German Federal Institute for Risk Assessment

FAQ

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Acute food poisoning: what are possible causes and how can they be prevented?

Food poisoning is a foodborne illness in humans that is triggered by the oral intake of toxins already present in food. Acute food poisoning occurs shortly after consumption of the respective food and can trigger various symptoms, including gastrointestinal and neurological symptoms. Depending on the toxin, acute poisoning can cause severe health impairments and, in some cases, may even be fatal. Health impairments due to chronic food poisoning result from long-term exposure to typically small amounts of toxins. Food poisoning must be distinguished from food infections caused by the intake of intact pathogens such as salmonella or noroviruses.

In Germany, there are no reliable figures on the frequency of acute food poisoning. However, certain types of food poisoning regularly lead to enquiries at poison centres (PCs). Starting in 2026, this data will be collated in a national poisoning register at the German Federal Institute for Risk Assessment (BfR) and published in the form of annual reports. It is not always possible to tell from the appearance, smell or taste whether food contains substances that are harmful to health. These substances can only be detected using complex analytical procedures in the laboratory. It is therefore important for consumers to know the causes of food poisoning and possible preventive measures.

How can acute food poisoning occur?

Food poisoning can occur when certain bacteria or moulds in food multiply and produce toxins. Information on the health risks posed by moulds in food can be found in the BfR's FAQ dated 25 June 2024.

Additionally, fish and mussels can contain marine biotoxins (also called algal toxins) that cause food poisoning. Poisoning can also be caused by toxins that occur naturally in plants and fungi.

Which kinds of food poisoning are caused by bacteria?

Food poisoning caused by bacteria typically has an acute course. The best-known bacterial food poisoning is botulism, which is triggered by "botulinum neurotoxins". Botulinum neurotoxins are produced by bacteria of the *Clostridium botulinum* species. They can cause nausea, diarrhoea and constipation as well as neurological symptoms ranging from paralysis to respiratory paralysis. Fatalities are possible. Further information can be found in the BfR's FAQ on botulism dated 15 June 2023.

Staphylococcus aureus can form extremely heat-stable enterotoxins in food, the intake of which can lead to nausea, vomiting, abdominal cramps, diarrhoea and circulatory symptoms after a short time (30 minutes to 8 hours). People affected sometimes have to be treated in the hospital. In addition, some strains of *Bacillus cereus* are able to form a heat-stable toxin (cereulide) in food, which triggers nausea and vomiting shortly after intake (30 minutes to 6 hours). Symptoms usually subside on their own within a few days. Very rarely, severe courses of the disease occur due to liver and brain damage. Further information can be found in the BfR consumer tips "Protection against foodborne illnesses caused by bacterial toxins".

In addition, biogenic amines (e. g. histamine, cadaverine, putrescine), which are heat-stable and can lead to intolerances, can be formed when certain bacteria multiply in foods containing protein. At higher doses, histamine can trigger symptoms similar to poisoning, such as headaches, dizziness, facial flushing, gastrointestinal problems, a drop in blood pressure, and even shock.

What can consumers do to prevent bacterial food poisoning?

Simply looking at most foods does not reveal whether they contain bacteria, spores or toxins of *Clostridium botulinum*. The spores can only be inactivated at temperatures above 100 °C. A process known as a botulinum cook, where food is cooked at 121 °C for 3 minutes, was developed for commercial production of canned foods. Anyone who preserves low-acid food items, such as meat or vegetables (especially beans), should, if possible, heat these under pressure to 121 °C. The laws of physics mean that the maximum heating limit of 100 °C (boiling water) cannot be exceeded when using the 'preserving' method commonly used in German households. Therefore, low-acid foods should be heated to 100 °C twice over the course of one to two days. Between the two heating processes, the preserved food should ideally be stored at room temperature. During the first heating process, the bacteria capable of multiplying are killed and the spores can germinate and develop into bacteria capable of multiplying. These can be killed with the second heating. To even further reduce the risk, the canned food can be heated to 100 °C directly before consumption to inactivate any botulinum neurotoxins that may be present. As a precautionary measure, bulging food cans (the process is known as "swelling") should not be opened but destroyed.

In order to avoid food poisoning caused by toxins from other bacteria, perishable food should be cooled sufficiently and heated food should be kept sufficiently hot (at least 60 °C at all points) or cooled quickly. The temperature range at which bacteria grow or spores germinate (7 to 60 °C) should be avoided or passed through as quickly as possible by rapid cooling.
The formation of biogenic amines can be prevented if, among other things, foods containing

protein are handled hygienically, cooled sufficiently and not stored for too long. Cooking or frying the food is not sufficient to inactivate heat-stable bacterial toxins or biogenic amines.

What should consumers do if they suspect bacterial food poisoning?

With the exception of botulism, bacterial food poisoning usually ends of its own accord after a few days. If diarrhoea occurs, fluid replacement is the most important measure. People should consult a doctor or visit a hospital in the event of prolonged or bloody diarrhoea, persistent vomiting or other more serious symptoms. This applies in particular to infants and small children, the elderly, people with weakened defences and those who are recovering from illness. If neurological symptoms occur (e. g. impaired vision, difficulty swallowing, paralysis) and botulism is suspected, people should visit a doctor or a hospital as soon as possible.

What specific legal regulations exist to protect the population from bacterial food poisoning?

To protect the population in Europe, Regulation (EC) No 2073/2005 (on microbiological criteria for foodstuffs) sets limit values for coagulase-positive staphylococci and staphylococcal enterotoxins in cheese, milk and whey powder and for histamine in certain fishery products. In addition, this regulation sets limit for presumptive *Bacillus cereus* in dried infant formula and dried dietary foods for special medical purposes intended for infants under six months of age. Presumptive *Bacillus cereus* are bacteria from the *Bacillus cereus* group, which includes several closely related bacterial species.

What is the BfR doing to protect the population from bacterial food poisoning?

At the BfR, experts deal with scientific issues relating to toxins produced by staphylococci , *Bacillus* spp. (e.g. *Bacillus cereus*), and clostridia. The National Reference Laboratory for coagulase-positive staphylococci including *Staphylococcus aureus* (NRL-Staph) and the specialised laboratory for spore formers are also located here. The tasks of the NRL-Staph include cooperating with the European Union Reference Laboratory (EURL) for coagulase-positive staphylococci including *Staphylococcus aureus*, advising and supporting official laboratories in the federal states, and developing and validating analytical methods.

Can ingredients in plant-based foods lead to acute poisoning?

Certain plants can produce toxic substances. Due to their chemical structure, plant toxins can be sorted into different structural classes. The ability to produce toxins is found in different plant families. Some plants that are used to produce food or feed can also form toxic substances.

One example is glycoalkaloids (solanine), occurring for example in green, sprouting or damaged potatoes. Mild cases of poisoning are characterised by nausea, abdominal pain, vomiting and diarrhoea, sometimes accompanied by fever. In severe cases of poisoning, impaired consciousness and other disorders affecting brain function, respiration or circulation may also occur. There have been isolated reports of deaths in older literature.

Further information on solanine in potatoes can be found in the BfR's FAQ dated 23 April 2018.

Cyanogenic glycosides, which are found as natural plant constituents in relatively high concentrations in foods such as bitter apricot kernels, flax seeds, and cassava, are another example. When consumed, cyanide is released from the cyanogenic glycosides by the enzyme ß-glucosidase, which is also contained in the plants. Cyanides are salts of hydrocyanic acid. Symptoms of acute poisoning include cramps, vomiting, and shortness of breath, which can lead to fatal respiratory paralysis. The lethal dose in humans is approximately 0.5–3.5 milligrams per kilogram of body weight. Further information can be found in the updated BfR Opinion No 009/2015 dated 7 April 2015 "Two bitter apricot kernels per day are the limit for adults - children should refrain from consuming apricot kernels altogether" and in BfR Communication No 006/2015 dated 3 March 2015 "New data from BfR human study: no cyanide risk from consumption of marzipan and persipan".

Other plant toxins can enter the food chain as contaminants. An example of this is the occurrence of 1,2-unsaturated pyrrolizidine alkaloids (PA) in (herbal) teas or spices. The plants used in food production do not usually contain PA themselves. These substances find their way into food when plants which are not suitable for food production and which produce toxins or plant parts of wild herbs growing in the crops are harvested along with the plants intended for food production. PA are a large group of natural substances that are mainly produced by plants, but also by fungi and bacteria. To date, several hundred PAs and their N-oxides are known. The PA-forming plants native to Germany include, for example, the common ragwort or the viper's bugloss. In humans, severe and sometimes fatal intoxication has been repeatedly observed following the intake of higher doses of 1,2-unsaturated PA. In recent decades, for example, several thousand cases of endemic poisoning have been documented in Afghanistan. The cause of the poisoning cases was the consumption of grain contaminated with plant parts of PA-forming *Heliotropium* species. In Asia, intoxication is also associated with the consumption of certain herbs that are used in traditional Chinese medicine and either contain 1,2-unsaturated PAs themselves or are confused with or contaminated with wild herbs containing PAs. In humans, acute poisoning manifests particularly in the liver in the form of venous occlusive disease (HSOS, *hepatic sinusoidal obstruction syndrome*; synonym: HVOD, *hepatic veno-occlusive disease*). Acute poisoning is very unlikely given the levels of PA detected in food in Germany and Europe. Further information on PA in food can be found in the BfR's FAQ dated 16 December 2022.

Other known plant toxins include cannabinoids in the hemp plant, opium alkaloids in poppy seeds, erucic acid in cruciferous plants such as rapeseed and mustard, and quinolizidine alkaloids in lupin seeds. Lectins in insufficiently heated pulses such as green beans, curcurbitacins in bitter courgettes and pumpkins, as well as greyanotoxins in honey (when bees have processed the nectar of heather plants, e.g., rhododendron honey from the regions of the Turkish Black Sea coast), can also lead to health impairments. Further information on the plant toxins mentioned can be found in the following BfR publications, among others: Opinion 03/2024 dated 23 January 2024 "Lectins in plant-based foods: Is there a health risk?" (in German); Communication No 027/2015 dated 4 September 2015 "Caution when eating bitter-tasting courgettes"; FAQ dated 3 May 2023 on grayanotoxins in honey.

What can consumers do to prevent acute poisoning caused by plant toxins?

Above a certain glycoalkaloid content in potatoes, consumers may experience a bitter taste and a burning sensation in the mouth when eating. If a bitter flavour is perceived in a potato dish, further consumption should be avoided. To reduce the intake of solanine, green spots and so-called eyes in potatoes should be thoroughly removed and the consumption of potato peels should be avoided. Young children in particular should only eat peeled potatoes. Frying fat for potato products should be changed regularly. Potato cooking water and potato dishes with a bitter flavour should be disposed of as a precaution.

Adults should only consume bitter apricot kernels in small quantities (no more than 2 kernels per day). However, the consumption of marzipan or persipan does not pose a risk of hydrocyanic acid poisoning. Ground linseed should only be consumed in moderate quantities by adults (maximum 15 g per meal). As children are particularly sensitive, they should not consume foods that contain high concentrations of cyanogenic glycosides.

In some parts of the population, a trend of collecting wild herbs or plants from parks, forests and meadows and processing them into salads and smoothies has been observed. This may be associated with health risks. For example, misidentifying poisonous plants can lead to hazardous food poisoning. When the wild garlic season begins in spring, many people collect the allium in forests. Although the garlic-like odour is a typical characteristic of wild garlic, the plant is often confused with poisonous lookalikes such as lily of the valley or autumn crocus. Such mix-ups lead to cases of poisoning every season, sometimes with fatal results. Other known “doppelganger pairs” are parsley and the poisonous monkshood; wild carrot, meadow chervil, celery and the poisonous spotted hemlock; and blueberries and poisonous deadly nightshade.

What specific legal regulations exist to protect the public from plant toxins in food?

The presence of plant toxins in food and feed cannot be completely prevented. The aim of consumer health protection is therefore to minimise the exposure of humans and animals, for example by setting maximum levels in food and feed.

The maximum levels laid down in Commission Regulation (EC) No 2023/915 of 25 April 2023 setting maximum levels for certain contaminants in foodstuffs apply throughout the EU.

Which types of acute food poisoning are caused by marine biotoxins (also called algal toxins)?

There are around 5,000 different species of algae in the world’s oceans, some of which are capable of producing toxic substances known as marine biotoxins. These toxins can accumulate in the tissue of marine animals that feed on toxin producing algae. Some marine biotoxins are heat stable and can cause various illnesses in humans after eating contaminated seafood.

Eating seafood contaminated with marine biotoxins can lead to further toxin-group-specific symptoms in addition to gastrointestinal symptoms (e.g., nausea, vomiting, diarrhoea or abdominal cramps). Three groups of marine biotoxins are of concern for consumers of mussels from the European region: paralytic shellfish poisoning (PSP) group toxins can also cause neurological symptoms, such as slight tingling in the lips or numbness in the arms or

legs. In very rare cases, fatal respiratory paralysis can occur. Amnesic shellfish poisoning (ASP) can also lead to confusion, disorientation, memory loss and epileptic seizures or coma. The diarrhetic shellfish poisoning (DSP) toxins group is characterised by gastrointestinal symptoms, chills, headache and fever. The symptoms can occur very quickly, within a few minutes, and up to two days after eating the contaminated shellfish.

Ciguatoxins are produced by dinoflagellates of the genera *Gambierdiscus* and *Fukuyoa*, which belong to the phytoplankton and are therefore a food source for herbivorous marine fish and water-filtering marine animals. Although they occur primarily in the warm marine waters of the tropics and subtropics, they are also increasingly found in the Mediterranean region. Around 200 species of fish, mainly coastal predatory fish such as barracuda, mackerel, snapper and grouper, can contain ciguatoxins. The illness caused by ciguatoxins is known as ciguatera. The illness is associated with a wide variety of clinical symptoms that can occur within a few minutes and up to 48 hours after eating fish or seafood. Specific to ciguatera, is a reversal of hot and cold sensations or experiencing pain on contact with cold tap water and objects as a result of an impaired stimulus transmission in neurons. In addition, gastrointestinal (e.g., nausea, vomiting, diarrhoea, cramp-like abdominal pain), neurological (e.g., muscle and joint pain, itching), respiratory, and cardiovascular symptoms (e.g., drop in blood pressure, very rarely cardiac arrhythmia) may occur. Some symptoms may persist for several months or years. The intake of certain foods, stimulants (e.g., alcohol, caffeine), and other external influences (e.g., heat, physical activity) can cause ciguatera-like symptoms that have subsided to reappear. Repeated exposure to ciguatoxins can increase the intensity of the symptoms.

Further information on poisoning by ciguatoxins from sea fish and seafood can be found in the BfR's FAQ dated 16 May 2022.

What can consumers do to prevent acute food poisoning caused by marine biotoxins?

Eating smaller portions can reduce the health risk posed by marine biotoxins. There used to be a guideline dictating that mussels should only be eaten in months with an "R" (winter months). The origin of the guideline was that mussels harvested in summer had a higher risk of accumulating marine biotoxins, which can cause health problems. Today, this is less relevant as mussels are traded worldwide, harvested, processed and sold throughout the year. It can still be applied to fresh mussels harvested in Germany. It is still important to buy mussels from trustworthy suppliers.

Avoiding the consumption of large predatory fish (> 2.5 kg) from tropical and subtropical fishing regions can reduce the risk of ciguatera. Due to their high fat content, fish liver, fish roe or fish heads may contain higher levels of ciguatoxins. Ciguatoxin contamination is unlikely in fish from colder waters such as the North Atlantic or the North Pacific.

While sufficient heating of the mussels before consumption can protect against food infections caused by viruses or bacteria (e.g., vibrions), cooking or frying the food is not sufficient to destroy the heat-stable marine biotoxins.

Further information on vibrions in food can be found in a BfR opinion dated 13 April 2022. The BfR has also published recommendations for protections against viral diseases after eating mussels (available in German).

Which specific legal regulations exist to protect the public from marine biotoxins in food?

To protect the population, the European Commission has set maximum levels for different groups of marine biotoxins in Regulations (EC) No 853/2004 and (EU) No 786/2013. The currently valid version of the Regulation (EC) No 2074/2005 regulates which test methods may be used for the detection of marine biotoxins.

The occurrence of ciguatoxins in fishery products and marine biotoxins in molluscs is regulated in Implementing Regulation (EU) 2019/627 (Annex VI, Chapter 1 G 3.) and in Regulation (EC) No 853/2004 (Section VIII, Chapter 5 E 2.).

What is the BfR doing to protect the public from marine biotoxins in food?

The National Reference Laboratory for the monitoring of marine biotoxins is part of the BfR. The NRL's tasks include cooperating with the European Union Reference Laboratory (EURL) for the monitoring of marine biotoxins, advising and supporting official laboratories in the federal states, and developing, validating, harmonising and standardising analytical methods.

What is mushroom poisoning?

Every year in Germany, especially in late summer and autumn, there are cases of acute poisoning due to the consumption of self-picked poisonous mushrooms, known as mushroom poisoning. The symptoms of mushroom poisoning are often unspecific at the beginning (e.g., stomach pain, nausea and vomiting) and cannot be distinguished from bacterial food poisoning or intolerances. The green death cap mushroom is the most poisonous mushroom in Germany: even a fraction of a normal portion of a mushroom meal can lead to death in adults and children.

Further information can be found in the BfR brochure "Verbraucherinfo: Risiko Pilze - Einschätzung und Hinweise" (available in German).

What can consumers do to prevent mushroom poisoning?

- To protect yourself from mushroom poisoning, you should only collect and prepare mushrooms that you are sure you can recognise as edible mushrooms. Although mushroom apps can help you recognise mushrooms, you should never rely solely on such an app to identify them. Always ask a mushroom advisory service if you are uncertain whether the mushrooms are poisonous or edible. In many cities and regions there are advice centres or people with extensive and proven knowledge of mushroom identification.
- Only fresh mushrooms should be prepared for consumption.
- To avoid intolerances, each mushroom meal should be cooked for at least 15 minutes.
- Leftover mushroom dishes should be disposed of or cooled quickly. They can be eaten after being briefly stored in the refrigerator and then heated completely to at least 70 °C for two minutes.

What should consumers do if they suspect mushroom poisoning?

If you feel unwell after eating mushrooms, you should seek medical advice or contact a poison centre as soon as possible. Important information in this case is the onset, type and sequence of symptoms, which mushrooms and how many of them were consumed, where they came from (bought or collected), how they were prepared, when they were consumed and details about the affected persons (age, weight, medication, allergies or other underlying illnesses). Whether alcohol was consumed at the same time as the mushroom meal is also important information for the poison centre, as some mushrooms can have harmful effects when combined with alcohol.

If mushroom poisoning is suspected, treatment should never be administered without medical advice. Even supposedly harmless measures such as inducing vomiting can have serious health consequences if, for example, vomit gets into the deep respiratory tract. Milk can enhance the uptake of poison. In the event of poisoning, mushroom residues from cleaning the mushrooms or from the meal – and possibly also vomit – often provide valuable information for determining the fungus (including spore analysis). Information on mushroom experts who can assist with mushroom identification in cases of poisoning or suspected poisoning can be found on the website of the German Society of Mycology. The poison centres of the German federal states ('Laender') can also provide relevant points of contact.

Where can consumers go in the event of food poisoning or to report it?

If you suspect food poisoning, contact one of the seven German poison centres. A consultation can clarify whether a visit to the doctor is necessary.

If there is a suspicion that a large number of people could be affected by food poisoning (for example after a meal in a restaurant, a communal catering facility or at a large private party), the responsible health authority must be informed.

Further information on plant toxins and poisoning in general can also be found in the BfR app "Poisoning accidents in children" (available in German).

Where is data on food poisoning recorded?

The seven German poison centres advise and document all enquiries about poisoning and suspected cases of poisoning, including enquiries about food poisoning. Starting in 2026, this data will be collated in the German Poisoning Register at the BfR and the results summarised in the form of annual reports. The BfR already receives reports of poisoning from doctors, accident insurance companies and other sources. Another source of data is, for example, the German Federal Health Monitoring System (GBE), where data on certain food poisonings resulting in hospitalisation or death can be accessed.

Data on foodborne disease outbreaks caused by bacterial toxins in food are recorded by the local health and food monitoring authorities and transmitted at the same time to the Robert Koch Institute (RKI) and the German Federal Office of Consumer Protection and Food Safety (BVL) in accordance with the Infection Protection Act (IfSG) or via the nationwide recording system for foodstuffs involved in disease outbreaks (BELA, in German). The transmitted data is collated at the federal level, jointly assessed by the RKI and the BVL and reported by the

BVL to the European Food Safety Authority (EFSA). Based on the notification data from the EU Member States, EFSA prepares an annual report on foodborne disease outbreaks in Europe, which is integrated into the European Union One Health Zoonoses Report.

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the Federal Ministry of Agriculture, Food and Regional Identity (BMLEH) 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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