



Acrylamide: The Next Food Safety Issue?

by Catherine Viator and Mary K. Muth

With the announcement in 2002 that researchers have found acrylamide in food, consumers wonder whether common foods such as french fries and potato chips are safe to eat. Consumer groups attest that hundreds of cancer cases per year are attributable to acrylamide; the food industry disputes this claim. Meanwhile, the international scientific community is racing to determine if acrylamide has harmful human health effects. We discuss the current state of knowledge about acrylamide and potential regulatory responses that government agencies might consider.

What Is Acrylamide?

Acrylamide is an organic chemical recently found to occur naturally in certain food products. It has long been used for industrial purposes, in producing polyacrylamide gels, and as a grouting agent in construction. Polyacrylamide is used as a paper-making aid, as a soil-conditioning agent, in ore processing, in sewage treatment, and occasionally as an additive for water treatment (FSA, 2002). Acrylamide is also a known component of cigarette smoke.

How Was Acrylamide Found in Food?

In April 2002, Swedish researchers announced their discovery of acrylamide in food. In a study analyzing the health effects of acrylamide exposure at a railway tunnel construction site in Sweden, both the control group and the workers in the study showed high levels of acrylamide in their bodies. This prompted further research on how acrylamide could be present in the control group, eventually leading to the discovery of acrylamide in food (FSA, 2002). This finding was later confirmed by researchers in Britain, Norway, Switzerland, and the United States (FDA, 2004).

How Is Acrylamide Formed in Food?

Acrylamide arises in food when asparagine, an amino acid, is heated with sugars such as glucose. According to Joseph Levitt, Director of the Center for Food Safety and Applied Nutrition (CFSAN) at the Food and Drug Administration, acrylamide is “a natural byproduct of the cooking process.” The cooking processes that produce acrylamide are baking, frying, grilling, and toasting, or any cooking method in which temperatures are greater than 120°C or 248°F.

What Food Products Contain Acrylamide?

High-carbohydrate foods baked or fried at high temperatures (greater than 120°C or 248°F) contain the highest levels of acrylamide. FDA consumption surveys show that eight food items contribute to the highest levels of acrylamide intake: potato chips, two brands of french fries, breakfast cereal, toast, soft bread, cookies, and brewed coffee (Gilcrest, 2003b).

Acrylamide is not found in raw or boiled foods that are high in carbohydrates, nor is it found in meat, fish, chicken, or infant formula. Furthermore, as more testing is done, it appears that acrylamide levels are highly variable across brands of the same food type and even within the same brand of food. For example, in a popular brand of potato chips, acrylamide levels in 25 bags varied from 249 to 549 parts per billion (FDA, 2004).

What Are the Human Health Risks of Acrylamide?

At this time, the risks of acrylamide through the diet are uncertain. Acrylamide is a known carcinogen in laboratory animals, impairs fertility in male animals, and causes nerve damage to humans exposed in the workplace (FSA, 2002). Epidemio-

logical studies conducted on persons with occupational exposure to acrylamide did not show an increased risk of cancer through acrylamide exposure, although the studies have been criticized because of the limited number of study participants. Two epidemiological studies published this year have looked for but not found a relationship between consumption of baked or fried potatoes and incidence of various cancers.

Any possible risks associated with acrylamide in food would arise from long-term exposure. Because acrylamide is produced through natural cooking processes, it is likely that humans have been exposed to it for a significant amount of time (FSA, 2002). Recent research at RTI International has characterized the process by which acrylamide consumed orally is metabolized in the human body. Results will contribute toward methods of measuring human exposure to acrylamide.

What Is the U.S. Government Doing About Acrylamide?

The FDA's Center for Food Safety and Applied Nutrition (FDA/CFSAN, 2004) released a draft action plan for acrylamide in food soon after the Swedish discovery. The draft action plan considers the following:

- *Acrylamide formation.* The National Center for Food Safety and Technology—a consortium between the FDA, academia, and industry—is investigating the mechanisms by which acrylamide is formed and eliminated.
- *Toxicology.* The FDA plans to conduct both short- and long-term studies to determine the toxicological effects of acrylamide. In the short term, the FDA's National Center for Toxicological Research (NCTR) will clarify how much acrylamide is absorbed from food and identify DNA and protein reaction products. In the long term, the NCTR will request chronic and subchronic carcinogenic studies from the National Institute for Environmental Health Sciences.
- *Testing methodology.* The FDA developed a methodology for detecting acrylamide in foods and posted the methodology on its website. Future plans call for a peer review of the testing methodology and the development of more rapid and less expensive testing methods.

- *Exposure.* The exposure assessment involves two phases: testing individual food products and measuring total consumption levels. In 2002, the FDA tested approximately 150 food samples to measure the level of acrylamide. In 2003, a private lab under contract with the FDA will test approximately 450 samples, and the FDA will analyze between 500 and 1,000 market basket samples from a national survey. To measure consumption levels, the FDA will predict the exposure in an average national diet using food intake survey data.
- *Consumer education.* As more information becomes available, the FDA will develop consumer education materials to inform consumers about the risks of acrylamide and how to reduce the risks.

In addition to the draft action plan, the FDA continues to host and participate in meetings with the intentions of gathering public and expert input and encouraging coordination of research (FDA, 2004).

What Is Being Done About Acrylamide on an International Level?

The global scientific community considers acrylamide in food an urgent issue, as evidenced by their collaboration on research projects and sharing of study results. The World Health Organization and Food and Agriculture Organization joined forces in addressing the acrylamide issue and recommended an international "Acrylamide in Food" network. The Joint Institute for Food Safety and Applied Nutrition, a joint research and education program between the FDA and the University of Maryland, developed and manages the Acrylamide in Food network (see <http://acrylamide-food.org>).

Governments from other countries, including Germany, Ireland, Japan, Australia, and New Zealand, issued statements regarding acrylamide in food, but none have yet implemented new food industry regulations or changed dietary guidelines for consumers.

What Is the Food Industry Doing About Acrylamide?

Large food manufacturers are playing an active role in acrylamide research. For example, Proctor and Gamble scientists discovered the link between the

role of asparagine and acrylamide formation. A food industry trade association, Grocery Manufacturers of America, stated that some food companies are already trying to reduce acrylamide levels in food by 10%. Frito-Lay is attempting this reduction through several methods, including disrupting acrylamide formation, removing food reactants, and removing acrylamide after formation (Gilcrest, 2003a). The German consumer affairs ministry announced that manufacturers in their country would lower the recommended temperature when cooking french fries.

After the initial discovery of acrylamide in high-carbohydrate foods, some in the food industry quickly pointed to its presence in a wide variety of

foods. The National Food Processors Association reminded consumers to consider the total contribution of a particular food to their diet, rather than eliminate entire food groups with higher concentrations of acrylamide. The American Frozen Food Institute, whose members produce more than 90% of the frozen food in the United States, continues to stress that scientific conclusions have not yet been reached concerning health hazards associated with acrylamide. Food industry representatives hope the acrylamide issue is resolved quickly, because it could have far-reaching effects in terms of consumer litigation or more demanding regulations for labeling (Gilcrest, 2003a).

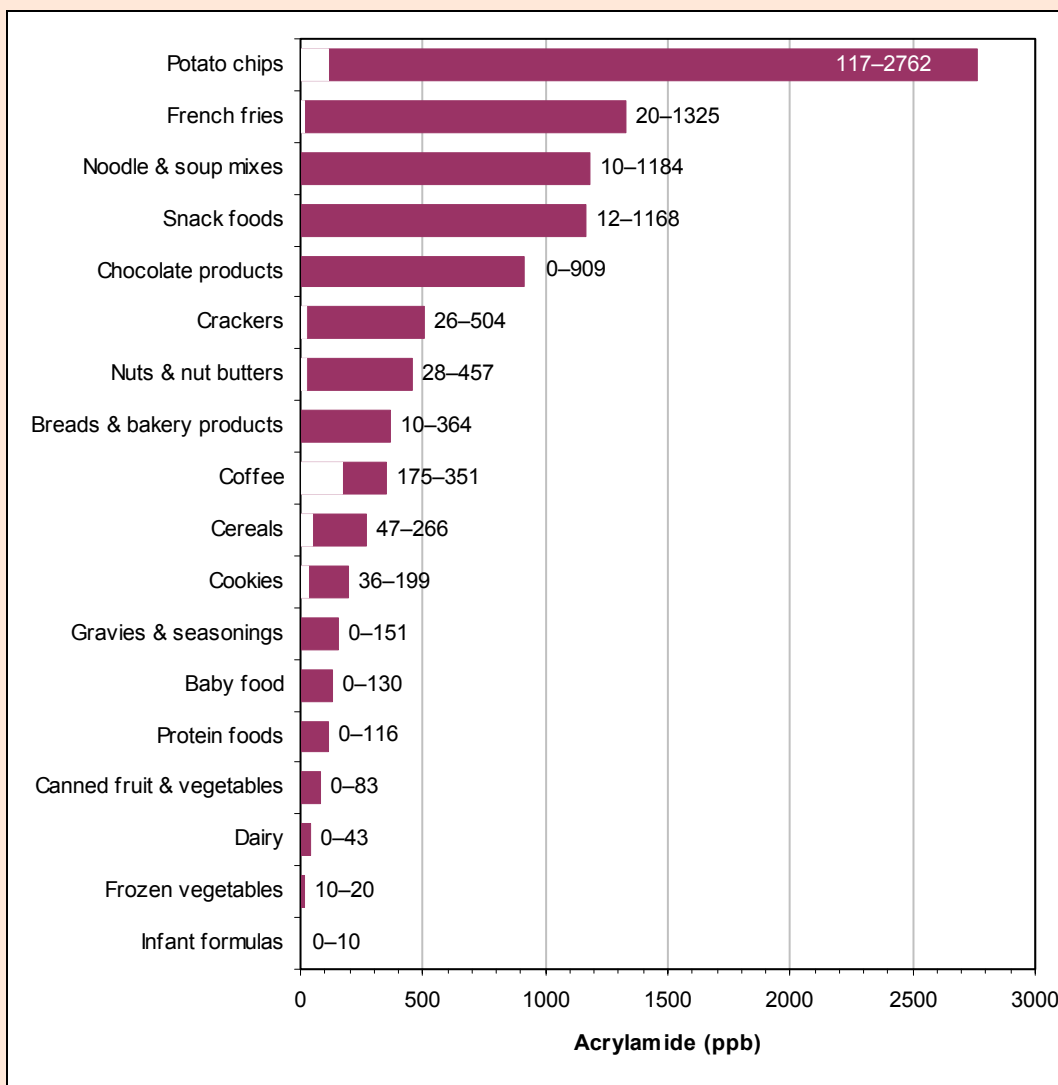


Figure 1. Ranges of acrylamide in various food products.

Note. Data from FDA/CFSAN (2002).

What Should Consumers Do About Acrylamide?

According to the International Food Information Council, results from recent focus groups indicate that consumers are not changing their dietary habits because of acrylamide's presence in food; rather they are changing their dietary habits because of general health reasons and to lose weight. Most of the study participants are waiting for further scientific evidence, and some believe that the media has sensationalized the issue.

In absence of specific data on the risks of acrylamide, the U.S. government encourages consumers to eat a healthy, balanced diet rich in fruits and vegetables. The FDA released test results on acrylamide levels of varying foods, although they state that the data are exploratory and should not be used to recommend food product choices to consumers (FDA, 2004; see Figure 1). The Norwegian government, however, recommended a decrease in consumption of potato chips for those consumers who consume excessive amounts (FDA, 2004). Consumer groups, such as the Center for Science in the Public Interest (CSPI), reinforce that acrylamide is another reason to avoid french fries and chips, in addition to their high caloric and low nutrient content. The CSPI has petitioned the FDA to set interim acceptable levels for acrylamide, which would require food manufacturers to lower acrylamide in their brands to a median level for the overall food category.

Some government officials do not want to overemphasize the link between high temperatures and acrylamide formation because of concerns that consumers will undercook their food. This practice might present another risk—foodborne illness.

What Are the Potential Future Regulatory Options?

To date, neither U.S. nor foreign governments have taken any regulatory action on the matter of acrylamides in food. All are waiting until further scientific data are gathered and analyzed. However, the state of California is currently considering a requirement for labeling of food products with high levels of acrylamide.

Once valid, conclusive data are accumulated, the FDA will have to decide whether it should reg-

ulate acrylamides in the United States. The FDA's regulatory options might include the following:

- *Limit allowable amounts of acrylamide in food.* If it is shown that acrylamide has harmful effects on humans, the FDA will assist food manufacturers in identifying methods to lower the amount present in foods. As mentioned earlier, some companies are already working toward this end. If successful in their efforts to identify methods for reducing or eliminating acrylamides in food, the FDA could create regulations that limit the amount allowed in food products. This type of rule would perhaps require companies to monitor acrylamide levels on an ongoing basis. If food manufacturers are not compliant, enforcement actions may be needed.
- *Require warning labels on foods with high levels of acrylamide.* If efforts to reduce or eliminate acrylamides are not successful, the FDA may require warning labels on foods. Such labels would inform consumers of the risks of acrylamide and could dissuade consumers from purchasing foods with high acrylamide levels.
- *Develop recommended maximum daily intake of acrylamide by consumers.* Researchers may find a threshold level for acrylamide consumption, whereby a small amount of acrylamide is not considered harmful but larger dosages are. In this case, the FDA would likely recommend a maximum daily intake for consumers, and the amount of acrylamides may be added to food product labels.

All of these options will increase costs to the government, industry, and consumers. Given the time required to conduct research and develop and implement new regulations, it will likely be several years before any changes are required.

For More Information

- Gilcrest, L. (2003a). Acrylamide study in Swedes draws mixed reviews at toxicology forum. *Food Chemical News*, 54(52), 13-14.
- Gilcrest, L. (2003b). FDA surveys show eight foods account for bulk of acrylamide in US diet. *Food Chemical News*, 45(3), 26-27.
- Food Standards Agency [FSA]. (2002). *FDA acrylamide study: Your questions answered*. London, UK: Food Standards Agency. Available on the

World Wide Web: http://www.foodstandards.gov.uk/multimedia/webpage/acrylamide_study_faq/.

U.S. Food and Drug Administration [FDA]. (2004). *Acrylamide in foods*. Washington, DC: United States Food and Drug Administration. Available on the World Wide Web: <http://www.cfsan.fda.gov/~lrd/pestadd.html#acrylamide>.

U.S. Food and Drug Administration Center for Food Safety and Applied Nutrition [FDA/CFSAN]. (2002). Exploratory data on acryla-

mide in foods. Washington, DC: United States Food and Drug Administration. Available on the World Wide Web: <http://www.cfsan.fda.gov/~dms/acrydata.html>.

Catherine Viator and Mary K. Muth are with RTI International, a trade name of Research Triangle Institute. Any opinions expressed in the article are those of the authors. We thank Tim Fennell, Center for Bioorganic Chemistry, RTI International, and Clark Nardinelli, Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration, for comments on an earlier draft.

