

Analysis of Bisphenol A in Canned Food: A Mini Review

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Bisphenol A is constantly discharged at trace levels in food packed in metal cans with PVC lining. This represents a cause for concern because of potential effects of bisphenol A to human health. In this paper, the authors compiled data on the methods used for analysis of bisphenol A in canned food published in the last ten years.

Key Words: Canned food, Bisphenol A, Food, High performance liquid chromatography (HPLC), GCMS.

Bisphenol A (BPA) is a chemical monomer used in the production of polycarbonate and epoxy-phenolic resins. Polycarbonate (PC) is widely used in the manufacture of food containers (*e.g.*, milk, water and infant bottles) and epoxy resins are used as an interior protective lining for food and beverage cans. As a result of these food contact uses, minute quantities of bisphenol A can potentially leach out into the water or food and consumers may be exposed to bisphenol A through the diet. Health Products and Food Branch (HPFB) has previously estimated the probable daily intake of bisphenol A for the general population from food packaging uses to be 0.18 $\mu\text{g}/\text{kg}$ b.w. from tested food cans in 1995, based on the results of food simulant extraction studies conducted on epoxy-lined cans. For infants, the PDI of bisphenol A from infant formula packaged in the epoxy-based cans was estimated¹ at 2.63 $\mu\text{g}/\text{kg}$ b.w.

In 1998, Gonzalez-Casado *et al.*² proposed a method for the determination of bisphenol A, which involved a micro liquid-liquid extraction using dichloromethane followed by a silylation step. Identification and quantitation were performed with gas chromatography-mass spectrometry, using an HP-5MS column. Single-ion monitoring (SIM) was used for quantitation. The method was applied to the determination of bisphenol A (10.0-250.0 ng/L) in different natural water samples. Yoshida *et al.*³ analyzed bisphenol A that had migrated into canned fruit and vegetables by high performance liquid chromatography method. The quantification limits were 10 ng/g for the solid portion and 5 ng/mL for the aqueous portion, respectively. Bisphenol A was mainly detected in the solid portion of canned food and found at the maximum level of 11 $\mu\text{g}/\text{can}$.

In 2002, Nerin *et al.*⁴ developed a fast screening method, suitable for the analysis of several bisphenol derivatives and their degradation products in aqueous solution, based on off-line solid-phase microextraction coupled to HPLC and fluorescence

detection. The method was proposed as a good method for the determination of bisphenol A in aqueous solution because of good analytical measurements obtained during analysis. Kang *et al.*⁵ determined bisphenol A levels in milk and dairy products by a selective and sensitive method. The method based on solvent extraction with acetonitrile and solid-phase extraction was developed for the analysis of bisphenol A in milk, yogurt, cream, butter, pudding, condensed milk and flavored milk and a method using two SPE cartridges (OASIS HLB and florisil cartridge) for skim milk was also developed. Another study described bisphenol A concentrations in canned beverages, fruits, vegetables and fat-containing foodstuffs bought in Austrian supermarkets. The analysis method consisted of sol-gel immunoaffinity chromatography followed by HPLC with fluorescent detector⁶.

Braunrath *et al.*⁷ described the development of a very simple method to prepare samples of canned food (beverages, fruits and vegetables) for the determination of bisphenol A by isocratic HPLC with fluorescence detection. Limits of detection (S/N = 3) ranged from 0.1 ng/mL for beverages to 4.3 ng/g for vegetables.

A method that can be applied on canned foods for the determination of migration of bisphenol A, BADGE and its derivatives from can coatings into food was developed and validated for the determination of bisphenol A, bisphenol A diglycidyl ether (BADGE), BADGE-H₂O, BADGE-2H₂O, BADGE-H₂O-HCl, BADGE-HCl and BADGE-2HCl in canned food based RP-HPLC with fluorescence detection⁸. Jiang, *et al.*⁹ developed a method for high performance liquid chromatography analysis of ultra-trace bisphenol A in water samples.

Based on solid-phase extraction and HPLC with fluorescence detection Xiao *et al.*¹⁰ developed a sensitive and simple method for the determination of bisphenol A and 4-nonylphenol in rat serum, liver and testis tissues. The developed method was applied to a toxico-kinetic study of bisphenol A and 4-nonylphenol including individual.

Bisphenol A and bisphenol A diglycidyl ether (BADGE) were determined in foods sold in Japanese markets and in water leached from six epoxy resin cans by Sajiki *et al.*¹¹ using high-performance liquid chromatography (HPLC) with electrochemical detection (LC/ECD), LC-mass spectrometric detection (LC/MS) and LC-tandem mass spectrometric detection (LC/MS/MS). The results concluded that the main source of human exposure to bisphenol A is food from cans with linings that contain high percentages of bisphenol A. Grumetto *et al.*¹² determined bisphenol A and bisphenol B in peeled canned tomatoes of different brands bought in Italian supermarkets. They used a solid phase extraction on C₁₈ Strata E cartridge followed by a step on florisil cartridge. Detection and quantitation were performed by RP-HPLC method with both UV and fluorescence detection (FD). Cao *et al.*¹³ developed a sensitive, efficient and reproducible method, based on solid phase extraction and derivatization with acetic anhydride followed by gas chromatography-mass spectrometry in selected-ion monitoring mode, for the determination of bisphenol A in liquid infant formula. A recent study described a novel approach for the determination of bisphenol A by dispersive liquid-phase microextraction with *in situ* acetylation

prior to GC-MS. The experimental results indicated a linearity over the range 0.1-50 µg/L with coefficient of correlation 0.9997 and good reproducibility with RSD 3.8 % (n = 5). The proposed method has been applied for the analysis of drinking water samples and satisfactory results were achieved¹⁴.

Sanchez-Acevedo *et al.*¹⁵ reported a biosensor for the fast, ultrasensitive and selective determination of bisphenol A in water. Picomolar concentrations of bisphenol A in only 2 min can be analyzed with this biosensor. This is the first device that experimentally showed that small molecules can also be selectively detected at ultralow concentrations using a CNTFET biosensor.

Bisphenol A from canned food and microwave containers was analyzed by Mariscal-Arcas *et al.*¹⁶ using HPLC and GC-MS. A method based on solid phase extraction and derivatization with acetic anhydride followed by GC-MS was validated by Cao *et al.*¹⁷ for the determination of bisphenol A in baby foods. The average bisphenol A level in the fruit products from all brands (0.60 ng/g) is lower than those in the mixed-dish products (1.1 ng/g) and the vegetable products (1.2 ng/g).

REFERENCES

1. Her Majesty the Queen in Right of Canada, Represented by the Minister of Health Canada, Cat.: H164-81/2008E-PDF. ISBN: 978-0-662-48686-2 (2008).
2. A. Gonzalez-Casado, N. Navas, M. del Olmo and J.L. Vilchez, *J. Chromatogr. Sci.*, **36**, 565 (1998).
3. T. Yoshida, M. Horie, Y. Hoshino and H. Nakazawa, *Food Addit. Contam.*, **18**, 69 (2001).
4. C. Nerin, M.R. Philo, J. Salafranca and L. Castle, *J. Chromatogr. A*, **963**, 375 (2002).
5. J.H. Kang and F. Kondo, *J. Food Prot.*, **66**, 1439 (2003).
6. R. Braunrath and M. Cichna, *J. Chromatogr. A*, **1062**, 189 (2005).
7. R. Braunrath, D. Podlipna, S. Padlesak and M. Cichna-Markl, *J. Agric. Food Chem.*, **53**, 8911 (2005).
8. C. Sun, L.P. Leong, P.J. Barlow, S.H. Chan and B.C. Bloodworth, *J. Chromatogr. A*, **1129**, 145 (2006).
9. M. Jiang, J.H. Zhang, S.R. Mei, Y. Shi, L.J. Zou, Y.X. Zhu, K. Dai and B. Lu, *J. Chromatogr. A*, **1110**, 27 (2006).
10. Q. Xiao, Y. Li H. Ouyang, P. Xu and D. Wu, *J. Chromatogr. B*, **830**, 322 (2006).
11. J. Sajiki, F. Miyamoto, H. Fukata, C. Mori, J. Yonekubo and K. Hayakawa, *Food Addit. Contam.*, **24**, 103 (2007).
12. L. Grumetto, D. Montesano, S. Seccia, S. Albrizio and F. Barbato, *J. Agric. Food Chem.*, **56**, 10633 (2008).
13. X.-L. Cao, G. Dufresne, S. Belisle, G. Clement, M. Falicki, F. Beraldin and A. Rulibikiye, *J. Agric. Food Chem.*, **56**, 7919 (2008).
14. X. Wang, C.P. Diao and R.S. Zhao, *J. Sep. Sci.*, **32**, 154 (2009).
15. Z.C. Sanchez-Acevedo, J. Riu and F.X. Rius, *Biosens. Bioelectron.*, **24**, 282 (2009).
16. M. Mariscal-Arcas, A. Rivas, A. Granada, C. Monteagudo, M.A. Murcia, F. Olea-Serrano, *Food Chem. Toxicol.*, **47**, 506 (2009).
17. X.-L. Cao, J. Corriveau, S. Popovic, G. Clement, F. Beraldin and G. Dufresne, *J. Agric. Food Chem.*, **57**, 5345 (2009).