Letter to Editor

Journal of Food Safety and Hygiene

Journal homepage: http://jfsh.tums.ac.ir

Exposure to acetaldehyde through food; a carcinogenic agent

Parisa Sadighara[1,2], Afsaneh Mohajer[1], Ebrahim Molaee-Aghaee[1,2], Mohammad Reza Zirak[3]*

[1]*Division of Food Safety & Hygiene, Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.*

[2]*Iranian Scientific Association of Food Safety & Hygiene, Tehran, Iran.*

[3] *Department of Pharmacodynamics and Toxicology, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad, Iran.*

Citation: Sadighara P, Mohajer A, Molaee-Aghaee E, Zirak MR. **Exposure to acetaldehyde through food; a carcinogenic agent.** J food safe & hyg 2020; 6(2):109-111.

Acetaldehyde is a colorless liquid aldehyde that is volatile at room temperature. Acetaldehyde is found in alcoholic and non-alcoholic beverages, and foods such as bread, coffee and ripe fruits (1). Fermentation of food by yeasts, oxidation of ethanol and phenolic compounds has been proposed as the mechanism of acetaldehyde formation in foods. Furthermore, polyethylene terephthalate (PET) that is used for food packages and beverage bottles can release acetaldehyde into foods (1).

The sources of acetaldehyde in food

Significant amounts of acetaldehyde are found in fermented products. Some yeasts can produce acetaldehyde from ethanol. It has been studied that eighty-six strains of *Saccharomyces cerevisiae* have the ability to produce acetaldehyde (2). Some bacteria can also produce acetaldehyde. The formation of acetaldehyde by *Lactobacillus delbrueckii* and *Streptococcus thermophilus* during fermentation milk has been approved (3). The production of acetaldehyde in yogurt fermented products has been confirmed by *Streptococcus thermophiles*. A significant level of acetaldehyde has been identified in fermented milk called Mursik, which is commonly consumed in Kenya (4). These bacteria and yeast have alcohol dehydrogenase (ADH) enzyme. This enzyme can produce acetaldehyde by ethanol oxidation. Therefore, microbial acetaldehyde is one of the sources.

Another exposure to acetaldehyde is the consumption of alcoholic beverages that convert ethanol to acetaldehyde. Acetaldehyde is naturally present in alcoholic beverages (5). Furthermore, gut microflora can change ethanol to acetaldehyde. This reaction also occurs in the oral cavity when consuming alcohol (6).

Acetaldehyde is present naturally and in small amounts in some plants, fruits and vegetables. But it is also added as a flavoring agent to some beverages. It tastes good in small amounts. Acetaldehyde is used as an aroma and as a preservative agent in food additives categories (7).

Acetaldehyde is present in PET and food packaging (8). Its migration to food has been observed which is higher in acidic foods (8). Exposure to acetaldehyde in mineral waters from packaging is high, so its amount should be measured regularly (9). Acetaldehyde is stable in carbonated water (9). The amount of specific migration limit is announced 6 mg/L. Fruit juices have also been reported in small quantities, probably due to their migration from the packaging. Acetaldehyde is also present in vinegar, pickled vegetables, kimchi, meads and tofu (7). Several robust methods such as gas chromatography (GC)/flame ionization detection (FID) and high-performance liquid chromatography (HPLC)/Fourier transform (FT) have been developed for detection and quantification of acetaldehyde in foods (10).
It has been estimated that the daily intake of acetaldehyde through foods is 0.53–1.07 mg/kg BW/day (11).

Toxicity of acetaldehyde

The carcinogenic effects of acetaldehyde have been confirmed in both in vitro and in vivo. The side effects of acetaldehyde have been proven in low doses. Its mutagenicity has been observed in concentrations of 40 to 100 μM (6). It is a strong reactive agent that reacts with macromolecules like proteins, lipids, and DNA. It is able to cause point mutations and form covalent bonds with DNA (12). In vitro studies performed on human cells, showed an increase in GG to TT mutations (12). Furthermore, acetaldehyde is produced following the lipid peroxidation of saturated fatty acids.

Acetaldehyde can cause cancer in digestive system organs including the liver, oral cavity, esophagus, stomach, gastrointestinal tract; pancreas, prostate, and female breast (13). Acetaldehyde accumulates as a carcinogenic agent in the upper gastrointestinal tract following multiple exposures (13). One of the estimated causes of esophageal cancer is the presence of acetaldehyde in alcoholic drinks. The alcoholic drinks may contain up to 4000 μmol/L of acetaldehyde (7).
Collectively, the exposure of acetaldehyde through food should be reduced, due to the toxic effects. It is used as a food additive should be reconsidered. Owners and people involved in the food industry should be informed in this regard. Due to the high consumption of bottled mineral water, the rate of exposure to acetaldehyde in this way is also high. Therefore, the amount of acetaldehyde in these products should be measured regularly. Regular measurement of acetaldehyde in food products, especially beverages and mineral water, and setting permisable limit in food by national and international health authorities are essential to control this dangerous substance in food.

Acknowledgments

This work was supported by the Tehran University of Medical Sciences.

Conflict of interest

The authors report no declarations of interest.

References

1. Paiano V, Bianchi G, Davoli E, et al. Risk assessment for the Italian population of acetaldehyde in alcoholic and non-alcoholic beverages. Food Chem 2014;154:26-31.

2. Romano P, Suzzi G, Turbanti L, et al. Acetaldehyde production in *Saccharomyces cerevisiae* wine yeasts. FEMS Microbiol Lett 1994;118: 213-8.

3. Ott A, Germond JE, Chaintreau A. Origin of acetaldehyde during milk fermentation using (13) C-labeled precursors. J Agric Food Chem 2000; 48: 1512-7.

4. Nieminen MT, Novak-Frazer L, Collins R, et al. Alcohol and acetaldehyde in African fermented milk mursik-a possible etiologic factor for high incidence of esophageal cancer in western Kenya. Cancer Epidemiol Biomark Prev 2013; 22: 69-75.

5. Lachenmeier DW, Kanteres F, Rehm J. Carcinogenicity of acetaldehyde in alcoholic beverages: risk assessment outside ethanol metabolism. Addiction 2009; 104: 533- 50.

6. Uittamo J, Nieminen MT, Kaihovaara P, et al. Xylitol inhibits carcinogenic acetaldehyde production by Candida species. Int J Cancer 2011; 129: 2038-41.

7. Salaspuro M. Acetaldehyde and gastric cancer. J Dig Dis 2011; 12: 51-9.

8. Lee D, Jeon H, Kim S. Theoretical migration estimation of acetaldehyde and butyraldehyde from polyethylene terephthalate (PET) into fermented food simulants. Korean J Environ Health Sci 2016; 42: 160-8.

9. Schmid P, Welle F. Chemical migration from beverage packaging materials—a review. Beverages 2020; 6: 37.

10. Zachut M, Shapiro F, Silanikove N. Detecting ethanol and acetaldehyde by simple and ultrasensitive fluorimetric methods in compound foods. Food Chem 2016; 201: 270-4.

11. Eriksson CJ. Measurement of acetaldehyde: what levels occur naturally and in response to alcohol? Novartis Found Symp 2007; 285: 247-55.

12. Sonohara Y, Yamamoto J, Tohashi K, et al. Acetaldehyde forms covalent GG intrastrand crosslinks in DNA. Sci Rep. 2019; 9: 660. https://doi.org/10.1038/s41598-018-37239-6

13. Song BJ, Abdelmegeed MA, Cho YE, et al. Contributing roles of CYP2E1 and other cytochrome P450 isoforms in alcohol-related tissue injury and carcinogenesis. Adv Exp Med Biol 2019; 1164: 73-87.