iMIS Food - Phycotoxins and Marine Biotoxins Hazards Table

Name	Origin	Food Product	Lethal Dose (µg/kg)	Illness	Regulation	Preventive Measures	Comments
Phycotoxins							
Amnesic Shellfish Poisoning (ASP)	Diatoms: *Pseudo-nitzschia spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: 1-4 mg domoic acid/kg bw. LOAEL (memory loss): 0.9 mg/kg bw (EFSA 2009;7(12):1382)	GI symptoms (vomiting, diarrhoea, pain) within 24h; neurological (confusion, memory loss, seizures) within 48h.	· **Reg. (EC) No 853/2004**: Max limit 20 mg domoic acid/kg shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of *Pseudo-nitzschia* & domoic acid in shellfish. Harvest area closures.	Water-soluble, heat-stable. Concern in Europe and globally; increasing incidence.
Paralytic Shellfish Poisoning (PSP; Saxitoxins)	Dinoflagellates: *Alexandrium, Gymnodinium, Pyrodinium spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: Lethal oral dose: 1-4 mg total toxin (EFSA 2009;7(12):1306).	Muscle paralysis, respiratory failure, death. Onset: 30 min - 2h. Mortality: 1-20% without support.	· **Reg. (EC) No 853/2004:** Max limit 800 µg STX eq./kg shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of toxic algae & PSP toxins. Harvest area closures.	Water-soluble, heat-stable. Global issue, recurrent in Europe. Many analogues.
Diarrhetic Shellfish Poisoning (DSP; Okadaic Acid - OA & Dinophysistoxins - DTXs)	Dinoflagellates: *Dinophysis, Prorocentrum spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: (LOAEL for OA): ~0.3 µg/kg bw (total dose ~20-50 µg) (EFSA 2008;6(1):589).	Severe diarrhoea, nausea, vomiting, abdominal pain. Onset: 30 min - several hours. Not usually lethal.	· **Reg. (EC) No 853/2004**: Max limit for OA, DTXs & Pectenotoxins combined: 160 µg OA eq./kg shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of toxic algae & DSP toxins. Harvest area closures.	Lipophilic, heat-stable. Common in European shellfish farming.
Pectenotoxins (PTXs)	Dinoflagellates: *Dinophysis spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: Oral toxicity data limited. Primarily hepatotoxic in animal studies. Mice (i.p. LD50 PTX2): 250 µg/kg bw (EFSA 2009;7(7):1209)	Liver damage in animals. Human GI effects from PTXs alone not clearly established.	· **Reg. (EC) No 853/2004**: Included in the 160 µg OA eq./kg limit with OA & DTXs. · **Reg. (EU) 2019/627**: Official controls.	Monitoring as part of DSP complex. Harvest area closures.	Lipophilic. Concern in Europe. Contribution to human diarrhetic illness less than OA/DTXs, but regulated due to other potential toxicities.
Yessotoxins (YTXs)	Dinoflagellates: Protoceratium, Lingulodinium, Gonyaulax spp.	Shellfish (mussels, scallops, clams).	Humans: Acute oral toxicity low. Mice (i.p. LD50 YTX): 100-500 µg/kg bw; (oral LD50 YTX): >5000 µg/kg bw (EFSA Journal 2009;7(3):1029)	Cardiotoxic in animals. No confirmed human illness from YTXs via shellfish at typical levels.	· **Reg. (EC) No 853/2004**: Max limit 3.75 mg YTX eq./kg shellfish flesh (3750 µg/kg). · **Reg. (EU) 2019/627:** Official controls.	Monitoring of YTXs. Harvest area closures.	Lipophilic. Found in European waters. Regulated due to potential cardiotoxicity seen in animals.
Azaspiracid Shellfish Poisoning (AZP; Azaspiracids)	Dinoflagellates: *Azadinium, Amphidoma spp*	Shellfish (mussels, oysters, scallops, clams, crabs).	Humans (Estimated toxic dose AZA1): ~2.3 µg/kg bw (EFSA Journal 2008;6(9):771)	Severe GI symptoms (nausea, vomiting, diarrhoea, cramps). Prolonged illness possible. Potential tumor promoter.	· **Reg. (EC) No 853/2004**: Max limit 160 µg AZA eq./kg shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of toxic algae & AZAs. Harvest area closures	Lipophilic. Significant concern in Europe. Many analogues known.
Neurotoxic Shellfish Poisoning (NSP;Brevetoxins)	Dinoflagellates: Karenia spp. (mainly *K. brevis*).	Shellfish (oysters, clams, mussels)	Humans: Intoxication reported at 2.8-4.8 µg BTX-2 eq./kg bw. (Search result 7.2). Mice (oral LD50 BTX-3): 520 µg/kg bw (EFSA CONTAM Panel, 2009)	GI & neurological symptoms (tingling, dizziness, temperature reversal). Respiratory irritation from aerosols. Rarely fatal. Onset: minutes to hours.	No specific EU-wide limits. National measures may exist. General Food Law applies. Monitoring in some areas.	Monitoring of Karenia blooms & toxins. Harvest area closures. Avoid recreational harvest during blooms.	Lipophilic, heat-stable. Primarily Gulf of Mexico, NZ. Potential emerging concern in Europe due to Karenia presence.
Palytoxin (PITX ; Group Toxins)	Dinoflagellates: *Ostreopsis spp.*; Soft corals: *Palythoa spp.*	Shellfish (mussels, clams, sea urchins), crabs, fish exposed to blooms.	Humans (Oral ARID by EFSA): 0.2 µg/kg bw for PITX + ostreocin-D. Guidance: 30 µg/kg shellfish.	Shellfish (mussels, clams, sea urchins), crabs, fish exposed to blooms.	No specific EU-wide limits. National measures may exist. General Food Law applies.	Avoid seafood from areas with Ostreopsis blooms/Palythoa. Harvest area closures. Avoid aerosol contact during blooms.	Heat-stable. Ostreopsis blooms an emerging issue in some European areas (e.g., Mediterranean).
Cyclic Imines (CIs; Spirolides - SPXs) **Gymnodimines** (GYMs, Pinnatoxins - PnTXs, etc.)	Dinoflagellates: *Alexandrium, Karenia, Vulcanodinium spp.*	Shellfish (bivalve molluscs).	Humans: No confirmed poisoning cases. Data limited. Mice (SPXs oral LD50: 50µg/kg bw. (PnTXs oral LD50 mix E/F): 23 µg/kg bw.	Neurotoxic in mice (fast-acting: paralysis, respiratory distress). Human symptoms unknown.	No specific EU-wide limits/ National measures may exist. General Food Law applies.	General shellfish monitoring principles. Research ongoing.	Lipophilic. Emerging toxins. Detected at low levels in European shellfish. Risk assessment ongoing.
Other Marine Biotoxins							
Ciguatera Fish Poisoning (CFP - Ciguatoxins - CTXs, Maitotoxins - MTXs)	Dinoflagellates: Gambierdiscus, *Fukuyoa spp.*	Large predatory reef fish (barracuda, grouper, snapper, etc.) accumulating toxins via food chain.	CTXs (Humans): LOAEL ~0.001-0.0025 µg P-CTX-1/kg bw (EFSA 2010;8(6):1627). MTXs: Extremely potent by injection in mice (LD50 ~0.05 µg/kg bw).	GI, neurological (paresthesia, itching, cold allodynia), and cardiovascular symptoms. Rarely fatal. Onset: 1-24h.	No specific EU-wide limits for CTXs in fish. General Food Law applies. Some regional monitoring (e.g., Canaries, Madeira). **Reg. (EC) No 853/2004**: Fish: Marketing of Tetraodontidae prohibited. Shellfish: No specific EU limit EFSA (2017) proposed guidance: <44 µg TTX eq./kg.	Avoid large predatory reef fish from endemic areas, especially viscera. Monitoring in affected areas.	Lipophilic, heat-stable. Primarily tropical/subtropical; emerging in Europe (Macaronesia). Imported fish also a risk.
Tetrodotoxin (TTX)	Marine bacteria (e.g., *Vibrio, Pseudoalteromonas spp.*).	Pufferfish (Tetraodontidae). Also some gastropods, bivalves, other marine animals.	Humans (MLD): 1-2 mg total dose. Serious effects at 0.2 mg (~4 µg/kg bw).	Potent neurotoxin; tingling (lips, tongue), paralysis, respiratory distress, cardiac arrhythmia. Can be fatal. Onset: minutes to hours.	Prohibition of pufferfish marketing. Monitoring of TTX in shellfish in at-risk areas.	Water-soluble, heat-stable. Concern in Asia; emerging in Europe in shellfish and via invasive fish (e.g., Lagocephalus sceleratus in Mediterranean).

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Phycotoxins							
Amnesic Shellfish Poisoning (ASP)	Diatoms: *Pseudo-nitzschia spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: 1-4 mg domoic acid/kg bw. LOAEL (memory loss): 0.9 mg/kg bw (EFSA 2009;7(12):1382)	GI symptoms (vomiting, diarrhoea, pain) within 24h; neurological (confusion, memory loss, seizures) within 48h.	· **Reg. (EC) No 853/2004**: MLs shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of *Pseudo-nitzschia* & domoic acid in shellfish. Harvest area closures.	Water-soluble, heat-stable. Concern in Europe and globally; increasing incidence.
Paralytic Shellfish Poisoning (PSP; Saxitoxins)	Dinoflagellates: *Alexandrium, Gymnodinium, Pyrodinium spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: Lethal oral dose: 1-4 mg total toxin (EFSA 2009;7(12):1306).	Muscle paralysis, respiratory failure, death. Onset: 30 min - 2h. Mortality: 1-20% without support.	· **Reg. (EC) No 853/2004:** MLs shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of toxic algae & PSP toxins. Harvest area closures.	Water-soluble, heat-stable. Global issue, recurrent in Europe. Many analogues.
Diarrhetic Shellfish Poisoning (DSP; Okadaic Acid - OA & Dinophysistoxins - DTXs)	Dinoflagellates: *Dinophysis, Prorocentrum spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: (LOAEL for OA): ~0.3 µg/kg bw (total dose ~20-50 µg) (EFSA 2008;6(1):589).	Severe diarrhoea, nausea, vomiting, abdominal pain. Onset: 30 min - several hours. Not usually lethal.	· **Reg. (EC) No 853/2004**: MLs for OA, DTXs & Pectenotoxins combined in shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of toxic algae & DSP toxins. Harvest area closures.	Lipophilic, heat-stable. Common in European shellfish farming.
Pectenotoxins (PTXs)	Dinoflagellates: *Dinophysis spp.*	Shellfish (mussels, scallops, clams, crabs).	Humans: Oral toxicity data limited. Primarily hepatotoxic in animal studies. Mice (i.p. LD50 PTX2): 250 µg/kg bw (EFSA 2009;7(7):1209)	Liver damage in animals. Human GI effects from PTXs alone not clearly established.	· **Reg. (EC) No 853/2004**: Included in the MLs with OA & DTXs. · **Reg. (EU) 2019/627**: Official controls.	Monitoring as part of DSP complex. Harvest area closures.	Lipophilic. Concern in Europe. Contribution to human diarrhetic illness less than OA/DTXs, but regulated due to other potential toxicities.
Yessotoxins (YTXs)	Dinoflagellates: Protoceratium, Lingulodinium, Gonyaulax spp.	Shellfish (mussels, scallops, clams).	Humans: Acute oral toxicity low. Mice (i.p. LD50 YTX): 100-500 µg/kg bw; (oral LD50 YTX): >5000 µg/kg bw (EFSA Journal 2009;7(3):1029)	Cardiotoxic in animals. No confirmed human illness from YTXs via shellfish at typical levels.	· **Reg. (EC) No 853/2004**: MLs shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of YTXs. Harvest area closures.	Lipophilic. Found in European waters. Regulated due to potential cardiotoxicity seen in animals.
Azaspiracid Shellfish Poisoning (AZP; Azaspiracids)	Dinoflagellates: *Azadinium, Amphidoma spp*	Shellfish (mussels, oysters, scallops, clams, crabs).	Humans (Estimated toxic dose AZA1): ~2.3 µg/kg bw (EFSA Journal 2008;6(9):771)	Severe GI symptoms (nausea, vomiting, diarrhoea, cramps). Prolonged illness possible. Potential tumor promoter.	· **Reg. (EC) No 853/2004**: MLs shellfish flesh. · **Reg. (EU) 2019/627**: Official controls.	Monitoring of toxic algae & AZAs. Harvest area closures	Lipophilic. Significant concern in Europe. Many analogues known.
Neurotoxic Shellfish Poisoning (NSP;Brevetoxins)	Dinoflagellates: Karenia spp. (mainly *K. brevis*).	Shellfish (oysters, clams, mussels)	Humans: Intoxication reported at 2.8-4.8 µg BTX-2 eq./kg bw. (Search result 7.2). Mice (oral LD50 BTX-3): 520 µg/kg bw (EFSA CONTAM Panel, 2009)	GI & neurological symptoms (tingling, dizziness, temperature reversal). Respiratory irritation from aerosols. Rarely fatal. Onset: minutes to hours.	No specific EU-wide limits. National measures may exist. General Food Law applies. Monitoring in some areas.	Monitoring of Karenia blooms & toxins. Harvest area closures. Avoid recreational harvest during blooms.	Lipophilic, heat-stable. Primarily Gulf of Mexico, NZ. Potential emerging concern in Europe due to Karenia presence.
Palytoxin (PITX ; Group Toxins)	Dinoflagellates: *Ostreopsis spp.*; Soft corals: *Palythoa spp.*	Shellfish (mussels, clams, sea urchins), crabs, fish exposed to blooms.	Humans (Oral ARID by EFSA): 0.2 µg/kg bw for PITX + ostreocin-D. Guidance: 30 µg/kg shellfish.	Shellfish (mussels, clams, sea urchins), crabs, fish exposed to blooms.	No specific EU-wide limits. National measures may exist. General Food Law applies.	Avoid seafood from areas with Ostreopsis blooms/Palythoa. Harvest area closures. Avoid aerosol contact during blooms.	Heat-stable. Ostreopsis blooms an emerging issue in some European areas (e.g., Mediterranean).
Cyclic Imines (CIs; Spirolides - SPXs) **Gymnodimines** (GYMs, Pinnatoxins - PnTXs, etc.)	Dinoflagellates: *Alexandrium, Karenia, Vulcanodinium spp.*	Shellfish (bivalve molluscs).	Humans: No confirmed poisoning cases. Data limited. Mice (SPXs oral LD50: 50µg/kg bw. (PnTXs oral LD50 mix E/F): 23 µg/kg bw.	Neurotoxic in mice (fast-acting: paralysis, respiratory distress). Human symptoms unknown.	No specific EU-wide limits/ National measures may exist. General Food Law applies.	General shellfish monitoring principles. Research ongoing.	Lipophilic. Emerging toxins. Detected at low levels in European shellfish. Risk assessment ongoing.
Other Marine Biotoxins							
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Tetrodotoxin (TTX)	Marine bacteria (e.g., *Vibrio, Pseudoalteromonas spp.*).	Pufferfish (Tetraodontidae). Also some gastropods, bivalves, other marine animals.	Humans (MLD): 1-2 mg total dose. Serious effects at 0.2 mg (~4 µg/kg bw).	Potent neurotoxin: tingling (lips, tongue), paralysis, respiratory distress, cardiac arrhythmia. Can be fatal. Onset: minutes to hours.	· **Reg. (EC) No 853/2004**: Fish: Marketing of Tetraodontidae prohibited. Shellfish: No specific EU limit EFSA (2017) proposed guidance: <44 µg TTX eq./kg.	Prohibition of pufferfish marketing. Monitoring of TTX in shellfish in at-risk areas.	Water-soluble, heat-stable. Concern in Asia; emerging in Europe in shellfish and via invasive fish (e.g., Lagocephalus sceleratus in Mediterranean).

iMIS Food - Phytoxins and Plant Biotoxins Hazards Table

Name	Food Product	Illness	Preventive Measures	Comments	Regulation
Pyrrolizidine Alkaloids (PAs)	Herbal teas, honey, spices, certain salads (e.g., rocket).	Liver damage with chronic exposure.	Good Agricultural Practices to control weeds in the field.	A large family of toxins that contaminate crops from co-mingling weeds.	• Reg. (EU) 2023/915
Tropane Alkaloids (TAs)	Grains (millet, sorghum, buckwheat), soy, herbal infusions.	Dry mouth, dilated pupils, heart rate changes, confusion.	Cleaning and sorting of grains to remove toxic weed seeds.	Contamination occurs when seeds of plants like Thorn apple are accidentally harvested with crops.	• Reg. (EU) 2023/915
Cyanogenic Glycosides	Raw apricot kernels, cassava, linseeds, bitter almonds.	Releases hydrogen cyanide, causing rapid breathing, dizziness, headache, vomiting.	Proper cooking (boiling, roasting) destroys the toxin.	The hazard is the hydrogen cyanide (HCN) released when the plant material is damaged.	• Reg. (EU) 2023/915
Glycoalkaloids	Potatoes (especially green, damaged, or sprouted tubers).	Nausea, vomiting, diarrhea, and neurological disorders.	Store potatoes in dark, cool conditions. Peel potatoes and avoid green parts.	Cooking does not significantly reduce the content of these toxins.	• Not regulated by a specific maximum level
Phytohaemagglutinin (Lectins)	Raw or undercooked legumes, especially red kidney beans.	Extreme nausea, vomiting, and diarrhea with rapid onset.	Soak beans for >5 hours, discard the water, and boil vigorously for at least 30 minutes.	Slow cookers may not get hot enough to destroy the toxin. Canned beans are safe.	• Not regulated by a specific maximum level
Erucic Acid	Vegetable oils (rapeseed/canola, mustard oil).	High long-term intake may affect heart health (myocardial lipidosis).	Use of modern low-erucic acid rapeseed (LEAR) varieties, known as canola. Food processing such as	Modern plant breeding has drastically reduced erucic acid levels in rapeseed oil.	• Reg. (EU) 2023/915
Opium Alkaloids	Poppy seeds.	Morphine-like effects: drowsiness, nausea.	washing, grinding, and heating can reduce alkaloid content.	Alkaloid content varies significantly depending on the poppy variety and harvesting method.	• Reg. (EU) 2023/915
Coumarins	Cassia cinnamon, tonka bean.	Liver toxicity with chronic high exposure.	Moderate intake of Cassia cinnamon. Use Ceylon cinnamon, which is lower in coumarin.	A natural flavouring compound found in high amounts in the most common type of cinnamon (Cassia).	• Reg. (EC) 1334/2008
Furocoumarins	Parsnips, celery, parsley, limes, grapefruit.	Can cause skin inflammation with UV light (sunlight).	Moderation of intake. Peeling root vegetables.	Best known for the "grapefruit juice effect," where it can interfere with medications.	• Not regulated by a specific maximum level
Oxalates	Spinach, rhubarb leaves, beets, nuts, Swiss chard.	Can contribute to kidney stones. Reduces calcium absorption.	Cooking can reduce oxalate content. Moderate intake of high-oxalate foods.	The reason rhubarb leaves are considered inedible is their very high oxalate content.	• Not regulated by a specific maximum level
Goitrogens	Cabbage, broccoli, kale, Brussels sprouts, soy.	Can interfere with thyroid function in specific circumstances.	Cooking deactivates the compounds. Ensure adequate iodine intake. Soaking, sprouting, and fermentation of grains and legumes reduce phytic acid.	Risk is very low for the general population with a balanced diet. Considered an	• Not regulated by a specific maximum level
Phytic Acid	Grains, legumes, nuts, seeds (especially in the bran).	Reduces the absorption of minerals like iron and zinc.		"antinutrient." It can also have some beneficial health effects.	• Not regulated by a specific maximum level