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II.7. FOOD CONTACT MATERIALS CONTAMINATION: A CASE STUDY OF BISPHENOL A

Elena UNGUREANU[1, 2], Gabriel MUSTATEA[2], Mona Elena POPA[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania
[2]National Research & Development Institute for Food Bioresources, 6 Dinu Vintila Street, Bucharest, Romania

Corresponding author email: elena_ungureanu93@yahoo.com

Abstract

Food contact materials represent a possible source of contamination of the packaged products, through monomers or additives that can migrate from the packaging, especially the plastic ones, into the product. This type of contamination is an important problem related to the safety of food products, carrying out a lot of research in this regard. These chemical contaminants include Bisphenol A, with the highest volume produced worldwide, which is used as a plasticizer or intermediate product in obtaining polymeric materials, especially in polycarbonate material, but also in obtaining epoxy resins used for inner surface coatings of cans. The release of this compound is influenced by certain factors, among which the most important are the following: temperature, contact time and light exposure. The aim of this research article is to determine the levels of bisphenol A in different packed food and to verify compliance with the limit established by the legislation in force.

Key words*: Bisphenol A, migration, polymeric materials, food packaging.*

INTRODUCTION

In recent years, more and more studies have been carried out to detect the chemical substances present in the packaging materials, to measure their levels and to determine the effects they have on human health (Alimohammadi et al., 2014). These include dioxins, alkyl phenols, organo-chlorine pesticides and bisphenol A (BPA) which can become toxic even at very low concentrations (Alfarhani et al., 2019; Alimohammadi et al., 2014).

BPA is used as a monomer to obtain different epoxy resins used as internal coatings for food and beverage cans (Chailurkit et al., 2016; Elobeid et al., 2012), but also to obtain polycarbonate plastic used for obtaining bottles for milk, water or other food products packaging (Cao and Ji, 2013; Alfarhani et al., 2019).

BPA is an endocrine disrupting chemical that mimics the activity of hormones, altering the normal functioning of the endocrine system, leading to reproductive diseases, obesity, cancer or diabetes (Alfarhnai et al., 2019; Elobeid et al., 2012). The migration of this compound from food packaging into water samples is influenced by certain factors such as the presence of other chemical compounds (detergents, amines), water hardness, repeated use of packaging, temperature at which the packaging is exposed (direct sunlight or microwave heating), time of contact (Alimohammadi et al., 2019; Cao and Ji, 2013).

Taking into account the fact that consumption of water bottled in plastic bottles is considered the main source of BPA contamination, the aim of this study was to determine the BPA levels in still mineral water available on the Romanian market.

MATERIALS AND METHODS

Sample collection

Fourteen different samples of still water (Table 1), packed in PET bottles, were purchased from the local market in Bucharest, Romania.

Reagents

Bisphenol A (2,2 - Bis(4-hydroxyphenyl) propane) was purchased from Sigma Aldrich. Nitric acid (HNO_3) and Potassium hydroxide (KOH) were purchased from Merck.

The characteristics of water samples are given in Table 1.

Table 1. Characteristics of the examined drinking waters

Sample	Mineral composition (mg/L)	pH value
P1	Ca^{2+} (45.80), Mg^{2+} (13.00), Na^{+} (0.80), HCO^{-}_3 (193.00), NO^{-}_3 (1.40)	8.0
P2	Ca^{2+} (62.57), Mg^{2+} (28.71), Na^{+} (2.36), HCO^{-}_3 (324.49)	7.44
P3	Ca^{2+} (17.20), Mg^{2+} (3.45), Na^{+} (0.74), K^{+} (0.53), HCO^{-}_3 (324.49)	-
P4	Ca^{2+} (9.126), Mg^{2+} (2.51), Na^{+} (3.023), K^{+} (1.312), HCO^{-}_3 (42.7), NO^{-}_3 (3.93)	7.27
P5	Ca^{2+} (118), Mg^{2+} (12.5), Na^{+} (6.81), K^{+} (1.81), HCO^{-}_3 (327)	-
P6	Ca^{2+} (95.8), Mg^{2+} (14.13), Na^{+} (13.25), K^{+} (7.01), HCO^{-}_3 (357.5)	7.6
P7	Ca^{2+} (64.79), Mg^{2+} (3.224), Na^{+} (0.87), K^{+} (1.215), HCO^{-}_3 (189.1)	7.76
P8	Ca^{2+} (43.2), Mg^{2+} (6.29), Na^{+} (2.59), K^{+} (0.75), HCO^{-}_3 (161)	8.2
P9	Ca^{2+} (192), Mg^{2+} (42.4), Na^{+} (71.1), HCO^{-}_3 (831)	6.7-6.9
P10	Ca^{2+} (94), Mg^{2+} (20), Na^{+} (7.7), HCO^{-}_3 (248)	7.8
P11	Ca^{2+} (80), Mg^{2+} (26), Na^{+} (6.5), K^{+} (1), HCO^{-}_3 (360)	7.2
P12	Ca^{2+} (18), Mg^{2+} (15), Na^{+} (18), HCO^{-}_3 (153)	7.7
P13	Ca^{2+} (73.1), Mg^{2+} (8.2), Na^{+} (6.81), K^{+} (3.3), HCO^{-}_3 (237)	7.23
P14	Ca^{2+} (113), Mg^{2+} (46.85), Na^{+} (55.3), K^{+} (8.5), HCO^{-}_3 (737)	-

Equipment

Bisphenol A analysis was performed using a Jasco V500 UV/VIS Spectrophotometer with a wavelength range of 190 nm to 900 nm and provided with a deuterium lamp and a tungsten iodine lamp. The instrument is capable of wavelength scanning from 10 nm/min to 4,000 nm/min.

Sample preparation

Samples were stored for a couple of days at room temperature prior to extraction. For the BPA analysis, the samples acidified with 0.5 ml of HNO_3 were boiled for 25 minutes. After cooling, 1 ml of KOH 50% was added in order to complete reaction. If BPA is present it can be observed a yellow coloration of the solution, which is measured at 430 nm.

Preparation of standard solutions

For obtaining the calibration curve, 0.1 g of BPA was weighted in a 100 ml volumetric flask and then filled with ethanol (solution A). By diluting 100 times solution A with distilled water, solution B is obtained. The standard solutions were prepared, from solution B, according to Table 2. Figure 1 shows the calibration curve obtained (by reading the extinctions at 430 nm).

Table 2. Preparation of standard solutions

Solution B (ml)	Distilled water (ml)
1	9
2	8
3	7
4	6
5	5
6	4
7	3
8	2
9	1

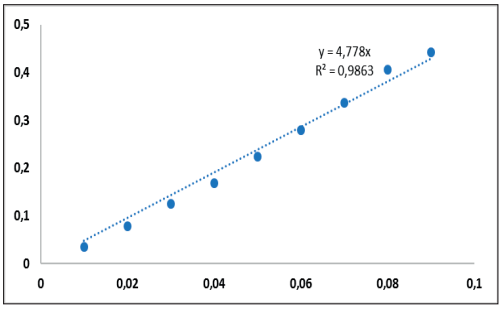

Figure 1. Calibration curve for BPA

RESULTS AND DISCUSSIONS

The results obtained for the BPA content of the analyzed samples (average of 3 parallel samples with two replicates for each one) are presented in Table 3.

BPA content ranged between < 0.1 µg/L and 1.9 µg/L. These values are higher than the values found in the literature for still mineral water bottled in PET bottles: < LOD and 0.006 µg/L (Chailurkit et al., 2016), 0.012-0.044 µg/L (Wang et al., 2020), 0.003-0.010 µg/L (Tayooka and Oshige, 2000), < LOD - 0.004 µg/L (Amiridou and Voutsa, 2011) and are affected by several factors such as mineral composition, pH, storage time and analysis method (interferences may appear at the same wavelength).

However, the values obtained are much lower than specific migration limit specified by Regulation (EU) no. 213/2018, regarding the use of BPA in materials for the inner coating of containers intended to come into contact with food and amending Regulation (EU) no. 10/2011 regarding the use of this substance in

plastics that come into contact with food, respectively 0.05 mg per kg of food (mg/kg).

Table 3. BPA concentrations in water samples

Sample	BPA concentration (μg/L)
P1	1.8 ± 0.2
P2	< 0.1
P3	< 0.1
P4	< 0.1
P5	1.1 ± 0.1
P6	< 0.1
P7	< 0.1
P8	0.7 ± 0.1
P9	0.9 ± 0.1
P10	1.8 ± 0.1
P11	< 0.1
P12	1.6 ± 0.1
P13	1.9 ± 0.2
P14	0.5 ± 0.1

CONCLUSIONS

In this article a simple and rapid method of determining bisphenol A from samples of still mineral water bottled in PET bottles was used. All the results obtained are below the maximum allowed limit, stated by Regulation (EU) no. 213/2018.

The level of BPA found in water samples packed in different polymeric bottles (PC, PVC, PE) mentioned in the literature are quite high, with maximum values found in polycarbonate bottles.

As a precautionary method, it is important to choose water packed in PET bottles, and for children it would be ideal to choose bottles labelled "BPA free".

The differences between the results of the study and the data from the specialized literature are most probably due to the experimental conditions, as well as the heterogeneity of the samples regarding the chemical composition, the pH or storage period.

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REFERENCES

Alfarhani, B. F., Al-Tameem, M., Fadhel, A. A., Hammza R. A., Kadhem M. I. (2019). Endocrine disrupting Bisphenol A detection in different water samples in Iraq. *Journal of Physics: Conference Series*, 1294(5).

Alimohammadi, M., Mehrabbegi, M., Nazmara, S., Dashtappeh M. M., Moghaddam, V. K. (2014). Quantitative assessment of Bisphenol A in multiple brands of bottled drinking water in Iran. *Iranian Journal of Toxicology*, 8(25), 1037-1040.

Amiridou, D. and Voutsa, D., 2011. Alkylphenols and phthalates in bottled waters. *Journal of Hazardous Materials*, 185(1), 281-286.

Cao, X. H., Ji, S. J. (2013). Migration study of bisphenol A from tea bottle of polycarbonate plastic to tea water. *Advanced Materials Research Vols*., 821-822, 929-932.

Chailurkit, L., Srijaruskul K., Ongphiphadhanakul B. (2016). Bisphenol A in canned carbonated drinks and plastic - bottled water from supermarkets. *Exposure and Health*, 9, 243-248.

Elobeid, M. A, Almarhoon Z. M., Virk, P. Hassan, Z. K., Omer, S. A., ElAmin, M., Daghestani, M. H., AlOlayan, E. M. (2012). Bisphenol A detection in various brands of drinking bottled water in Riyadh, Saudi Arabia using Gas Chromatography/Mass Spectrometer. *Tropical Journal of Pharmaceutical Research*, 11(3), 455-459.

Toyo'oka, T. and Oshige, Y., 2000. Determination of alkylphenols in mineral water contained in PET bottles by liquid chromatography with coulometric detection. *Analytical Sciences*, 16(10), 1071-1076.

Wang, H., Liu, Z. H., Tang, Z., Zhang, J., Yin, H., Dang, Z., Wu, P. X., Liu, Y. (2020). Bisphenol analogues in Chinese bottled water: Quantification and potential risk analysis. *Science of the Total Environment*, 713, in press.

COMMISSION REGULATION (EU) No. 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food.

COMMISSION REGULATION (EU) 2018/213 of 12 February 2018 on the use of bisphenol A in varnishes and coatings intended to come into contact with food and amending Regulation (EU) No 10/2011 as regards the use of that substance in plastic food contact materials.