



International Food Safety Authorities Network (INFOSAN)

1st March 2005

INFOSAN Information Note No. 2/2005 - *Acrylamide*

Acrylamide in food is a potential health hazard

SUMMARY NOTES

- Acrylamide is formed during the frying, roasting, or baking of a variety of foods, including potatoes, cereal products and coffee, generally at temperatures above 120 °C.
- Acrylamide causes cancer in long term feeding studies in rats.
- Since 2002, FAO and WHO have been involved in the risk assessment of acrylamide in foods, including a special consultation in 2002 and a recent meeting of the FAO/WHO Joint Committee on Food Additives (JECFA).
- As part of efforts to improve risk assessment advice, JECFA has used an approach (Margin of Exposure) which can provide information for risk managers, particularly for substances for which there may be no completely safe level of exposure, and can be used in comparing risks.
- JECFA has determined that the estimated intake of acrylamide from certain foods may be a human health concern.
- Consumers who eat large amounts of certain fried, roasted or baked foods may have an increased risk of cancer.
- Efforts to reduce acrylamide levels in foodstuffs should continue, and, specifically, the food industry and other researchers should be encouraged to share information about new technologies that can achieve this goal.
- Consumers should eat a balanced and varied diet, which includes plenty of fruit and vegetables.

Introduction

Acrylamide is a chemical used in a variety of industrial applications, including in the production of polyacrylamide plastics and other materials that may contain low levels of residual acrylamide.¹ Acrylamide is also present in tobacco smoke. The toxic effects of acrylamide on the nervous system in humans following high occupational and accidental exposures are well documented. Studies have also shown that acrylamide is genotoxic in test systems and causes reproductive and developmental problems and cancer in animals.

The problem

In 2002, Swedish studies showed for the first time that relatively high levels of acrylamide are formed during the customary frying or baking of potatoes and cereal products. This raised public health concerns, even though the health impact of acrylamide in foods was uncertain. In the wake of the Swedish studies, a special consultation was convened in Geneva by FAO and WHO in June 2002 to review available data. (http://www.who.int/foodsafety/publications/chem/acrylamide_june2002/en/ and ftp://ftp.fao.org/es/esn/jecfa/acrylamide_2002-09-16.pdf). In recognizing acrylamide as a potential hazard, the experts at this consultation recommended that additional studies be carried out in order to properly

¹ There is no evidence that trace amounts of acrylamide present in polyacrylamide contribute significantly to human exposure.

evaluate the toxicity and health impact of acrylamide exposure through foods. Subsequently, the 64th Joint FAO/WHO Expert Committee on Food Additives (JECFA) met in Rome from 9 – 17 February 2005 to evaluate the health risks of several chemical contaminants in foods, including acrylamide. A summary report of this meeting is available at <http://www.who.int/ipcs/food/jecfa/summaries/en/> and http://www.fao.org/es/ESN/jecfa/whatisnew_en.stm .

The JECFA evaluation

JECFA reviewed all available data on acrylamide, particularly the new toxicity and intake information since the 2002 consultation. This new information included a large amount of data on the extent and levels of acrylamide contamination in foods. Acrylamide is formed when certain foods, particularly plant-based foods that are rich in carbohydrates and low in protein, are cooked at high temperatures such as in frying, roasting or baking. The major foods containing acrylamide in countries for which data were available are potato chips and crisps (French fries and potato chips, respectively), coffee, pastries, sweet biscuits (cookies), breads, rolls and toasts. The Committee expressed concern about the lack of intake data from several regions. The Committee concluded that adverse effects of acrylamide relative to non-cancer endpoints, including nervous system damage and reproductive and developmental problems, are unlikely at the estimated average intakes. However, they noted that nerve structural changes, the relevance of which is unclear, cannot be excluded for some individuals with very high intakes. The Committee concluded that, on the basis of the tests in animals, cancer was the most important toxic effect of acrylamide.

Acrylamide is clearly genotoxic and carcinogenic in studies in animals. It causes increased tumour incidence at a variety of sites. The International Agency on Research on Cancer has classified acrylamide as "probably carcinogenic to humans (IARC Group 2A)". The pathways for metabolism of acrylamide are similar in rats and humans, as indicated by the formation of acrylamide adducts with haemoglobin in both rodents and humans. At this time, there is no information to indicate any significant differences between rodents and humans in sensitivity to cancer formation from acrylamide.

Epidemiological studies of human industrial and accidental exposures suggest that the nervous system is the principal site of toxicity in humans as a result of such exposures. In these studies, acrylamide was not associated with overall cancer mortality, nor with any statistically-significant dose-related increase in cancer risk at any organ site, except a doubling of risk for pancreatic cancer for workers with the highest cumulative exposures. These studies, however, were based on low numbers of investigated human cases. Furthermore, measurements of dietary exposure to acrylamide were not made, and potential confounders such as tobacco smoking were not considered. The low number of humans included in the studies results in insufficient sensitivity to detect the relatively low-level differences in cancer rates that would be expected between case and control groups. Finally, most of the occupational and accidental exposures were through inhalation and dermal contact, and there are no data to indicate that exposures by these routes would be comparable to dietary exposures. The only information available that considers dietary intake of acrylamide comes from case-control studies originally designed to assess the potential cancer risk of dietary factors other than acrylamide. JECFA determined that available human studies were not suitable for use in the risk assessment of acrylamide in food.

To estimate the risk posed to humans, JECFA used a risk assessment approach known as the Margin of Exposure (MOE). The value of the MOE indicates the level of concern to assist risk managers in setting priorities for implementing measures to protect public health. The MOE is calculated by dividing the toxicity estimate from animal experiments by the estimated intake from food. Consequently, the lower the MOE the greater is the public health concern. The Committee selected the most sensitive carcinogenicity estimate of 0.30 mg/kg body weight per day from the animal studies. For the intake estimates, intake values of 0.001 and 0.004 mg acrylamide/kg body weight per day were selected to represent intakes by the general population and high consumers, respectively. The MOEs were thus calculated to be 300 for the general population and 75 for high consumers (large amounts of foods that contain acrylamide). JECFA considered these margins to be low for a substance that causes cancer in animals. (For

comparisons, see the information below on polycyclic aromatic hydrocarbons and ethyl carbamate, which were also evaluated by JECFA.) Consequently, JECFA concluded that these Margins of Exposure for acrylamide in food may indicate human health concern. The Committee also noted that there is still considerable uncertainty in determining the precise risk level for human health. These uncertainties result to a large degree from insufficient knowledge of the mechanisms of action, the broad assumptions used to compare the most relevant animal data to the human situation, and the geographically limited data used for intake assessments. Several additional studies of carcinogenicity and long-term neurotoxicity of acrylamide, which may help in reducing the uncertainty in the risk estimates, are currently underway and should be completed within the next 2-3 years. The Committee recommended that acrylamide be re-evaluated when results from these studies become available.

The amount of acrylamide can vary dramatically in the same foods depending on several factors, including cooking temperature and time. Because of this, JECFA experts concluded that it was not possible to issue recommendations on how much of any specific food containing the substance is safe to eat. The formation of acrylamide takes place as part of a very complex group of reactions in the cooking process. These reactions also produce characteristic flavour, colour and aroma components and textures that are associated with certain foods.

JECFA noted that scientists in the food industry and other institutions have on-going studies of methods to reduce acrylamide levels in various foods. Some of these measures have been implemented on a commercial scale. However, the details of most of these studies have not been published and were not made available to JECFA. The experts cautioned that major changes in food processing to reduce the levels of acrylamide would need to be assessed for safety, including microbiological and chemical hazards that may result.

At the same meeting, JECFA evaluated several other contaminants and applied the same approach to derive MOEs. The results for polycyclic aromatic hydrocarbons (PAHs) and ethyl carbamate, both of which also have been shown to cause cancer in animal studies, are given here for the purpose of comparing their estimated risks to those of acrylamide.

PAHs are a large class of organic compounds that are formed during incomplete combustion or pyrolysis of organic matter. The most studied of the group is benzo(a)pyrene. PAHs can occur in foods as a result of environmental contamination, drying and smoking processes, and cooking, especially grilling, roasting, and frying. Many of the PAHs were genotoxic and carcinogenic in animal studies. JECFA calculated MOEs of 25,000 and 10,000 for the average and high intakes for PAHs, respectively. (Compare with analogous MOEs of 300 and 75 for acrylamide.) The Committee concluded that the estimated intakes of PAHs from foods were of low concern for human health. However, they recommend that measures to reduce intake of PAHs should continue, including avoiding contact of foods with flames and cooking with the heat source above or on the side rather than below the food. Efforts should be made to reduce contamination during drying and smoking processes.

Ethyl carbamate is inadvertently formed in fermented foods and beverages such as bread, yoghurt, soy sauce, spirits, wine, and beer. It has been shown to be a carcinogen in a number of animal studies. JECFA estimated MOEs of 20,000 and 3,800 for the average and high (which includes alcoholic beverages) intakes, respectively. The Committee concluded that exposure to ethyl carbamate in food would be of low concern, but that mitigation measures to reduce concentrations in some types of alcoholic beverages should be continued.

General conclusions

Cancer is a very complex group of diseases, the causes of the majority of which are largely unknown. It is estimated that diet accounts for a significant number of all cancers worldwide. These causes include not only certain contaminants and intrinsic food components, but also certain dietary habits. The relative levels of acrylamide in the diet are higher than many other known carcinogens. Without evidence to the

contrary, the presence at relatively high levels of a substance such as acrylamide that is genotoxic and carcinogenic in animal tests is of human health concern. While efforts to reduce the levels of acrylamide in foods are important, the total elimination of acrylamide and other carcinogens from the diet is impossible. Therefore, the important role of fruits and vegetables in the prevention of cancer should be emphasized (see article in Bulletin of the World Health Organization, February 2005, 83(2) at <http://www.who.int/bulletin/volumes/83/2/en/100.pdf>)

International normative action

Acrylamide is an inadvertent contaminant, produced by cooking food, generally above 120°C. It is found in foods produced in commercial processing plants, in food service establishments, and in the home. This ubiquity makes it highly unlikely that it can be completely eliminated from foods. Given the results of the recent JECFA risk assessment, the most appropriate international normative actions may be codes of practice with the aim of lowering the concentration of acrylamide in foods.

The outcomes of the 64th JECFA will be considered by the 37th Session of the Codex Committee on Food Additives and Contaminants (The Hague, The Netherlands, 25-29 April 2005). The provisional agenda of the meeting (<http://www.codexalimentarius.net/web/current.jsp?lang=en>) includes discussion papers on acrylamide and polycyclic aromatic hydrocarbons in food.

Reduction of the risk

- 1) National food safety authorities should urge relevant food industries to work towards improving food preparation technologies that lower significantly the acrylamide content in critical foods, particularly potato chips and crisps (french fries and potato chips, respectively), coffee, pastries, sweet biscuits (cookies), breads, rolls and toasts. Preliminary investigations by industry and other researchers seem to suggest that significant reductions are feasible in several foods. The knowledge gained should help in developing guidance for home-prepared foods.
- 2) In moving towards lowering the acrylamide concentrations in critical food groups, national food safety authorities should encourage industry and other researchers to communicate the data obtained and the techniques/technologies developed in an open and transparent manner enabling use by other producers and consumers. Such communication of developments is key to national and international efforts to lower acrylamide levels in human diets. National food safety authorities and international food safety organizations should strongly encourage the international exchange of information on technologies and methods for reducing acrylamide in food. Such information can be rapidly disseminated through the WHO/FAO Acrylamide Infonet (<http://www.acrylamide-food.org/>), which serves as a global resource and inventory of ongoing research on acrylamide in food. It includes summaries of formal research, results of surveillance/monitoring, reports on investigations to reduce levels and other related information.
- 3) National authorities should develop guidance directed at lowering acrylamide content in home-cooked foods and reducing intake of foods high in acrylamide as part of nutritional guidance for an overall healthy diet. These messages should be communicated in a simple manner and preferably be combined with suggestions on how to lower or prevent other unwanted (potentially carcinogenic) substances formed during home-cooking, such as polycyclic aromatic hydrocarbons. Such messages will need to be adapted to local diets and preparation techniques.
- 4) In developing further methodologies, authorities and industries should ensure that methods used to reduce acrylamide in food do not increase or introduce microbiological and chemical hazards. In particular, changes in time-temperature provisions have to be closely monitored to evaluate kill-effect related to pathogenic and other microorganisms. Nutritional quality and consumer acceptability also should be taken into account.

- 5) The latest information available on acrylamide reinforces general advice on healthy eating. National authorities should continue to encourage consumers to eat balanced and varied diets, which include plenty of fruit and vegetables, and to moderate their consumption of fried and fatty foods.

INFOSAN serves as a vehicle for food safety authorities and other relevant agencies to exchange food safety information and to improve collaboration among food safety authorities at both the national and international level.

INFOSAN Emergency, embedded in INFOSAN, links official national contact points to address outbreaks and emergencies of international importance and allows for the rapid exchange of information. INFOSAN Emergency is intended to complement and support the existing WHO Global Outbreak Alert and Response Network (GOARN).

INFOSAN is operated/managed by WHO, Geneva. It currently includes 135 Member States.

More information is available at: www.who.int/foodsafety