MINISTRY OF FOOD AND DRUG SAFETY
National Institute
of Food and Drug Safety Evalution

Risk Assessment of Acrylamide

The formation of acrylamide in food takes place naturally when carbohydrate-rich, low-protein vegetable foods are cooked at high temperatures. Concentrations of acrylamide in food vary with the type of food, cooking method, water content, viscosity, and length of heating time. Acrylamide is listed as “probably carcinogenic to humans” (Group 2A) by the IARC. Human exposure to acrylamide primarily comes from ingestion, dermal contact, and inhalation; dietary intake is known to account for the highest percentage of exposure. Results of experiments performed on rats show that acrylamide is rapidly metabolized and excreted in urine. When orally administered, acrylamide is quickly absorbed in the digestive tract, and 40% of the administered dose is excreted in urine within 24 h after administration.

Residual hazardous substances that are formed during food manufacturing, processing, or cooking, and remain in the foods, may pose a threat to food safety, even in small amounts, as they tend to be ingested for a lifetime. This has heightened anxiety over food safety among the Korean people. Under the existing monitoring system for hazardous substances, the content of a hazardous substance in uncooked food is measured to estimate its exposure dose based on the monitoring results. This approach fails to capture the true content of a harmful substance accurately because of changes that occur during the cooking process, where concentrations can be increased or decreased due to both physical and chemical interactions. For this reason, this risk assessment determined daily exposure doses more accurately based on a TDS, which estimates daily intakes through an analysis of table-ready foods, or an analysis of the content of hazardous substances. A quantitative assessment of potential health risks was also performed.

This risk assessment was carried out in accordance with the Regulations on Risk Assessment

Methods and Procedures, as well as the Risk Assessment Guide, in the following four stages: hazard identification, hazard characterization, exposure assessment, and risk characterization. Target foods were selected from the 2008–2013 (six years) Integrated Database, and this study covered 97.4% of the total food intake of Koreans and 98% or more of their energy, protein, fat, and carbohydrate intakes. A final set of 1,224 sample pairs was selected (290 pairs from agricultural products, 96 from livestock products, 233 from fishery products, and 605 from processed foods) after adding food commodities that were intended to be eaten uncooked (raw) to the "food and cooking method pairs." The analysis of acrylamide present in food was performed using LC-MS, and samples of the food commodities purchased across the country were combined to create composite samples. One sample was analyzed for each cooking method per food, and the pairs from which acrylamide was not detected were considered to have a zero content.

The daily exposure dose of Koreans to dietary acrylamide is 0.086 μg/kg bw/day, and is higher among infants, children, and teenagers under 18 years than in adults over 18 years of age. Considering the major contributors to acrylamide exposure, this result is attributable to the fact that confectionary intake is higher among those under 18 years of age. Food groups contributing to acrylamide exposure were found to be in the following order: cereals (22.1%), flavor enhancers (19.8%), potatoes (19.2%), and meats (17.8%). Among food commodities, the acrylamide contribution from pepper powder is the highest at 18.2%, followed by confectionery (biscuits and cookies) at 10.6%, potatoes at 10.5%, imported beef at 8.3%, and instant coffee (powder) at 8.1%. The top five "food and cooking method pairs" samples with the highest content of acrylamide were all from pepper powder, cooked with five different methods. Instant coffee (as is), French fries, and potato chips were included in the top 10 list. Among all the pepper powder samples prepared using different cooking methods, the grilled sample showed the highest content of acrylamide, followed by deep-fried, stir-fried, boiled, and pan-fried samples.

MINISTRY OF FOOD AND DRUG SAFETY
National Institute
of Food and Drug Safety Evalution

Results of the TDS-based risk assessment showed that dietary exposure to acrylamide in Korea is at safe levels compared to that in other countries. However, as eating habits change, or as the environment changes, exposure levels may exceed the margins of safety. Therefore, it is considered necessary to continue monitoring exposure trends and reducing exposure levels by finding new methods for reducing acrylamide formation during manufacturing, cooking, and processing, and by focusing on foods whose exposure levels are on an increase.

Acrylamide increases rapidly at 160 °C or higher temperatures. Therefore, as a method of reducing the acrylamide formation during cooking, it is recommended to cook at lower temperatures (160 °C or lower for frying and 200 °C or lower for oven cooking). You can further reduce the formation of acrylamide by choosing steaming or boiling over grilling as your cooking method. Adding or sprinkling pepper to season a food before stir-frying or deep-frying increases the acrylamide content in the food; therefore, it is advisable to add pepper to taste after cooking is complete. When raw potatoes are stored under refrigeration, the levels of reducing sugar in the potatoes increase, which then increases the formation of acrylamide during the cooking process. Therefore, potatoes should not be kept in the refrigerator. Also, acrylamide formation can be reduced if potatoes are soaked in water at 60 °C for 45 min, and using less sugar during the cooking process will help reduce the formation of acrylamide.

Key words: Acrylamide, Foods, Risk Assessment, Total Diet Study, ALARA, Reduction