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Natural toxins in food

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Key facts

- Some natural toxins can be formed in food as defense mechanisms of plants, through their infestation with toxin-producing mould, or through ingestion by animals of toxin-producing microorganisms.
- Natural toxins can cause a variety of adverse health effects and pose a serious health threat to both humans and livestock. Some of these toxins are extremely potent.
- Adverse health effects can be acute poisoning ranging from allergic reactions to severe stomachache and diarrhoea, and even death.
- Long-term health consequences include effects on the immune, reproductive or nervous systems, and also cancer.
- A scientific expert committee jointly convened by WHO and the Food and Agriculture Organization of the United Nations (FAO) – called JECFA – is the international body responsible for evaluating the health risk from natural toxins in food.
- International standards and codes of practice to limit exposure to natural toxins from certain foods are established by the Codex Alimentarius Commission based on JECFA assessments.

What are natural toxins?

Natural toxins are toxic compounds that are naturally produced by living organisms. These toxins are not harmful to the organisms themselves but they may be toxic to other creatures, including humans, when eaten. These chemical compounds have diverse structures and differ in biological function and toxicity.

Some toxins are produced by plants as a natural defense mechanism against predators, insects or microorganisms, or as consequence of infestation with microorganisms, such as mould, in response to climate stress (such as drought or extreme humidity).

Other sources of natural toxins are microscopic algae and plankton in oceans or sometimes in lakes that produce chemical compounds that are toxic to humans but not to fish or shellfish that eat these toxin-producing organisms. When people eat fish or shellfish that contain these toxins, illness can rapidly follow.

Some of the most commonly found natural toxins that can pose a risk to our health are described below.

Aquatic biotoxins

Toxins formed by algae in the ocean and fresh water are called algal toxins. Algal toxins are generated during blooms of particular naturally occurring algal species. Shellfish such as mussels, scallops and oysters are more likely to contain these toxins than fish. Algal toxins can cause diarrhea, vomiting, tingling, paralysis and other effects in humans, other mammals or fish. The algal toxins can be retained in shellfish and fish or contaminate drinking water. They have no taste or smell, and are not eliminated by cooking or freezing.

Another example is ciguatera fish poisoning (CFP) which is caused by consuming fish contaminated with dinoflagellates that produce ciguatoxins. Some fish known to harbour ciguatoxins include barracuda, black grouper, dog snapper, and king mackerel. Symptoms of ciguatera poisoning include nausea, vomiting, and neurologic symptoms, such as tingling sensation on fingers and toes. There is currently no specific treatment for ciguatera poisoning.

Cyanogenic glycosides

Cyanogenic glycosides are phytotoxins (toxic chemicals produced by plants) which occur in at least 2000 plant species, of which a number of species are used as food in some areas of the world. Cassava, sorghum, stone fruits, bamboo roots and almonds are especially

important foods containing cyanogenic glycosides. The potential toxicity of a cyanogenic plant depends primarily on the potential that its consumption will produce a concentration of cyanide that is toxic to exposed humans. In humans, the clinical signs of acute cyanide intoxication can include: rapid respiration, drop in blood pressure, dizziness, headache, stomach pains, vomiting, diarrhoea, mental confusion, cyanosis with twitching and convulsions followed by terminal coma. Death due to cyanide poisoning can occur when the cyanide level exceeds the limit an individual is able to detoxify.

Furocoumarins

These toxins are present in many plants such as parsnips (closely related to carrots and parsley), celery roots, citrus plants (lemon, lime, grapefruit, bergamot) and some medicinal plants. Furocoumarins are stress toxins and are released in response to stress, such as physical damage to the plant. Some of these toxins can cause gastrointestinal problems in susceptible people. Furocoumarins are phototoxic, they can cause severe skin reactions under sunlight (UVA exposure). While mainly occurring after dermal exposure, such reactions have also been reported after consumption of large quantities of certain vegetables containing high levels of furocoumarins.

Lectins

Many types of beans contain toxins called lectins, and kidney beans have the highest concentrations – especially red kidney beans. As few as 4 or 5 raw beans can cause severe stomachache, vomiting and diarrhoea. Lectins are destroyed when the dried beans are soaked for at least 12 hours and then boiled vigorously for at least 10 minutes in water. Tinned kidney beans have already had this process applied and so can be used without further treatment.

Mycotoxins

Mycotoxins are naturally occurring toxic compounds produced by certain types of moulds. Moulds that can produce mycotoxins grow on numerous foodstuffs such as cereals, dried fruits, nuts and spices. Mould growth can occur before harvest or after harvest, during storage, on/in the food itself often under warm, damp and humid conditions.

Most mycotoxins are chemically stable and survive food processing. The effects of food-borne mycotoxins can be acute with symptoms of severe illness and even death appearing quickly after consumption of highly contaminated food products. Long term effects on health of chronic mycotoxin exposure include the induction of cancers and immune deficiency.

- **Fact sheet on Mycotoxins**

Solanines and chaconine

All solanacea plants, which include tomatoes, potatoes, and eggplants, contain natural toxins called solanines and chaconine (which are glycoalkaloids). While levels are generally low, higher concentrations are found in potato sprouts and bitter-tasting peel and green parts, as well as in green tomatoes. The plants produce the toxins in response to stresses like bruising, UV light, microorganisms and attacks from insect pests and herbivores. To reduce the production of solanines and chaconine it is important to store potatoes in a dark, cool and dry place, and not to eat green or sprouting parts.

Poisonous mushrooms

Wild mushrooms may contain several toxins, such as muscimol and muscarine, which can cause vomiting, diarrhoea, confusion, visual disturbances, salivation, and hallucinations. Onset of symptoms occurs 6–24 hours or more after ingestion of mushrooms. Fatal poisoning is usually associated with delayed onset of symptoms which are very severe, with toxic effect on the liver, kidney and nervous systems. Cooking or peeling does not inactivate the toxins. It is recommended to avoid any wild mushrooms, unless definitively identified as non-poisonous.

Pyrrolizidine alkaloids

Pyrrolizidine Alkaloids (PAs) are toxins produced by an estimated 600 plant species. The main plant sources are the families *Boraginaceae*, *Asteraceae* and *Fabaceae*. Many of these are weeds that can grow in fields and contaminate food crops. PAs can cause a variety of adverse health effects; they can be acutely toxic and of main concern is the DNA-damaging potential of certain PAs, potentially leading to cancer.

PAs are stable during processing, and have been detected in herbal teas, honey, herbs and spices and other food products, such as cereals and cereal products. Human exposure is estimated to be low, however. Due to the complexity of the subject and the large number of related compounds, the overall health risk has not been fully evaluated yet. Guidance is under development by the FAO/WHO Codex Committee on Contaminants in Food on management strategies to prevent PA-containing plants from entering the food chain.

How can I minimize the health risk from natural toxins?

When it comes to natural toxins it is important to note that they can be present in a variety of different crops and foodstuff. In a usual balanced, healthy diet, the levels of natural toxins are well below the threshold for acute and chronic toxicity.

To minimize the health risk from natural toxins in food, people are advised to:

- **not assume that if something is 'natural' it is automatically safe;**
- **throw away bruised, damaged or discoloured food, and in particular mouldy foods;**
- **throw away any food that does not smell or taste fresh, or has an unusual taste; and**
- **only eat mushrooms or other wild plants that have definitively been identified as nonpoisonous.**

WHO response

WHO, in collaboration with FAO, is responsible for assessing the risks to humans of natural toxins – through contamination in food – and for recommending adequate protections.

Risk assessments of natural toxins in food done by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) are used by governments and by the Codex Alimentarius Commission (the intergovernmental standards-setting body for food) to establish maximum levels in food or provide other risk management advice to control or prevent contamination. Codex standards are the international reference for national food supplies and for trade in food, so that people everywhere can be confident that the food they buy meets the agreed standards for safety and quality, no matter where it was produced.

JECFA sets the tolerable intake level for natural toxins

JECFA or ad hoc FAO/WHO scientific expert groups consist of independent, international experts who conduct scientific reviews of all available studies and other relevant data on specific natural toxins. The outcome of such health risk assessments can either be a maximum tolerable intake (exposure) level, or other guidance to indicate the level of health concern (such as the Margin of Exposure), including advice on risk management measures to prevent and control contamination, and on the analytical methods and monitoring and control activities.

Exposure to natural toxins needs to be kept as low as possible to protect people. Natural toxins not only pose a risk to both human and animal health, but also impact food security and nutrition by reducing people's access to healthy food. WHO encourages national authorities to monitor

and ensure that levels of the most relevant natural toxins in their food supply are as low as possible and comply with both national and international maximum levels, conditions and legislation.