

Acrylamide in Food

What is acrylamide?

Acrylamide is a chemical compound (C₃H₅NO) which is a white, odorless, and generally crystalline in nature. It is produced industrially and used in products such as dyes, plastics, grouts, water treatment chemicals, and cosmetic products.

How does acrylamide get into food?

Acrylamide forms in food as a result of a reaction between an amino acid (asparagine) and sugars (glucose, fructose)—compounds which are naturally present in foods. The formation of acrylamide occurs as part of the Maillard reaction which leads to browning in cooked foods as well as the formation of desirable flavors. Primarily, this happens at cooking temperature above 120 °C when frying, roasting, or baking foods.

There are also some foods, such as prune juice and canned black olives, in which acrylamide has been detected and high temperature cooking has not occurred.

Is acrylamide something new in food?

According to the best information from the United States Food and Drug Administration (US FDA), acrylamide has probably always been present in cooked foods. Studies revealing its presence were first published in 2002.

Acrylamide has been documented primarily in plant-based foods such as potato products, cereals, bread, and coffee.

How can acrylamide affect human health?

Acrylamide has been shown to be carcinogenic in rats and mice and is therefore considered to be a potential carcinogen for humans. In 2005, a report by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) concluded that acrylamide was present in food at levels high enough to be a concern.

Acrylamide is on the State of California Proposition 65 (the Safe Drinking Water and Toxic Enforcement Act) list of chemicals known to cause cancer or reproductive toxicity (such as birth defects and other reproductive harm).

How have governments responded to acrylamide?

Is acrylamide regulated?

The US FDA has undertaken a variety of actions related to acrylamide including the development of detection methods, analysis of a wide variety of food stuffs, exposure assessments, toxicity studies, migration studies, and the developed a public information campaign. As they are still developing and analyzing data, the agency has not instituted any regulatory action at this time.

The European Union (EU) has conducted preliminary evaluations of the risks associated with acrylamide in food. Workshops and scientific meetings have been held in order to share information and coordinate further research. In addition, the Confederation of Food and Drink Industries (CIAA) has developed an Acrylamide Toolbox to provide methods of detection and techniques to mitigate the risk.

Acrylamide was added to the State of California's Proposition 65 list as a carcinogen in 1990 and as a reproductive toxicant in February 2011. A lawsuit brought by the State of California against food manufacturers alleging violations of Proposition 65 was settled in 2005 with the manufacturers agreeing to cut acrylamide levels in half.

Proposition 65 has been mentioned numerous times in association with acrylamide. What is Proposition 65?

Proposition 65 is a "right to know" law that was approved by voters in the State of California in 1986. It requires the State to maintain a list of chemicals that are known to cause cancer or reproductive toxicity (such as birth defects). Businesses that knowingly expose individuals to the chemicals which are included on this list above the stated levels generally are required to provide written or posted warnings for the consumer.

Currently, there are more than 800 compounds on this list, including acrylamide. Many of the chemicals included in the list are additives or ingredients in foods, drugs, and common household products. The Proposition 65 list is maintained and updated by the California Office of Environmental Health Hazard Assessment (OEHHA).

Proposition 65 does not ban or regulate specific chemicals in consumer products—it provides a warning of the chemicals present in a product which in turn allows consumers to make an informed choice as to whether they wish to purchase or consume that product.

The California Attorney General, county district attorneys and certain city attorneys have the power to enforce Proposition 65. They can file civil suits against businesses that do not comply with the law.

Should I change my eating habits in response to the presence of acrylamide?

The US FDA continues to study the presence of acrylamide in food, its formation during cooking, its effect on health, and potential alternative cooking methods that can reduce acrylamide levels in foods. This research may lead to more specific dietary advice or federal regulation of specific food products in the future but at this time no specific restrictions either regulatory or dietary have been issued.

How is acrylamide detected in food?

Food samples are prepared using solid-phase extraction (SPE) or similar techniques prior to instrumental analysis in order to optimize the sample—interfering compounds may be removed, background contaminants can be minimized, and the compounds of interest may be concentrated. All of these can lead to more sensitive and accurate analysis of the sample.

Instruments used for the detection and quantification of acrylamide include gas chromatography (GC) coupled with electron capture detection (ECD), nitrogen phosphorus detection (NPD), flame photometric detection (FPD), flame ionization detection (FID), or liquid chromatography (LC) coupled with ultraviolet detection (UV) and/or fluorescence detection.

What Waters products can aid in the detection of acrylamide?

For the preparation of samples, Oasis® SPE cartridges are considered the best available products in terms of repeatability, quality, and selectivity.

For LC analysis, Waters has both HPLC and UPLC® instrumentation which provide a variety of options for food safety laboratories depending on specific analytical and business needs. A wide selection of detectors can be coupled to these instruments to ensure proper detection of the compounds of interest.

Waters has specifically developed an LC column for the detection of food sugars—the XBridge™ Amide column. It is available in a variety of HPLC and UPLC sizes and can provide optimal retention and selectivity for these compounds and as well as excellent resolution of acrylamide.

What are Oasis SPE cartridges? What are the benefits that they can provide?

Oasis products are recognized as the “gold standard” for sample preparation by SPE. Offering the highest degree of reproducibility, recovery, quality, and sensitivity, these products provide the user with the best SPE results possible. Using a polymeric sorbent, Oasis products are also water wettable (i.e. don't suffer loss of reproducibility if they dry out) and can be used over a large pH range for maximum method flexibility. Oasis cartridges are available in a wide variety of formats to fit customer and method requirements.

What are XBridge Amide HPLC columns? What are the benefits that they can provide?

XBridge Amide columns were specifically created for the retention of sugars and related compounds such as acrylamide. Because of this very focused application area, the product was able to be optimized for the detection of these compounds and provides superior retention, separation and repeatability. In addition, the product is built using the polymeric ethylene bridged hybrid (BEH) particle which allows for extended column lifetime as well as utilization over the complete pH range. The columns are available in HPLC and UPLC formats and methods can be easily transferred between both of these types of systems.

Can Waters provide me with any methods for the detection of acrylamide?

Waters scientists have developed a number of different methods for the detection of acrylamide. Of particular interest, you may wish to download and view the following documents from the Waters Applications Library:

Description	Literature Code*
Acrylamide in Potato Chips (HPLC method using Oasis SPE)	oasis35
Analysis of Acrylamide, Methacrylic Acid, and Methacrylamide using ACQUITY UPLC (UPLC Method featuring Amide column)	wa60108
The Determination of Acrylamide using the Waters Quattro Premier™ LC/MS/MS System (HPLC method)	720000846en
XBridge Amide HPLC Columns Application Notebook (HPLC Method, Amide column)	720003438en

*Search my literature code at waters.com

As always, we recommend that you check with relevant regulatory agencies to ensure that methods adhere to their guidelines.

How does Waters contribute to food safety overall?

Waters Corporation is committed to helping scientists across the globe keep the food supply safe. We collaborate with government, industrial, and academic institutions focused on developing methods for both QC as well and R&D purposes. We develop and provide cutting edge instrumentation which is optimized to meet the latest challenges for the food industry and we are an active participant and supporter of industry trade and scientific groups.

Most recently, Waters has been a sponsor for the establishment of an international network of food testing training laboratories. Partnering with local government agencies and academic institutions, the establishment of these training programs will provide scientists access to and training on the latest methods and equipment in the food testing industry. These training course are developed and taught by regulatory scientists and industry leaders who in many cases have developed the regulatory guidelines and methods which the class is studying.

For more information, please visit us at www.waters.com/food

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