

Information for Caterers on Microbial Toxins and Marine Biotoxins

1. Microbial Toxins

1.1 What are microbial toxins?

Microbial toxins are chemical substances which are produced by microorganisms. They can occur naturally in food.

1.2 What types of microorganisms produce toxins?

Bacteria and fungi are typically associated with toxin production (Table 1). However, it should be noted that not all species of bacteria and fungi produce toxins.

Table 1. Microbial toxins

MICROORGANISM	NAME OF TOXIN PRODUCED	EXAMPLE OF TOXIN
Bacteria, e.g. <i>Bacillus cereus</i>	Bacterial toxin	Staphylococcal enterotoxin <i>Bacillus cereus</i> toxin
Fungi, e.g. <i>Penicillium expansum</i>	Mycotoxin	Aflatoxin Ochratoxin Patulin

1.3 Are these microbial toxins dangerous?

As the name suggests, these toxins affect the health of humans. Symptoms range from mild to acute/chronic depending on a number of factors including:

- Level of exposure
- Susceptibility of the person
- Toxicity of the toxin

The symptoms are specific to each type of toxin. Symptoms include abdominal cramps, vomiting/diarrhoea, cancer, kidney disease and muscular paralysis.

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1.4 What type of foods are microbial toxins formed in?

Microbial toxins can be formed in a wide range of foods (Table 2):

Table 2. Foods commonly associated with microbial toxins

TYPE OF MICROBIAL TOXIN	EXAMPLES OF FOOD
Bacterial toxins	Bakery products, deli products, gravy, cooked meats, cooked rice etc.
Mycotoxins	Crops, nuts, figs, dried fruits, spices, maize, rice, cereals/cereal grains, coffee beans, beer, fruit juice, maize kernels etc.

Please note that shellfish are associated with marine biotoxins, while certain fish are associated with histamine formation. These are addressed in Sections 2 and 3 of this factsheet, respectively.

Further details regarding microbial toxin production

TYPE OF TOXIN	REQUIREMENTS FOR TOXIN PRODUCTION	WHERE IS THE TOXIN PRODUCED?	WHEN IS THE TOXIN PRODUCED?
Bacterial	<ul style="list-style-type: none"> • Growth of the bacterium to sufficient levels in the food • Suitable environmental conditions, e.g. temperature, moisture, oxygen, nutrients 	<ul style="list-style-type: none"> • In the food or • In the body following consumption of food contaminated with adequate numbers of bacterial cells 	<ul style="list-style-type: none"> • At any stage during production, processing, storage of the food
Mycotoxins	<ul style="list-style-type: none"> • Growth of the fungus to sufficient levels in the food • Suitable environmental conditions, e.g. temperature, moisture, oxygen, nutrients 	<ul style="list-style-type: none"> • In the food 	<ul style="list-style-type: none"> • Pre-harvest • Post-harvest

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1.5 Are limits specified in legislation for microbial toxins?

1.5.1 Bacterial toxins

Commission Regulation (EC) No 2073/2005 on Microbiological Criteria for Foodstuffs lays down microbiological criteria for various combinations of food commodities and microorganisms, their toxins or metabolites. It requires food business operators to take measures, as part of their procedures based on good hygiene practices (GHP) and hazard analysis and critical control points (HACCP) principles, to ensure compliance with the relevant microbiological criteria. Food business operators should test against these criteria, as appropriate, when validating and verifying the correct functioning of these procedures.

The Regulation differentiates microbiological criteria into:

- 1) Process hygiene criteria:** These criteria indicate if the production process is operating in a hygienic manner. These criteria apply during or at the end of the manufacturing process
- 2) Food safety criteria:** These criteria define the acceptability of a foodstuff in terms of its microbiological safety. They are applicable to foodstuffs placed on the market during their shelf-life

The Regulation lays down i) process hygiene criteria for coagulase positive staphylococci in certain cheeses, milk powder and whey powder and ii) food safety criteria for **staphylococcal enterotoxin** in the same commodities. Testing for the staphylococcal enterotoxin must be conducted if the coagulase positive staphylococci count exceeds 10^5 cfu/g. Failure to comply with the food safety criterion requires withdrawal or recall of the product or batch of foodstuff from the market in accordance with Article 19 of Regulation (EC) No 178/2002.

1.5.2 Mycotoxins

Commission Regulation (EC) No 1881/2006 sets maximum levels for mycotoxins in certain foodstuffs, e.g.

- Aflatoxins in peanuts, almonds, pistachios etc
- Ochratoxin A in dried vine fruits, unprocessed cereals, soluble coffee etc
- Patulin in fruit juices, soft drinks, baby foods, etc
- Deoxynivalenol in cereals, pasta, bread, etc
- Zearalenone in cereals, bread, maize oil, etc
- Fumonisin in maize
- T-2 and HT-2 toxin in unprocessed cereals and cereal products

Foodstuffs must not be placed on the market where they contain a contaminant exceeding the maximum level set out in this Regulation.

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1.6 How are microbial toxins controlled?

Once formed it is very difficult to inactivate/remove bacterial toxins and mycotoxins from the food. Control strategies are therefore required at all stages of the food chain.

Early in the food chain, good agricultural practices are undertaken by primary producers during the cultivation of crops, cereals etc to prevent bacterial and fungal growth and thus bacterial toxin and mycotoxin production. The control strategies listed below are relevant to caterers:

i) **Ensure the quality and safety of all supplies:**

- Deal with reputable suppliers
- Ensure supplies meet the relevant legislative requirements as outlined in section 1.5 of this factsheet. This can be achieved by undertaking supplier audits/inspections, setting supplier specifications (which at a minimum, meets the legal requirements) and/or periodic testing of in-coming products
- Monitor the temperature of supplies upon delivery
- Check that all packaging is intact
- Check fruit, vegetables and cereals for the presence of fungi/molds

ii) **Implement good hygiene practices:**

- Personal hygiene is critical. Food handlers should wash their hands regularly, they should be clean and tidy and they should treat food with care
- Environmental hygiene is critical. Ensure that work surfaces, dishcloths, sponges etc. are kept clean and fresh.
- Store food at the correct temperature
- Separate raw and cooked/ready-to-eat food
- Where possible use separate work areas, utensils and equipment for preparing raw and cooked/ ready-to-eat food

iii) **Ensure process controls:**

- Ensure that food is cooked thoroughly (the thickest part reaches 75°C or above), that hot foods are held hot (above 63°C) and cooked food is cooled quickly to less than or equal to 5°C. In the case of spore forming bacteria, temperature abuse during cooling/storage may result in germination, cell growth and possibly toxin production

iv) **Implement a food safety management system based on the principles of HACCP:**

- This is a management system which is designed to prevent food hazards, e.g. microbial toxin production, from occurring

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2. Marine Biotoxins

2.1 What are marine biotoxins?

Phytoplankton are marine microbes that can produce toxins, known as marine biotoxins. Shellfish which filter feed on phytoplankton, e.g live bivalve molluscs, can accumulate these marine biotoxins in their bodies. The main species of bivalve molluscs grown and served in Ireland are mussels and oysters. The symptoms are specific to each type of toxin and include diarrhoea, vomiting, nausea, numbness, loss of short term memory, muscular paralysis and death.

2.2 Are limits specified in legislation for marine biotoxins?

Regulation (EC) No 853/2004 lays down health standards for live bivalve molluscs which include specific limits for marine biotoxins. Food business operators who are approved to place live bivalve molluscs on the market for human consumption must ensure that their product meets these standards. The legislation also includes labelling requirements and the EU approval number of the approved establishment that placed the product on the market must be displayed on the product.

2.3 How are microbial toxins controlled?

Marine biotoxins are resistant to treatments such as cooking and freezing and so control strategies are targeted at the shellfish production areas to ensure that shellfish are not harvested when toxins are present. The National Biotoxin Monitoring Programme monitors shellfish production areas to ensure that only safe live bivalve molluscs are harvested and placed on the market through approved establishments.

2.4 Specific control measures for caterers

Caterers should ensure that they are only supplied with products from approved establishments and that the products bear the EU approval number of the establishment.

3. Histamine in Fish

3.1 What is histamine?

Although not a bacterial toxin, histamine is a by-product of bacterial activity on histidine, a naturally occurring amino acid found in many types of fish, e.g. tuna, mackerel, herring and sardines. Histidine is converted into histamine by an enzyme produced by certain bacteria. Histamine formation is directly linked to mishandling and incorrect temperature storage. Toxic amounts of histamine can form before a fish smells or tastes bad. Symptoms include a peppery taste sensation, tingling of the mouth and lips, a skin rash and headaches.

3.2 Are limits specified in legislation for histamine?

Commission Regulation (EC) No 2073/2005 on Microbiological Criteria for Foodstuffs lays down standards for fishery products which are associated with high levels of histamine. If a product fails to comply with the criterion then there must be a withdrawal or recall of the product or batch of foodstuff from the market in accordance with Article 19 of Regulation (EC) No 178/2002.

3.3 How is histamine controlled?

Cooking or other heat treatments (such as canning or smoking) do not destroy histamine and so control strategies are targeted at avoiding its formation through strict control of the cold chain. Fish species associated with the development of histamine must be chilled immediately after they are caught (conditions for histamine formation are most likely to occur during this period). Fish must be handled and stored correctly at all stages of the food chain, including the correct use of ice.

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3.4 Specific control measures for caterers:

Caterers should ensure they are supplied only with fish products where adequate care has been taken to avoid the formation of histamine. Time and temperature controls are essential to prevent the development of histamine.

i) Ensure the quality and safety of all supplies:

- Deal with reputable suppliers with high standards for food quality and safety
- Monitor the temperature of fish supplies upon delivery, this is particularly important for fish species at risk of histamine formation, e.g. tuna, mackerel, herring and sardines
- Undertake sensory checks (organoleptic assessment) of fish on delivery (note: this will identify spoiled fish, however, high levels of histamine may be present without obvious spoiling if fish were exposed to high temperatures soon after death)

ii) Ensure process controls:

- Temperature control must be maintained. Particular care must be taken if the fish is raw and unfrozen
- Fresh fish should be served as fresh as possible

iii) Implement a food safety management system based on the principles of HACCP

- This is a management system which is designed to prevent food hazards from occurring

Food business operators, including caterers, must be aware of their legal responsibility with respect to food safety.

Caterers must keep up-to-date with all amendments to legislation. For further information on food legislation please consult the FSAI website:
http://www.fsai.ie/legislation/food_legislation.html

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Additional Reading

Food Safety Authority of Ireland – Safe Food to Go

Food Safety Authority of Ireland – Safe Catering: Your guide to making food safety

Food Safety Authority of Ireland – Guidance Note No 15 Cook-chill Systems in the Food Service Sector

National Standards Authority of Ireland – I.S. 340:2007. Hygiene in the catering sector

National Standards Authority of Ireland – ISO 22000:2005 Food safety management systems - requirements for any organisation in the food chain

Food Safety Authority of Ireland – HACCP Information Pack

1. What is HACCP?
2. Terminology explained
3. Catering
4. How to select an external HACCP consultant

Commission Regulation (EC) No 2073/2005 of 15 November 2005 on Microbiological Criteria for Foodstuffs

Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs

Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin

Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety

Further information on shellfish safety can be found at www.fsai.ie and www.marine.ie