

# 2016 SCIENTIFIC REPORT



MINISTRY OF FOOD AND DRUG SAFETY

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## Risk Assessment of Aldehydes

Acetaldehyde is a metabolite of ethanol, the active ingredient in alcoholic beverages, and 90% of the alcohol absorbed is metabolized to acetaldehyde. This compound is found in ripe fruits and is widely present in nature. Acetaldehyde can also be formed by yeasts and acetic acid bacteria (AAB) during alcohol fermentation or through the natural oxidation of ethanol and phenolic elements. Formaldehyde is formed in the flesh of marine fish and crustaceans from the enzymatic reduction of trimethylamine oxide, catalyzed by the enzyme trimethylamine oxide aldolase, or from the oxidation of methyl alcohol. It is also present in fruit, vegetables, meat, and fish as lipids and amino acids break down in various ways during processing or storage.

Acetaldehyde is quickly absorbed in the lungs and gastrointestinal tract, and most of it is completely metabolized in the liver. The concurrent administration of acetaldehyde, L-cysteine, and nitrite produces N-nitroso-2-methylthiazolidine 4-carboxylic acid, a carcinogen of which more than 90% is excreted in urine. Formaldehyde is quickly absorbed in the gastrointestinal tract, and then in the gaseous state, it is rapidly absorbed through the respiratory system and converted immediately to formate. Hence, formaldehyde in its natural state has been rarely measured in the blood of a human being or animal, but the half-life of formaldehyde in the human body is reported to be 3.3 h. The IARC has listed acetaldehyde as “possibly carcinogenic to humans” (Group 2B) and formaldehyde as “carcinogenic to humans” (Group 1).

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

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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 states: 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 acetaldehyde present in food was performed using GC-MS, and samples of the food items 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 an acetaldehyde was not detected were considered to have a zero content.

As a result of the TDS-based risk assessment, dietary exposure to formaldehyde was determined to be at safe levels for all age groups and in both the average and extreme exposure groups. Risk levels were determined as low when measured against the HBGV; risk against the tolerable daily intake (TDI) was also low. Since there is no HBGV set for

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acetaldehyde, the HBGV for formaldehyde was used to estimate acetaldehyde risk. The daily dietary doses of exposure to acetaldehyde and formaldehyde are 93  $\mu\text{g}/\text{kg}$  bw/day and 11  $\mu\text{g}/\text{kg}$  bw/day, respectively. The top contributors to acetaldehyde exposure were determined as follows: napa cabbage kimchi at 15.0%, makgeoli (rice wine) at 11.7%, beer at 7.1%, water melon at 6.8%, and garlic at 5.9%. On the other hand, foods contributing the most to formaldehyde exposure were white rice (11.4%), napa cabbage kimchi (4.4%), and ramyeon or instant noodles (4.3%). Formaldehyde was detected in various food commodities. Consequently, the intake of formaldehyde from the top 10 contributors to dietary exposure accounted for about 35% of the total intake of acetaldehyde. The food and cooking method pairs with the highest acetaldehyde content were dried shiitake (macerated), garlic (boiled), cheonggukjang or rich soybean paste (as is), and yeast (pan-fried), while formaldehyde content was found to be the highest in dried Alaskan pollack (as is), followed by dried shiitake (boiled after maceration), dried Alaskan pollack (broiled), myeongran jeot or salted pollack roe (as is), yeast (as is), and dried Alaskan pollack (boiled), in that order.

Acetaldehyde is used as a fumigant and a preventative for wheat mildew and oat rot, and is added as a bleach for its bleaching effect. In China, it was once used to remove dregs in the beer-making process.

It is necessary to continue monitoring the exposure trends and reducing exposure levels by finding methods for reducing aldehydes formation during manufacturing, cooking, and processing, and by focusing on foods whose exposure levels show an upward trend.

**Key words:** Acetaldehyde, Formaldehyde, Foods, Risk Assessment, Total Diet Study