

# Micro-organisms in Foods

Micro-organisms, in relation to food, can have one of these 3 roles:

1. Pathogenic micro-organisms can cause infections or intoxications
2. Saprophytic micro-organisms play a role in biodegradation and cause food spoilage
3. Cultured micro-organisms like probiotic bacteria are used in food processing.

## Pathogenic micro-organisms

Pathogenic micro-organisms cause food-borne infections or intoxication, and include bacteria, viruses, parasites and moulds. It is important to note that pathogenic bacteria and viruses usually do not cause food spoilage, their contamination cannot be seen nor tasted.

- The main factors that contribute to occurrence of foodborne diseases are:

1. The use of raw food and ingredients from unsafe sources
2. Inadequate cooking or heat processing
3. Improper cooling and storing, for example leaving cooked foods at room temperature for longer periods of time, or storing foods in large containers in the fridge
4. Allowing several hours to pass between preparation and eating of food
5. Inadequate reheating
6. Improper hot holding, meaning below 65°C
7. Food handling by infected persons or carriers of infection
8. Cross contamination from raw to cooked food. For example by cutting vegetables for salad on a cutting board where you have cut raw meat before
9. Inadequate cleaning of equipment and utensils

## Bacteria

- **Campylobacter jejuni:** Is a common cause of diarrhea humans as well as some animal species. The transmission can be by direct contact between humans and infected animals or their feces. More commonly, it is transmitted by the consumption of contaminated food or water, or person-to-person spread. The symptoms range from mild diarrhea to severe invasive disease which can include abdominal pain, fever, and blood and mucous in stools.
- **Non-typhi salmonellosis:** There are more than 2000 serotypes of salmonella spp, of which only a few cause Salmonella gastroenteritis in humans. The symptoms include acute watery diarrhea accompanied by nausea, cramps and fever. Blood in stool may occur. Animals are the main reservoir, and transmission occurs by ingestion of contaminated products. Foods especially at risk are poultry, meat, eggs and milk.
- **Salmonella typhi and paratyphi:** Cause typhoid fever and paratyphoid fever respectively. Since the reservoir for both these bacteria are usually humans, transmission occurs mainly through person-to-person contact or contamination of food by food handlers.
- **Staphylococcus aureus:** The source of this infection are humans. The bacteria are often found in smaller amounts in the nose and on the skin of clinically healthy people. Higher amounts can be found in lesions of skin such as infected eczema, psoriasis or any other pus draining lesion. These people should therefore not be handling food. Food poisoning caused by this bacteria is caused by heat resistant staphylotoxin, resulting in diarrhea, vomiting, cramps and fever. The symptoms start suddenly and usually disappear within 24 hours.
- **Escherichia coli:** There are several serotypes, some of which are harmless to humans whereas others can cause gastroenteritis. Enterotoxigenic E.coli is the most common cause of traveller's diarrhea. The source is humans, and transmission usually occurs through contaminated food and water.
- **Listeria monocytogenes:** This bacterium is highly associated with food stored for long periods of time in the fridge because it is ubiquitous, and has the ability to grow slowly, even at low temperatures. Can be fatal in immunocompromised, where it can cause septicemia and meningitis.

- **Shigella:** The source is humans and primates. Because it has low infectious dose, the main mode of transmission is person-to-person contact. It can also be transmitted through infected food and water. The symptoms of shigellosis are fever and watery diarrhea. The infection can also manifest as a dysenteric syndrome which includes fever, abdominal cramps and tenesmus, and frequent, small volume, bloody stools containing mucous.
- **Vibrio Cholerae 01:** The source of this infection is humans. The main mode of transmission is through contaminated water and food, or person-to-person spread in overcrowded, unhygienic situations. It causes severe watery diarrhea, which can reach up to 20 liters per day.
- **Clostridium Botulinum:** Its source is the intestinal tract of fish, birds, and mammals. It is also widely distributed in nature. The bacterium is a spore producing anaerobe, with a highly potent heat labile toxin that affects the nervous system.

## Viruses

Viruses, unlike bacteria, cannot multiply in foods. The main mode of transmission therefore by food handlers and the use of dirty utensils, which transfer the virus to food whereupon it is ingested by humans.

- **Rotaviruses and Norwalk virus** are the major causes of gastroenteritis
- **Viral hepatitis A** outbreaks are mainly caused by asymptomatic carriers which handle food.

## Parasites

Many parasites, such as the helminths, have a complex lifecycle involving more than one host. The major route of transmission for these parasites to humans is by the route of food. The consumption of undercooked pork or beef, or the consumption of raw salads washed in contaminated water seems to be the trend.

**Taenia solium and T. saginata:** also called pig and beef tapeworms. Their cysts,, present in the muscle of the animal are ingested and the adult worm develops in the gut. The ova may develop into larvae that may invade other tissues, such as the brain, forming cysticercosis and severe neurological disorders as a consequence.

**Trichinella spiralis:** is found in undercooked pork. The larvae can invade tissues and cause a febrile illness.

**Giardia lamblia:** This infection can be foodborne, waterborne or spread by interpersonal contact. It causes acute or subacute diarrhea, with malabsorption, fatty stools, and abdominal pain and bloating.

**Entamoeba histolytica:** The transmission is mainly food- or waterborne. The cysts pose a major problem since they are highly resistant to chemical disinfectants, including chlorination. The infection is usually asymptomatic, but may appear as either a persistent mild diarrhea or a fulminant dysentery.

## Food Spoilage

It is the change of look, consistency, flavor and odor of foods, and is caused by bacteria, moulds and yeasts.

**Bacteria:** Examples of action of bacteria involved in food spoilage:

1. Lactic acid formation: Lactobacillus, Leuconostoc
2. Lipolysis: Pseudomonas, Alcaligenes, Serratia, Micrococcus
3. Pigment formation: Flavobacterium, Serratia, Micrococcus
4. Gas formation: Leuconostoc, Lactobacillus, Proteus
5. Slime or rope formation: Enterobacter, Streptococcus

**Moulds:** Some strains produce mycotoxins under certain conditions

1. Aspergillus produces aflatoxin, ochratoxin, citrinin and patulin
2. Fusarium
3. Cladosporium

#### 4. Alternaria

Mycotoxins can penetrate into the parts of food that are not visibly mouldy as well. It is therefore necessary to throw away all of the food if any part of it is mouldy. They are also notoriously difficult to destroy as they are stable to both heat and chemicals.

- Hepatotoxins: aflatoxins, sporidesmins, luteoskyrin
- Nephrotoxins: ochratoxin, citrinin
- GIT toxins: trichocetens
- Neuro- and myotoxins: tremorgens, citreoviridin
- Dermatotoxins: verukarins, psoralen, sporidesmins, trichocetes
- Respiratory tract toxins: patulin

Foods most at risk for moulds:

1. Grains and grain products - many mycotoxin types
2. Peanuts, nuts and pulses - aflatoxin
3. Fruits and vegetables (raw and preserved) - patulin
4. Milk and milk products - aflatoxin

It is important to note that if any contaminated fodder is fed to animals, this is metabolized and the toxic derivatives can be found in animal products consumed by humans, e.g. milk and meat.

## Microorganisms in food production

Most commonly used microorganisms are yeast, bacteria, moulds, or a combination of these. A good example of microorganism usage in food production is the process of fermentation, which results in the production of organic acids, alcohols and esters. These help to either:

1. Preserve the food
2. generate distinctive new food products

### Yeast in food production

- Leavened bread and bakery products: *Saccharomyces cerevisiae* ferments sugars to produce CO<sub>2</sub>, the gas that gives the porous structure of bakery products. It also contributes to the flavor by formation of alcohols, aldehydes, esters etc.
- Beer
- Wine
- Vinegar
- Pickles

### Bacteria in food production

- Fermented milk products: *Lactobacillus*, *Lactococcus*, *Bifidobacterium*
- A variety of foods including Indian dosa, rabri: fermentation by *Leuconostoc mesenteroides*, *S. faecalis*
- Probiotics: are live food supplements used in yoghurt and other fermented milk products. It includes *Lactobacillus acidophilus* and *Bifidobacterium bifidum*. A minimum of 10<sup>8</sup> bacteria per 1 ml must get to the colon alive to have any significant effect. These bacteria improve the microbial spectrum in the gut and thus contribute to the following effects:

1. Influence immunity and hence prevent or make diarrheal diseases milder
2. Decrease the risk of colon cancer
3. Decrease cholesterol absorption
4. Produce acids that decrease the pH in the gut and thus increase the absorption of minerals such as calcium and phosphorous.

### Mould in food production

- Cheese: *Penicillium roqueforti* and *Penicillium camemberti* (note that this one produces mycotoxin at 25°C, therefore the cheese production must happen at 15°C)
- Dry salami: makes the use of *Penicillium* and *Scopulariopsis* moulds.
- Soy sauce: *Aspergillus* spp, especially *A. oryzae*, are involved in this production. There is also a subsequent lactic fermentation where lactic bacteria produce lactic acid.
- Sake: is produced using a combination of the mould *Aspergillus oryzae* and yeast.

## **Links**

## **Related Articles**

## **Bibliography**

BENCKO CHARLES UNIVERSITY, PRAGUE 2004, 270 P, V, et al. Hygiene and epidemiology. Selected Chapters. 2nd edition. Prague. 2008. ISBN 9788024607931.

## **References**

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