Microbiological Hazards Datasheet E-book

Essential facts about the 11 most common Microbiological Hazards in the food industry.
# Table of Contents

- **Escherichia coli** ................................................................. 3
- **Salmonella** ........................................................................ 5
- **Listeria monocytogenes** ...................................................... 7
- **Hepatitis A** .......................................................................... 9
- **Staphylococcus aureus** ....................................................... 11
- **Campylobacter jejuni** ........................................................... 13
- **Clostridium botulinum** .......................................................... 15
- **Bacillus cereus** .................................................................... 17
- **Norovirus** .......................................................................... 19
- **Clostridium Perfringens** ...................................................... 21
- **Yersinia enterocolitica** ......................................................... 23

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Pathogenic Bacteria :: *Escherichia coli* 0157

**DATASHEET**
Microbiological Hazard Series

**Pathogen Name:** *Escherichia coli* 0157

**Characteristics:** *Escherichia coli* 0157 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:** *Escherichia coli* 0157 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.

**Infectious Dose:** The infective dose of *Escherichia coli* 0157 is estimated to be very low, in the range of 10 to 100 cells.

**Sources (Including High - Risk food groups):** Ground meats, unpasteurised milk, unpasteurised 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 both from contaminated drinking water and from recreational waters. Person to person contact is also a mode of transmission though 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.

**Onset Period:** Usually begins 3 to 4 days after exposure but it can range from 1 to 9 days.

**Illness, Symptoms and Complications:** 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% to 7% of the haemorrhagic colitis cases progress to HUS or TTP.

**Controls to reduce the risk:**
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. Good agricultural practices are extremely important for the production of fresh fruits and vegetables, this can be done by protecting fields from animal faecal contamination and keeping harvest/storage equipment clean and dry.

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.

It is important to make sure correct personal hygiene procedures are in place such as making sure hands are thoroughly washed prior to handling food and making sure there is control over food handlers after returning to work after suffering from food poisoning illness.

It is essential that staff designated for carrying out cleaning and disinfection procedures are adequately supervised, instructed and/or trained to ensure the procedures are carried out effectively every time. Consumers should be advised to cook food such as burgers thoroughly, avoid unpasteurised food products and to wash fruit and vegetables thoroughly before consumption.
### Summary Table

| Source          |  • Ground meats  
|                 |  • Unpasteurised milk  
|                 |  • Fresh produce  
|                 |  • Water  
|                 |  • Person to person  

| Growth Temperature | • 7 - 46°C  
|--------------------|-------------------

| Growth pH range   | • Low as 4.4  
|--------------------|-------------------

| Onset period      | • 3 - 4 days (Can range from 1 - 9)  
|--------------------|-----------------------------------

| At risk groups    |  • The very young  
|--------------------|-------------------
|                    |  • The elderly  
|                    |  • Those with a weakened immune system  

| Illness, Symptoms, Complications |  • Bloody diarrhoea (Hemorrhagic colitis)  
|----------------------------------|----------------------------------
|                                  |  • Vomiting  
|                                  |  • Nausea  
|                                  |  • Can lead to HUS and TTP in severe cases  

| Controls             |  • Good agricultural practices  
|----------------------|-------------------
|                      |  • Prevent cross contamination  
|                      |  • Use treated water  
|                      |  • Heat treatment e.g cooking at 70°C for 2 minutes  
|                      |  • Good personal hygiene practices  
|                      |  • Gloves  
|                      |  • Personal Protective Clothing  

### Published Risk Assessments

|--------------------------------------------------------|---------------------------------------------------------------

|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------

|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------

### Example Outbreaks

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>UK (Wales)</td>
<td>Cooked meat that was contaminated was supplied to schools and resulted in 157 illness, 21 hospitalisations and 1 death.</td>
</tr>
<tr>
<td>2016</td>
<td>UK</td>
<td>Mixed salad leaves became contaminated resulting in 105 confirmed illness and 2 deaths.</td>
</tr>
<tr>
<td>2017</td>
<td>US and Canada</td>
<td>Romaine lettuce became contaminated causing 66 illnesses and 2 deaths</td>
</tr>
</tbody>
</table>

### References

**Pathogen Name:** *Salmonella*

**Characteristics:** *Salmonella* is a motile, non-sporeforming, Gram-negative, rod-shaped bacterium of the family Enterobacteriaceae that is approximately 0.7-1.5 by 2.0-5.0 µm in size. It has the ability to grow between a pH of 3.7 - 9.5 and a temperature of 7–48°C.

**Pathogenicity:** *Salmonella* is a zoonotic infection which means it can be transmitted to humans from animals. *Salmonella* can cause two types of illness (1) nontyphoidal salmonellosis and (2) typhoid fever. The symptoms of nontyphoidal salmonellosis can be quite unpleasant, but this illness is generally self-limiting among healthy people with an intact immune system (although it can cause life-threatening illness even in healthy people). Typhoid fever is more serious and has a higher mortality rate than nontyphoidal salmonellosis. Vulnerable people would be the young, elderly and those suffering from chronic illness or disease such as HIV.

**Infectious Does:** For Nontyphoidal Samonellosis it can be as low as one cell depending on the age and health of the host. For Typhoid fever it can be fewer than 1,000 cells.

**Sources (Including High-Risk food groups):** Raw meats, poultry, eggs, unpasteurised milk and dairy products, seafood, fresh produce (including seed sprouts) and spices. *Salmonella* is also widely dispersed in nature and the environment. It can colonize in the intestinal tracts of vertebrates, including livestock, wildlife, domestic pets and humans.

**Onset Period:** Nontyphoidal Salmonellosis: 6-72 hours of exposure to the bacteria. Typhoid Fever: Generally, 1 to 3 weeks, but may be as long as 2 months after exposure.

**Illness, Symptoms and Complications:**
Salmonellosis symptoms include nausea, vomiting, abdominal cramps, diarrhoea, fever and headache and can last between 4-7 days with acute symptoms lasting 1-2 days depending on the host factors and the dose ingested.

Nontyphoidal *Salmonella* can sometimes escape from the gastrointestinal tract into the body and cause blood poisoning (septicemia) or infect the blood, internal organs, and/or joints (bacteremia).

Typhoid fever which symptoms include high fever, lethargy, gastrointestinal symptoms including abdominal pain, diarrhoea or constipation, acheiness, loss of appetite. Sometimes a rash of flat rose coloured spots can sometimes occur. Septicemia, with colonization of other tissues and organs; e.g. may lead to endocarditis. Septic arthritis may occur, in which the infection directly affects the joints and may be difficult to treat. Chronic infection of the gallbladder may occur, which may cause the infected person to become a carrier.

**Controls to reduce the risk:**
The control of *Salmonella* in food should start on the farm with the careful production of animal derived raw materials such as eggs, poultry, pork and fresh produce. Suppliers should carefully source their ingredients and supplies from approved suppliers and in particular, purchase pasteurised products (such as milk or eggs). *Salmonella* can be effectively controlled by relatively mild heat processing (e.g pasteurisation) but it is essential that cross contamination between food is avoided. General good hygiene practices such as washing hands thoroughly after handling raw meat and effective temperature controls are also very important.

HACCP should be used to identify and implement adequate controls for *Salmonella* (ensuring the organism is absent) in all ready to eat food and drinks. To ensure that ready-to-eat foods remain free from *Salmonella*, careful handling and storage of product should be encouraged at the retail stage and in the consumers home.
## example outbreaks

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>UK</td>
<td>Chocolate bars became contaminated which resulted in 37 people falling ill.</td>
</tr>
<tr>
<td>2017</td>
<td>France</td>
<td>Infant formula became contaminated which resulted in 35 infants falling ill.</td>
</tr>
<tr>
<td>2018</td>
<td>USA</td>
<td>Raw sprouts that were not washed were served with sandwiches which resulted in 8 people falling ill.</td>
</tr>
</tbody>
</table>

## summary table

<table>
<thead>
<tr>
<th>Source</th>
<th>Raw Meat</th>
<th>Poultry</th>
<th>Eggs</th>
<th>Seafood</th>
<th>Spices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Temperature</td>
<td>7 and 48°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth pH range</td>
<td>3.7-9.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onset period</td>
<td>Non-typhoid: 6-72 hours</td>
<td>Typhoid: 1-3 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At risk groups
- Immunocompromised Individuals and those suffering from chronic illnesses
- Those with weaker immune systems – (Elderly and the very young)

Illness, Symptoms, Complications
- Diarrhoea
- Fever
- Vomiting
- Serious cases can result in meningitis and septicemia

Controls
- Careful production of animal derived products at farm level
- Mild heat processing treatments
- Good hygiene procedures
- Effective temperature control
- Gloves
- Personal Protective Clothing

Published Risk Assessments

## references

Pathogenic Bacteria :: *Listeria monocytogenes*

**DATASHEET**
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**Pathogen Name:** *Listeria monocytogenes*

**Characteristics:** *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.

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.

**Pathogenicity:** *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.

Although relatively rare, human listeriosis is often severe and mortality rates can approach 50%. The main target populations for Listeriosis are pregnant women/foetuses/neonates - perinatal and neonatal infections; persons immunocompromised by, for example, corticosteroids, anticancer drugs, graft suppression therapy, AIDS, cancer patients, particularly leukemic; the elderly.

**Infectious Does:** The approximate infective dose of *Listeria monocytogenes* is estimated to be 10 to 100 million colony forming units (CFU) in healthy hosts, and only 0.1 to 10 million CFU in individuals at high risk of infection. However, the infective dose may vary widely and depends on a variety of factors including the individual effected.

**Sources (Including High - Risk food groups):** 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.

**Onset Period:** Gastroenteritis caused by *Listeria monocytogenes* has a relatively short incubation period, from a few hours to 2 or 3 days. The severe, invasive form of the illness can have a very long incubation period, estimated to vary from 3 days to 3 months.

**Illness, Symptoms and Complications:** It can cause 2 forms of disease. One can range from mild symptoms to intense symptoms of diarrhoea, nausea, vomiting, aches, 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.

**Controls to reduce the risk:**
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*. Controls include making sure floors are designed to drain areas rapidly to prevent pooling. Drains should have adequate capacity and be trapped inside and outside the facility.

As it is known to grow at low temperatures, environmental and storage temperatures must be maintained, controlled and monitored at all times. Storage areas should be designed to maintain the correct product temperature.

Cleaning with detergents followed by disinfection helps to reduce the number of microorganisms. The correct choice of chemicals, equipment, procedures and frequency are all important.

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 (e.g. pH, Temperature) may be used as a listericidal step. However, it is recommended that a combination of variables is used.
### Example Outbreaks

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Canada</td>
<td>Cross-contamination of cooked ready to eat deli meat products resulting in 22 deaths.</td>
</tr>
<tr>
<td>2011</td>
<td>USA</td>
<td>Contaminated Cantaloupes affected at least 146 people and resulted in 22 deaths.</td>
</tr>
<tr>
<td>2014</td>
<td>Denmark</td>
<td>Contaminated meat products including salami and hot dogs resulting in 15 deaths.</td>
</tr>
</tbody>
</table>

### Summary Table

#### Source
- **Food:**
  - Raw or unpasteurised milk
  - Soft cheese
  - Raw vegetables
  - Raw meat
- **Environment:**
  - Soil
  - Water
  - Floors and drains (in food manufacturing facilities)

#### Growth Temperature
- 1 and 45°C

#### Growth pH Range
- 4.3 and 9.6

#### Onset Period
- 2-3 days for gastroenteritis
- Invasive form – 3 days to 3 months

#### At Risk Groups
- Pregnant women
- Elderly
- Those who are immunocompromised
- Those suffering from cancer (particularly leukemia)

#### Illness, Symptoms, Complications
- Diarrhoea
- Fever
- Vomiting
- Serious cases can result in meningitis and blood poisoning
- In pregnant women it can lead to spontaneous abortion or premature delivery.

#### Controls
- Cook food to 70°C for 2 minutes.
- Have an adequate cleaning and sanitising program in place.
- Adequate drainage in food manufacturing facilities.
- Gloves
- Personal protective clothing

#### Published Risk Assessments
- WHO: Risk Assessment of *Listeria monocytogenes* in RTE foods
- FDA: Quantitative Assessment of Relative Risk to Public Health From Foodborne *Listeria monocytogenes* Among Selected Categories of Ready-to-Eat Foods
  - [https://www.fda.gov/downloads/Food/FoodScienceResearch/UCM197330.pdf](https://www.fda.gov/downloads/Food/FoodScienceResearch/UCM197330.pdf)
- Wiley Online Library: Risk Assessment and Management of *Listeria monocytogenes* in RTE Lettuce Salads

### References
Pathogenic Virus :: Hepatitis A

**DATASHEET**
Microbiological Hazard Series

**Pathogen Name:** Hepatitis A virus (HAV)

**Characteristics:** HAV is a member of the Picornaviridae family and Hepatovirus genus. It is an icosahedral, non-enveloped, positive-sense RNA virus and is 27 to 32 nm in diameter. Although HAV cannot grow in the environment, it can survive refrigeration and freezing for up to two years and is resistant to acid (pH 1 for 2 hours at room temperature). HAV has a high resistance to many chemicals and drying than other enteroviruses.

**Pathogenicity:** HAV causes acute hepatitis and is not associated with chronic liver disease. Most individuals infected with HAV develop nonspecific constitutional signs and symptoms followed by gastrointestinal symptoms. The virus is primarily spread when an uninfected (and unvaccinated) person ingests food or water that is contaminated with the faeces of an infected person.

**Infectious Dose:** The infective dose for HAV is unknown. However, it is thought that as few as 10-100 virus particles could cause disease.

**Sources (Including High - Risk food groups):** HAV is most commonly spread by direct person to person contact via the faecal-oral route. Food-borne outbreaks can often be traced back to an infected food handler or foods that have come into contact with faecally contaminated water.

Food sources include water, shellfish (such as oysters, cockles and mussels) and milk. Fresh produce such as salads, fruit and vegetables are also sources. These are likely to be consumed raw or lightly cooked and can become contaminated with faecal matter at almost any point during growing, harvesting, transport and packing.

**Onset Period:** Can range between 15-50 days.

**Illness, Symptoms and Complications:** Symptoms usually include fever, nausea, vomiting, diarrhoea, fatigue, poor appetite, abdominal discomfort and often jaundice. The jaundice starts to occur generally 5-7 days after the onset of the gastrointestinal symptoms.

HAV infections can be asymptomatic or symptomatic. When disease does occur, it is usually mild and recovery is complete within 1 to 2 weeks, although it may last up to several months, in which case it is also generally self-limiting.

The severity of disease and fatal outcomes are higher in older age groups. Infected children under 6 years of age do not usually experience noticeable symptoms, and only 10% develop jaundice. Among older children and adults, infection usually causes more severe symptoms, with jaundice occurring in more than 70% of cases.

An atypical, and rare, clinical outcome of acute HAV infection is fulminant hepatitis or fulminant hepatic disease, which occurs in less than 1% to 1.5% of cases. This more severe outcome of acute HAV infection and illness involves massive hepatic necrosis, with acute liver failure, and has a high case-fatality rate (70% to 80%)

**Controls to reduce the risk:**
Strategies to reduce the risk of food-borne outbreaks of Hepatitis A should focus on preventing foods from becoming contaminated.

It is always important to make sure only approved suppliers are used when purchasing raw materials. It is also important that clean treated water should be used for the irrigation, washing and processing of foods.

Food handlers should implement frequent hand washing and the wearing of gloves particularly at points of the food chain where foodstuffs that will receive no further cooking are handled. Any food handlers suffering from Hepatitis A should be removed from food production areas until medical release.

HAV is relatively heat resistant, however thorough cooking at a temperature of 85°C for 1 minute can inactivate the virus.

For shell fish, harvesting should be monitored for sewage contamination.
### SUMMARY TABLE

| Source                      | • Person to person (via faecal oral route)  
|                            | • Water  
|                            | • Shellfish  
|                            | • Fruits and vegetables
| Growth Temperature          | • Not specified – However it is heat resistant at 70°C for up to 10 minutes.
| Growth pH range             | • Resistant to acidic conditions (pH as low as 1 for 2 hours)
| Onset period                | • Range between 15-50 days
| At risk groups             | • Anyone who have not been vaccinated or been previously infected
|                            | • Anyone who resides in areas where the virus is widespread (high endemicity)
|                            | • More severe in older groups
| Illness, Symptoms, Complications | • Fever  
|                                | • Vomiting  
|                                | • Abdominal Pain  
|                                | • Poor appetite  
|                                | • Jaundice
| Controls                    | • Ensure safe water supplies
|                            | • Heat treatment of food and liquids to 85°C for 1 minute.
|                            | • Personal hygiene e.g. regular hand washing for food handlers
|                            | • Food handlers suffering from Hepatitis A should be removed from food production areas.
|                            | • Gloves
|                            | • Personal Protective Clothing

### Published Risk Assessments

- American Society for Microbiology: Risk Assessment in Shellfish-Borne Outbreaks of Hepatitis [link](http://aem.asm.org/content/75/23/7350.full)
- Science Direct: Quantitative farm-to-fork risk assessment model for norovirus and hepatitis A virus in European leafy green vegetable and berry fruit supply chains [link](https://www.sciencedirect.com/science/article/pii/S0168160514006187)
- EFSA: Outbreak of hepatitis A virus infection in Italy and Ireland [link](https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/ROA-update_HAV_Italy_Ireland-final.pdf)

### EXAMPLE OUTBREAKS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>USA</td>
<td>Imported green onions contaminated before or during packing on the farm resulted in 601 cases with 3 deaths.</td>
</tr>
<tr>
<td>2016</td>
<td>Hawaii</td>
<td>Raw scallops linked to the virus resulted in 206 people becoming ill with 51 requiring hospitalisation.</td>
</tr>
<tr>
<td>2017</td>
<td>Denmark</td>
<td>Dates originating from Iran linked to the virus which resulted in 27 people becoming ill.</td>
</tr>
</tbody>
</table>

### References

Pathogenic Bacteria :: *Staphylococcus Aureus*

**Characteristics:** 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 to 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 between 7.0 and 7.5.

**Pathogenicity:** *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.

**Infectious Dose:** 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 to 200 ng of enterotoxin can cause symptoms.

**Sources (Including High - Risk food groups):** 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 fillings have also been implicated.

**Onset Period:** The onset can be rapid, from 30 minutes to 7 hours (average of 2-4 hours).

**Illness, Symptoms and Complications:** 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.

**Controls to reduce the risk:**

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 *Staphylococcus Aureus* Enterotoxin will be inactivated during cooking of 100°C for 30 minutes. Although lower water activity foods, those with high salt such as ham may need longer time. It is also important to store foods correctly e.g. refrigeration of high risk foods.

Food handlers should use disposable gloves or utensils that can help reduce direct human contact with food products. Those who are suffering from infected cuts and from any illness should be temporarily excluded from dealing with ready to eat products.

Carry out testing against microbiological criteria as appropriate when validating and verifying correct functioning of HACCP based procedures and other hygiene controls.
Pathogenic Bacteria :: *Staphylococcus Aureus*

### Example Outbreaks

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Brazil</td>
<td>During a celebration in Brazil an outbreak caused the illness of 4000 people with 16 deaths. Food handlers are said to have caused this transmission to food.</td>
</tr>
<tr>
<td>2013</td>
<td>Canada</td>
<td>223 people became ill due to consumption of burgers containing maple bacon jam which was contaminated with <em>Staphylococcus aureus</em> toxsin.</td>
</tr>
<tr>
<td>2015</td>
<td>Luxembourg</td>
<td>31 people hospitalized due to <em>Staphylococcus aureus</em> outbreak in a buffet restaurant.</td>
</tr>
</tbody>
</table>

### Summary Table

| Source | Environment, soil, water  
|        | Can live in animals and humans  
|        | Food sources: Raw milk, cream filled pastries, meat such as ham, corned beef and sandwich fillings |
| Growth Temperature | 7°C to 47.8°C |
| Growth pH range | 4.5 and 9.3 |
| Onset period | 30 minutes – 7 hours (average 2-4 hours) |
| At risk groups | Severe cases have been known in the  
|        | Elderly  
|        | Infants  
|        | Debilitated people |
| Illness, Symptoms, Complications | Nausea  
|        | Vomiting  
|        | Diarrhoea  
|        | Dehydration  
|        | Muscle Cramping |
| Controls | Food handlers who have boils, cuts or suffering from flu/colds should be excluded from food handling.  
|        | Refrigeration of high risk foods  
|        | Temperature Control  
|        | Gloves  
|        | Personal Protective Clothing |
| Published Risk Assessments | Journal of Food Protection: Quantitative Microbial Risk Assessment for *Staphylococcus aureus* and *Staphylococcus Enterotoxin A* in Raw Milk.  
|        | Taylor and Francis Group Online: The formation of *Staphylococcus aureus* enterotoxin in food environments and advances in risk assessment  

### References

4. FSAI file:///C:/Users/Danielle%20Duffy/AppData/Local/Packages/Microsoft.MicrosoftEdge_Bwekyb3dIlbww/TempState/Downloads/Staphylococcus%20Factsheet%20FINAL.pdf [Accessed on 17th April 2018]
Characteristics: Campylobacter jejuni (C. jejuni) is a nonsporeforming, gram-negative rod with a curved-to-S-shaped morphology. It is 0.2-0.9 μm wide and 0.5-5 μm long, and moves by a corkscrew-like motion. It can grow between a temperature of 30 to 45°C with an optimum of 42°C and between a pH of 6.5 to 7.5.

Pathogenicity: C. jejuni cause infections by invading and colonizing the human gastrointestinal tract. Motility appears to be an important factor in the pathogenesis, enabling the bacterium to invade the human intestinal mucosa.

Infectious Dose: As few as 500 cells.

Sources (Including High-Risk food groups): Can be found in the intestinal tract of many warm-blooded animals such as poultry, cattle, sheep and pigs.

Major food sources linked to C. jejuni infections include improperly handled or undercooked poultry products, unpasteurised (“raw”) milk, cheese made from unpasteurised milk and contaminated water.

C. jejuni has been found in a variety of other foods such as vegetables and seafood. C. jejuni also occurs in non-chlorinated water, such as that found in ponds and streams.

Onset Period: Generally 2-5 days.

Illness, Symptoms and Complications: Anyone can get sick from food contaminated with C. jejuni and it is generally self-limiting in healthy people. Younger children and those with weaker immune systems are at higher risk.

Symptoms include fever, diarrhoea, abdominal cramps, headache and muscle pain. Blood and mucus may be present in stools.

Long term complication includes autoimmune disorders such as Guillain-Barre syndrome (GBS) which is a severe nerve disorder and can lead to paralysis. Reactive Arthritis is another potential long-term complication.

C. jejuni bacteraemia may also affect pregnant women, leading to infection of the foetus, which can lead to miscarriage or stillbirth.

Controls to reduce the risk:

At abattoir and poultry plants, control measures should be implemented to prevent or control contamination of meat from the skin, hides or alimentary tract of infected animals.

Ensure that only drinking water is used in food preparation. Where water from private group schemes or private wells is used, it is essential that any disinfection/treatment systems are properly maintained.

Campylobacter is killed by heat, so cooking to 70°C for 2 minutes eliminates this bacterium.

Food handlers should undertake good handling and hygiene practices to prevent cross-contamination of ready-to-eat foods from raw products, e.g. by using separate chopping boards and utensils for preparing raw poultry meat and ready-to-eat foods and ensuring that any surface which comes into contact with raw poultry meat is thoroughly sanitised.
**EXAMPLE OUTBREAKS**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>Copenhagen</td>
<td>80 people became ill after consuming chicken salad that was contaminated.</td>
</tr>
<tr>
<td>2011</td>
<td>USA</td>
<td>16 students became ill at an Elementary school after consuming raw/unpasteurised milk.</td>
</tr>
<tr>
<td>2011</td>
<td>USA and Mexico</td>
<td>26 people became ill due to inadequately disinfected tap water.</td>
</tr>
</tbody>
</table>

**SUMMARY TABLE**

| Source | Intestinal tracts of animals e.g poultry and cattle  
|• Unpasteurised (raw) milk  
|• Undercooked poultry products  
|• Shellfish  
|• Contaminated water supply |
| Growth Temperature | 30 to 45°C |
| Growth pH range | 6.5 to 7.5 |
| Onset period | 2 to 5 days |
| At risk groups | Very young children  
| Those with weakened immune systems  
| Pregnant women |
| Illness, Symptoms, Complications | Fever  
| Diarrhoea  
| Muscle Pain  
| Autoimmune disorders e.g Guillain-Barre syndrome and reactive arthritis  
| Can lead to miscarriage or stillbirth in pregnant women |
| Controls | Control of contamination at the abattoir stage  
| Ensure treated water is used in food preparation  
| Cooking to 70°C for 2 minutes  
| Gloves  
| Personal Protective Clothing |

**Published Risk Assessments**


**References**

9. University of Leicester [https://www2.le.ac.uk/projects/agec/schoolandcolleges/Microbial%20Science/Bacteria-passport/Campylobacter jejuni-1](https://www2.le.ac.uk/projects/agec/schoolandcolleges/Microbial%20Science/Bacteria-passport/Campylobacter%20jejuni-1) [Accessed 1st May]
Pathogenic Bacteria :: Clostridium botulinum

**DATASHEET**
Microbiological Hazard Series

**Pathogen Name:** Clostridium botulinum

**Characteristics:** 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.

**Pathogenicity:** 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.

**Infectious Dose:** An extremely small amount is needed, a few nanograms of the toxin can cause illness.

**Sources (Including High - Risk food groups):** 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.

**Onset Period:** Usually 18-36 hours but it can range from 4 hours to 8 days.

**Illness, Symptoms and Complications:** Initial symptoms include double vision, blurred vision, slurred speech, vertigo, 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.

**Controls to reduce the risk:**

Sources recommend that the following controlling factors should be used singly or in combination to prevent growth 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 (a_w) of 0.97 or less throughout the food and throughout all components of complex foods.

Other factors to help eliminate would include avoiding cross-contamination e.g take care when gutting or preparing fish products.

Safety of canned food is based on the destruction of the spores i.e 121°C for a minimum of 3 minutes also known as (Botulinum Cook).

It is also important to discard any cans that are blown or have defective seams.
Pathogenic Bacteria :: *Clostridium botulinum*

### Example Outbreaks

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>UK</td>
<td>Hazelnut Yoghurt became contaminated from canned hazelnut puree that was used during its production. This resulted in 27 people becoming ill and 1 death.</td>
</tr>
<tr>
<td>2013</td>
<td>China</td>
<td>Smoked ribs consumed from a restaurant resulted in 12 people becoming ill.</td>
</tr>
<tr>
<td>2017</td>
<td>USA</td>
<td>Nacho cheese consumed caused 10 people to be hospitalized with 7 of those patients being placed on ventilators due to paralysis of muscles used for breathing. It resulted in 1 death.</td>
</tr>
</tbody>
</table>

### Summary Table

<table>
<thead>
<tr>
<th>Source</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Found in the environment and intestinal tracts of mammals/fish</td>
<td></td>
</tr>
<tr>
<td>Canned products</td>
<td></td>
</tr>
<tr>
<td>Smoked fish</td>
<td></td>
</tr>
<tr>
<td>Garlic Oil</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Growth Temperature</th>
<th>3 to 50°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth pH range</td>
<td>4.6 and 9.0</td>
</tr>
<tr>
<td>Onset period</td>
<td>18 to 36 hours (Can range from 4 hours to 8 days)</td>
</tr>
</tbody>
</table>

| At risk groups | All groups are susceptible |

<table>
<thead>
<tr>
<th>Illness, Symptoms, Complications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blurred or Double vision</td>
<td></td>
</tr>
<tr>
<td>Slurred speech</td>
<td></td>
</tr>
<tr>
<td>Vertigo</td>
<td></td>
</tr>
<tr>
<td>Muscle weakness</td>
<td></td>
</tr>
<tr>
<td>Severe cases: Paralysis of muscles</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Controls</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat treatment: 90ºC for ten minutes or equivalent lethality</td>
<td></td>
</tr>
<tr>
<td>Canned products: 121 ºC for minimum for 3 minutes (Botulinum Cook)</td>
<td></td>
</tr>
<tr>
<td>Avoid cross contamination</td>
<td></td>
</tr>
<tr>
<td>Gloves</td>
<td></td>
</tr>
<tr>
<td>Personal Protective Clothing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Published Risk Assessments</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Journal of Environmental Health Engineering: Risk assessment of the growth of <em>Clostridium botulinum</em> and spores germination induced by high hydrostatic pressure in seafood. <a href="http://www.ijehe.org/article.asp?issn=2277-9183;year=2016;volume=5;issue=1;spage=20;epage=20;aulast=Jalali">http://www.ijehe.org/article.asp?issn=2277-9183;year=2016;volume=5;issue=1;spage=20;epage=20;aulast=Jalali</a></td>
<td></td>
</tr>
<tr>
<td>Journal of Food Protection: Estimating the Survival of <em>Clostridium botulinum</em> Spores during Heat Treatments</td>
<td></td>
</tr>
</tbody>
</table>

### References

23. CDC [https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6429a6.htm](https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6429a6.htm) [Accessed 24 April 2018]
26. FS&I [https://www.fsid.wv.gov/Pages/FOODSAFEandINSPECT.php](https://www.fsid.wv.gov/Pages/FOODSAFEandINSPECT.php) [Accessed 24 April 2018]
**Pathogenic Bacteria :: Bacillus cereus**

**DATASHEET**  
Microbiological Hazard Series

**Pathogen Name:** Bacillus cereus

**Characteristics:** Bacillus cereus (B. cereus) is a Gram-positive, facultatively 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 (82.4°F to 95°F), with a minimum growth temperature of 4°C (39.2°F) and a maximum of 48°C (118.4°F). Growth can occur in pH ranges from 4.9 to 9.

**Pathogenicity:** It causes two kinds of foodborne disease: i) an intoxication due to a toxin preformed in the food and ii) an infection due to the ingestion of cells which produce enterotoxins in the small intestine.

**Infectious Dose:** Requires high numbers of bacteria usually more than >10^5.

**Sources (Including High - Risk food groups):** Widespread in the environment being found in soil, water, air and vegetable matter.

A wide variety of foods including rice products, pasta, vegetables, herbs, spices, milk and meat.

**Onset Period:** For emetic onset can be between 30 minutes to 6 hours. For diarrhoeal onset it can be between 6 to 24 hours.

**Illness, Symptoms and Complications:** B.cereus food poisoning is caused by toxins produced during the growth of the bacteria and these toxins cause two distinctly different forms of food poisoning – the emetic/vomiting type or diarrhoeal type. Symptoms usually last around 24 hours.

Emetic type symptoms include nausea, vomiting and abdominal cramps.

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.

**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 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) and chilled food should ideally be maintained at a temperature less than or equal to 4°C (39.2°F).

Low pH foods (less than pH 4.3) and dry foods will not support the growth of B. cereus; however, particular care should be paid to dried foods which are rehydrated and stored prior to consumption.

Food handlers must be aware of the microbiological risks and implement good handling and hygiene practices.
### Summary Table

<table>
<thead>
<tr>
<th>Source</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Found in the environment, soil and water</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td></td>
</tr>
<tr>
<td>Pasta</td>
<td></td>
</tr>
<tr>
<td>Spices/Herbs</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Growth Temperature</th>
<th>28°C to 35°C (82.4°F to 95°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth pH range</td>
<td>4.9 to 9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Onset period</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Emetic: 0.5 to 6 hours</td>
<td></td>
</tr>
<tr>
<td>Diarrhoeal: 6 to 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>At risk groups</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Those with weakened immune systems</td>
<td></td>
</tr>
</tbody>
</table>

### Illness, Symptoms, Complications

**Emetic**
- Nausea
- Vomiting
- Abdominal cramps

**Diarrhoeal**
- Watery diarrhoea
- Abdominal cramps and pain

### Complications
- Pyogenic infections
- Gangrene
- Septic meningitis

### Controls
- Cooking foods thoroughly to 70°C (158°F) for 2 minutes and chilling rapidly to prevent germination of spores
- Storing foods at correct temperatures e.g. hot holding, maintain at 63°C (145.4°F) or above or for refrigerating keep at 4°C (39.2°F) or less
- Gloves
- Personal Protective Clothing

### Published Risk Assessments
- AP Food Microbiology: A risk assessment study of Bacillus cereus present in pasteurized milk [https://pdfs.semanticscholar.org/52bc/Sf6aee0348962d50c0b223b9d61fa26eddb11.pdf](https://pdfs.semanticscholar.org/52bc/Sf6aee0348962d50c0b223b9d61fa26eddb11.pdf)

### Example Outbreaks

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Belgium</td>
<td>Pasta salad refrigerated at incorrect temperature for 3 days resulted in 4 people becoming ill and 1 death.</td>
</tr>
<tr>
<td>2014</td>
<td>UK</td>
<td>Liquid food for premature newborns used in hospitals resulted in 18 newborns becoming ill with blood poisoning.</td>
</tr>
<tr>
<td>2014</td>
<td>USA</td>
<td>Fried rice served at a Chinese restaurant resulted in 44 people becoming ill including 25 children.</td>
</tr>
</tbody>
</table>

---

**References**
**Pathogen Name:** *Norovirus*

**Characteristics:** Noroviruses are a group of viruses belonging to the *Norovirus* genus and the Caliciviridae family. Based on the sequence of the major capsid protein, these viruses are further divided into 6 genogroups (GI-GVI), consisting of numerous genotypes. GI, GII and GIV are the only genogroups known to infect humans.

The virus is round, non-enveloped, single-stranded, positive-sense, polyadenylated RNA.

**Pathogenicity:** Noroviruses are environmentally hardy organisms that not only can be transmitted by food and water, but also can be easily transmitted through person to person contact and contact with environmental surfaces.

*Norovirus* infection causes acute gastroenteritis, characterized by rapid onset of symptoms. Up to 30% of infections are asymptomatic however, these individuals are able to transmit the virus.

**Infectious Dose:** The infective dose is very low; it is estimated to be as low as 1 to 10 viral particles.

**Sources (Including High-Risk food groups):** Consumption of contaminated water or food. Also through the faecal/oral route.

Food vehicles can include shellfish, salad ingredients and fruit.

**Onset Period:** Typically, 24-48 hours after ingestion of the virus.

**Illness, Symptoms and Complications:** Typical symptoms are vomiting (often projectile), diarrhoea, abdominal pain, nausea, headache, stomach cramps and occasionally low-grade fever.

The severity of symptoms appears to be higher in hospitalized patients, immunocompromised people and elderly people.

Dehydration is the most common complication especially among the young, the elderly and patients with underlying medical conditions.

The illness usually lasts from 12-60 hours although there have been reports symptoms have lasted for more than two weeks.

**Controls to reduce the risk:**

To reduce the risk of food-borne transmissions of noroviruses controls include, using only potable water for food processing. Only using approved suppliers and shellfish from approved harvesting waters.

Any food handlers suffering from viral gastroenteritis should not return to work in a food handling environment for at least 48-72 hours after symptoms have stopped.

There should be strict hygiene control for all employees e.g. adequate hand washing facilities and training in adequate personal hygiene practices is essential.

Adequate cleaning of surfaces and equipment using approved detergents and sanitizers.
### SUMMARY TABLE

<table>
<thead>
<tr>
<th>Source</th>
<th>TRANSMITTED BY FOOD AND WATER</th>
<th>TRANSMITTED FROM PERSON TO PERSON</th>
<th>SHELLFISH</th>
<th>SALAD INGREDIENTS</th>
<th>FRUIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Temperature</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth pH range</td>
<td>CAN SURVIVE AT A pH OF 3.4 AND HAS BEEN KNOWN TO SURVIVE AT A pH OF 2.7 FOR 3 HOURS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onset period</td>
<td>24 TO 48 HOURS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At risk groups</td>
<td>ELDERTLY PEOPLE</td>
<td>IMMUNOCOMPROMISED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illness, Symptoms, Complications</td>
<td>VOMITING</td>
<td>DIARRHEA</td>
<td>NAUSEA</td>
<td>FEVER</td>
<td>DEHYDRATION</td>
</tr>
<tr>
<td>Controls</td>
<td>ONLY USE POTABLE WATER FOR FOOD PROCESSING</td>
<td>STRICT HYGIENE CONTROL SHOULD BE IN PLACE</td>
<td>ADEQUATE TRAINING IN PERSONAL HYGIENE</td>
<td>ONLY SOURCE SHELLFISH FROM APPROVED HARVESTING WATERS</td>
<td>GLOVES</td>
</tr>
<tr>
<td>Published Risk Assessments</td>
<td>FDA RISK ASSESSMENT OF NOROVIRUS TRANSMISSION IN FOOD ESTABLISHMENTS</td>
<td>NCBI QUANTITATIVE RISK ASSESSMENT OF NOROVIRUS TRANSMISSION IN FOOD ESTABLISHMENTS: EVALUATING THE IMPACT OF INTERVENTION STRATEGIES AND FOOD EMPLOYEE BEHAVIOR ON THE RISK ASSOCIATED WITH NOROVIRUS IN FOODS.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### EXAMPLE OUTBREAKS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Germany</td>
<td>More than 30 people were hospitalized after consumption of frozen strawberries imported from China.</td>
</tr>
<tr>
<td>2015</td>
<td>Sweden</td>
<td>Presence of norovirus in frozen berries caused 70 people in a nursing home to become ill, with 3 deaths also linked to this outbreak.</td>
</tr>
<tr>
<td>2016</td>
<td>Denmark</td>
<td>More than 400 people became ill after consuming lettuce that was contaminated.</td>
</tr>
<tr>
<td>2018</td>
<td>Spain</td>
<td>39 people became ill after consuming mussels that were contaminated.</td>
</tr>
</tbody>
</table>

### References

**Pathogen Name:** *Clostridium perfringens*

**Characteristics:** *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 (131-59°F) with the optimum being between 43-47°C (109.4-116.6°F). The optimum growth pH is 6.0 – 7.0.

**Pathogenicity:** The 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.

**Infectious Dose:** Symptoms are caused by ingestion of large numbers (> 10^6) vegetative cells or >10^8 spores/g of food.

**Sources (Including High - Risk food groups):** 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.

**Onset Period:** 8-22 hours (typically 8-12 hours) after ingestion of contaminated food.

**Illness, Symptoms and Complications:** 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.

**Controls to reduce the risk:**

**Heat Treatment**
- 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.

**Cooling**
- 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).

**Meat Size**
- When cooking meats, it is best practice to keep joint sizes as small as possible to ensure adequate cooking to the core of the product.

**Temperature Mapping**
- It is important to validate any cooking procedures. This will help identify any “Cold spots” which will help make sure all product being cooked is subject to the correct temperature/time.
**Pathogenic Bacteria :: Clostridium perfringens**

**EXAMPLE OUTBREAKS**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>UK</td>
<td>33 people became ill after consuming contaminated cooked turkey meat during a Christmas dinner.</td>
</tr>
<tr>
<td>2014</td>
<td>USA</td>
<td>More than 300 people fell ill from a wedding after consuming gravy that was contaminated.</td>
</tr>
<tr>
<td>2015</td>
<td>USA</td>
<td>58 people became ill after consuming contaminated cooked meat during a school lunch.</td>
</tr>
</tbody>
</table>

**SUMMARY TABLE**

<table>
<thead>
<tr>
<th>Source</th>
<th>Food Sources:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Found in the environment</td>
<td></td>
</tr>
<tr>
<td>• Stuffed poultry</td>
<td></td>
</tr>
<tr>
<td>• Rolled meat</td>
<td></td>
</tr>
<tr>
<td>• Gravies</td>
<td></td>
</tr>
<tr>
<td>• Stews</td>
<td></td>
</tr>
</tbody>
</table>

| Growth Temperature | 15 to 55°C (131-59°F) |
| Growth pH range    | 6.0 to 7.0 |
| Onset period       | 8 to 22 hours |
| At risk groups     | Elderly |
|                    | Young children |
|                    | Immunocompromised individuals |

**Illness, Symptoms, Complications**

- **Gastroenteritis form:**
  - Abdominal pain
  - Watery Diarrhoea

- **Enteritis necroticans form:**
  - Pain and gassy abdomen
  - Diarrhoea (Sometimes bloody)
  - Vomiting

**Controls**

- Rapid Cooling of high risk product after cooking
- Storage maintained at a temperature of <4°C (39.2°F)
- Gloves
- Personal Protective Clothing

**Published Risk Assessments**

- NCBI Quantitative Microbial Risk Assessment for [Clostridium perfringens](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4932574/) in Natural and Processed Cheeses [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4932574/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4932574/)

**References**

Pathogen Name: *Yersinia enterocolitica* (*Y. enterocolitica*)

**Characteristics:** Yersinia species are gram negative, non-spore forming, facultatively anaerobic bacteria belonging to the group *Enterobacteriaceae*. Strains are usually 0.5-0.8 µm by 1-3 µm in size. *Y. enterocolitica* is psychrotrophic and has the ability to grow at temperatures between 0-44°C (32°F – 111.2°F). It can grow over a pH of 4-10 with the optimum being pH 7.6.

**Pathogenicity:** As zoonotic pathogens *Y. enterocolitica* enter the gastrointestinal tract after ingestion of contaminated food or water.

Gastric acid is a significant barrier to infection. The infective dose might be lower among people with gastric hypoacidity.

**Infectious Dose:** Estimated to be 10⁴ to 10⁶ organisms.

**Sources (Including High - Risk food groups):** It can be found in a wide range of animals and the environment.

Food sources associated are pork products and milk. It has also been found in fruits, vegetables, various meats and poultry.

**Onset Period:** 1 to 11 days.

**Illness, Symptoms and Complications:** The disease is usually self-limiting and symptoms include abdominal pain, fever, vomiting, nausea and diarrhoea. These symptoms usually last a few days but occasionally can last up to 3 weeks or even a few months.

Longer term effects include reactive arthritis and skin disorders such as painful red lesions. In rare cases bacteraemia can occur which may occasionally be fatal.

Those most at risk of developing the disease and its associated long-term effects are infants, the elderly and the immunocompromised.

**Controls to reduce the risk:**

**Using careful measures during slaughter**

- Raw pork should always be considered a potential source of *Yersinia enterocolitica*. It is important to limit the level of faecal contamination on pig carcases after slaughter. Careful removal of the tongue from the head can also help minimise carcass contamination.

**Control of fresh produce**

- Implement good practices in growing and harvesting to help reduce risk of faecal contamination. The use of irrigation water from clean, uncontaminated sources is also important.

**Cooking and Pasteurisation**

- It is recommended to heat food to 66°C (150.8°F) for at least 2 seconds. Typical pasteurization treatments should easily ensure that the organism is destroyed.
Pathogenic Bacteria :: Yersinia enterocolitica

**EXAMPLE OUTBREAKS**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>LOCATION</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Norway</td>
<td>11 people became ill after consumption of Ready-To-Eat pork products.</td>
</tr>
<tr>
<td>2011</td>
<td>USA</td>
<td>5 people became ill after consuming pasteurized milk from the same dairy.</td>
</tr>
<tr>
<td>2011</td>
<td>Norway</td>
<td>21 people became ill after consumption of Ready-to-Eat Salad Mix.</td>
</tr>
</tbody>
</table>

**SUMMARY TABLE**

<table>
<thead>
<tr>
<th>Source</th>
<th>Can be found in the environment and in a wide range of animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pork and pork products</td>
</tr>
<tr>
<td></td>
<td>Milk</td>
</tr>
<tr>
<td></td>
<td>Vegetables</td>
</tr>
</tbody>
</table>

**Growth Temperature**

- 0-44°C (32°F – 111.2°F)

**Growth pH range**

- 4-10

**Onset period**

- 1 to 11 days

**At risk groups**

- Elderly
- Young children
- Immunocompromised Individuals

**Illness, Symptoms, Complications**

- Abdominal Pain
- Nausea
- Vomiting
- Diarrhoea
- Fever
- Long term reactive arthritis can occur

**Controls**

- Careful measures during slaughter
- Using of irrigation water from clean uncontaminated sources
- Heat treatment such as pasteurization treatments
- Gloves
- Personal Protective Clothing

**Published Risk Assessments**

- Norwegian scientific Committee for Food Safety :: A preliminary RA of Yersinia enterocolitica in the food chain. [https://vkm.no/download/18.645b840415d03a2fe8f12d5c/1500909967436/d165b9d426.pdf](https://vkm.no/download/18.645b840415d03a2fe8f12d5c/1500909967436/d165b9d426.pdf)

References
