

iMIS Food - Chemical Hazards - Plant Toxins Table

Name	Origin	Food Products	Health Effects	Toxicological Thresholds	Regulation (EU)	Prevention	Comments
Pyrrolizidine Alkaloids (PAs)	Natural toxins from various weed species (e.g., <i>Senecio</i> , <i>Echium</i>). Contamination occurs via co-harvesting.	Herbal teas, tea, honey, spices, salads, grains.	Genotoxic carcinogens. Primary target is the liver, causing severe liver disease.	No Tolerable Daily Intake (TDI) established. Health-based guidance values exist (BMDL).	• Reg. (EU) 2023/915: Sets Maximum Levels (MLs) for various foods.	GAP to control weeds in the field. Physical sorting of raw materials (e.g., tea leaves, seeds).	Heat-stable and survive processing/cooking. A large family of toxins monitored in the EU.
Tropane Alkaloids (TAs)	Natural toxins from <i>Solanaceae</i> plants (e.g., <i>Datura stramonium</i>). Contamination via co-harvested seeds.	Grains (millet, sorghum), cereal-based foods, herbal infusions.	Potent anticholinergic agents. Acute symptoms: dry mouth, dilated pupils, confusion, hallucinations.	Acute Reference Dose (ARfD) exists.	• Reg. (EU) 2023/915: Sets MLs for the sum of atropine and scopolamine.	GAP to control weeds. Physical cleaning and sorting of grains to remove seeds.	The hazard is acute toxicity, especially for infants. The toxins are heat-stable.
Cyanogenic Glycosides (e.g., Amygdalin, Linamarin)	Natural plant components that release hydrogen cyanide (HCN) when the plant tissue is crushed.	Raw apricot kernels, bitter almonds, cassava, linseeds.	Acute cyanide poisoning. Blocks cellular respiration. Can lead to respiratory failure and death.	Acute Reference Dose (ARfD) exists for cyanide.	• Reg. (EU) 2023/915: Sets MLs for hydrocyanic acid (HCN).	Critical: Processing (peeling, grating, soaking, boiling) is essential to release and eliminate HCN, especially for cassava.	The hazard is the volatile HCN, not the original compound. Proper processing is the critical control step.
Glycoalkaloids (Solanine & Chaconine)	Natural toxins produced by potatoes (<i>Solanum tuberosum</i>). Levels increase when tubers are exposed to light (greening).	Potatoes and potato products. Also found in green tomatoes.	Acute toxicity. Gastrointestinal disorders (nausea, vomiting, diarrhoea) and neurological symptoms.	Toxic dose established at >1 mg/kg bw. Potatoes >200 mg/kg are considered unsafe.	No specific MLs. Monitoring levels is recommended.	Proper storage in dark, cool conditions. Peeling, removing green parts and sprouts before consumption.	Heat-stable; cooking methods do not destroy them. They concentrate in the skin and green parts.

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Phytohaemagglutinin (Lectins)	Natural toxic protein (lectin) found especially high in red kidney beans (<i>Phaseolus vulgaris</i>).	Raw or improperly cooked beans (red kidney, cannellini, broad beans).	Acute gastrointestinal illness. Rapid onset of extreme nausea, profuse vomiting, diarrhoea.	As few as 4-5 raw beans can cause illness.	No specific MLs.	Soaking beans for >5 hours, discarding water, and then **boiling vigorously** for at least 30 minutes.	The toxin is heat-labile (destroyed by heat). Slow cookers may not reach a high enough temperature.
Erucic Acid	Natural fatty acid in the oils of plants from the Brassicaceae family (rapeseed, mustard).	Vegetable oils (rapeseed oil, mustard oil), fats, baked goods, infant formula.	High long-term intake is associated with myocardial lipidosis (fat accumulation in heart muscle) in animal studies.	Tolerable Daily Intake (TDI) exists.	• Reg. (EU) 2023/915: Sets Maximum Levels (MLs) for oils and fats.	Sourcing low-erucic acid rapeseed (LEAR) varieties (canola).	Not a contaminant. Levels are controlled through plant breeding.
Opium Alkaloids (e.g., Morphine, Codeine)	Natural compounds from the opium poppy (<i>Papaver somniferum</i>). Contamination is on the seed surface.	Poppy seeds (for baking), bakery products containing poppy seeds.	Opioid effects: drowsiness, nausea, dizziness. High doses can lead to respiratory depression.	Acute Reference Dose (ARfD) exists.	• Reg. (EU) 2023/915: Sets MLs for the sum of morphine and codeine.	Food processing (washing, heating) can reduce alkaloid content. Sourcing seeds with certified low alkaloid content.	The toxins are heat-stable. Consumption can result in a positive drug test for opiates.
Coumarin	Natural flavouring compound found in high concentrations in "Cassia" cinnamon (<i>Cinnamomum cassia</i>).	Cassia cinnamon powder, bakery products, desserts, teas containing Cassia.	Liver toxicity with chronic high exposure in sensitive individuals.	Tolerable Daily Intake (TDI) exists.	• Reg. (EC) 1334/2008 (Flavourings): Sets MLs for coumarin in specific food categories.	Sourcing Ceylon cinnamon (<i>Cinnamomum verum</i>), which has negligible coumarin content.	Regulated as a natural undesirable substance in flavourings.
Furocoumarins (e.g., Psoralens)	Natural toxins produced by plants (e.g., <i>Apiaceae</i> family) as a defence mechanism when stressed.	Celery, parsnips, citrus fruits (grapefruit, bergamot), and their juices.	Phototoxic. Causes skin inflammation when exposed to UV light after contact.	No human threshold established.	• Reg. (EC) 1334/2008: Restricts levels in certain beverages.	Moderation of intake. Peeling root vegetables (toxins are highest in the peel).	Known for the "grapefruit juice effect," where they interfere with drug metabolism.

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Oxalates (Oxalic Acid)	Natural organic acid found as soluble and insoluble salts.	Rhubarb (especially leaves), spinach, beet greens, tea, cocoa.	Antinutrient. Reduces mineral (calcium, iron) absorption. Can form calcium oxalate kidney stones in susceptible individuals.	Acute toxic dose estimated at 2-5 grams.	No specific MLs. Rhubarb leaves are considered unfit for consumption.	Discarding rhubarb leaves. Blanching and boiling reduces soluble oxalate content.	Insoluble crystals in some plants cause immediate mouth irritation.
Goitrogens (Glucosinolates)	Natural compounds in cruciferous vegetables (Brassicaceae family) and soy.	Raw broccoli, cabbage, kale, Brussels sprouts, soy products.	Antinutrient. Interferes with iodine uptake by the thyroid, potentially leading to goiter.	No specific toxic dose established. Effect is conditional on iodine status.	No specific MLs. Hazard is considered negligible with adequate iodine intake.	Cooking (boiling, steaming) deactivates the enzyme that releases the active goitrogenic compounds. Ensuring adequate iodine intake.	Risk is negligible for healthy individuals. Compounds are also studied for beneficial health effects.
Phytic Acid (Phytates)	The primary storage form of phosphorus in the bran and hull of grains and seeds.	Whole grains (wheat bran), beans, legumes, raw nuts, and seeds.	Antinutrient. Binds strongly to essential minerals (iron, zinc, calcium), reducing their absorption.	Not acutely toxic. Adverse effects are chronic and related to overall diet.	No specific MLs.	Processing methods like soaking, sprouting, and fermentation activate the enzyme phytase, which breaks down phytic acid.	Impact is most significant in diets heavily reliant on unrefined cereals. Can also have beneficial antioxidant properties.
Saponins	Diverse group of natural glycosides that have soap-like properties.	Quinoa (coating on the seed), beans, lentils, chickpeas, soy.	Poorly absorbed. High concentrations impart a bitter taste and can cause local gastrointestinal irritation.	No specific toxic dose for food.	No specific MLs. Hazard is managed by processing.	Rinsing quinoa thoroughly under running water to remove the bitter coating. Soaking and cooking legumes also reduces content.	Responsible for the foaming characteristic of soaked legume water (aquafaba).

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Grayanotoxins (GTXs)	Natural neurotoxins produced by <i>Rhododendron</i> species. Bees collect nectar from these flowers.	"Mad honey" (honey produced from <i>Rhododendron</i> nectar).	"Mad Honey Poisoning" (Deli Bal). Acute onset of dizziness, low blood pressure, slow heart rate, nausea, vomiting.	A single teaspoon of highly toxic honey can cause illness.	No specific MLs. Managed under General Food Law (Reg. (EC) 178/2002).	Sourcing honey from trusted suppliers. Diluting/blending honey from high-risk regions.	Rare intoxication. The toxins are heat-stable and survive pasteurization. Known risk in honey from specific regions.
Quinolizidine Alkaloids (QAs)	Natural toxins produced by <i>Lupinus</i> (lupin) plants.	"Bitter" lupin seeds and flour. "Sweet" lupins are low-level varieties.	Acute neurotoxicity. Symptoms include dizziness, confusion, nausea, and potential respiratory paralysis.	Tolerable Daily Intake (TDI) established.	No specific MLs. Industry standards are used for "sweet" lupin varieties.	Sourcing "sweet" lupin varieties. "Bitter" lupins require traditional processing (soaking/boiling) to leach out the water-soluble toxins.	The hazard is from unprocessed "bitter" lupins. The toxins are water-soluble.

