

Protection against food-borne diseases caused by bacterial toxins

Every year more than 100,000 cases of disease are reported in Germany that can be attributed to microorganisms (especially bacteria, viruses or parasites) in food; however, the number of unreported cases is likely to be much higher. But it is not only these microorganisms themselves that cause disease. Some bacteria are also able to form harmful metabolic products (toxins) when they multiply.

The toxin-producing bacteria fall into two groups; those germs that form their toxins in food and those that only release their toxins in the human intestine. Some of the toxins produced in the food are heat-stable, which means that they can cause diseases even if the food is cooked sufficiently before consumption.

This leaflet provides tips for consumers on how to protect themselves against diseases caused by toxins from the bacteria *Staphylococcus aureus*, *Bacillus cereus* and *Clostridium perfringens*. It is aimed at people who prepare food in private households. In principle, all age groups are at risk of falling ill after ingesting these bacteria or the toxins they produce. The symptoms usually subside on their own within a few days. In individual cases, infants, toddlers and elderly people in particular can fall seriously ill.



After preparation, cool the heated food and store it in the refrigerator until it is reheated just before consumption.

Further information on verotoxin-producing *Escherichia coli* and *Clostridium botulinum* can be found in the leaflets: "Consumer Tips: Protection Against Infections Caused by Enterohaemorrhagic *E. coli*" and "Advice for Consumers on Botulism from Food".

Diseases caused by *Staphylococcus aureus*

Staphylococcus (S.) aureus occurs naturally on the skin and mucous membranes in humans and animals, but it also causes purulent infections. In cattle in particular, this pathogen is the cause of udder infections. In order for *S. aureus* to cause food poisoning, it is necessary that the pathogen was able to multiply sufficiently in food and form enterotoxins (intestinal toxins). High salt tolerance is a feature of *S. aureus*. This means that the pathogen also multiplies in very salty foods. The optimum growth temperature of *S. aureus*, including for the formation of enterotoxins, ranges between 35 degrees Celsius and 40 degrees Celsius, but growth is generally possible between 6 degrees Celsius and 48 degrees Celsius.

The enterotoxins of *S. aureus* withstand extreme influences such as high heat, an acidic environment or digestive enzymes, meaning that neither the gastric passage nor the heating of food in the kitchen can inactivate them safely and permanently. Ingestion of these toxins leads to nausea, vomiting, abdominal cramps, diarrhoea and circulatory symptoms after a short time (30 minutes to 8 hours), so that those affected sometimes have to be treated in hospital.

Foods commonly associated with diseases caused by *S. aureus* are protein-rich foods prepared by hand that have not been adequately refrigerated. These include, for example, sliced roasted meats, delicatessen salads including potato salad, cooked or smoked fish, desserts, homemade ice cream, pasta and dishes with raw milk.

Diseases caused by *Bacillus cereus*

Bacillus (B.) cereus occurs in the intestinal tract of humans and animals, in the soil, in water and dust. The bacterium is able to form very resistant developmental stages, so-called spores, and is therefore widespread in the environment. *B. cereus* can easily be transferred to food through contamination with soil particles or dust. Therefore, low levels of *B. cereus* must be expected in many plant and animal foods. The risk of poisoning by toxins from *B. cereus* increases if the bacteria are allowed to multiply in the food prior to consumption.

Most *B. cereus* bacterial strains grow in a range between 7 degrees Celsius and 48 degrees Celsius, with an optimum temperature between 30 degrees Celsius and 40 degrees Celsius. However, *B. cereus* is unable to grow in dry or very acidic foods. The heat resistance of the spores varies and depends on the type of food. Usual heat treatments (e.g. boiling, pasteurisation) kill cells capable of reproduction, but allow individual spores to survive. The reduction of other bacteria present in the food through heat treatment supports the germination of these spores and the subsequent multiplication of the bacteria.

A distinction is made between two different forms of the associated disease:

1. Vomiting: Here, a toxin (cereulide) formed in the food during cell reproduction is ingested. It is extremely resistant to heat, acid, and digestive enzymes. The toxin causes nausea and vomiting within a short period of time (30 minutes to 6 hours). The symptoms usually subside on their own within a few days. In rare cases severe disease progression can lead to liver and brain damage.

Foods that are often associated with vomiting caused by *B. cereus* are, above all, foods which are improperly stored after heating, especially starchy, cooked foods such as rice or pasta.

2. Diarrhoea: In this case, large amounts of *B. cereus* cells capable of reproduction and/or spores are ingested with the food. Cells capable of reproduction develop from the spores in the small intestine, which then form enterotoxins. These enterotoxins typically cause diarrhoea and abdominal cramps (toxic infection). The time to the onset of diarrhoea is 6 to 24 hours.

Food that is often associated with diarrhoea caused by *B. cereus* is primarily food that has been improperly stored after heating. *B. cereus* can enter food through ingredients such as spices, dried mushrooms or vegetables.



Store leftovers from rice and pasta that have already been prepared in the refrigerator so that spores do not develop into reproductive bacteria.

Diseases caused by *Clostridium perfringens*

Clostridium (C.) perfringens is also found in the intestinal tract of humans and animals, in the soil, in water and dust and forms heat-stable spores.

In order for *C. perfringens* to cause food poisoning, it is necessary that the pathogen was able to multiply sufficiently in food. The bacterium prefers to grow without oxygen. However, it can still multiply in the presence of oxygen, only more slowly. When food is prepared in the kitchen by either boiling or frying, the bacteria within, which are capable of reproduction, die when heated to 70 degrees Celsius or more for at least 2 minutes. However, the endospores of *C. perfringens* are not killed reliably even with longer cooking times at 100 degrees Celsius. The heat resistance of the spores varies widely and can be up to 60 minutes at 100 degrees Celsius. In addition, heating can help to germinate the spores, leading to the growth of reproductive bacteria in insuf-

ficiently refrigerated foods. *C. perfringens* can in principle grow within a range of 10 degrees Celsius to 50 degrees Celsius. To be affected by disease requires the uptake of many cells capable of reproduction, which form spores and the enterotoxin in the small intestine. After activation of this toxin (for example through digestive juices in the intestine), its ingestion can suddenly lead to diarrhoea and abdominal cramps, usually within a day (8 to 16 hours). The symptoms usually subside on their own within a day.

Foods that are often associated with diseases caused by *C. perfringens* include: roast meats, sauces, stews containing meat and soups that have been insufficiently cooled after heating. Cases of disease are often recorded in situations where large portions of food are prepared and stored for a long time.

Handling prepared food

Improper handling of prepared food increases the risk of diseases caused by bacterial toxins. In order to prevent spores from re-developing into reproductive bacteria, which then reproduce and create toxins, food products should not be stored at temperatures between 7 degrees Celsius and 60 degrees Celsius. It is therefore necessary to cool prepared food quickly to below 7 degrees Celsius (do this by placing larger quantities in several shallow bowls). The food should also be stored at this temperature, and it should not be reheated until just prior to consumption.

Another option is to keep food sufficiently hot. The food must maintain a temperature of at least 60 degrees Celsius uniformly throughout. This may be an option for predominantly liquid dishes (e. g. soups, sauces, stews), but it is difficult to implement for most other household dishes. In this case, intermediate cooling is more suitable.

It is recommended to use a thermometer with a penetration probe to check that the temperature is maintained. The thermometer should be food grade, easy to clean and suitable for the intended temperature range. Prepared meals that are procured via a delivery service must also meet the temperature requirements.



Either keep heated food sufficiently hot or cool it down quickly to below 7 degrees Celsius. This also applies to prepared meals procured via a delivery service

By adhering to these steps, consumers in private households can protect themselves from diseases caused by bacterial toxins

The following consumer tips are designed to help reduce the risk of disease from toxins produced by *Staphylococcus aureus*, *Bacillus cereus*, or *Clostridium perfringens*:

- ▶ Avoid cross-contamination in the kitchen, i. e. the transfer of germs from one (mostly raw) food to other food
- ▶ Wash hands thoroughly with soap and water before preparing food and after contact with raw food or objects that have not been cleaned
- ▶ Avoid touching mouth, nose and hair when handling food
- ▶ In the case of infections of the upper respiratory tract, do not prepare any food for other people if possible
- ▶ Before preparing food, properly cover any purulent wounds on hands and work with a waterproof bandage or gloves
- ▶ Quickly prepared, heated food to below 7 degrees Celsius (fill larger amounts of food into several shallow bowls) and store in the refrigerator until reheating shortly before consumption
- ▶ When keeping food hot (e. g. soups, sauces, stews), make sure that all parts of it maintain a temperature of at least 60 degrees Celsius. Do not store perishable foods or heated dishes for long periods at temperatures between 7 degrees Celsius and 60 degrees Celsius
- ▶ For dishes that contain raw and cooked ingredients (e. g. pasta salad), cool the cooked ingredients sufficiently first before adding the other ingredients
- ▶ When preparing, seasoning and warming up heated food, warm up all parts of it (including the inside) to at least 70 degrees Celsius for at least 2 minutes in order to kill existing vegetative bacterial cells (if necessary, check the temperature with a penetration thermometer)
- ▶ When warming up in the microwave, ensure that the food is heated uniformly throughout and sufficiently, and stir it occasionally