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No Quick Fix For Acrylamide In Food

Intense scrutiny has provided methods of reduction but few answers about risk

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If certain states have their way, your favorite snack may have an acrylamide warning. The substance has been the subject of much research after it was first discovered in food. Ways to reduce its presence in food have been developed, but consensus on the risk it poses to human health has not been reached. Whether it is regulated in the U.S. depends partly on the fate of legislation before the Senate.

John Richbourg/Big Stock Photo

Under Review French fries are one of the major sources of acrylamide in the U.S. diet.

Acrylamide is formed naturally when starchy foods are baked, roasted, fried, or toasted. It gained notoriety when Swedish scientists found it in food in 2002. At high levels in animals, it causes cancer and reproductive and developmental problems. It is also a probable human carcinogen and damages the human neurological system. But no one knows for sure whether the levels in food are dangerous for humans.

Before 2002, acrylamide was known only as a synthetic compound used primarily in industrial grout, as a coagulant for drinking water treatment, as a sizing agent for paper and textiles, and as a raw material for other organic chemicals. The Environmental Protection Agency's limit for the substance in drinking water is extremely low-0.5 ppb.

Intense research on the compound began in the U.S. and Europe after Swedish researchers found acrylamide in food at concentrations hundreds of times higher than what EPA and the World Health Organization (WHO) consider safe for drinking water. In the past four years, about 200 scientific papers have been published on the chemical.

Since 2002, the Food & Agricultural Organization and WHO have been involved in the risk assessment of acrylamide in foods. They held a special consultation to review available data on acrylamide in 2002, and the FAO/WHO Joint Expert Committee on Food Additives (JECFA) held a meeting on the topic in February 2005.

Last year, California proposed rules that would require warning labels on foods that contain acrylamide. The state invoked authority for those proposals under Proposition 65, a law that requires warnings on foods contaminated with human or animal carcinogens. The proposed rules engendered so many negative comments from the food industry that California was unable to finalize them within a year and withdrew them from consideration in April. But California plans to revise the rules and repropose them. And last year, the state filed lawsuits against nine large snack food manufacturers because they failed to include acrylamide warnings on products sold in the state.

Acrylamide of late is the lightning rod in a controversy over congressional legislation that would forbid states from passing food safety laws that are more stringent than federal rules. The proposed National Uniformity for Food Act would prohibit states from requiring warning labels on foods unless FDA requires them. The bill would, for example, prevent California from placing warnings on foods saying they contain mercury or the probable human carcinogen acrylamide. The bill passed the House last March and was the subject of a July 27 hearing in the Senate.

Food authorities in Europe are taking specific steps to curb acrylamide. European Commission officials are working with food processors to help them monitor and lower the levels of acrylamide in food, says David R. Lineback, who recently retired from his position as director of the Joint Institute for Food Safety & Applied Nutrition at the University of Maryland, College Park.

The food safety authority in Germany has the most stringent approach to acrylamide reduction. In 2002, it recommended that companies that produce foods with acrylamide levels in the top 10% in a specific category, such as potato chips, reduce the levels as much as they could. In a few years, when the average levels of acrylamide are lower, the new top 10% firms will be asked to reduce amounts of the chemical still further.

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FDA has not been as aggressive. It has made many measurements of acrylamide levels in foods, and it has initiated carcinogenicity and

neurotoxicity studies. It will further evaluate acrylamide when the studies are complete in 2007. But it has not recommended that food processors reduce levels of acrylamide. It has been strongly criticized by the Center for Science in the Public Interest for refusing to take steps to limit acrylamide levels in food. CSPI Director Michael F. Jacobson has urged FDA to adopt a policy similar to Germany's.

"We filed a petition with the agency in 2003, calling on it to take regulatory action," he says. "We recommended that FDA identify the median level of acrylamide" in each category of food that contains significant amounts. Those companies with levels above the median should then be given two years "to get below that median," Jacobson explained. "FDA is a regulatory agency that doesn't want to accept the fact that it is a regulatory agency."

Since acrylamide's discovery in food in April 2002, many basic facts have come to light about it. Scientists in Canada, England, Switzerland, and the U.S. have independently come to the same conclusions about acrylamide: The highest levels are found in french fries and potato chips. Acrylamide forms from the amino acid asparagine when it is heated with sugars. Asparagine, as well as other amino acids, reacts with sugars via the Maillard reaction to yield precursors to acrylamide, along with other compounds that give taste, aroma, and color to food (C&EN, Oct. 7, 2002, page 7).

The amount of acrylamide formed depends on several factors, including cooking time and temperature, moisture content, the amount of free asparagine, and the presence of glucose. The issue is complicated because the same foods produced by the same cooking process can contain different levels of acrylamide. For example, one batch of potato chips may have higher levels than the next, if the potatoes used differ in glucose or moisture content, Lineback says. However, when starchy foods are cooked long enough and at high enough temperatures so they become very brown, they usually contain more acrylamide than the same food that has not acquired a dark color, he says.

Methods of reducing the acrylamide content of foods have emerged. For example, researchers at the University of Reading in England reported in July that, if 0.39% glycine and 0.39% citric acid by weight are added to potato cakes before cooking, the amount of acrylamide formed can be reduced by about 40% (*J. Agric. Food Chem.* **2006**, *54*, 5976).

TOP 20 SOURCES

Acrylamide in the U.S. diet comes from various food items

	MEAN INTAKE (µG/KG BODY WEIGHT/DAY)
French fries (restaurant)	0.070
French fries (oven-baked)	0.051
Potato chips	0.045
Breakfast cereal	0.040
Cookies	0.028
Brewed coffee	0.027
Toast	0.023
Pies & cakes	0.018
Crackers	0.017
Soft bread	0.014
Chile con carne	0.014
Corn snacks	0.011
Popcorn	0.007
Pretzels	0.007
Pizza	0.006
Burritos/tostadas	0.006
Peanut butter	0.003
Breaded chicken	0.003
Bagels	0.003
Soup mix	0.003

NOTE: Mean intake calculated from estimated average daily consumption by a 70-kg person. **SOURCE:** Food & Drug Administration

Because the reactions that yield acrylamide also yield flavor and aroma compounds, it can be difficult to reduce acrylamide without degrading flavor. Thus it is notable that the treatment developed by the U.K. researchers has only a small effect on the formation of volatile flavor compounds. "It is now possible to identify strategies for reducing acrylamide without reducing quality," Lineback says.

While advances have been made in reducing acrylamide in food, understanding of the risk it poses remains incomplete. At the February 2005 consultation, JECFA reviewed all available data on acrylamide, especially then-new toxicity and intake information. In addition to french fries and potato chips, the major foods containing acrylamide include coffee, pastries, cookies, cereals, rolls, and toast, it said. JECFA concluded that average acrylamide intakes from food are unlikely to cause nervous system damage and developmental and reproductive problems in humans. On the basis of animal tests, however, it decided that cancer is the most likely effect of acrylamide in foods.

One reason for this decision is that acrylamide is both genotoxic and carcinogenic in rodents, causing tumors at a variety of sites. Also, metabolism of acrylamide is the same in mice and rats as in humans. "There is no information to indicate any significant differences between rodents and humans in sensitivity to cancer formation from acrylamide," JECFA concluded.

Because acrylamide levels in foods can vary dramatically with cooking time and temperature, JECFA did not recommend maximum amounts of

acrylamide-containing foods for people to consume. It noted that several ongoing studies may cast more light on safe exposures for humans.

"The relative levels of acrylamide in the diet are higher than [the levels of] many other known carcinogens," JECFA concluded. "Without evidence to the contrary," the relatively high concentrations in food are "of human health concern," it wrote.

FDA, however, calculates that human exposure to acrylamide is somewhat lower than JECFA's estimates. It recently reported a mean exposure of 0.0004 mg/kg of body weight/day. An average man weighs 70 kg, so this exposure equates to an intake of 0.028 mg or 28 µg per day.

One interesting fact is that in 2002, FDA, when applying a conventional safety factor derived from an animal study, concluded that people should not consume more than 12 µg per day to protect against neurotoxic effects. (*Fed. Reg.*, June 25, 2002, page 42714). After the discovery of acrylamide in food, FDA totally ignored that previous recommendation.

What happens with acrylamide over the next few years−that is, whether or not U.S. food processors make serious efforts to reduce it−may well depend on the fate of the National Uniformity for Food Law. After the August recess, the Senate could pass the bill. If it does become law, it will effectively kill Proposition 65 and California's efforts to regulate acrylamide and other chemicals more stringently than FDA does.

At the July 27 hearing, industry representatives supported the bill. But William K. Hubbard, FDA's former associate commissioner for policy, opposed it. The bill would remove FDA's partners-the states-in protecting against food adulteration and give the agency even more responsibilities, he said.

The federal government has never had primary responsibility for contaminants in the food supply, Hubbard said. "FDA's ability to adequately oversee such potential threats to the food supply is inadequate and growing weaker every day," he explained.

The bill sets up a process allowing states to petition to maintain an existing state standard. But FDA has so few resources that it can deal with only a fraction of the citizen petitions it currently receives, Hubbard said.

Sens. Barbara Boxer (D-Calif.) and Dianne Feinstein (D-Calif.) have vowed to filibuster the bill if it comes up for consideration on the Senate floor. The vast majority of state attorneys general, as well as state food and drug officials, oppose the bill. Given the few weeks remaining in this Congress and the opposition, the bill seems unlikely to pass.

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