NATIONAL CANCER INSTITUTE FactSheet

Acrylamide in Food and Cancer Risk

Key Points

- Acrylamide is a chemical used primarily for industrial purposes (see Question 1).
- Acrylamide has been found in certain foods, with especially high levels in potato chips, French fries, and other food products produced by high-temperature cooking (see Question 2).
- Food and cigarette smoke are the major sources of exposure to acrylamide (see Question 6).
- Acrylamide is considered to be a mutagen and a probable human carcinogen, based mainly on studies in laboratory animals (see Question 7).
- Scientists do not yet know with any certainty whether the levels of acrylamide typically found in some foods pose a health risk for humans (see Questions 7 and 10).

1. What is acrylamide?

Acrylamide is a chemical used primarily as a building block in making polyacrylamide and acrylamide copolymers. Polyacrylamide and acrylamide copolymers are used in many industrial processes, such as the production of paper, dyes, and plastics, and in the treatment of drinking water and wastewater, including sewage. They are also found in consumer products, such as caulking, food packaging, and some adhesives. Trace amounts of acrylamide generally remain in these products.

2. Is there acrylamide in food?

Researchers in Europe and the United States have found acrylamide in certain foods that were heated to a temperature above 120 degrees Celsius (248 degrees Fahrenheit), but not in foods prepared below this temperature (1). Potato chips and French fries were found to contain higher levels of acrylamide compared with other foods (2). The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) stated that the

levels of acrylamide in foods pose a "major concern" and that more research is needed to determine the risk of dietary acrylamide exposure (2).

3. How does cooking produce acrylamide?

Asparagine is an amino acid (a building block of proteins) that is found in many vegetables, with higher concentrations in some varieties of potatoes. When heated to high temperatures in the presence of certain sugars, asparagine can form acrylamide. High-temperature cooking methods, such as frying, baking, or broiling, have been found to produce acrylamide (3), while boiling and microwaving appear less likely to do so. Longer cooking times can also increase acrylamide production when the cooking temperature is above 120 degrees Celsius (4, 5).

4. Is there anything in the cooking process that can be changed to lower dietary acrylamide exposure?

Decreasing cooking time, blanching potatoes before frying, and postdrying (drying in a hot air oven after frying) have been shown to decrease the acrylamide content of some foods (6, 7).

5. Should I change my diet?

Acrylamide levels in food vary widely depending on the manufacturer, the cooking time, and the method and temperature of the cooking process (8, 9). The best advice at this time is to follow established dietary guidelines and eat a healthy, balanced diet that is low in fat and rich in high-fiber grains, fruits, and vegetables.

6. Are there other ways humans are exposed to acrylamide?

Food and cigarette smoke are the major sources of acrylamide exposure (10). Exposure to acrylamide from other sources is likely to be significantly less than that from food or smoking, but scientists do not yet have a complete understanding of all sources of exposure. Acrylamide and polyacrylamide are used in some industrial and agricultural procedures, and regulations are in place to limit exposure in those settings.

7. Does acrylamide increase the risk of cancer?

Studies in rodent models have found that acrylamide exposure poses a risk for several types of cancer (11, 12, 13). However, the evidence from human studies is still incomplete. The National Toxicology Program (NTP) and the International Agency for Research on Cancer consider acrylamide to be a "probable human carcinogen," based on studies in laboratory animals given acrylamide in drinking water. However, toxicology studies have shown differences in acrylamide absorption rates between humans and rodents (14).

A series of case-control studies have investigated the relationship between dietary intake of acrylamide and the risk of developing cancers of the oral cavity, pharynx, esophagus, larynx, large bowel, kidney, breast, and ovary. These studies generally found no excess of tumors associated with acrylamide intake (15, 16, 17, 18, 19). In the studies, however, not all acrylamide-containing foods were included in estimating exposures. In addition, information in case-control studies about exposures is often based on interviews (personal or through questionnaires) with the case and control subjects, and these groups may differ in the accuracy of their recall about exposures. One factor that might influence recall accuracy in cancer-related dietary studies is that diets are often altered after receiving a diagnosis of cancer.

To avoid such limitations in accurately determining acrylamide exposure, biomarkers of exposure were recently used in a Danish cohort study designed to evaluate the subsequent risk of breast cancer in postmenopausal women (20). Among women with higher levels of acrylamide bound to the hemoglobin in their blood, there was a statistically significant increase in risk of estrogen receptor-positive breast cancer. This finding suggests an endocrine hormone-related effect, which would be consistent with the results of a questionnaire-based cohort study in the Netherlands that found an excess of endometrial and ovarian cancer—but not of postmenopausal breast cancer—associated with higher levels of acrylamide exposure (21). Another cohort study from the Netherlands suggested a positive association between dietary acrylamide and the risk of renal cell cancer, but not of prostate or bladder cancer (22).

8. What are other health effects of acrylamide?

High levels of acrylamide in the workplace have been shown to cause neurological damage, e.g., among workers using acrylamide polymers to clarify water in coal preparation plants (23).

9. Are acrylamide levels regulated?

The U.S. Environmental Protection Agency (EPA) regulates acrylamide in drinking water. The EPA established an acceptable level of acrylamide exposure, set low enough to account for any uncertainty in the data relating acrylamide to cancer and neurotoxic effects. The U.S. Food and Drug Administration regulates the amount of residual acrylamide in a variety of materials that come in contact with food, but there are currently no guidelines governing the presence of acrylamide in food itself.

10. What research is needed?

Although studies in rodent models suggest that acrylamide is a potential carcinogen, additional epidemiological cohort studies are needed to help determine any effects of dietary acrylamide intake on human cancer risk. It is also important to determine how acrylamide is formed during the cooking process and whether acrylamide is present in foods other than those already tested. This information will enable more accurate and comprehensive estimates of dietary exposure. Biospecimen collections in cohort studies

will provide an opportunity to avoid the limitations of interview-based dietary assessments by examining biomarkers of exposure to acrylamide and its metabolites in relation to the subsequent risk of cancer.

For information about acrylamide in food from the WHO and FAO, please visit the WHO Web site at http://www.who.int/foodsafety/chem/chemicals/acrylamide/en on the Internet.

For information about acrylamide from the NTP's Eleventh Report on Carcinogens, please visit http://ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932 on the Internet.

Selected References

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Related NCI materials and Web pages:

- National Cancer Institute Fact Sheet 3.25, *Heterocyclic Amines in Cooked Meats* (http://www.cancer.gov/cancertopics/factsheet/Risk/heterocyclic-amines)
- *What You Need To Know About™ Cancer* (http://www.cancer.gov/cancertopics/wyntk/overview)

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