Microorganisms in food

The importance of microorganisms in the human diet is multifaceted:

- Pathogenic, conditionally pathogenic and toxigenic microorganisms can cause serious diseases.
- Saprophytic microorganisms cause spoilage of food and can lead to the formation of toxic metabolic products.
- Noble microbial cultures are used in food technology.
- Probiotic bacteria (probiotics), which are present in some foods, affect the microflora of the colon and thus health.

Pathogenic, conditionally pathogenic and toxinogenic microorganisms

Food contamination with pathogenic microorganisms leads to alimentary infections and toxicosis. Alimentary infections are a major health and economic problem worldwide. Their epidemic occurrence is directly related to non-compliance with hygienic principles in the production and handling of food, in the transport, storage and serving of food, especially in catering, and in defects in the water supply. According to the mode of food contamination, the following diseases are distinguished:

- **primary**, where diseased animals or their products have been used to produce food;
- **secondary**, where germs enter the food during handling, processing and other manipulations (from the hands or clothing of workers, contaminated containers, packaging, contact with insects or rodents, bird droppings, etc.).

Bacterial infections and foodborne intoxication

Until 2006, salmonellosis was the most common cause of reported bacterial alimentary diseases in the Czech Republic, after which it was overtaken by campylobacteriosis (State Institute of Health).

The causative agent of **salmonellosis** is bacteria of the genus *Salmonella*. The most common sources are foods of animal origin (meat, meat products, dairy products, eggs). Infection occurs through food contaminated primarily or secondarily when the source of infection is the animal or human who contaminates the food. In poultry, especially ducks, Salmonella can pass from the oviduct to the eggs. A large infectious dose is required to become ill. Salmonella can survive in frozen food for several months, but they do not tolerate high temperatures and are therefore reliably destroyed by boiling or by a temperature of at least 65°C for 15-20 minutes. After an incubation period of usually 12-24 h, shivering, fever, constipation, headache, diarrhoea, vomiting occur. These symptoms are caused by thermostable endotoxin.

🔎 *For more information see Salmonella enteritis.*

The causative agent of **campylobacteriosis** is the microaerophilic to anaerobic Gram-negative non-sporulating rod *Campylobacter jejuni*. The disease may present with watery diarrhoea or dysentery-like symptoms. The reservoir of infection is poultry, but humans shedding the micro-organism in their faeces may also be a source of infection. Infection most commonly occurs after consumption of undercooked poultry or food that has been contaminated by contact with raw poultry.

The causative agent of **shigellosis** (bacillary dysentery) is *Shigella spp*. Unlike Salmonella, a small infectious dose is required to become ill, so it is transmitted from person to person by contaminated hands, objects, uncooked food (fruit, vegetables, especially those fertilised by infected sewage), and possibly water. The incubation period is usually 2-3 days, clinical signs are characteristic of acute diarrhoeal disease with fever, tenesmus, vomiting. Toxic products of microorganisms cause alimentary intoxication.

🔎 *For more information see Shigellosis.*

A thermostable enterotoxin produced by *Staphylococcus aureus* causes *staphylococcal enterotoxicosis*. The onset of illness is sudden, usually only a few hours (2-4) after incubation, with nausea, vomiting, cramps and diarrhoea. However, this dramatic onset usually subsides rapidly. The source of infection is a person with a staphylococcal infection of the skin (panaritium) or even the upper respiratory tract who comes into contact with food and food preparation. Under the right conditions, staphylococci multiply in contaminated food (cream sauces, dairy, deli and confectionery products, minced meat) and produce enterotoxin.

🔎 *For more information see Staphylococcal enterotoxicosis.*

The causative agent of **listeriosis** is *Listeria monocytogenes*, which causes severe disease with a mortality rate of more than 25% in pregnant women, newborns and immunocompromised persons. The disease often starts with diarrhoea or other gastrointestinal symptoms, with severe cases developing sepsis or meningitis, often complicated by encephalitis. In pregnant women, miscarriages, premature births and severe infection of the newborn (Todar)

occur. Listeria are ubiquitous and can multiply, albeit slowly, even at temperatures below 5 °C. The disease is most commonly associated with the consumption of foods stored for long periods in refrigerators, especially soft cheeses and meat and fish products. Listeria tend to be present in small quantities in foods, but improper storage of food can multiply the bacteria to the levels needed to cause infection. The expansion of the food market, i.e. the place and time of production and consumption are becoming increasingly distant, also increases the risk. The risk of infection increases if appropriate conditions are not observed in the shop, but also in the home.

Clostridium botulinum, an anaerobic, sporulating microorganism found in the intestinal tract of animals, is well maintained in soil and water. It produces a highly potent thermolabile neurotoxin. Transmission occurs through ingestion of salted or preserved foods (sausages, canned meat, fish and vegetables) containing *Cl. botulinum* without sufficient heat treatment. The incubation period is usually 12-18 h. **Botulinum** is manifested by headache, vomiting, constipation, double vision, difficulty in speaking and swallowing and even paralysis of the respiratory muscles. Prevention is based on observance of all technological procedures in the preparation of sausages and preserves and their proper storage. Sufficient cooking of these products before consumption. Spore germination is inhibited by adding pickling salts (mixtures of nitrates and nitrites) to the meat mixture when making sausage products.

🔎 *For more information see Botulism.*

Clostridium perfringens is part of the normal intestinal microflora. Type A produces a thermolabile enterotoxin. It multiplies very rapidly when contaminating food (cooling soup, sauce) and induces vomiting and diarrhoea after 10-12 h of incubation.

Bacillus cereus produces two enterotoxins that produce different disease patterns: either after 1-5 h spasmodic abdominal pain, violent vomiting without diarrhea (form A), or after 8-16 h spasmodic abdominal pain with profuse diarrhea (form B). B. cereus is commonly present in the environment and disease can occur when it massively multiplies, especially in cereal foods (rice).

Foodborne viral diseases

Alimentary infections of viral aetiology include **viral hepatitis A**. Foodborne transmission can also include **adenoviruses**, **reoviruses, enteroviruses**, **tick-borne encephalitis virus** transmitted by the milk of infected domestic animals, as well as **myxoviruses** and **parainfluenza viruses** causing mastitis in cows.

Alimentary protozoan diseases and parasitoses

Enterobiosis is an endemic geohelminthosis with a high incidence in preschool and school-age children. The prevalence of infection in children is as high as 80%. It is often familial and due to reinfection, it is maintained in families and collectives for a long time. The causative agent of the disease is the childhood roach (*Enterobius vermicularis*). The source of infection is the infected individual, the gateway is the mouth (autoinfection, contaminated food, toys, dust).

🔎 *For more information see Enterobiosis.*

Teniasis are parasitic diseases caused by various helminths in whose life cycle humans are the definitive or intermediate host. *Taenia saginata* is transmitted by the consumption of processed beef or veal containing boubella, and *Taenia solium* is contracted from undercooked pork or by ingestion of tapeworm eggs.

Askariosis are caused by the parasite *Ascaris lumbricoides*, the source of infection is a sick person or soil contaminated with eggs, transmission occurs by ingestion of contaminated, inadequately treated food or contaminated soil.

🔎 *For more information see Ascariasis.*

Amoebiasis occurs in the tropics and subtropics and is caused by the protozoan *Entamoeba histolytica*. The source of infection is a sick person and transmission occurs via the faecal-oral route. The disease is manifested by diarrhoea and colonic involvement with the possibility of perforation and peritonitis or transition to a chronic stage. Hepatic involvement is manifested by hepatitis or abscess.

🔎 *For more information see Entamoeba histolytica.*

Food spoilage micro-organisms

Food is a suitable breeding ground for many types of microorganisms, especially **bacteria, moulds and yeasts**. These use the nutrients in food to grow and multiply, decomposing and producing a variety of metabolic products, including toxic ones. This process leads to changes in the composition, appearance, texture, taste and odour of the food - spoilage.

Yeasts or **mesophilic bacteria** (grow fastest at temperatures of 25-40°C) with lipolytic and proteolytic activity cause significant changes in taste and aroma (sour, rotten, rancid). The typical microflora of refrigerated products are *psychrophilic bacteria* (they grow at a low temperature of 2-8 °C). Their numbers can triple in 3-5 days at 5 °C, leading to a change in the taste and smell of the product (atypical taste, rancid, rotten).

Some species of **mould** produce mycotoxins that are toxic to humans - see the article Foreign substances in food.

Since ancient times, people have tried to **prevent spoilage and prolong the shelf life of food**. **Salting, drying and fermentation** are among the oldest methods. They were joined in the late 18th century by canning, followed by a number of other methods. All methods of extending the shelf life of food are based on preventing contamination by micro-organisms or destroying or preventing their growth.

Microorganisms used in food production

Many foods are produced using the biochemical activity of certain species of yeasts, bacteria and moulds, or a combination of these.

Yeast (yeast - Saccharomyces cerevisiae Hansen) is used to make **bread and leavened bread**. Yeast ferments carbohydrates during the rising process to produce a gas (CO2) giving the product a porous structure and alcohols, aldehydes, esters and other substances giving the typical flavour. Brewer's and wine yeasts are used in the production of **beer** and **wine**. Also, **vinegar**, **cabbage** and **quick pickles'** are fermented by the action of yeasts.

In the production of all *fermented dairy products*, certain strains of *Lactococcus, Lactobacillus and Streptococcus* bacteria are used to produce lactic acid. Other bacteria are added to some products (ripened cheese). Fungal cultures of *Penicillium camemberti, roqueforti* are added to mould cheese.

Some long-lasting sausages are matured under the cover of the fungi *Penicillium* or *Scopulariopis*. Soya sauce is produced by the fungus Aspergillus oryzae growing on soya beans.

Coffee beans are fermented by pectinolytic and lactic acid bacteria. **Cocoa beans** are fermented by yeast and lactic acid bacteria. No micro-organisms are used in the fermentation of tea - auto-fermentation takes place.

Microorganisms are also used in the production of the Japanese alcoholic beverage sake and a range of Japanese, Chinese, Indonesian and Indian dishes such as soy cheese, tempeh, miso, angkbak, dosa and rabri.

Probiotics

There are around 400 species of bacteria in the large intestine. Beneficial bacteria acidify the intestinal contents, block the development of pathogens and unfavourable bacteria, block the conversion of nitrates to nitrites and produce some B vitamins and vitamin K. Adverse bacteria contribute to the risk of colorectal canceru by forming nitrite and converting bile acids to the carcinogen desoxycholate. The physiological function of the normal intestinal microflora is part of a defence mechanism that involves the barrier of adherence of pathogenic bacteria to the intestinal mucosa, the synthesis of compounds that inhibit and destroy bacteria, and the competitive consumption of nutrients required for the growth of pathogenic microorganisms. The physiological microflora also modulates the immune system by stimulation with microbial antigens. The microflora is also of nutritional importance as an aid in the digestion of short-chain fatty acids and in the removal or disposal of harmful substances. (Human microflora). Probiotics are bacteria that affect the composition of the microflora of the colon and thus the state of health - they have probiotic properties. All known bacteria with a probiotic effect belong to the lactic acid bacteria group. Only certain strains of *Lactobacillus, Bifidobacterium and Enterococcus* are used. The criteria that bacteria used as probiotics must meet include:

- must not be pathogenic,
- be sufficiently resistant not to be destroyed or weakened during passage through the digestive tract or during processing,
- must remain viable throughout the shelf life of the food,
- should not affect the organoleptic properties of the food,
- attach to epithelial cells in the intestine and are capable of further growth,
- their positive effect on health is proven.

Probiotics improve the composition of the intestinal microflora and thus may positively influence immunity (prevention or alleviation of diarrhoea, urinary tract infections), reduce the risk of colon cancer (by reducing the number of harmful microbes producing toxic substances), reduce the absorption of cholesterol and thus its level in the blood, reduce the pH in the intestines by increased acid production and thus improve the absorption of minerals, especially calcium and magnesium. Probiotic microorganisms must enter the colon at a minimum of 10^8/ml each time they are ingested to be able to significantly influence the composition of the intestinal microflora. The colonisation of the gut by probiotic microorganisms is only transient - their numbers gradually decrease over the days to weeks following administration of the probiotic.

Prebiotics are substances that are not digested in the small intestine and enter the large intestine, where they serve as nutrients only for the desired bacterial species (probiotics) and thus promote their growth. Prebiotics occur naturally as a component of some foods. In breast milk, oligosaccharides are the third largest component in quantity after lactose and fat. The most commonly used industrial prebiotics are oligosaccharides or certain polysaccharides (e.g. inulin) that stimulate the growth of *Bifidobacterium or Lactobacillus* bacteria.

References

Related articles

- Diarrhoeal diseases
- Differential diagnosis of diarrhoeal diseases
- Botulism
- Enterotoxicosis

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