

2016 SCIENTIFIC REPORT



MINISTRY OF FOOD AND DRUG SAFETY

National Institute
of Food and Drug Safety Evaluation

Risk Assessment of Trihalomethanes (THMs)

Trihalomethanes (THMs) are the primary by products of chlorination formed during the treatment of drinking water. THMs are detected in chlorinated drinking water when chlorine reacts with natural organic matter in the presence of bromide ions. Human exposure usually takes place via consumption of water. The formation of THMs may increase as a function of the chlorine and humic acid concentrations, temperature, pH, and bromide ion concentration. Among the THMs, chloroform and bromodichloromethane (BDCM) are classified by the IARC as “possibly carcinogenic to humans” (Group 2B), while dibromochloromethane (DBCM) and bromoform are listed as “not classifiable as to its carcinogenicity to humans” (Group 3).

Residual hazardous substances in food 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 TDS, which estimates daily intakes through an analysis of table-ready foods, or an analysis of 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

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Methods and Procedures, as well as the Risk Assessment Guidelines, 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 the 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 1,222 sample pairs was selected (289 pairs from agricultural produce, 96 from livestock, 233 from fishery, and 604 from processed foods) after adding food commodities intended to be eaten uncooked (raw) with the “food and cooking method pairs.” The analysis of THMs present in food was performed using 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 THM was not detected were considered to have a zero content.

As a result of the TDS-based risk assessment, dietary exposure to THMs is within 2% of its HBGV, showing that risks posed by THMs are under control at safe levels. The exposure dose of chloroform was 0.0446 $\mu\text{g}/\text{kg}$ bw/day, with the following food commodities contributing the most to its exposure: turnips (8.8%), milk (6.2%), cucumbers (5.9%), tofu (4.5%), ramyeon or instant noodles (4.2%), and napa cabbage kimchi (3.7%). On the other hand, BDCM exposure was estimated at 0.0051 $\mu\text{g}/\text{kg}$ bw/day, with its primary contributors being ramyeon (25.6%), tofu (15.6%), and milk (7.8%). DBCM exposure was measured at 0.0011 $\mu\text{g}/\text{kg}$ bw/day, with its contributors being tofu (17.8%), dried noodles (15.5%), bean sprouts (8.9%), and drinkable yogurt (6.5%). Bromoform exposure was measured at 0.0004 $\mu\text{g}/\text{kg}$ bw/day, with its contributors being green laver (18.9%), yeolmu-kimchi (young summer radish kimchi; 17.1%), watery yeolmu-kimchi (7.2%), and raw seaweed (6.4%). A look at the food and cooking method pairs with high THM content indicates that chloroform content is high in a range of food types: flying fish roe (as is), instant coffee (with boiled water added), green tea powder (with boiled water added), dried tree-ear (stir-fried after

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maceration), salt (boiled), dried date (boiled), red pepper powder (boiled), ramyeon in a styrofoam container (boiled water added), and olive oil (boiled after stir-frying). Note that the cooking method used for most of these food items was either boiling or adding boiling water. Like chloroform, BDCM was also found to be highest in flying fish roe (as is), followed by dried seaweed, udon (noodle-type ramyeon), olive oil, soybean oil, red pepper powder, regular types of ramyeon, butter, and bibimmyeon (spicy noodles). That means BDCM was detected the most in boiled noodles and in oils and fats boiled after stir-frying. DBCM was also the highest in flying fish roe (as is), whereas bromoform content was the highest in order of the following items: dried seaweed (as is), flying fish roe (as is), dried kelp (as is), green laver (as is), Hizikia fusiforme (as is), dried kelp (air-fried), and dried green laver (as is). The top 10 food commodities were from the algae and fish/shellfish groups, with the cooking method for most of the algae being “as is.”

THMs were formerly used as flame retardants, or as intermediates in chemical manufacturing. Today, they are used as laboratory reagents or extractants. For this reason, respiratory exposure to THMs among industrial workers and laboratory technicians is considered to be higher than that from dietary exposure.

Key words: Chloroform, Bromodichloromethane, Dibromochloromethane, Bromoform, Risk Assessment, Total Diet Study