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## Microbiological hazards in the food

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### Abstract

This paper describes the microbiological hazards in food. For protecting human health, nowadays food safety authorities face with many challenges. Food safety is one of the main objectives related to public health protection. It is expected to prevent, minimize or eliminate risks on different stages of the food chain and in the meantime maintain, provide, and distribute high-quality food to meet consumer demands. However, millions of cases of food-borne diseases occur every year worldwide. Microbiological hazard, or bio-hazard, is a biological substance that poses a threat to the health of living organisms, primarily humans. This could include a sample of a microorganism, bacteria microbial hazards in food comprise mycotoxin-producing moulds, protozoae, viruses and prions that can adversely affect human health.

**Keywords:** Green computing, eco-friendly technology, carbon emissions, carbon foot print, e- waste, degradation

### Introduction

The presence of botulinum neurotoxins in food is not new, but still an important issue because of their high toxicity to human. Botulinum neurotoxins are high-molecular thermolabile proteins produced by *Clostridium botulinum*, botulin neurotoxins are divided into seven types A-G, however only types A, B, E and F are toxic to humans and some animals. Verocytotoxigenic *Escherichia coli* O104:H4 has been isolated in Germany on 2011. It was characterized by unique features such as presence of enter aggregative *Escherichia coli* genes (aatA, aggR, aap, aggA, aggC) and resistance to most antibiotics. Increasingly common microbiological hazard in food is methicillin-resistant *Staphylococcus aureus* (MRSA). Viruses may contaminate food either through contamination at source, principally through sewage pollution of the environment, or in association with food. Food-borne diseases can be caused consuming food or water contaminated by pathogenic microorganisms such as bacteria and their toxins, fungi, viruses, and parasites. Food can be contaminated both at the source as raw material, and during food processing up to storage and distribution. Also people (infected persons or carriers of pathogens) and the environment (food contact surfaces and facilities) can spread microorganisms on raw or processed food. The genetic variation and phenotypic characteristics of *L. monocytogenes* isolates from retail raw foods, as well as the growth potential of isolates from milkshakes, prepared from naturally contaminated ice- cream scoops linked to a listeriosis outbreak were studied and reported.

### Characteristics

*Bacillus cereus* (*B. cereus*) is a Gram-positive, facultative anaerobic, endospore forming, large rod and has colonial morphology of about 2-7 mm in diameter, with a white granular texture. The optimal growth temperature is 28°C to 35°C, with a minimum growth temperature of 4°C and a maximum of 48°C. Growth can occur in pH ranges from 4.9 to 9. *Staphylococcal* species are Gram-positive, nonmotile, catalase-positive, small, spherical bacteria (cocci), which, on microscopic examination, appear in pairs, short chains, or bunched in grape-like clusters. *S. aureus* growth, in general, ranges from 7°C - 47.8°C, with 35°C being the optimum temperature for growth. The growth pH range is between 4.5 and 9.3, with an optimum from 7.0 - 7.5. *Listeria monocytogenes* is a Gram-positive, rod-shaped, facultative bacterium, motile by means of flagella typically measuring 0.5 to 2µm long and 0.5µm in diameter. It has the ability to grow at low temperatures, a range of pH values (between 4.3 and 9.6), and can reproduce at temperatures between 1 and 45°C.

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Not only can it survive at 1°C, unlike many other pathogens but it can also grow in these conditions so it is known as a psychrophile. It is also notable for its persistence in food-manufacturing environment. *Clostridium perfringens* is an anaerobic (but aerotolerant) Gram-positive, spore-forming rod that produces enterotoxin. There are different strains (types A-E), most cases of food poisoning are caused by type A and sometimes type C. Not all strains are enterotoxin producers. It can grow between temperatures of 15-55°C with the optimum being between 43-47°C (109.4-116.6°F). The optimum growth pH is 6.0 – 7.0.

*Clostridium botulinum* is an anaerobic, gram-positive, spore-forming bacterium that produces a potent neurotoxin. The spores are heat-resistant and can survive in foods that are incorrectly or minimally processed. It can grow between a temperature of 3 to 50°C and a pH of 4.6 – 9.0. There are 7 distinct forms of botulinum toxin, types A–G. Four of these (types A, B, E and rarely F) cause human botulism. Types C, D and E cause illness in other mammals, birds and fish.

*Escherichia coli* O157 is gram negative, rod shaped, non-spore forming bacteria belonging to the family, Enterobacteriaceae. It is a harmful bacterium that is particularly dangerous because it has the ability to survive during refrigeration and freezing and has been shown to be tolerant of acid, salt and dry conditions. It can grow between temperature of 7- 46°C and at a pH as low as 4.4.

### Pathogenicity

*B. cereus* causes two kinds of food borne disease: An intoxication due to a toxin preformed in the food. An infection due to the ingestion of cells which produce enterotoxins in the small intestine. *Staphylococcus aureus* is found in foods and can make toxins (enterotoxins) that might not be destroyed by cooking, although the bacterium itself can be destroyed by heat. Staphylococcal enterotoxins are stable in the gastrointestinal tract and indirectly stimulate the emetic reflex centre by way of undetermined molecular events. It is thought that the vagus nerve is involved in the sequence of events that produce the emetic response.

*Listeria monocytogenes* is the bacteria that is the principal cause of listeriosis in humans. It was first described as a human pathogen in the 1920s. The main target populations for Listeriosis are pregnant women/foetuses/neonates - perinatal and neonatal infections; persons immunocompromised, for example, corticosteroids, anticancer drugs, graft suppression therapy, AIDS, cancer patients, particularly leukemic; the elderly.

*Clostridium perfringens* enterotoxins are produced when vegetative cells of the bacterium start to multiply in the human intestine and sporulate. During the sporulation the organism also releases the enterotoxin that causes the symptoms.

Botulism is caused by a neurotoxin formed during the growth of *Clostridium botulinum*. This neurotoxin binds to the neuromuscular junction and blocks excitatory synaptic transmission by inhibiting acetylcholine release causing (flaccid) paralysis and sometimes fatal respiratory failure. Foodborne botulism, caused by consumption of improperly processed food, is a rare but potentially fatal disease if not

diagnosed rapidly and treated with antitoxin.

*Escherichia coli* O157 is commonly found in the lower intestine of warm-blooded organisms. It can produce a toxin (Shiga toxin) which can cause serious illness. It can affect all ages; however there have been higher mortality rates occur in the elderly and young. The infective dose of *Escherichia. coli* O157 is estimated to be very low, in the range of 10 to 100 cells.

### Sources of Exposure

*B. cereus* widespread in the environment being found in soil, water, air and vegetable matter. Rice products, pasta, vegetables, herbs, spices, milk and meat. It is very common in the environment and can be found in soil, water and air. It can live in humans and animals, approximately 50% of humans are carriers of this organism and food handlers are frequently implicated in the transmission of this pathogen to food. Some food sources include milk and milk-based products, cream, and cream-filled pastries and butter. Ham, other cured meats such as corned beef, bacon and sandwich. The intoxication dose of *Staphylococcus Enterotoxin* is less than 1.0 microgram. This toxin level is reached when *S. aureus* populations exceed 100,000 organisms/g in food. In highly sensitive people, ingestion of 100 - 200ng of enterotoxin can cause symptoms.

Many foods have been associated with *Listeria monocytogenes*. Examples include raw milk, inadequately pasteurized milk, chocolate milk, cheeses (particularly soft cheeses), soft serve ice cream, pâté, raw vegetables, raw poultry and meats (all types). It is also found widely in the environment, soil, manure, decaying vegetable matter, silage, water and animal feed. Another major source is the food manufacturing environment especially on floors and drains.

*Clostridium perfringens* Type A is widely distributed in the environment in soil, vegetation and intestinal tracts of animals. Food sources include cooked meats especially beef and poultry products. Meat containing products such as stews, rolled meat, meat pies and gravies. Can also be found on vegetable products, including spices and herbs.

*Clostridium botulinum* widely distributed in nature with it being found in soil and marine environments as well as the intestinal tracts of fish and mammals. Common food vehicles include low-acid processed foods, canned products, garlic oil, smoked fish or other marine products especially those packed in vacuum packs.

*Escherichia. Coli* O157 present in Ground meats, un-pasteurised milk, un-pasteurised fruit juice, lettuce, spinach and sprouts. Soil where fresh produce grows can become contaminated so root crops and leafy vegetables are a potential source. Also, a major source is animals and their environment, in particular cattle. Waterborne transmission has been reported for *E.coli* O157 both from contaminated drinking water and from recreational waters. Person to person contact is also a mode of transmission through the oral-faecal route. An asymptomatic carrier state has been reported, where individuals show no clinical signs of disease but are capable of infecting others.

### Illness and Symptoms

*B. cereus* food poisoning is caused by toxins produced during the growth of the bacteria (emetic toxin (ETE)) and three different enterotoxins: Hemolysin (HBL), Nhe, and EntK. These toxins cause two distinctly different forms of

food poisoning – the emetic/vomiting type or diarrhoeal type. Symptoms usually last around 24 hours. EntK (Not involved in food poisoning). Emetic type symptoms include nausea, vomiting and abdominal cramps.

*Staphylococcus aureus* diarrhoeal type symptoms include watery diarrhoea, abdominal cramps and pain with occasional nausea and vomiting. Although both forms are self-limiting more severe cases have been reported which included complications such as pyogenic infections, gangrene, septic meningitis, lung abscesses and infant death. Symptoms include nausea, abdominal cramping, vomiting and diarrhoea. In more severe cases headache, muscle cramping, dehydration and low blood pressure occur. The illness is relatively mild and usually lasts from only a few hours to one day; however, in some instances, the illness is severe enough to require hospitalization. Death from food poisoning from *Staphylococcus aureus* is uncommon; however, deaths have occurred among the elderly, infants and severely debilitated people.

*Listeria monocytogenes* can cause 2 forms of disease. One can range from mild symptoms to intense symptoms of diarrhoea, nausea, vomiting, aches, and fever and usually will go usually away by itself. The other is a deadlier form which can occur when the infection spreads through the bloodstream and can result in meningitis and blood poisoning. The duration of symptoms generally depends on the health status of the infected person and can last from days to several weeks. In pregnant women, Listeriosis occurs mostly during the third trimester, and is characterised by a “flu like” illness with symptoms such as fever, chills, malaise, arthralgia, back pain, and diarrhoea. Intrauterine infection of the foetus can lead to foetal death, spontaneous abortion, premature delivery, or the birth of a foetus that dies shortly after birth.

Foodborne illness caused by *Clostridium perfringens* can take two forms. *Gastroenteritis form*: Symptoms include, abdominal cramps and watery diarrhoea. It is generally self-limiting depending on the strain, in some cases it can lead to more severe gastroenteritis which can lead to damage of the small intestine. *Enteritis necroticans (pig-bel disease)*: This is much more severe and fatal, but it is rare. Symptoms include pain and gassy bloating in the abdomen, diarrhoea and vomiting.

Initial symptoms of *Clostridium botulinum* infection included double vision, blurred vision, slurred speech, vertigo, and trouble swallowing and muscle weakness. If the disease is not treated symptoms may progress to paralysis of the arms, legs, trunk and respiratory muscles. Patients with severe cases that involve paralysis of the respiratory muscles may need mechanical ventilation and intensive care for weeks or months.

*Escherichia coli* 0157 infection includes Bloody diarrhoea (haemorrhagic colitis), severe cramping, nausea and vomiting. In severe cases this may progress to life-threatening complications as (HUS) where red blood cells are destroyed causing kidney injury. This can result in the person requiring intensive care, kidney dialysis, and transfusions. It can also lead to Thrombotic thrombocytopenic purpura (TTP). About 3% -7% of the haemorrhagic colitis cases progress to HUS or TTP.

### Controls to reduce the risk

Foods should be cooked to a core temperature of 75°C (167°F) e.g. 70°C (158°F) for 2 minutes which will destroy the cells however in order to prevent the (*Bacillus Cereus*) spores germinating it is essential that rapid cooling takes place. It may be beneficial to implement or install rapid chilling equipment to speed up the cooling process. Hot food should be maintained at a temperature greater than or equal to 63°C (145.4°F) for *S. aureus* and chilled food should ideally be maintained at a temperature less than or equal to 4°C (39.2°F). Implementation of a food safety management system based on the principles of HACCP. This includes good process control, e.g. temperature control during cooking – sources report that the *Staphylococcus Aureus* enterotoxin will be inactivated during cooking of 100°C for 30 minutes. Although they are lower water activity foods, those with high salt such as ham may need a longer cooking time. It is also important to store foods correctly e.g. refrigeration of high-risk foods.

The design and layout of floors and drainage systems is particularly important as floors and drains have been confirmed as a source of *Listeria monocytogenes*. Where feasible, food processors should incorporate a listericidal processing step (e.g. cooking meat products to 70°C for two minutes) into the production of RTE and other at risk foods. Thermal processing steps such as cooking and pasteurisation are very effective in reducing numbers of *Listeria monocytogenes*. In some foods, a single intrinsic or extrinsic variable (H, Temperature) may be used as a listericidal step. Cook foods until core temperature of 75°C (176°F) and serve immediately or store above 63°C (145.4°F). This will inactivate the vegetative cells however cooling is required to prevent spore germination of *Clostridium perfringens*. Rapid cooling of high risk product after cooking especially through the temperature of 55-15°C (131-59°F) followed by storage at a temperature of below 4°C (39.2°F).

Prevent the growth of *Clostridium botulinum* and toxin production in chilled foods with a shelf-life of more than ten days. A heat treatment of 90°C for ten minutes or equivalent lethality, a pH of 5 or less throughout the food and throughout all components of complex foods. A minimum salt level of 3.5% in the aqueous phase throughout the food and throughout all components of complex foods, a water activity (aw) of 0.97 or less throughout the food and throughout all components of complex foods. Safety of canned food is based on the destruction of the spore's i.e. 121°C for a minimum of 3 minutes also known as (Botulinum Cook).

The control starts on the farm with the implementation of good agricultural practice which can help reduce the shedding of *Escherichia coli* 0157 from animals such as cattle.

The prevention also requires controls during manufacturing and preparation of foods such as preventing cross-contamination of foods and cooking food so that the core reaches at least 70°C for 2 minutes. Water supplied to food businesses, including private supplies, must meet potable water standards.

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