MINISTRY OF FOOD AND DRUG SAFETY
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Risk Assessment of 3-MCPD and 1,3-DCP

3-Monochloropropane-1,2-diol (3-MCPD) and 1,3-dichloro-2-propanol (1,3-DCP) are chemical compounds that belong to the group of chloropropanols, which are created during food manufacturing processes. For instance, these compounds are created by the acid hydrolysis of proteins during the production of soy sauce. The most common chloropropanols, formed from acid-hydrolyzed vegetable proteins, are 3-MCPD, followed by 2-MCPD, 1,3-DCP, and 2,3-DCP. The compounds 3-MCPD and 1,3-DCP are produced when grains and malts are roasted, and then they are detected in processed foods such as soy sauce, sauces, soups, doughnuts, burger patties, roasted grains, and beer. These compounds are not formed in foods that undergo natural fermentation processes. The International Agency for Research on Cancer (IARC) has classified 3-MCPD and 1,3-DCP as "possibly carcinogenic to humans" (Group 2B). When intraperitoneally administered in rats, these compounds were distributed throughout the blood and testicles within 45 min, but there have been no definite reports on their accumulation in the body. In the 24 h after the intraperitoneal administration of 3-MCPD in rats, 30% passed out of the lungs as CO_2. When administered orally in rats, about 5% of 1,3-DCP was excreted in urine in the form of beta-chlorolactate.

Residual hazardous substances that are formed during food manufacturing, processing, or cooking, and remain in the foods afterward, 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 total diet study (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 1,227 sample pairs was selected (291 pairs from agricultural products, 96 from livestock products, 233 from fishery products, and 607 from processed foods) after adding food commodities that were intended to be eaten uncooked (raw) with the “food and cooking method pairs.” The analysis of 3-MCPD and 1,3-DCP present in food was performed using gas chromatography-mass spectrometry (GC-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 3-MCPD or 1,3-DCP was not detected were considered to have a “zero” content.

Results of the TDS-based risk assessment showed that dietary exposure to 3-MCPD and 1,3-DCP is kept at safe levels within the health-based guidance values (HBGVs). Average daily exposures of Koreans to 3-MCPD and 1,3-DCP are 312.168 ng/kg bw/day and 5.700 ng/kg bw/day, respectively, which are similar to those from Hong Kong, Austria, and Brazil. Major food commodities contributing to dietary exposure were chicken (31.0%), pork (13.0%), processed pork (ham) (11.0%), imported beef (11.0%), and Korean beef (9.8%) for 3-MCPD. The key contributors for 1,3-DCP were red pepper powder (13.0%), squid (10.8%), mackerel (8.7%), Alaskan pollack/frozen pollack (8.4%), and eomuk or fish cake (8.0%). The “food and cooking method pairs" with high 3-MCPD content were found to be dried green laver (stir-fried), Korean beef sirloin (marinated–grilled), red ginseng extract (with hot water added), and sliced hams (boiled), in that order. On the other hand, 1,3-DCP content was found to be high in red pepper powder (as is) and flounder (as is), dried sea cucumber (boiled after maceration), half-dried skipjack tuna (scooped out after boiling), and dried Alaskan pollack (as is/boiled). The latter substance was detected mostly in fish and shellfish, as all of its top 10 contributors, except for the red pepper powder, belong to the category of fish and shellfish.

As eating habits change, or as the environment changes, exposure levels may exceed the margin of safety. Therefore, it is necessary to continue monitoring exposure trends and to reduce exposure levels by finding new ways to reduce the formation of these substances during manufacturing, cooking, and processing by focusing on foods whose exposure levels are on the rise. Methods for reducing dietary exposure to 3-MCPD and 1,3-DCP include adjusting production processing conditions (e.g., the acid density used for acid-hydrolyzed soy sauce), neutralization conditions, and reaction times. At home, you are advised to cook at lower temperatures and to cut down on edible oils and fats.

Key words: 3-MCPD, 1,3-DCP, Foods, Risk Assessment, Total Diet Study, Reduction