and objects thoroughly with dishwashing liquid and warm water and dry them.
- If possible, change cloths and towels after preparing raw meat and wash them at a temperature of at least 60 °C.
- Wash raw fruit and vegetables thoroughly before consumption (at least 30 seconds with vigorous rubbing, use warm water if possible) and peel if necessary. Washing and peeling vegetables reduces the number of germs and thus reduces the risk of infection. However, neither can completely eliminate the germs.

Certain foods may have a particular link to STEC/EHEC outbreaks, either because they are particularly frequently associated with STEC/EHEC outbreaks (e.g. raw milk and beef) or because they have been identified as the cause of particularly severe outbreaks (e.g. sprouts and seeds from which sprouts are grown). Additional measures must be observed when handling these foods.

The consumption of raw milk and raw milk products (e.g. raw milk cheese) is therefore generally not recommended, especially for particularly sensitive people (children under the age of five, elderly or immunocompromised people).

Sprout seeds are also sometimes used as an additive for other foods, for example fenugreek seeds can be found in herbal teas and curry mixes.

Tea bags with fenugreek seeds should be infused with boiling water like any other herbal tea and left to infuse 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 the preparation of herbal teas.

Further information on this can be found in a BfR scientific opinion statement, which can be downloaded at https://www.bfr.bund.de/cm/343/temperierte_heisswasserspender_fuer_kraeuterteeaufguesse_nicht_geeignet.pdf

Fenugreek seeds are used in ground form for the production of spice blends, especially curry powder. Fenugreek seeds are a common ingredient in Indian curry spice blends in particular. In the industrial production of spices, thermal processes such as steam treatment, which are also effective against STEC bacteria, are usually used to reduce germs.

Home-made spice mixtures made from fenugreek seeds are safe if the seeds have been heated beforehand, e.g. by roasting in a pan or by boiling.

How can STEC bacteria be killed?

STEC are killed by heating processes such as boiling, frying and braising. The prerequisite for this is that a temperature of 70 °C is reached in the centre of the food for at least two minutes (this temperature-time combination may not be sufficient for foods with a low water content, such as flour). However, these bacteria are relatively insensitive to other environmental influences, such as an acidic environment, cold or dehydration. STEC bacteria cannot be reliably killed by freezing food.

Can STEC also be found in processed and tinned foods?

Whether STEC can occur in processed or packaged foods depends on the type of processing. Products in which the food is no longer raw generally pose no risk from transmission of the bacteria.

The pathogen does not survive the usual heating processes used in the production of tinned food. The temperatures used for the pasteurisation of milk and the production of cooked sausages are also sufficient. For products such as pickled gherkins, the low pH value in addition to the salt content generally provide sufficient preservation.

Vegetable foods that have not been heated and have only been washed, such as bagged salad, may well contain STEC. Further information on this topic can be found in the [FAQ on green smoothies](#).

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

The National Breastfeeding Commission at the BfR has indicated that STEC is not transmitted to infants via breast milk.

Does it make sense 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 use concentration is only suitable for sterilising water. In the worst case, increasing the concentration without prior effectiveness tests could lead to damage to health due to resulting residues on the food.

In Germany, no agents for disinfecting food are currently authorised and regularly available. Disinfectants that are authorised for the food sector are used exclusively to kill germs on surfaces, including utensils and floors.

Can pets also become infected with STEC?

Pets can also come into contact with STEC, e.g. when fed raw meat ("BARF"), and may become infected with them. However, such diseases are usually milder than in humans. However, pets could in turn infect humans via smear infection if they are not handled with sufficient hygiene.

Is there a connection between STEC in wild animals, in wild meat and STEC diseases in humans?

The federal states regularly collect data on the occurrence of STEC in game and game meat samples as part of zoonosis monitoring. This shows a high STEC prevalence (occurrence) of 40 % in (roe) deer and approx. 30 % in deer meat samples. In comparison, STEC-positive samples are found in approx. 20 - 25 % of fattening cattle and calves, while STEC are detected in approx. 2 - 3 % of beef samples. The more significant reduction in the occurrence of STEC in beef compared to game meat is attributed to differences in the slaughtering process.

STEC infections or outbreaks due to the consumption of game meat are rarely reported, the reasons for this are probably manifold (other STEC types, frequency of consumption, form of consumption, distribution range).

Due to the frequent occurrence of STEC in wild ruminants, good hand hygiene is recommended immediately after visiting petting zoos or petting enclosures in wildlife parks.

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

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 EAaggEC), but nevertheless produces Shiga toxins. Bacteria with a combination of properties are also known as hybrid strains.

EAEC are another group of pathogenic *E. coli*. They adhere very well to the intestinal wall in a specific pattern with the help of adhesion factors and cause watery diarrhoea. EAEC can be transmitted from person to person via smear infections.

Normally, a clear distinction can be made between STEC/EHEC and 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 serious illnesses in humans such as haemolytic uraemic syndrome (HUS) - a disease in which small blood clots form throughout the body.

What is being done to protect consumers from STEC?

Reference laboratories dealing with the detection, characterisation and risk assessment of STEC have been established at the BfR and the Robert Koch Institute. At the BfR, *E. coli* from food sent in by the monitoring authorities of the federal states are characterised in order to identify human pathogenic STEC. The identification of STEC types and their virulence characteristics is necessary in order to determine whether human infections can be traced back to the consumption of STEC-contaminated food. The aim is to recognise and contain outbreaks of disease as quickly as possible. The detailed characterisation of STEC strains and the comparison of isolates from food and humans is carried out using whole genome sequencing. These genome sequences provide information about the relationship between individual strains and can provide information about possible infection events. They also provide a precise overview of the occurrence and variability of STEC in general or specific subtypes in Germany. As part of this so-called cross-sectoral genomic surveillance, the BfR works closely with the competent authorities of the federal states, the Federal Office of Consumer Protection and Food Safety and the Robert Koch Institute to protect consumers from outbreaks caused by STEC-contaminated food.

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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