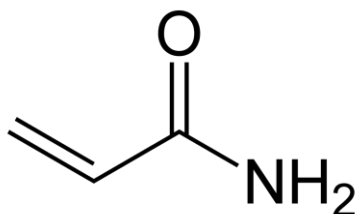


**FUNCTIONAL**  
TECHNOLOGIES

## About Acrylamide

Acrylamide (or acrylic amide) is a chemical compound with the chemical formula  $C_3H_5NO$ . Its IUPAC name is 2-propenamide. It is a white, odourless, crystalline solid, soluble in water, ethanol, ether and chloroform. Acrylamide is incompatible with acids, bases, oxidizing agents, iron and iron salts. It decomposes non-thermally to form ammonia, and thermal decomposition produces carbon monoxide, carbon dioxide and oxides of nitrogen.



Acrylamide is an industrial chemical used in products for water purification, grouts, packaging and scientific research. Acrylamide is also found in cigarette smoke. Acrylamide has probably always been present in cooked foods. However, acrylamide was first detected in certain foods in April 2002.

In April 2002, Swedish scientists surprised the world by announcing the discovery of significant quantities of the chemical acrylamide in a variety of cooked foods. Acrylamide is a known animal carcinogen and human neurotoxicant, and the discovery of acrylamide in food prompted immediate reaction from governments worldwide, as well as intense media coverage.

### How does acrylamide get into food?

So what is acrylamide doing in food? The formation of acrylamide is part of the Maillard reaction that leads to browning and flavour changes in cooked foods. Acrylamide appears to form as a byproduct of the high-temperature cooking processes found in frying, baking and roasting (greater than  $120^{\circ}C$  or  $248^{\circ}F$ ), and in low-moisture conditions. It does not appear to be present in uncooked food, and is apparent in low or undetectable levels in foods cooked at lower temperatures, such as by boiling. Research to date suggests that acrylamide formation is particularly likely in carbohydrate-rich foods such as potatoes and cereals. Scientists have determined that acrylamide forms in food cooked at high temperatures from a chemical reaction between the amino acid asparagine and reducing sugars such as glucose and fructose

In other words, acrylamide is created during the cooking or thermal processing of food, from the sugars, and an amino acid, that are found naturally in the food; it does not come from food packaging or the environment.

Acrylamide has probably always been present in cooked foods, and is found mainly in plant-based foods that are rich in carbohydrates and low in protein, notably potato products such as French fries and potato chips; cereal foods such as cookies, crackers, breakfast cereals, baby foods and toasted bread; and coffee. The highest concentrations of acrylamide have been detected in potato chips and French fries. Additional research is being undertaken in order to more fully understand the risks of acrylamide to human health. Acrylamide does not form — or forms at lower levels — in dairy, meat and fish products. Generally, acrylamide is more likely to accumulate when cooking is done for longer periods or at higher temperatures.

### Regulatory action

Acrylamide caused cancer in animals in studies in which animals were exposed at very high doses. As a result, acrylamide is considered by the WHO as “probably carcinogenic to humans” and is listed as a Group 2A carcinogen. However, it is not clear whether acrylamide causes cancer in humans at the much lower levels found in food. Acrylamide causes nerve damage in people exposed to very high levels at work. Health regulators have not yet determined the exact public health impact of acrylamide from the lower levels found in foods, and research studies are being conducted to determine its potential risk.

In the meantime, regulatory authorities continue to tighten regulations. For example, acrylamide has been listed on the State of California’s Proposition 65 list of carcinogenic or mutagenic substances since 1990 as a cancer risk. In 2010, the Californian authorities are recommending revising the list to also label acrylamide as a known reproductive toxicant. Any products sold in California that contain a Proposition 65 listed compound must carry a label warning the purchaser of the presence of the substance in the product.

A major international evaluation of acrylamide by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 2005 concluded that the levels of acrylamide in food were of concern, given the carcinogenicity rates seen in rodents. Acrylamide is also a known human neurotoxicant and animal reproductive and developmental toxicant. However, although more research is being carried out, acrylamide is considered unlikely to have neurological, reproductive or developmental effects at the levels encountered in human foods.

FDA scientists estimate that the average U.S. consumer’s intake of acrylamide is 0.4 microgram/kilogram body weight/day ( $\mu\text{g}/\text{kg}\text{-bw}/\text{d}$ ), while international estimates for the average consumer ranged at 0.2–1.4  $\mu\text{g}/\text{kg}\text{-bw}/\text{d}$  as of 2005.

### Children’s exposure to acrylamide twice that of adults

Health Canada’s preliminary calculations suggest that the average exposure of adults to acrylamide in food is between 0.3 and 0.4 micrograms per kilogram of body weight per day ( $\mu\text{g}/\text{kg}\text{ bw}/\text{day}$ ). A microgram ( $\mu\text{g}$ ) is one-millionth of a gram. For young children six to 11 years of age, the average exposure is roughly twice the adult exposure. This is due largely to the fact that children consume more food than adults on a “per body weight” basis. These estimates of Canadian exposure to acrylamide are consistent with exposures that have been calculated in other countries. For example, the average daily intake of acrylamide in Sweden has been estimated at 0.5  $\mu\text{g}/\text{kg}\text{ bw}/\text{day}$  (as of 2009)

Scientific research has focused on ways to reduce or minimize the formation of acrylamide during food preparation. The proposed techniques generally fall into one of several areas:

- reducing the availability of free asparagine or reducing sugars;

- use of an enzyme — asparaginase — to lower asparagine levels prior to cooking;
- modifying other ingredients (e.g., amino acids, calcium, citric acid) that interfere with acrylamide formation; and
- changing cooking time or temperature.

The various techniques appear to be useful for different types of products:

For potato products:

- selecting potatoes low in reducing sugar;
- controlling storage conditions;
- application of asparaginase; and
- reducing the time or temperature of cooking.

While for cereal products:

- modifying the time or temperature of cooking;
- avoiding use of ammonium bicarbonate;
- application of asparaginase; and
- using materials low in asparagine may be more relevant.

No suitable techniques have been identified for reducing acrylamide in coffee while preserving taste.

Proposed measures for reducing acrylamide, e.g., application of asparaginase, is being slowly adopted in some food processing sectors, but is still commercially unproven. Additionally, manufacturers will need to know whether these measures affect the taste, stability and safety of a product.

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