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Exposure to lead and cadmium released from ceramics and glassware

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Abstract

The migration of lead and cadmium from ceramic and glassware used for food contact is a significant source of lead and cadmium intake in humans. This study shed light on the analysis carried out to identify the presence of lead and cadmium in samples of ceramic and glassware, which are available on the market in the Republic of North Macedonia. The analysis involved examining 33 samples, consisting of 16 ceramic and 17 glass items that were subsequently categorized into three categories, following the guidelines outlined in Directive 84/500/EC and the Official Gazette of the Republic of Macedonia, no. 1/2013 for ceramics, as well as ISO 7086:2020 1, 2 for glass. An atomic absorption spectrometer (AAS) was used to analyze the concentration of lead and cadmium in samples. The obtained results indicate that the level of Pb concentration in ceramics from the second category exceeds the Maximum Permissible Migration Level (MPML). It is suspected that the lead found may have come from the lead-based paints used on the interior surfaces, as well as from the improperly applied glaze. The results also reveal that the concentration of Pb in the first category of glassware surpasses the Maximum Permissible Migration Level (MPML). It is believed that the migrated lead comes from the full exterior decoration. Upon reviewing the measured and calculated Pb values in the remaining glassware, it is evident that in all the other samples analyzed from each category, it does not surpass the values above the MPML. Additionally, Cd concentrations do not exceed the MPML in all 33 samples.

Among the 33 tested samples, 10% of second-category ceramic items were found to be inadequate. This highlights the necessity for ceramics and glassware sold in the market to contain accurate declarations, particularly regarding the levels of lead and cadmium that could migrate into the food. Consumers should pay attention when purchasing such products, especially ceramics, to minimize health risks to the population.

Key words: Ceramic products, Glass products, Cadmium, Lead, GF-AAS

Introduction

Ceramics and glassware are identified as items that could potentially lead to the migration of lead or cadmium into food. To protect consumers from health hazards linked to the migration of lead or cadmium from ceramics and glassware, the maximum levels of these substances have been determined at the European level (Official Gazette of Republic of Macedonia No.1,2013; ISO 7086-2:2020).

The painted glaze on ceramics may contain toxic heavy metals like lead and cadmium, which have the

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to migrate into food. The extent of this migration depends on factors whether the pottery is burned at high or low temperatures, the type of food being stored, and the duration of storage (Sheets, 1997). Metal migration happens when ceramic particles interact with food and beverages, leading to ceramic ware becoming a significant contributor to the intake of toxic metals (Fewtrell et al., 2003). The most significant migration happens when lead is released from ceramic vessels that have been glazed. The risk of exposure to lead and cadmium has been assessed by national and international authorities (IPCS, Geneva, 1995). Ingesting these heavy metals can result in detrimental health effects for humans. The presence of lead has adverse impacts on multiple systems of the human body such as the nervous, cardiovascular, gastrointestinal, and hematological systems. Children are especially vulnerable to the neurotoxic effects of lead, and even minimal exposure can lead to detrimental consequences for their young developing brain (IPCS, Geneva, 1995). The toxic nature of cadmium extends to a wide range of organs, primarily impacting the kidneys and bones when exposed to it over a prolonged period. The International Agency for Research on Cancer - IARC designates cadmium as a human carcinogen (Group 1), with ample evidence supporting its link to lung cancer and limited evidence indicating its potential connection to kidney, liver, and prostate cancer (IARC, France 1993). Most countries monitor the migration of lead and cadmium from ceramic and glass products as a potential source of contamination. Within the European Union (EU), specific requirements are established for ceramics that are intended to be in contact with food products. These requirements encompass the permissible limits of lead and cadmium, as well as the designated test method. The European Commission is currently in the process of revising the directive, aiming to reduce the permissible limits and optimize the test conditions (Revision of Directive 84/500/EC, 2017). The German Federal Institute for Risk Assessment (BfR) reported that the intake of lead and cadmium exceeded the PTWI more than 10 times, assuming that ceramic products release lead and cadmium above the permitted migration levels set by the Directive.

In 2020, using the reference values set by EFSA (EFSA, 2011), The German Federal Institute for Risk Assessment (BfR) analyzed the risk of exposure to lead and cadmium. The BfR assumed that the single daily dietary intake of small children from a ceramic plate with a surface area of 3 dm² would exceed the reference doses (BfR, 2020). The available data regarding the intake of lead and cadmium from ceramic and glassware raises significant concerns. The migration of lead and cadmium decreases with the repeated use of ceramic and glassware (Rebeniak et al., 2014).

To protect the population from potential risks associated with the use of ceramic products, it is essential to establish efficient control measures for the migration of lead and cadmium. This is especially crucial when dealing with improperly formulated, applied, and burned glazes and decorations on ceramic food contact surfaces. These surfaces are commonly found on vessels utilized for the preparation, serving, and storage of food products (Mania et al., 2018). Ceramic and glass products that are heavily colored or decorated on their surfaces that come in contact with food, or those with a high surface area compared to their volume, have a higher probability of releasing lead and/or cadmium compared to other products. ISO standards (ISO 7086-1:2019; ISO 7086-2:2020) address the issue of lead and cadmium migration from refillable glassware used for the preparation, cooking, serving, and storage of food and beverages. The initial part specifies the test procedure, while the subsequent part pertains to the maximum permissible migration limits.

The ISO standard (ISO 6486-1:2019) defines the test method for the migration of lead and cadmium from ceramics, glass ceramics tableware and glassware used in contact with food, but excluding porcelain enameled products.

Material and methods

Sample collection

A total of 33 samples were purchased from the market in Republic of North Macedonia, 16 ceramic and 17 glass items and subsequently, these samples were tested in terms of migration of lead and cadmium (Table 1 and 2). As per the declaration, the ceramic items were sorted into three categories: category I (non-refillable products where internal depth measured from the lowest point to the horizontal plane does not exceed 25 mm from the upper edge); category II (refillable products); category III (vessels with a capacity exceeding 3000 mL). (Official Gazette of the RM, No. 1/2013). Additionally, the glass items were also sorted into three categories: category I (vessels with a volume of 600 mL or less); category II (vessels with a volume ranging from 600 to 3000 mL); category III (vessels with a volume exceeding 3000 mL) (ISO 7086-1:2019).

For ceramic samples, when filled with a simulant solution, the migration of lead and cadmium is the concentration value, measured by the device and expressed in mg/l. The quantity of metals migrated from the vessel into the simulant solution is considered to be the total migrated amount. When the samples lack depth or when the external part that makes contact with the mouth is subjected to testing, the surface of that particular segment is also taken into account. The migration of metals is determined according to the formula, and the final result is expressed in mg/dm^2 (Dong et al., 2014).

Chemicals, reagents and equipment

Glacial acetic acid (ρ = 1.05 g/mL), CARLO ERBA, Italy; certified reference standards of Pb (1000 mg/L) and

Cd (1000 mg/L) from CPA Chem., Bulgaria; Matrix Modifiers: Magnesium Nitrate 10g/L in H2O, Palladium 10.0 g/L in 15% Nitric Acid, Ammonium Hydrogen Phosphate 100 g/L in 1% HNO_3 all from CPA Chem, Bulgaria; Water, grade 1, according to ISO 3696; BINDER KB 400 (E6) system cooling chamber.

Methods

Quantitative analyses of Pb and Cd metals were carried out by using the method for ceramic vessels outlined in the Official Gazette of the RM, no. 1/2013 (Annex 1 and 2) and ISO 7086-1:2019 standard for glassware.

Preparation of the samples

Before immersion, the samples should be thoroughly cleaned, and free of grease or any other substance that might affect the test. To achieve this, the samples are meticulously washed using ordinary detergent and water at a temperature of 40 °C and subsequently dried.

The samples that can be refilled are placed in a test solution containing 4% acetic acid (simulant solution) up to 1 mm below the overflow point, measured vertically. The samples are then covered and placed in a thermostat with a cooler set at a temperature of (22 ± 2) °C. After (24 ± 0.5) hours, the extract is collected. The extraction process is carried out in the dark to prevent any loss of cadmium, which is sensitive to light.

The samples, where the outer decorated section comes into contact with the mouth, are immersed upside down in a suitable laboratory container with a diameter between 1.25 and 2 times that of the sample. Sufficient amount of simulant solution is added to the container to fill it to the 20 mm mark on the object. The extract is then collected from these vessels after (2 ± 0.1) hours.

When dealing with samples that possess a flat or slanted edge, such as plates or trays, it is crucial to immerse them in a manner that the distance between the liquid surface and the point of overflow does not exceed 6 mm. This measurement is taken from the slanted edge.

Samples fully immersed in a simulant solution accurately depict the realistic conditions of use as well as the migration of metals within the entire item volume.

Quantitative determination

Quantitative analysis of the concentrations of the metals Pb and Cd was carried out using the GF-AAS PerkinElmer Analyst 600 device, along with the system Autosampler model AS-800, background correction, an appropriate lamp, and a pyrolytically coated graphite cuvette.

Calculation

The concentration of migrated lead and cadmium in each tested sample is done under the following equation:

$$M = C \times V / P \times 1000 \qquad \text{Equation (1)}$$

where:

M- is a migration in mg/L or mg/dm^2

C - is the concentration measured by the device and converted to mg/kg

V - is the volume of added simulant mL

P - is the surface area of the sample in contact with the food product or the simulant expressed in dm^2 during the migration test.

Results and discussion

For ceramic samples, when filled with a simulant solution, the migration of lead and cadmium is the concentration value, measured by the device and expressed in mg/l. The quantity of metals migrated from the vessel into the simulant solution is considered to be the total migrated amount. When the samples lack depth or when the external part that makes contact with the mouth is subjected to testing, the surface of that particular segment is also taken into account. The migration of metals is determined according to the formula, and the final result is expressed in mg/dm^2.

Calibration curves are made for each individual element, at specified concentrations of their standard solutions in the range of 0 - 100 ppb for Pb and 0-10 ppb for Cd. For Pb, according to the regression equation: $y = 0.004x + 0.007$, the regression coefficient (R2) was 0.998, and the relative standard deviation from the repeatability %RSD was 3.3. For Cd, according to the regression equation: $y = 0.048x + 0.021$, the regression coefficient (R2) was 0.994, and the relative standard deviation from the repeatability %RSD was 1.99.

The results for glass vessels are expressed in mg/L. Samples 5, 6, 7, and 12 were tested twice (filled in and inverted), so the total score is determined by summing the results of both migrations. The values from the inverted parts of the vessels are calculated by the area and then multiplied by 6 to obtain a value in mg/L. This value is added to the value from the filled part of the same cup and thus the total value of the two migrations is obtained.

For ceramic products, the MPMLs for Pb are 0.8 mg/dm², 4.0 mg/L and 1.5 mg/L and for Cd are 0.07 mg/dm², 0.3 mg/L and 0.1 mg/ L, for category I, II and III, respectively. (Official Gazette of the Republic of Macedonia, No. 1/2013). For glass products, the MPMLs for Pb are 1.5 mg/L, 0.75 mg/L and 0.5 mg/L and for Cd are 0.5 mg/L, 025 mg/L and 0.25 mg/L, for categories I, II and III, respectively (ISO 7086-2:2019).

Table 3 displays the measured and calculated values for metals found in ceramic products. It is evident from the obtained data that the concentration of cadmium in all three categories (I, II, and III) does not exceed the MPML. The lead migration values of samples 1, 3, 14, and 16 within Category II have surpassed the MPML. Indicating a significant level of lead migration. It is believed that the lead found in samples 1 and 14 originated from lead paints

used in the internal glaze application. The presence of lead in sample 3 can be attributed to the colors utilized on the interior of the vessel while in sample 16, the higher migration of lead originates from the external decoration of the coffee cup. Specifically, it is found in the inverted part of the cup that comes into contact with the mouth, and it is not applied 20 mm below the top edge. Consequently, the ceramic products listed in Table 3 are deemed unsuitable for use due to potential health risks. Lead is a toxic heavy metal, and impacts neurological, cardiovascular, nephritic, gastrointestinal and hematological systems. Lead is stored in bones. Children are especially susceptible to the neurotoxicity of lead, and even low levels of exposure can result in the damage to developing brain.

Based on the measured and calculated values for Cd in the glassware, it is evident that the values in all analyzed samples from different categories do not surpass the MPML. The lead migration value of sample 6 exceeds the MPML although it serves as a comprehensive external decoration, including the part that comes into contact with the mouth. It is important to note that the inverted test part of the sample does not adhere to the rule of having the decoration positioned 20 mm below the upper edge. On the other hand, the remaining glass samples are deemed safe for human use. Cadmium is toxic to a wide range of organs, and chronic exposure to cadmium exerts toxic effects mainly on kidneys and bones. The International Agency for Research on Cancer (IARC) identifies cadmium as carcinogenic to humans, with sufficient evidence for lung cancer and limited evidence for kidney, liver and prostate cancer.

The migration of lead and cadmium from ceramics and glassware, which are specifically designed for food contact, serves as a crucial pathway for the intake of these elements in the human body. Extensive research and studies on this subject were conducted by various authors worldwide.

Państwowego (2014) released a publication where ceramics and glassware (mainly decorated) were analyzed. The items were obtained from the Polish market between 2010 and 2012. A total of 1273 samples were analyzed, revealing that the migration levels of lead and cadmium were found to be below the analytical limits of detection in the majority of the products. Predominantly defective in terms of health were items imported from non-EU countries.

Table 1. Name and description of tested ceramic items, by category (Official Gazette of the Republic of Macedonia, No. 1/2013)

Ceramic sample/lab. no.	Name and description of the sample	Caegory
1	Brown ceramic pot 750 ml with lid and external patterns	II
2	Deep ceramic bowl 750 ml with exterior decor in multiple colours	II
3	Ceramic vessel 250 ml with inner patterns	II
4	Ceramic jug 300 ml with an external patterns	II
5	Ceramic brown coffee mug 350 ml with white letters and outer patterns	II
5a	Ceramic brown coffee mug 350 ml with white letters and outer patterns (inverted)	II
6	White ceramic bowl 240 ml for appetizers	II
7	Brown ceramic bowl 250 ml with outer patterns	II
8	Grey ceramic bowl 150 ml	II
9	Ceramic pan 250 ml with outer patterns	II
10	White ceramic vessel 100 ml in the form of a leaf	II
11	Ceramic shallow plate 200 ml. with the decor in 4 colours	I
12	Ceramic plate 250 ml. with internal patterns	I
13	Ceramic serving bowl 200 ml with internal patterns in dark blue colour	II
14	Small brown ceramic mug 80 ml with a handle	II
15	Large ceramic baking pan 3500 ml	III
16	Ceramic coffee mug 170 ml with floral patterns	II
16a	Ceramic coffee mug 170 ml with floral patterns (inverted)	II
16b	Ceramic coffee tray with floral patterns	I

Table 2. Name and description of tested glassware, by category (ISO 7086-1:2019)

Glass sample/lab. no.	Name and description of the sample	Category
1	Glass bottle for milk with external patterns 1000 ml	II
2	Glass bottle for water 450 ml with external patterns	I
3	Transparent glass bottle 250 ml	I
4	Dark green glass bottle 180 ml	I
5	Dark glass cup with black and golden exterior patterns 340 ml	I
5a	Dark glass cup with black and golden exterior patterns 340 ml (inverted)	I
6	Glass cup with black and white outer patterns 350 ml	I
6a	Glass cup with black and white outer patterns 350 ml (inverted)	I
7	Coloured glass tumbler in colours that flow from yellow to purple 230 ml	I
7a	Coloured glass tumbler in colours that flow from yellow to purple 230 ml (inverted)	I
8	Glass cup in blue colour 240 ml	I
9	Glass cup in brown colour 250 ml	I
10	Colourless glass cup 200 ml	I
11	Small colourless glass for brandy 30 ml	I
12	Small glass mug with a handle, having outer Christmas patterns 70 ml	I
12a	Small glass mug with a handle, having outer Christmas patterns 70 ml (inverted)	I
13	Glass jar with external patterns 350 ml	I
14	Small transparent glass jar 180 ml	I
15	Glass bottle for children with external patterns 250 ml	I
16	Colourless glass bowl for appetizers 180 ml	I
17	Oval glass baking dish 3500 ml	III

The lead migration levels of 0.9 and 11.9 mg/dm^2 were observed in two imported, decorated ceramic flat plates, while the migration values of 4.7 mg/L and 8.6 mg/L were recorded in five imported deep ceramic dishes. Among the tested glassware, results with high lead migration were obtained for drinking glassware with decorations. The greatest migration of lead is noticed in those items where the decoration is 2 mm up to the edge (8.96 - 163.8 mg/L). The study results have led to the conclusion that it is necessary to revise the permissible limits of lead and cadmium, to ensure the protection of the population from possible hazards (Rebeniak et al., 2014).

The Turner study in 2018 involving 197 samples found high levels of the heavy metals lead and cadmium in both new and second-hand refillable decorative glassware. Significant amounts of metal migration were detected from products with decorative designs on the section that comes into contact with the mouth, precisely 20 mm below the upper edge of the glasses. From a health standpoint, the biggest concern is the presence of Pb and Cd in these decorated glass cups. Pb was found to exceed the MPML in 139 samples, while Cd did so in 134 instances (Turner, 2018).

A study conducted in 2021 aimed to evaluate the levels

of lead and cadmium intake among Belgian consumers who use ceramic products. According to the reference doses set by the European Food Safety Authority (EFSA), the risk associated with lead and cadmium exposure is determined by the margin of exposure (MOE) and tolerable weekly intake (TWI) levels, respectively. The probable mean and 95% of lead intake were from 0.02 to 5.77 μg/kg body weight per day for adults, and from 0.07 to 17.3 μg/kg body weight per day for children. For average consumers, the MOE for neurotoxicity, nephrotoxicity and cardiovascular effects were 7.1, 27 and 64 while for heavy consumers 0.02, 0.1 and 0.3. The deterministic mean value and 95% cadmium intake was 0.026 to 0.03 μg/kg body weight per day for adults and 0.08 to 0.09 μg/kg body weight per day for children. The researchers from Belgium advise that the risk of exposure to lead and cadmium suggests taking measures, such as lowering the migration limits for ceramic products, to minimize the risk and control the dietary intake of lead. Although the intake of cadmium from ceramic products was below TWI, the total intake exceeded TWI by as much as 20 times due to the combination with exposure from food products (Yan Li et al., 2021).

Table 3. Measured values of heavy metals in ceramic vessels

Sample			HEAVY METALS		
				Pb	Cd
			Calculated M		
Lab. no.	Category	V (ml)	P (dm^2)	mg/dm^2	
11	I	200	3.6	0.036	0.002
12	I	250	3.93	0.655	0.008
16 в	I	110	2.01	0.037	0.024
				mg/l	
1	II	750	n.d	5.145	0.001
2	II	750	n.d	0.005	0.002
3	II	250	n.d	17.617	0.0
4	II	300	n.d	0.072	0.016
5	II	350	n.d	0.001	0.0
5/a	II	200	1.15	0.010	0.109
5 (total)				0.011	0.109
6	II	240	n.d	0.0	0.0
7	II	250	n.d	0.089	0.0
8	II	150	n.d	0.0	0.0
9	II	250	n.d	0.035	0.068
10	II	100	n.d	0.021	0.051
13	II	200	n.d	0.711	0.002
14	II	80	n.d	6.985	0.0
16	II	170	n.d	0.291	0.097
16 a	II	200	1.2	4.901	0.123
16 (total)				5.229	0.244
15	III	3500	n.d	0.0	0.0

*n.d = not detected or uncounted surface area of the object that was all charged with simulant.

Table 4. Measured values of heavy metals in glassware

Sample			HEAVY METALS		
				Pb	Cd
			Calculated M		
Lab. no.	Category	V (mL)	P (dm^2)	mg/L	
2	I	450	n.d	0.098	0.001
3	I	250	n.d	0.016	0.0
4	I	180	n.d	0.010	0.0
5	I	340	n.d	0.880	0.005
5a	I	75	0.85	0.243	0.004
5 Total:				1.123	0.009
6	I	350	n.d	1.116	0.010
6a	I	75	1.1	0.667	0.001
6 Total:				1.783	0.011
7	I	230	n.d	0.840	0.021
7a	I	75	0.94	0.223	0.017
7 Total:				1.063	0.038
8	I	240	n.d	0.425	0.001
9	I	250	n.d	0.616	0.001
10	I	200	n.d	0.289	0.001
11	I	30	n.d	0.772	0.0
12	I	70	n.d	0.314	0.042
12a	I	80	0.78	0.585	0.057
12 Total:				0.899	0.099
13	I	350	n.d	0.342	0.002
14	I	180	n.d	0.485	0.0
15	I	250	n.d	1.002	0.0
16	I	180	n.d	0.629	0.0
1	II	1000	n.d	0.675	0.002
17	III	3500	n.d	0.246	0.0

*n.d = not detected or uncounted surface area of the object that was all charged with simulant

The objective of the study carried out in Poland in 2018 by Mania was focused on investigating the migration of lead, cadmium, zinc, and copper from ceramic and glassware available in the Polish market. A total of 248 samples mainly originating from China were analyzed, where 62 of them were decorative flat ceramic vessels. Lead levels below the LoQ were detected in 47 samples (76%) and for cadmium in 60 samples (97%). Based on the results obtained, it was concluded that in most of the tested ceramic and glassware samples, the migration of the tested elements did not exceed the permissible limits set by Directive 84/500/EC, 2017. However, as observed in the analyzed individual samples, the consumption of Pb and Cd by children holds significant importance in terms of health safety (Mania et al., 2018).

Conclusion

The migration of lead and cadmium from ceramics and glassware is lower in situations when they are frequently used. It is important to underline that there is a technical

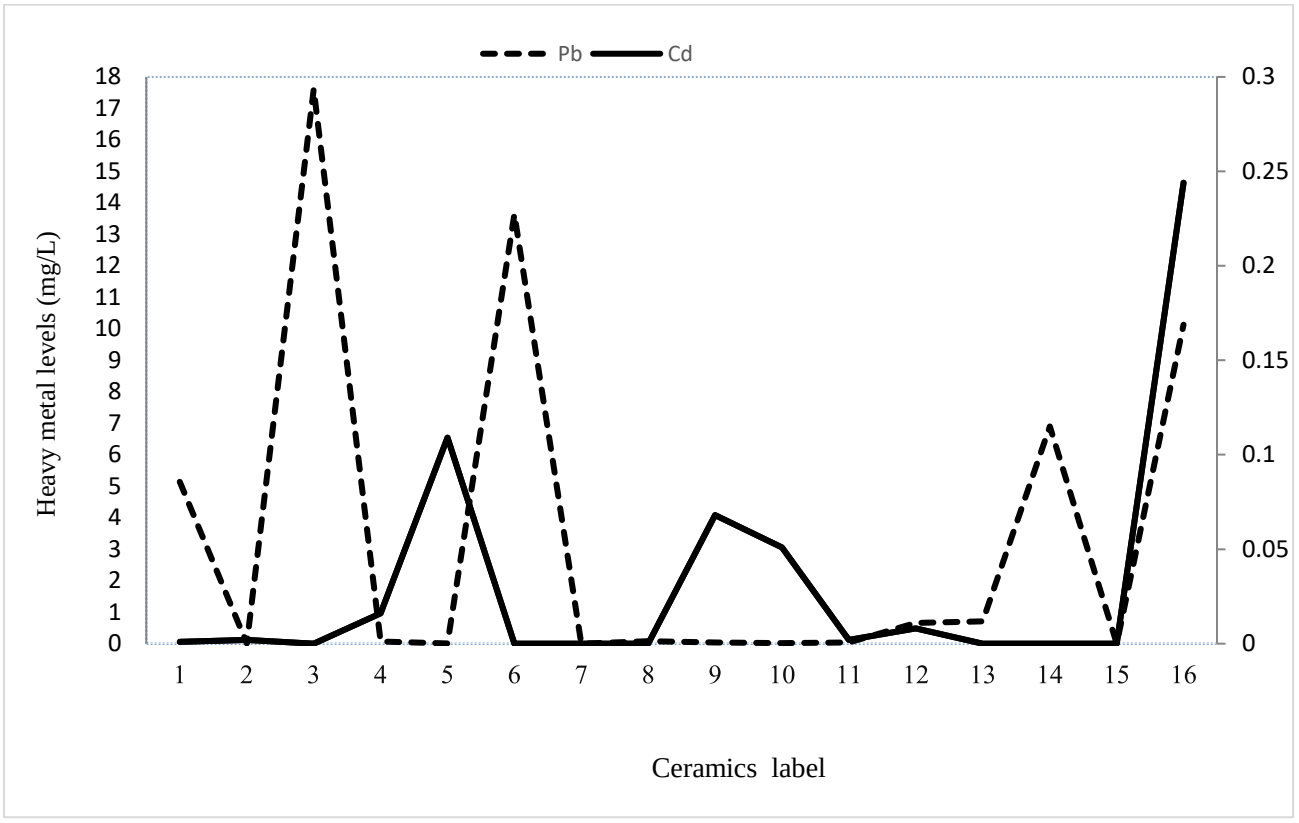

Fig. 1. The levels of Pb and Cd in the tested ceramic vessels are presented in Table 3.

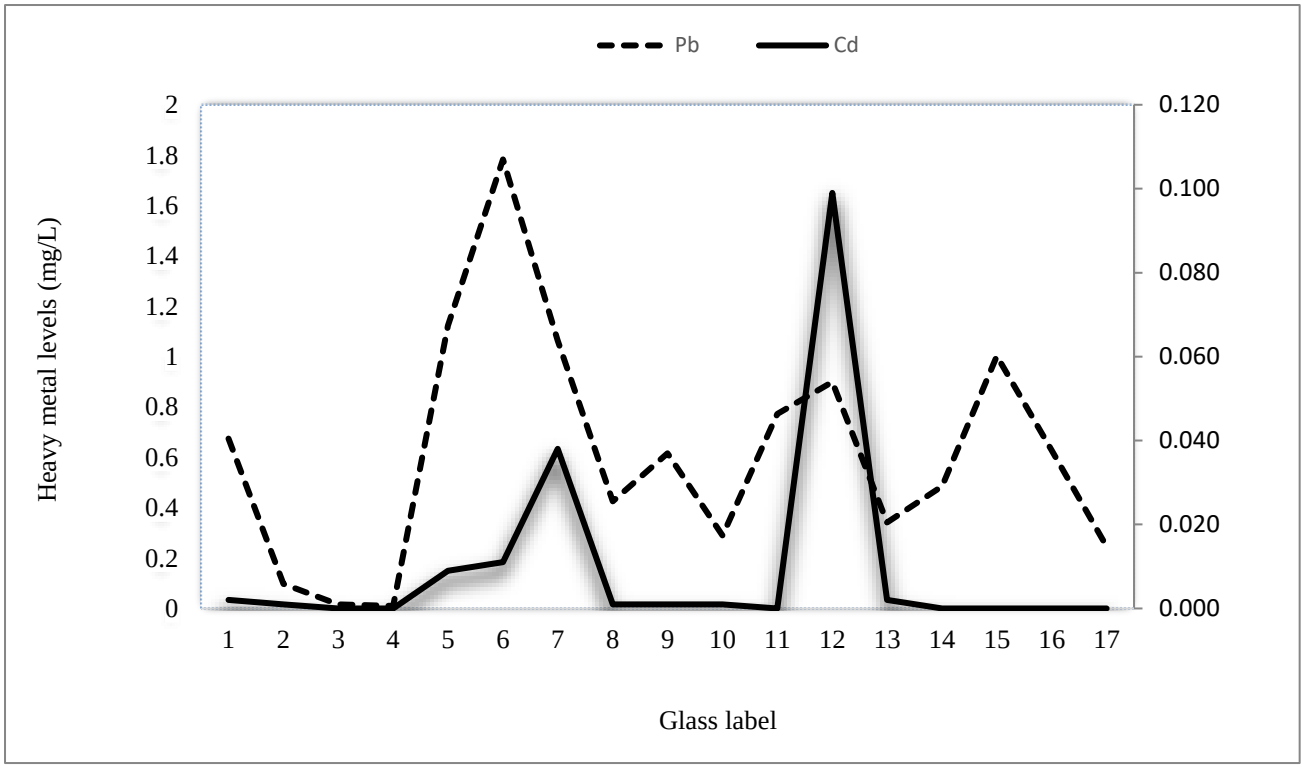

Fig. 2. The levels of Pb and Cd in the tested glassware are presented in Table 4.

possibility to manufacture products with a considerably lower risk of heavy metal migration. Heavy metals in the form of borosilicate's are incorporated as glazes during the production process of ceramics and glassware. The migration of lead and cadmium in 33 samples (16 ceramic and 17 glass vessels) showed that there were values above the MPML in 4 ceramics and 1 glass item. According to the results obtained from this research, it has been revealed that ceramic items, whether produced locally or purchased from markets and stores in RNM, do not always guarantee health safety. Out of the total 33 tested samples, it was discovered that 10% of the ceramic items were unfit for use. These results align with similar trends observed in investigations conducted in the EU and worldwide.

Negative effects on human health have been detected from food stored for a long time in ceramic and glass vessels with a high migration rate of lead and cadmium. Therefore, it is essential to implement appropriate measures to minimize sources of exposure. When introducing ceramics and glassware to the market, it is crucial to provide accurate declarations, especially regarding the levels of lead and cadmium that could potentially migrate into food. It is also necessary to pay attention when buying such products, to reduce the health hazard. To effectively lower the migration limits it is imperative to undertake a comprehensive examination of the relevant EU and national laws applicable to the migration of lead and cadmium from ceramic and glass products. Some restrictions should be particularly applied to ceramics and glassware with decorations intended for beverages. Taking all this into account, the Commission can analyze appropriate next steps and actions to lower migration levels of heavy metals from ceramic and glass products that come into contact with food to ensure a high standard of consumer health and safety.

References

BfR, 2020. Ceramic Crockery: BfR Recommends Lowers Release of Lead and Cadmium. Opinion No.043/2020 of the BfR Dated 21 September 2020. Available at: https://www.bfr.bund.de/cm/349/ceramic-crockery-bfr-recommends-lower-release-of-lead-and-cadmium.pdf

Council Directive 84/500/EEC of the European Parliament and of the Council of 15 October 1984 on the approximation of the laws of the Member States relating to ceramic articles intended to come into contact with foodstuffs, OJ, L277, P12, 20.10.1984. Available at: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31984L0500

Dong, Z., Lu, L., Liu, Z., Tang, Y., Wang, J., 2014. Migration of toxic metals from ceramic food packaging materials into acid food simulants. Math. Probl. Eng. 10, 1–7. doi:10.1155/2014/759018

Fewtrell, L., Kaufmann, R., Prüss-Üstün, A., 2003. Lead: Assessing the Environmental Burden of Disease at National and Local Levels, Environmental Burden of Disease Series, No. 2, WHO, Geneva. Available at: https://iris.who.int/bitstream/handle/10665/42715/9241546107.pdf?sequence=1&isAllowed=y

EC, Revision of Directive 84/500/EC, 2017. Available at: https://food.ec.europa.eu/system/files/2017-11/cs_fcm_ceramic_presentation.pdf

EFSA,2011. EFSA Panel on Contaminants in the Food Chain (CONTAM), Scientific Opinion on tolerable weekly intake for cadmium, EFSA J. 9 (2), [151 pp.]. Available at: https://doi.org/10.2903/j.efsa.2011.1975

IARC - International Agency Rresearch Cancer,1993. Beryllium, Cadmium, Mercury, and Exposures in the Glass Manufacturing Industry, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Lion, France, Volume 58, ISBN-13, 978-92-832-1258-4. Available at: https://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/

International Organization for Standardization, 2019. ISO 7086-1:2019 Glass hollowware in contact with food — Release of lead and cadmium — Part 1: Test method, Available at: https://www.iso.org/standard/67562.html.

International Organization for Standardization, 2020. ISO 7086-2:2020 Glass hollowware in contact with food Release of lead and cadmium — Part 2: Permissible limits. Available at: https://www.iso.org/obp/ui/en/#iso:std:iso:7086:-2:ed-2:v1:en

International Organization for Standardization, 2019. ISO 6486-1:2019 - Ceramic ware, glass ceramic ware and glass dinnerware in contact with food — Release of lead and cadmium. Available at: https://www.iso.org/standard/67561.html.

IPCS, Inorganic Lead, World Health Organization, 1995 International Programme on Chemical Safety, Environmental Health Criteria 165, Geneva. Available at: http://www.inchem.org/documents/ehc/ehc/ehc165.htm

JECFA, 2011. Evaluation of Certain Food Additives and Contaminants: Seventy-fourth Report of the Joint FAO/WHO Expert Committee on Food Additives, WHO. Available at: http://apps.who.int/iris/bitstream/handle/10665/44788/WHO_TRS_966_eng.pdf?sequence=1

Li, Y., Zhang, J., 2021. Exposure to lead and cadmium of the Belgian consumers from ceramic food contact articles, Toxicology Reports 8, 548-556. doi:10.1016/j.toxrep.2021.02.015

Mania, M., Szynal, T., Rebeniak, M., Postupolski, J., 2018. Exposure assessment to lead, cadmium, zinc and copper released from ceramic and glass wares intended to come into contact with food. Rocz. Panstw. Zakl. Hig. 69(4), 405–411. doi: 10.32394/rpzh.2018.0047

Official Gazette of Republic of Macedonia No.1,2013. Rulebook for special requirements for the safety of ceramic products that come in contact with food. Available at: https://www.fao.org/faolex/results/details/en/c/LEX-FAOC150374/

Rebeniak, M., Wojciechowska-Mazurek, M., Mania, M., Szynal, T., Strzelecka, A., Starska, K., 2014.

Exposure to lead and cadmium released from ceramics and glassware intended to come into contact with food. Rocz. Panstw. Zakl. Hig. 65(4) 301–309, Available at: https://www.ncbi.nlm.nih.gov/pubmed/25526575

Sheets, R.W., 1997. Extraction of lead, cadmium and zinc from overglaze decorations on ceramic dinnerware by acidic and

basic food substances. Sci. Total Environ. 197(1-3), 167-175. doi:10.1016/S0048-9697(97)05431-4
Turner, A., 2018. High levels of migratable lead and cadmium on decorated drinking glassware. Science of The Total Environment 616–617, 1498-1504. doi: 10.1016/j.scitotenv.2017.10.164

Резиме

Изложеност на олово и кадмиум мигрирани од керамички и стаклени садови

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Клучни зборови: керамички производи за контакт со храна, стаклени производи за контакт со храна, тешки метали, максимално дозволено ниво на миграција

Миграцијата од керамички и стаклени садови наменети за контакт со храна е важен извор на внес на олово и кадмиум кај луѓето. Во овој труд се прикажани резултати од определување на олово и кадмиум, во примероци од керамички и стаклени садови, кои се достапни на пазарот во Република Северна Македонија. Беа анализирани 33 примероци, 16 керамички и 17 стаклени садови и истите беа поделени во по три категории, согласно Directive 84/500/EC и Сл. Весник на РМ, бр. 1/2013 за керамика и ISO 7086:2020 1, 2 за стакло. Концентрациите на металите беа определени со помош GF-AAS PerkinElmer Analyst 600, Autosampler model AS-800, систем со background корекција, соодветни ламби и пиролитички обложена графитна кивета, после соодветна подготовка. Добиените резултати покажаа дека концентрацијата на Pb во керамички садови од втора категорија е значително повисока од максималното дозволено ниво на миграција (МДК). Се смета дека мигрираното олово, потекнува од оловните бои, кои се нанесени во внатрешноста на садовите и несоодветно нанесената глазура кај истите. Добиените резултати покажаа дека концентрацијата на Pb во стаклените садови од прва категорија е значително повисока од максималното дозволено ниво на миграција (МДК). Се смета дека мигрираното олово, потекнува од целосната надворешна декорација. Од измерените и пресметани вредности за Pb во сите останати стаклените садови се забележува дека во испитуваните примероци од сите категории, не се надминуваат вредностите над МДК. Концентрациите на Cd не ги надминуваат МДК во сите 33 примероци.

Од вкупно тестираните 33 примероци, неисправни за употреба беа 10 % од керамички садови од втора категорија. Затоа, керамичките и стаклените садови што се пласираат на нашиот пазар потребно е да имаат соодветни декларации, особено за количеството на олово и кадмиум што може да мигрираат во храната. Потребно е да се води сметка при купувањето на вакви производи, посебно керамички, со цел да се намали ризикот по здравјето на населението.