

Paralytic Shellfish Poisoning

Bivalve molluscs are one of the only foods normally delivered to the consumer alive. This, and the fact that bivalve molluscs can selectively retain contaminants that are harmful to human health, means controls are in place to mitigate against this.

A good understanding of the controls and how the animals respond to various handling regimes can lead to a safer seafood being delivered to market.

To ensure best practice guidelines are followed Seafish has produced a series of industry guidance notes for fishers and shellfish farmers. These cover:

- **Paralytic Shellfish Poisoning (PSP)**
- **Amnesic Shellfish Poisoning (ASP)**
- **Diarretic Shellfish Poisoning (DSP)**

This fact sheet details:

- What is PSP?
- The symptoms of PSP
- Algal toxins
- The legislative framework
- Controls in place
- How the samples are tested
- What harvesters should be doing
- Sources of further information

What is PSP?

Paralytic Shellfish Poisoning (PSP) is a serious illness that can cause paralysis, and in the worst case scenario, death. It can be induced by consuming fish, bivalve molluscs, crustacea or gastropods that contain algal toxins.

PSP events in the UK are very rare, which indicates that the controls in place do work. The only recorded event occurred at the end of May 1968. However, the serious nature of any future outbreak is sufficient to imbue a responsible approach to the sourcing and handling of any batches of bivalves, whether from the UK or other nation's coastal waters.

The symptoms and treatment of PSP

The symptoms of PSP can include:

1. Tingling or numbness in the face, arms and legs;
2. Followed by headache, dizziness, nausea and loss of muscle coordination;
3. In cases of severe poisoning – paralysis and respiratory failure;
4. Death may follow 2-12 hours after consumption.

If the amount consumed is low and proper medical treatment is administered, symptoms should diminish in approximately nine hours. Patients who survive PSP for 24 hours, with or without medical intervention, have a high probability of a full and rapid recovery.

Algal toxins

Algal toxins sometimes referred to as 'biotoxins' are produced by naturally occurring phytoplankton sometimes found in UK coastal waters. The number of phytoplankton occurring at any one time can be very small and local in size, or can be so vast that they can create 'blooms' in UK waters of more than 1,000 square miles in size. The term 'algal bloom' is sometimes used to denote such an event.

Bivalve molluscs in particular have the ability to abstract any toxins present in the locality, and retain them for significant periods of time.

The biotoxin that can elicit the symptoms of PSP is saxitoxin (STX). Saxitoxin is one of the most potent natural toxins known. It disrupts nerve cells, preventing normal cellular function which can lead to paralysis.

The term saxitoxin (STX) can also refer to an entire suite of related neurotoxins. More than 30 different STX analogues have been identified. Pure saxitoxin (STX), neosaxitoxin (neoSTX), gonyautoxins (GTX) and decarbamoylsaxitoxin (dcSTX) seem to be the most toxic ones.

The toxins are mainly produced by dinoflagellates, microscopic algae or tiny plants which live in the sea and obtain energy from sunlight during the day, belonging to the genus *Alexandrium*.

The legislative framework

It is a criminal offence to place any food on the market that is not of the 'substance', 'nature' or 'quality' demanded by the consumer. It is reasonable to assume that no consumer would wish to purchase seafood

with algal toxins levels above the regulatory limit.

The health standards for live bivalve molluscs are contained in EC Regulation 853/2004. This lays down the specific hygiene rules. All live bivalve molluscs placed on the market for human consumption must not contain marine biotoxins in total quantities (measured in the whole body or any part edible separately) that exceeds 800 micrograms per kilogram for PSP. This is also represented as 80 micrograms/100 grams. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0055:0205:EN:PDF>

The sampling regime suggested for live bivalve molluscs is contained in EC Regulation 854/2004. This details the official controls necessary to check for compliance with the criteria and targets laid down in Community legislation. This highlights the need to target relaying and production areas. These must be periodically monitored to check for the presence of toxin-producing plankton in production and relaying waters, and biotoxins in live bivalve molluscs.

The sampling frequency for toxin analysis in the molluscs is, as a general rule, to be weekly during the periods at which harvesting is allowed. This frequency may be reduced in specific areas, or for specific types of molluscs, if a very low risk of toxic episodes is suggested. It may be increased where such an assessment suggests that weekly sampling would not be sufficient. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0206:0320:EN:PDF>

Controls in place

Food businesses that wish to place bivalve molluscs on the market must determine what controls they are going to put in place to prevent contaminated product being consumed.

- **End Product Testing (EPT)**

This normally means establishing a programme of frequently sampling statistically significant batches, namely End Product Testing (EPT). This should be based on risk and be linked back to a risk assessment or Hazard and Critical Control Plans (HACCP). Some businesses may wish to rely on the statutory monitoring programme to supplement their own HACCP plan.

- **Monitoring harvesting grounds**

In general the best method of controlling the risk is by monitoring the harvesting grounds for the presence of saxitoxin in the mollusc flesh, and establishing if the trend is for increasing, or decreasing amounts of toxin.

It is especially important to monitor those areas where an *Alexandrium* bloom of algal toxins has previously occurred. It could occur in the same location again provided conditions were correct for cyst germination.

- **Occurrence of blooms**

Nitrogen and phosphorus are required for the growth of *Alexandrium* blooms. Levels of toxins within *Alexandrium* cells vary with light, temperature, life cycle stage and nutritional status. Phosphorus in particular is thought to be important, with the toxicity of *Alexandrium* cells known to increase when phosphorus is limited. This ultimately leads to cell deaths and a population crash. At this phase of the bloom many *Alexandrium* cells form resting

cysts which settle to the bottom and may provide inoculum for the next bloom.

- **Registration Document**

A vital industry role is to ensure that accurate information about where bivalves are harvested is recorded on a 'Registration Document' for each and every batch. All bivalves must be sold through a licensed dispatch or purification centre, except for wild caught scallops where alternative controls exist.

Direct consumption of resting cysts by bivalves may explain shellfish toxicity in areas without known blooms. This may occur where sediment disturbance re-suspends toxic cysts.

How the samples are tested

Bivalve molluscs do not accumulate and retain biotoxins at a uniform rate given similar environmental parameters and availability of toxins. A single small mussel could retain enough saxitoxin to deliver a lethal dose.

Different species harvested from the same locality can be expected to have differing levels of contamination. Different individuals of the same species can also be expected to have markedly different levels of contamination.

Individual animals can and do have different levels of toxin for different body parts such as adductor muscle, gonads and viscera.

- **Determining batch size for testing**

Difficulties can exist for harvesters and food businesses in determining an appropriate batch size when considering carrying out EPT for saxitoxins. A batch can be a bag, box or bin of shellfish or two days fishing. The

decision as to what constitutes a batch can only be taken by the business placing the animals on the market in the light of the operators own risk assessment.

If a batch should test over the regulatory limit set, the whole batch becomes a 'Category 1 waste' and must be destroyed at the food businesses expense. This must include incineration or rendering under pressure and burial in an appropriate authorised landfill site. This may be very expensive.

The other option is to reduce the size of a batch and hence reduce the risk and cost of non-compliance. This would however increase the sampling costs.

If the batch size is large the toxin sampling costs are lower but the potential costs should a non-compliance occur is much higher than for a small batch.

- **Testing methods**

1. Mouse Bioassay (MBA)

Traditionally samples have been tested using MBA. This is a quantitative and robust method for the detection of PSP in mollusc flesh. This method is officially approved in the EU for the detection of STX-group toxins. Samples (after preparation) of mollusc flesh are injected into mice. The MBA is not available for food business operators for EPT.

2. High Performance Liquid Chromatography (HPLC)

The move to an alternative method is driven by animal welfare considerations. HPLC has been used as part of the UK monitoring programme for mussels since May 2008. In August 2011 the FSA approved the use of HPLC as a quantitative assay for the testing

of PSP toxins in scallops and minor clam species. This method is officially approved in the EU for the detection of STX-group toxins.

The HPLC method can detect down to between 10 to 80 μ STX equivalents per kg (depending on the toxin profile) and has been validated to international standards. Further validation is being undertaken to extend the method to other bivalve species and toxins not covered in the original validation.

The FSA is now assessing the impact of implementing the HPLC method for oysters. A review has indicated that it is a more accurate and appropriate method for Pacific and native oysters than the MBA, but does appear to consistently return a higher toxicity result in the case of oysters that that recorded with the MBA.

3. Liquid Chromatography Mass Spectrometry (LCMS)

This second chemical method of quantifying saxitoxin is being investigated and may be used to confirm any HPLC results once it is validated. However this may not be an available options for some time.

- **End Product Testing kits**

Test kits are very useful, as they are quick and easy to use and maybe used in the field. There are two kits available.

The RidaScreen®Fast PSP SC is an enzyme immunoassay for the analysis of PSP. <http://www.r-biopharm.com/>

The Jellett Rapid Test for PSP is another quick test kit. <http://www.jellett.ca/>

Although these tests detect the main saxitoxins, they do have some limitations.

Guidance for harvesters

- Monitor the harvesting grounds for the presence of saxitoxin in the mollusc flesh. Establish if the trend is for increasing or decreasing toxin levels.
- Be aware of the sampling regime suggested for live bivalve molluscs.
- For King Scallops it is possible to reduce the risk of ingestion of saxitoxin and other biotoxins by effective shucking, where the adductor muscle and roe are separated from the viscera, followed by washing in clean running water for five minutes. This activity will not completely remove saxitoxins, but is still recommended.
- Bivalves fed toxic algal and held out of water for 24 hours almost never showed growth of harmful algae in fecal material after more than 24 hours of re-immersion. This practice may be considered when formulating biosecurity plans for transfer of stock from one site to another.
- Prior to delivery to market EPT is crucial as the ultimate reassurance to operators that their product is safe.

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For further information

EC Regulation 853/2004 laying down specific hygiene rules on the hygiene of foodstuffs. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0055:0205:EN:PDF>

EC Regulation 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0206:0320:EN:PDF>

Seafish Good manufacturing practice guidelines - Live bivalves workbook. A step-by-step guide to good live bivalve preparation for the market. See Appendix 2 and 3 for EPT standards.

http://www.seafish.org/media/Publications/GMPG_Bivalves_downloadable.pdf

Animal By-products Regulations on Disposal options

<http://www.seafish.org/processors/legislation/waste-legislation/by-products-usage-and-disposal>

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See:

<http://www.seafish.org/aquaculture/information-for-culturists/delivering-safer-seafood>

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