



## **Risk Assessment of Ethyl Carbamate (EC)**

Ethyl Carbamate (EC) has been used for commercial purposes in the production of amino resins or as a solvent for pesticides, fumigants, and cosmetics in the form of ethyl ester of carbamic acid. Ethyl carbamate forms naturally in foods due to chemical reactions during processing and storage, and is present in alcoholic beverages and fermented foods. Examples of alcoholic drinks containing the substance include wine, cheongju (refined rice wine), and whiskey, while fermented foods such as miso (Japanese bean paste), natto (Japanese food made from fermented soybeans), yogurt, cheese, kimchi, and soy sauce are also reported to contain EC. The IARC has classified ethyl carbamate as “probably carcinogenic to humans” (Group 2A). It is absorbed rapidly, and almost completely, from the gastrointestinal tract and the skin, and more than 90% is eliminated as CO<sub>2</sub>, with 2% to 8% excreted in urine.

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 the content of hazardous substances. A quantitative assessment of potential health risks was also performed.

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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 1,222 sample pairs was selected (290 pairs from agricultural products, 96 from livestock products, 233 from fishery products, and 603 from processed foods) after adding food commodities intended to be eaten uncooked (raw) with the “food and cooking method pairs.” The analysis of ethyl carbamate 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 EC was not detected were considered to have a zero content.

Based on the results of the TDS-based risk assessment for dietary exposure to ethyl carbamate, risks posed by the ingestion of food were at safe levels in both the average exposure group and the extreme exposure group. The average daily exposure level of Koreans to ethyl carbamate was 0.0021  $\mu\text{g}/\text{kg}$  bw/day, while the average for the extreme exposure group (P95) was 0.0058  $\mu\text{g}/\text{kg}$  bw/day. Major contributors to ethyl carbamate exposure are soy sauce (61.7%), maesil ju or green plum liquor (30.9%), and whiskey (5.5%). Ethyl carbamate is usually detected in fruit wines and soy sauces. The food and cooking method pairs with the highest EC content were listed in the following order: maesilju (boiled/as is), brewed soy sauce (boiled/as is/stir-fried), whiskey (as is), bokbunjaju (black raspberry wine; as is/stir-fried), and traditional Korean soy sauce (as is/stir-fried).

In Europe, EC exposure levels were about four times higher for drinkers than non-drinkers. Considering the Korean diet, with relatively high intakes of fermented foods such as kimchis, fermented pastes, fermented seafoods, and alcoholic drinks, the possibility of human health

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risk due to diet-derived EC cannot be ruled out. Therefore, it is necessary to identify the potential exposure trends through continuous monitoring.

**Key words:** Ethyl Carbamate, Foods, Risk Assessment, Total Diet Study, Reduction