Imported food risk statement

Bivalve molluscs and brevetoxin-group toxins

Scope: Brevetoxin-group toxins in bivalve molluscs. This includes whole or portions of bivalve molluscs that are fresh, frozen, dried or canned, such as cockles, clams, mussels, oysters and scallops.

The following products are excluded and therefore not covered by this risk statement:

- Cephalopod molluscs (e.g squid, octopus, cuttlefish) and jelly fish

Recommendation and rationale

Do brevetoxin-group toxins in imported bivalve molluscs present a potential medium or high risk to public health:

☐ *Yes*

☑ *No*

Rationale:

- Brevetoxin-(BTX) group toxins are heat stable toxins, naturally produced by ocean dwelling algae.
- BTX group toxins consumed in bivalve molluscs can cause Neurotoxic Shellfish Poisoning (NSP). NSP is characterised by gastrointestinal and neurological symptoms including vomiting, diarrhoea, numbness and tingling in the facial regions and extremities.
- Symptoms occur shortly after consumption of contaminated bivalve molluscs and usually resolve with 48 – 72 hours. No fatalities have been associated with NSP.
- Notified cases of poisoning associated with brevetoxin in bivalve molluscs are relatively rare events globally and have generally affected only a small number of individuals. No cases have been reported in Australia and no cases have been reported in New Zealand since 1996.
- Schedule S19-5 of the Australian New Zealand Food Standards Code specifies a maximum level (ML) of 200 mouse units (MU)/kg for Neurotoxic Shellfish Poison.
- On the basis of the historically low reported incidence of NSP associated with BTX group toxins in Australia, and available international prevalence data, the risk to public health in Australia is currently considered low.

General description

Nature of the toxin:

Brevetoxin-(BTX) group toxins are naturally occurring lipophilic, heat-stable, cyclic polyether compounds produced by ocean dwelling algae, primarily dinoflagellates of the genera *Karenia spp.*[1,2,3].

The parent toxins BTX-1 and BTX-2 are produced by the algae. The parent toxins are metabolised in bivalve molluscs to form multiple toxins with varying potencies, including BTX-3 and BTX-B1 to -B5. Consumers are therefore mainly exposed to the BTX-group metabolites rather than the parent toxins[1].

BTX group toxins are rapidly accumulated in bivalve molluscan tissues but removal rates are slow, up to 5 months for some mussel species[6] and at least 7 months for oyster[2].

The mode of action of BTX-group toxin toxicity involves the binding of the BTX to voltage-gated sodium channels on cell membranes causing an influx of sodium ions which in turn causes excitation/firing of nerves[1,2,8,9].

The oral median lethal dose (LD_{50}) value for BTX-2 and BTX-3 in mice was 6600 mg/kg bodyweight and 520 mg/kg bodyweight, respectively. Intoxication in humans, based on symptoms, has been reported at 2.8-4.8 µg/kg bodyweight BTX-2 equivalents[1].

BTX group toxin concentrations are not reduced by rinsing, cleaning, cooking, freezing or steam autoclaving[1]. In addition, the presence of BTXs in shellfish cannot be detected by taste, smell or morphological changes in the shellfish[7,8].

General description
Adverse health effects: People affected by NSP typically show gastrointestinal and neurological symptoms which may include: • mild to moderate nausea • vomiting • diarrhoea • numbness and tingling of lips, mouth, face and extremities • overall loss of coordination • partial limb paralysis • slurred speech • difficulty in swallowing • headache The onset of symptoms is from a few minutes up to 18 hours after ingestion with a mean time of onset of 3-4 hours. Resolution of clinical effects generally occurs within 48 hours, although neurological symptoms may take up to 3 days[1,2,11]. The symptoms of NSP can be incapacitating but no fatalities have been attributed to NSP and hospitalisation is uncommon[2]. People of all ages may experience NSP but children, people with underlying health conditions and the elderly have been reported to be more susceptible[2]. No long term effects in humans have been reported for BTX-group toxins.
Consumption patterns: In the 2011 – 2012 Nutrition and Physical Activity Survey (part of the 2011 – 2013 Australian Health Survey), <1 % of children (aged 2 – 16 years), <1 % of adults (aged 17 – 69 years) and <1% of people aged 70 and above reported consumption of bivalve molluscs (Australian Bureau of Statistics 2011).[13] High level consumers of bivalve molluscs (97.5 percentile) in Australia consumed approximately 250 grams per day per consumer (across the whole population 2+ years). [13] Mixed foods that contained bivalve molluscs and canned product were excluded from the analysis. In the 2018-19 Australian Consumption of Selected Foodstuffs[12], the daily consumption of crustacean and molluscs was estimated to be 2.1g per capita.
Risk factors and risk mitigation Key risk factors: • Harvesting too soon after a harmful algal bloom (HAB) – depuration rates vary between molluscan bivalve species and bioaccumulation can occur due to previous exposure (in a preceding season) and/or due to accumulation up the food chain. • Harvesting shellfish from waterways with a known history of BTX producing HABs that are not monitored or that are not open for harvesting. • Eating shellfish caught in areas where ballast water taken from areas of BTX producing HABs has been discharged. • Individual consumer sensitivity to effects of NSP. • Monitoring for *K.brevis* only; other algae species can also produce BTXs. • Reliance on visual colour change in water ("red tide") as an indicator for unsafe levels • The unpredictable influence external factors have on proliferation of BTX-producing HABs i.e. there is a risk that NSP outbreaks will occur in non-historic areas. Risk mitigation strategies: • Monitoring of areas historically associated with NSP outbreaks for levels of *K.brevis* and other associated algae for cell counts and BTXs levels in the water column and bivalve molluscs. • Monitoring for presence of algae blooms and targeted testing for number of cells and BTX levels in column water as well as BTX levels in bivalve molluscs. • Signage at sites historically associated with NSP outbreaks, warning of the risk of consuming bivalve molluscs (warning may need to be in several languages to allow for recreational harvest by tourists).

General description
• Testing samples of bivalve molluscs to verify the maximum level (ML) of Neurotoxic Shellfish Poison is below 200 mouse units[1] (MU)/kg of mollusc flesh, as outlined in Schedule S19-5 of the Australian New Zealand Food Standard Code.

Surveillance information:

NSP is a notifiable disease in South Australia, New Zealand and the USA.

In the period 2017/18, according to the then Australian Department of Agriculture, approximately 80% of imported bivalves into Australia came from three countries: China (55%), Chile (16%) and Japan (8%)[15]. Table A1, Appendix 1, shows the majority NSP outbreaks found in the literature originated in the USA; in the 2017/18 period the USA accounted for 4% of bivalve imports into Australia[15].

Illness associated with consumption of bivalve molluscs contaminated with brevetoxins

On the basis of a search of the scientific literature via EBSCO, US CDC National Outbreak Reporting System Online Database (NORS), European Rapid Alert System for Food and Feed online consumer portal (RASFF) and other publications up to July 2020, it appears that BTX outbreaks associated with consumption of bivalve molluscs are relatively rare and usually only affect a small number of individuals (refer to Table A1, Appendix 1).

Data on the prevalence of BTXs in bivalve molluscs

A search of the public literature revealed limited information on the reported analytical concentrations of BTX-group toxins in bivalve molluscs. These are presented in Table A2, Appendix 1 and generally relate to MU, which allows for an assessment against regulatory MLs and gives a general indication of the toxic potency of the BTX-group toxins in the bivalve mollusc. In some cases that MU value has been converted into BTX equivalents however the reliability of BTX-equivalents as a measure of toxicity is uncertain in the absence of agreed toxic equivalency factors[10].

Standards or guidelines

Australia and New Zealand

Schedule S19-5 of the Australian New Zealand Food Standard Code specifies a ML of 200 MU/kg for neurotoxic shellfish poisons in bivalve molluscs.

New Zealand

The Ministry of Primary Industries, Animal Products Notice: Bivalve Molluscan Shellfish for Human Consumption, August 2018, specifies a maximum permissible level of 0.8 mg BTX-2 equivalent/kg of edible portion[14].

Codex

The Codex Standard 292-2008 for live and raw bivalve molluscs specifies a ML of ≤200 MU or equivalent/kg molluscs flesh for the BTX group.

The following Codex Standards are also relevant in the prevention of NSP from consumption of bivalve molluscs:

Codex general principles of food hygiene CAC/RCP 1 – 1969 (Codex 2003)

Codex code of practice for fish and fishery products CAS/RCP 52-2003

Codex guidelines for the sensory evaluation of fish and shellfish in laboratories (Codex 1999)

Other countries

USA - National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish specifies a guidance/action level or Trigger/action levels for any BTX toxin found in shellfish meat at or above 20 MU per 100 g (0.8 mg BTX-2 eq/kg shellfish)[7].

Europe – currently there are no regulations on BTXs in shellfish in Europe. The European Food Safety Authority (2010) concluded that due to limited quantitative data both in experimental animals and related to human intoxications, establishment of an oral acute reference dose was not possible[1].

[1] An estimate of the toxicity of an extract, determined by a mouse bioassay.

Management approaches used by overseas countries
New Zealand - has a specific monitoring programme for both recreationally and commercially harvested shellfish, which includes monitoring at specific sites for BTX-group toxins and associated phytoplankton species[5]. **USA** – The National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan shellfish; 2017 revision[7] requires as a minimum, a contingency plan for proactive management of NSP toxins. A management plan is required where there is a history of NSP biotoxin closures, or if NSP toxin-producing phytoplankton are known to occur in the growing area.

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References

1. EFSA Scientific opinion on Marine biotoxins in shellfish – Emerging toxins: Brevetoxins group (2010). EFSA Journal; 8(7):1677
2. Watkins S.M., Reich A., Fleming L.E., Hammond R. (2008). Neurotoxic Shellfish Poisoning. Marine Drugs 6, 431-455
3. Food and Agriculture Centre of United Nations (FAO), (2004). Food and Nutrition Paper 80, Marine Biotoxins, Chapter 5, Neurotoxic shellfish poisoning (NSP). http://www.fao.org/3/y5486e/y5486e00.htm - accessed June 2020
4. Australia and New Zealand Food Authority, (2001). Shellfish Toxins in Food, A Toxicological Review and Risk Assessment, Technical Report series No. 14
5. New Zealand Ministry of Primary Industries (2018), Animal Products Notice: Regulated Control Scheme – Bivalve Molluscan Shellfish for Human Consumption. https://www.mpi.govt.nz/dmsdocument/30282-animal-products-notice-regulated-control-scheme-bivalve-molluscan-shellfish-for-human-consumption-2018 - accessed August 2020
6. McFarland K., Jean F., Soudant P., Volety A. (2015). Uptake and elimination of brevetoxin in the invasive green mussel, *Perna viridis*, during natural *Karenia brevis* blooms in southwest Florida. Toxicon 97: 46-52
7. US NSSP – National Shellfish Sanitation Program (2017), Guide for the control of molluscan shellfish 2017 revision. https://www.fda.gov/media/117080/download - accessed June 2020
8. Vilarino N., Louzao m.C., Abal P., Cagide E., Carrera C., Vieytes M.R., Botana L.M. (2018). Human Poisoning from Marine Toxins: Unknowns for Optimal Consumer Protection. Toxins 10, 324-361
9. Poli M.A., Templeton C.B., Thompson W.L., Hewetson J.F. (1990). Distribution and Elimination of Brevetoxin PbTx-3 in Rats. Toxicon 28 (8) 903-910
10. FAO/WHO (2016), Technical Paper, Toxicity equivalence factors for marine biotoxins associated with bivalve molluscs. http://www.fao.org/3/a-i5970e.pdf - accessed June 2020
11. MPINZ – Toxic shellfish poisoning Neurotoxic shellfish poisoning
12. Australian Bureau of Statistics (2020), Apparent Consumption of Selected Foodstuffs, Australia 2018-19. https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4316.02018-19?OpenDocument – accessed June 2020
13. ABS (2014) National Nutrition and Physical Activity Survey, 2011-12, Basic CURF, CD-ROM. Findings based on ABS CURF data. Australian Bureau of Statistics, Canberra
14. CDC NORS (Centre for Disease Control, National Outbreak Reporting), dashboard, NSP outbreaks, all states, 1998-2017. Last accessed June 2020
15. Australian Government, Department of Agriculture and Water Resources (2018). Proposed changes to food safety import requirements for bivalve molluscs. Amendments to the Imported Food Control Order 2001 https://haveyoursay.agriculture.gov.au/41955/widgets/226136/documents/94231 - accessed July 2020

Appendix 1 – Illnesses associated with consumption of bivalve molluscs contaminated with BTX toxins and associated toxin levels

Table A1 – Overview of NSP cases located from the literature

The NSP classification was based on symptoms.

Country of origin	Year	Product	Number of cases	Comments
USA[14]	2017	Not reported	2	One case hospitalised.
USA[14]	2007	Not reported	3	-
USA[2,14]	2006	Clams	20	Two separate outbreaks. Six hospitalisations. Recreational harvest.
USA[2]	2005	Oysters	4 (2 children; 2 adults)	All hospitalised. Oysters harvested from a closed area due to high *K.brevis* numbers.
USA[14]	2001	Not reported	4	All hospitalised.
USA[14]	2000	Not reported	3	-
USA[2]	1996	Whelks and clams	3 (1 adult; 2 children)	Children hospitalised.
USA[2]	1995	Mussels	3	-
New Zealand[3]	1994-96	Mussels	10	-
New Zealand[2,3,4]	1992	Mussels, cockles and oysters	>180	Organism responsible *K.mikimoti* close relative of *K.brevis*
USA[2]	1987	Oysters and clams	48	Largest known outbreak in USA, but few hospitalisations. Most cases associated with eating 12 or more oysters.

Table A2 – Prevalence data

Country of origin	Year	Product	Reported value
USA[6]	2011-13	Mussels	137 mg/kg BTX3 equiv
USA[2]	2006	Clams	24-42.9ppm (considered to be well above 200 MU/kg, 0.8 mg/kg BTX2 equiv)
USA[2]	1996-1997	Clams (collected from same geographic area as 1996 cases reported in Table A1).	Maximum level 951 MU/kg. Clam samples were positive for NSP up to 1-year post-bloom.
New Zealand[4]	1992-1996	Edible shellfish	1992 - Maximum level 5920 MU/kg. Over the period September 1994 to July 1996, 1.5% of shellfish samples taken from around New Zealand showed NSP toxin levels above the regulatory limit. The maximum levels reported were 9450 MU/kg tissue in oysters and 260 MU/kg various shellfish tissue.
USA[1,2]	1987	Oysters	350-600 MU/kg (samples from 2 implicated meals)

MU – Mouse Unit. This value gives an estimate of the total toxicity of the extract when tested in mice. The test does not provide information on amounts of individual BTX-group toxins which may be present.
BTX equiv – each BTX-group toxin has a different specific toxicity. When expressed as "BTX3 equiv" this means all the different analogues detected in the extract have been converted to amounts of BTX3. A similar process would have been undertaken for BTX2 equiv's. However, there is uncertainty around these values because currently there is no international consensus on the factors (known as toxic equivalency factors (TEF's) to be used to rank the potencies of the different BTX-group toxins.