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Editorial

Importance of Neo-formed Contaminants (NFCs) in Chemical Food Safety

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Editorial

Food safety is the number one priority of the food and drink industry worldwide. It is always the target for modern food industry to meet the highest food safety standards based on sound science. While there are many scenarios that might cause food contamination, most fall under one of four categories; biological, chemical, physical and cross-contamination. Specifically, chemical contamination occurs when food comes into contact with chemicals and can lead to chemical food toxicant. Chemicals can produce both acute and chronic diseases depending on the level of contaminants in the food.

When the level of contaminant is high, the result may be an acute disease with dramatic consequences, but when the level of contaminants is low; they may accumulate in a live organism and produce a long term disease. Usually, chemical contaminants are found in the environment, both naturally and produced by human activity. In the past several decades, chemical hazards in food have been high on the lists of consumer concerns, especially due to their long-term carcinogenic potential. In recent decades, chemical food safety issues that have been the center of media attention include the presence of agrochemicals (pesticides, fungicides, veterinary drug residues), natural toxins (mycotoxins and marine toxins), allergens, processing-produced toxins (e.g., acrylamide, heterocyclic aromatic amines, furan, trans fats), heavy metals (lead, arsenic, mercury, cadmium), industrial chemicals (benzene, perchlorate), packaging-derived chemicals (bisphenol A, semicarbazide), unconventional contaminants/adulterants (melamine, chemical threat agents), and genetically modified crops in food and feed. Finally, food additives and contaminants resulting from manufacturing and processing can also adversely affect health.

Chemical food safety deals with all aspects of chemical risks in the food chain; the contamination of food by chemical hazards is a worldwide public health concern and is a leading cause of trade problems internationally. Processed foods are a way of life in the modern world. Interestingly, thermal processing may induce the formation of harmful compounds such as various mutagens, carcinogenic heterocyclic aromatic amines (HAAs), polycyclic aromatic hydrocarbons (PAHs), furan, acrylamide (AA), and N-nitrosamines. Carcinogens from heated foods have been a health concern since the 1970s, when it was discovered that HAAs were formed in overheated meats, PAHs were produced in barbequed meats, and N-nitrosamines were created in fried bacon. Cooking or heat processing causes free amino acids and sugars to react via the Maillard reaction to form a wide variety of chemical compounds. The Maillard reaction products are important for the sensory properties of foods such as flavor, color, and texture, but some are toxic. Examples of toxic Maillard reaction-derived products include the HAAs and AA. Furan, a toxic volatile cyclic ether found in a number of foods that receive heat treatment.

Heating of foods is primarily necessary for improving the digestibility and increasing the safety by eliminating pathogenic microorganisms. During heating significant chemical changes are induced that improve the sensory quality of the foods; either by changing the aroma and color or by changing the texture. In addition to the improved quality chemical changes can occur resulting in a formation of toxicologically relevant substances that could also be carcinogenic. Household and industrial heat treatments are key issues to provide important functions in food preparation such as improvement of digestibility, microbiological safety assurance and development of flavor, color and taste through the Maillard reaction (MR).

Neo-formed contaminants (NFCs) are compounds formed during heating processes that exhibit potential harmful effects to humans. Among the several NFCs described in literature, AA, furan and 5-hydroxymethylfurfural (HMF) are mainly formed through MR in starchy based potato and cereal products and can be regarded as some of the most important heat induced contaminants occurring in potato, bread and bakery products. NFCs naturally formed during thermal processing of foods are suspicious due to deleterious health effects in animals and humans. AA is known as a neurotoxin in humans and it is classified as a probable human carcinogen by the International Agency of Research on Cancer (IARC). Similarly, furan is considered as a potential carcinogen to humans by the IARC. On the other hand, HMF has been recently shown to be converted in vivo to 5-sulfoxymethylfurfural (SMF), thus becoming a genotoxic compound. Since some NFCs generated by MR could have serious deleterious effects on human health but at the same time MR is responsible of the desired flavor, taste and color of heat processed foods, an interesting challenge arises: How to mitigate NFC formation in heat processed foods without affecting negatively their attractive sensory attributes and thus, their consumer acceptance?

AA is found in starchy foods like bread, cookies and potato chips and is mainly

formed from free asparagine and reducing sugars during high-temperature cooking and processing of common foods, principally through MR. On the other hand, HMF is a furanic compound which forms as an intermediate in the MR and from direct dehydration of sugars under acidic conditions (caramelisation) during thermal treatments applied to foods. HMF is mainly formed through MR and can be regarded as the most important heat-induced contaminant occurring in bread and bakery products.

Finally, the diversity of foods found to contain furan suggests that multiple routes of formation are likely to form furan in foods. These mechanisms are based on the decomposition of ascorbic acid and related compounds, oxidation of polyunsaturated fatty acids, the MR and pyrolysis of sugars. However in low moisture starchy foods, it is postulated that the main route of dietary furan formation is MR. Although NFCs are relatively well-known due to their effects on the color and taste of foods, recent discoveries have sparked attention in relation to the potential food safety implications of industrial and domestic heat treatment into sharper focus. The observed variations in NFC levels within different food products as well as different brands for a given food result from the amount of precursors and variations in processing conditions.

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