FOREWORD

This virtual Special Issue is dedicated to the 12 papers published in Food Additives and Contaminants from 2005 to date covering the topic of Bisphenol A (BPA). These publications give significant scientific insight into the current safety discussions on this compound by not only describing appropriate methods for the determination of BPA in food and food products, but also investigating the migration potential of BPA from food packaging materials into food and the occurrence of BPA in food to assess the exposure.

BPA is a chemical that is used not only for the manufacture of products for technical application but also in households, such as food packaging containers made from polycarbonate, epoxy-resin can liners, and food utensils. The source for human exposure to BPA is widespread. Despite the fact that many risk assessment studies have been performed over the decade worldwide, there is still not a clear conclusion as to the toxicological effects of BPA on humans. The biggest challenge in the risk assessment of BPA concerns the systemic toxicological endpoints, namely reproductive and (neuro) developmental toxicity and carcinogenicity, especially in relation to potential endocrine disrupting properties, since BPA has been shown to have weak binding affinity to oestrogen receptors.

The European Food Safety Authority (EFSA) has an on-going programme of monitoring the outcome of toxicological investigations and has considered more than 800 published risk assessment studies for its latest opinion. As a precautionary measure, the EU decided to ban the use BPA for manufacturing of polycarbonate baby bottles since June 2011. Besides BPA, there are also concerns about its congeners such as bisphenol B (BPB), bisphenol F (BPF) and bisphenol S (BPS) that are used in many consumer articles as well. It is of utmost importance to understand the potential contamination of food e.g. by coming into contact with BPA containing food containers or utensils. Therefore appropriate, simple, rapid and if possible low-cost analytical methods are required.

Several research groups worldwide developed and refined analytical approaches prior to the
monitoring of BPA in canned food and beverages. Most methods published recently in Food Additives & Contaminants were based on GC-MS whereas two methods were based on liquid chromatography:

A paper published in 2008 by Liu et al. describes a method based on solid phase micro extraction (SPME) coupled to HPLC with fluorescence detection to determine BPA in milk samples. Optimal conditions were established to eliminate matrix effects. The method was successfully applied to milk and soybean milk samples. A 2009 paper authored by Perez Bendito et al. informs about an innovative approach using coacervative microextraction allowing an efficient and simple extraction of BP from a variety of canned food. This method requires only very small amounts of samples thereby reducing the consumption of organic solvents without the use of special equipment. The method was successfully applied to the determination of BPA in the solid content of canned fish and meat.

A GC-MS method was published by Zafra-Gomez et al. in 2009 for the determination of BPA in rice-prepared dishes packaged in plastic containers. The detection limit (LOD) was about 2.0 ng g⁻¹ with a very good intra- and inter-day variability. The monitoring of 250 rice-prepared dishes purchased in Spain showed no presence of BPA above the LOD and the authors concluded that there would be no reason for adult consumers to change their consumption patterns as a result of their findings.

Another GC-MS method for the simultaneous determination of BPA and bisphenol F (BPF) was described by Rastkari et al. in 2010 making use of the potential of single-walled carbon nanotubes (SWCNT) as a new solid-phase microextraction (SPME) adsorbent. The SWCNT fibre showed a higher sensitivity and longer life span than other SDME materials. The LOD was 0.1 ppb allowing for the determination of trace amounts of BPA in food samples such as canned tomato paste and corn. The authors analysed 24 samples from the local market demonstrating the contamination of about two third of the samples above the LOD in the range of 0.9 to 5 ng g⁻¹.

FAC published a number of papers on monitoring and exposure assessment studies of BPA that were carried out worldwide:
Already in 2005 Thomson and Grounds published exposure results from the consumption of canned and bottled food by adults from New Zealand. BPA levels analysed by GC-MS were highest in canned food. Nevertheless the authors concluded that based on the consumption data and exposure levels there is unlikely to be a concern to adult health. Canned food and beverage samples purchased on the Belgian market were analysed by Geens et al. to assess the amounts of BPA and the subsequent intake of adults through canned products. Again GC-MS was used as the method of choice. The interesting finding was that intake assessments, based on urinary metabolite concentrations from the literature, resulted in slightly higher BPA intakes. The authors concluded that there are sources other than canned food products contributing to the overall exposure of BPA.

A fast and simple method for simultaneous determination of BPA and BPB in beverages and powdered infant formula based on GC-MS was published by Cunha et al. in 2011. BPA was found in low levels in about 70 % of canned beverages and in 25 % of canned powdered infant formula samples from those purchased on the Portuguese market, whereas BPB could only be detected in about 50 % of the canned beverages.

Results from the 2008 Canadian total diet study indicated that BPA was detected in less than half of a total number of 154 composite food samples. This was investigated by Cao et al. using GC-MS and published in 2011. Most positive samples were canned food products that were responsible for the total dietary intakes. However, the dietary intakes of BPA were demonstrated to be low in all age-sex groups.

In toxicological safety assessments vulnerable populations play a special role. As many plastic baby bottles were made of polycarbonate, there was a particular concern about the potential migration of BPA from the bottles into the infant formula or other baby food. As already mentioned above, there is now a ban, not only in the European Union but also in other countries, on the marketing of baby bottles made from polycarbonate (PC). There are four papers published recently in FAC showing the results of migration studies in this respect. These publications however show that things may not necessarily be as straightforward as just banning products that are considered potentially unsafe. All articles deal with migration of chemicals from baby bottles, and they all present findings that
potentially shed another light on the current debate:

Kubwabo et al. developed a suitable analytical method for trace-level determination of BPA leaching from baby bottles and reusable drinking bottles made of PC. They concluded in their paper published in 2009 that in comparison with the migration observed from PC bottles, non-PC bottles and baby bottle liners showed only trace levels of BPA. Two recently (2011) published European survey studies authored by Santillana et al. and Simoneau et al. showed results on the release of BPA from PC bottles purchased at the European market reporting independently that migration of BPA (if at all) occurs only at very low amounts.

On the other hand, and more interestingly, some of the other plastic baby bottles do not seem to be free of concerns. Recent results from another large Europe-wide survey published in FAC in 2012 have shown that BPA may also occur in plastic materials other than polycarbonate. Furthermore, other undesirable substances such as phthalates were detected as contaminants in the survey. Therefore the authors strongly recommend intensifying testing of PC substitute plastics now in use, with the aim of informing risk managers on trends of evolution of the market and potential issues based on experimental data.

As mentioned above there are still many research projects ongoing on BPA and related compounds, especially examining those substances which are potential endocrine disruptors. The editors of FAC are looking forward to receiving papers in this field, not only from an analytical but also toxicological point of view. Appropriate tools for monitoring of harmful substances and evidence based knowledge on the impact on human health will facilitate the establishment of appropriate legal limits respectively evidence based legislation in general.

Elke Anklam
Editor