Editorial

Contaminants in Food – Brominated Flame Retardants

Persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) have been found in food since the 1960s. Although most of these chemicals have since been phased out, residues are still being found, emphasizing the persistent character of these POPs. On top of that, chemical contaminants that remained undiscovered in food for many years have recently been identified. One such category is the group of brominated flame retardants (BFRs). About 75 commercially available BFRs are currently being used to flameproof electronic equipment such as personal computers and televisions, but also in upholstery, building materials, planes, cars, *etc*. The amounts in which they are added to the plastics or fibers are in the range of 1% to more than 10% by weight. Some BFRs are chemically bound to the materials to be flame proofed, while others are applied as additives. During production, impregnation and after use (end-of-life disposal) these chemicals "escape" to the environment and accumulate in sediments and organisms. Fish and meat, as well as human milk are now known to contain these chemicals at the level of micrograms per kilogram. The important issue is the dose-response relationship: Do the present BFR concentrations in food cause toxic effects or not and, if not, what are the margins of safety?

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Although the presence of BFRs in the environment was discovered in the early 1980s, the scientific research on these compounds really took-of after the Dioxin symposium of 1998 in Stockholm. On that occasion, Daiva Meironyté and Koidu Norèn presented a study that showed exponentially increasing levels of pentabrominated diphenylethers (PeBDEs) in Swedish human milk, while in the same session, we reported substantial levels of PeBDEs in sperm whales that were stranded on the Dutch coast. Since then, many studies on BFR exposure have followed. A striking, ten-fold difference in PBDE concentrations between North America and Europe was later found, most likely caused by the more stringent fire safety regulations in the USA.

This special issue gives an up-to-date overview of the current state of the science dealing with the occurrence and possible health effects of BFRs in food. BFR levels in American food reported by Schecter *et al*. were substantially higher than those in food from various European countries (The Netherlands, Belgium, Norway, Sweden, France and England). Fängström *et al*. report on the further development of the BFR trends in Swedish human milk, also extending the set of polybrominated diphenylethers (PBDEs) to another type of BFR: hexabromocyclododecane (HBCD). HBCD is also the subject of the study by Van Leeuwen *et al.* on BFRs in Dutch fish and shellfish. Risks of BFRs to the foetus and newborn are discussed in the contribution of Antignac *et al*., with preliminary data from France. Thomsen *et al*. describe how local pollution can have effects on BFR concentrations in lake fish and in blood of consumers in Norway.

The production of toxicological information on BFRs has been slower, partly due to the relatively long time needed for *in vivo* studies. Clearly, the toxic effects of BFRs are different from those caused by chlorinated dibenzo-*p*-dioxins and dibenzofurans and PCBs, as they elicit a much lower response at the Ah receptor or do not activate this receptor at all. Over the last years, increasing evidence has become available that many BFRs are endocrine disruptors. The paper of Hamers *et al*. in this issue addresses that topic with a special focus on BFR metabolites. That paper is based on a large European study ("FIRE") on the possible endocrine effects of BFRs.

Consumption of fatty fish is generally recommended because of the healthy effects of the omega-3 fatty acids. However, until now there has been little information on the possible protective effects of the omega-3 fatty acids in relation with contaminants. Sioen *et al*. contribute to this issue with a paper on this nutritional-toxicological conflict, in which they have analysed both BFRs and omega-3 fatty acids in fish.

Obviously, there are still many questions on this topic to be answered. Based on the current knowledge, health risks due to BFR-contaminated food items seem to be limited. However, margins of safety in the USA may be small, and a more precise assessment of those margins is urgently needed.

On the other hand, this type of compounds can be detected because over the last half century the sensitivity of our analytical methods has improved more than five (!) orders of magnitude. In the 1970s, the sensitivity of analytical methods only allowed detection limits of ca. 0.1 mg/kg. Nowadays these limits are down to the sub-ng/kg range. This does imply, however, that risks of BFRs or other POPs that are currently being found at trace levels in food should not be overestimated until effects at those low (or slightly higher) levels are demonstrated.

BFRs will not be the last group of chemicals that we will see occurring in food. The vast number of chemicals that we produce and need in our modern society for all sorts of reasons from fire safety to pharmaceuticals will continue to contribute to the spectrum of chemical residues present in our food. Knowledge on existing classes of chemicals and modern analytical and toxicological techniques will help us make an inventory of the associated risks in an early stage, long before those residues reach levels of concern. We hope that this special issue will contribute to a better understanding of the occurrence of contaminants in food.

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