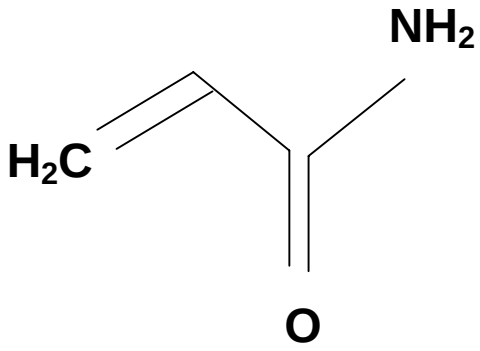
FOOD STANDARDS AGENCY STUDY OF ACRYLAMIDE IN FOOD
BACKGROUND INFORMATION & RESEARCH FINDINGS
PRESS BRIEFING 17.05.02

What is Acrylamide?



Synonyms: 2-Propenamide; ethylene carboxamide; acrylic amide; vinyl amide
CAS No: 79-06-1
Molecular weight: 71.09
Chemical Formula: $CH_2CHCONH_2$
Boiling Point: 125C
Melting Point: 87.5C (183F)

Acrylamide is a chemical intermediate (monomer) used in the synthesis of polyacrylamides. This monomer occurs in a white flowing crystalline form, it is soluble in water, ethanol, methanol, dimethyl ether and acetone, it is not soluble in heptane and benzene. It readily polymerises on reaching melting point or exposure to UV light. Solid acrylamide is stable at room temperature, but may polymerise violently when melted or exposed to oxidating agents. The annual production of acrylamide in the EU is 80,000 to 100,000 tonnes.

The main uses of polyacrylamide are as a flocculant in the treatment of municipal water supply and in paper and pulp processing. The polymer is also used to remove suspended solids from industrial waste water before discharge, reuse, or disposal. However, it has a large number of other applications including cosmetic additives, soil conditioning agents and in the formulation of grouting agents. Smoking is a known source of exposure to acrylamide.

The health effects of acrylamide

Acrylamide has been found to cause damage to the genetic material in studies using a range of experimental systems, including cultured mammalian cells *in vitro*, and *in vivo* in rats and mice. It has also been shown to induce tumours in rats following long-term administration. Together, these observations lead to the conclusion that acrylamide is a genotoxic carcinogen, for which it is not possible to identify a safe level of exposure. Some risk should be assumed, albeit small, even at very low levels of exposure.

Two studies have investigated the numbers of deaths due to cancer in workers exposed to acrylamide in factories. The studies did not show clear evidence of increased cancer deaths in the acrylamide-exposed workers, but no conclusions could be drawn because of inadequacies in the studies. Overall, taking into account all of the available relevant information, the International Agency for Research on Cancer (IARC) has classified acrylamide as “probably carcinogenic to humans”.

The UK independent Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC) advises that exposure to genotoxic carcinogens such as acrylamide should be as low as reasonably practicable.

Acrylamide is also known to cause nerve damage in humans, most frequently seen as peripheral neuropathy. The studies were mainly in workers exposed to acrylamide via the inhaled air and through the skin, and it is not possible to estimate how the level of exposure compares with potential exposure from food.

Animal studies have also shown effects on the reproductive system, particularly impaired fertility of the male animal. No information is available with regards to effects on the human reproductive system.

The information that is currently available is not sufficient to allow us to estimate total intake of acrylamide from food in the UK. The Swedish studies have indicated that intake might be up to 100 microgram per day, which is about 1.7 microgram/kg bodyweight per day. This is more than 1000 times lower than the dose levels that have been found to cause effects on the nervous system or reproductive system in animal studies.

The Food Standards Agency's acrylamide study

Following the publication of the results of the Swedish study as a matter of urgency the Agency commissioned new work to verify the Swedish research.

The work was conducted by the Central Science Laboratory who used an established GC-MS method as well as a newly developed LC-MS-MS method to analyse various foods.

The results of the analysis are shown in Table 1. Foods including crisps, cereals and chips were analysed. Levels of acrylamide were found similar to those in the corresponding foods analysed in the Swedish study. The analyses of raw, boiled and fried potatoes (chips) confirmed that acrylamide is absent from the raw or boiled food but present at significant levels in fried food. Additionally it was shown that overcooking chips increased the levels of acrylamide further.

Details of methodology

Extraction

Samples were homogenised and a specimen extracted using hot water (80ºC) for 2 hours with occasional swirling. A second specimen was taken, spiked with acrlyamide, and extracted. Portions of the extracts were taken for analysis.

Analysis

GC-MS method.

The method used is based on that published in the following paper.

Determination of acrylamide monomer in mushrooms grown on polyacrylamide gel. *L. Castle, Journal of Agricultural & Food Chemistry, 1993, 41, 1261-1263.*

LC-MS-MS method.

Extracts were defatted using hexane where necessary. Detection was by positive electrospray ionisation, monitoring transition m/z 72 to 55. A Hypercarb LC column running with 0.1% acetic acid in water was used with 50 ul injection. Quantification used methacrylamide as an internal standard. This method was established at short notice by CSL and therefore has not yet been properly validated. Results are not corrected for recovery and are semi-quantitative only. Work on the validation of this method is on-going.

Frying method

Equipment. Deep frying pan (11 cm deep, 25 cm diameter) with non-stick interior coating. Metal tongs. Gas (HPG) hob. Lanfranchi olive oil.

Cooking. Approx. 8 cm of oil was placed in the pan and heated until visibly hot (bubbles appear). A single chip was placed in the hot oil to check the temperature (see if it sizzles). The chips were then placed in the oil and cooked following the recommended time. The chips were removed from the oil using metal tongs and excess oil shaken off. The cooked chips were placed on aluminium foil and allowed to cool before the foil was wrapped-up to store the chips prior to analysis.

Potatoes that were chipped in the lab and so had no on-pack cooking instructions, were cooked until they appeared ready to eat. This was approximately 16 minutes.

The oil was drained from the pan and the pan was washed between each cooking batch. It was left to drain dry and no paper towels were used. Fresh oil was used each time.

Overcooking. The chips were left past the recommended cooking time until they were visibly darker. This was about +40% of the recommended cooking time, for example 12 +5 minutes.

Table 1: Results of acrylamide study

Sample number	Sample description	acrylamide, ppb (GC-MS)	acrylamide, ppb (LC-MS-MS)	Comparable SNFA result*, microg/kg
141	Sainsburys baking potatoes - raw	<10	Nd	
	- boiled	<10	Nd	*<30*
	- chipped & fried	310	350	*300-1100*
142	Tesco King Edward potatoes – raw	<10	Nd	
	- boiled	<10	Nd	*<30*
	- chipped & fried	2800	3500	*300-1100*
144	Ross frying chips - as sold	200	100	
	-cooked†	3500	3500	*300-1100*
	-overcooked	12800	12000	
147	Walkers Crisps 'Sensations'	1220	not tested	*330-2300*
148	Walkers Crisps ready-salted	1270	not tested	
149	Walkers Ridged Crisps	1280	not tested	
150	Asda maize/potato sticks	2040	not tested	
151	Reduced fat crisps - Cape Cod	170	not tested	
152	Ryvita – Sesame	1340	2000	1194
153	Ryvita – Dark Wholemeal Rye	2400	4000	*<30-1900*
154	Ryvita – Rye	1800	2400	1874 &1453
155	Kellogg's Rice Crispies	110	150	247
156	Kellogg's Special K	300	250	269
157	Pringles (original)	1480	1500	614

nd = not detected. The detection limit for the LC-MS method has not yet been established, it is approximately 50 ppb.

* Comparable Swedish National Food Administration result where available. *Numbers given in italics give the range of acrylamide levels found in comparable foods in the Swedish study.*

† Fried according to on-pack instructions.