Determination of the Specific Migration of Lead and Cadmium from Ceramicware in Contact with Foodstuff

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Food and beverage contamination by lead and cadmium occurs either in direct way or by contact with packaging, serving, cooking and/or store materials. In this study, we were interested in lead and cadmium migration into food in contact with ceramicwares. The quantities of these transferred from ceramic articles shall not exceed the limits: 0.3mg/L for cadmium and 4 mg/L for lead for objects can be filled, with a volume smaller than 3 liters, in accordance with European Directive 84/500/EEC. The analytical application of GFAAS method was tested with samples from Romania and China.

Keywords: lead and cadmium migration, GFAAS, ceramicware, material in contact

"Ceramic articles" means articles manufactured from a mixture of inorganic materials with a generally high argillaceous or silicate content to which small quantities of organic materials may have been added [1,2]. These articles must not transfer their constituents to foodstuffs in quantities that could endanger human health. Pb and Cd are environmental pollutants and their presence in food contact materials is regulated by specific EU directives.

Lead poisoning causes permanent neurological, hematological and growth problems [3]. Cadmium is an extremely toxic metal which has no known necessary function in the body. Cadmium toxicity contributes to a large number of health conditions, including the major killer diseases such as heart disease, cancer and diabetes.

In 2009, 160 ceramic samples (from EU/non-EU countries) were analyzed in Romania, for evaluation of metals in acidic extracts from ceramic objects by atomic absorption spectrometry [4]. Other studies were made on dairy products for determination of lead and cadmium contamination and it repercussion on total dietary intake [5].

In the present paper, we present the results regarding the evaluation of lead and cadmium from ceramicware (cups) manufactured in Romania and China using graphite furnace atomic absorption spectrometry (GFAAS) with a background correction.

Experimental part

Instrumentation

For lead, A GBS AVANTA PM atomic absorption spectrophotometer with a deuterium background correction and a GF PAL 3000 graphite furnace atomizer system was used. A lead hollow cathode lamp was used as radiation source at 217 nm. The optimum operating parameters for GFAAS are indicated in table 1.

For cadmium, A GBS AVANTA PM atomic absorption spectrophotometer with a deuterium background correction and a GF PAL 3000 graphite furnace atomizer system was used. A cadmium hollow cathode lamp was used as radiation source at 228.8 nm. The optimum operating parameters for GFAAS are indicated in table 2.

Table 1
OPERATING PARAMETERS FOR GFAAS

Parameters	
Lamp current (mA)	5.0
Wavelength (nm)	217
Slit (nm)	1.0
Air flow rate (L/min)	6 (stopped during atomizing)
Sample volume (µL)	10
Temperature program	
Drying	110^0 C (Ramp 10 s, Hold 20 s)
Ashing	400^0 C (Ramp 10 s, Hold 20 s)
Atomizing	2000^0 C (Ramp 1.2 s, Hold 2 s)
Cleaning	2200^0 C (Ramp 1 s, Hold 2 s)

The detection limit for lead and cadmium must be equal to or lower than:

-0.1 mg/L for lead;

-0.01 mg/L for cadmium.

Standard solution and reagents

Stock solutions containing 1000 mg/L of lead and 500 mg/L of cadmium respectively in a 4% acetic acid solution have been used. The tests were carried out at a temperature of 22 ± 2°C for duration of 24 h (to the dark - is important for the migration of cadmium). The sample must be clean and free from grease or other matter likely to affect the test. The samples were washed in a solution containing liquid detergent, after that they were rinsed and dried. The

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Table 2
OPERATING PARAMETERS FOR GFAAS

Parameters	
Lamp current (mA)	3.0
Wavelength (nm)	228.8
Slit (nm)	0.5
Air flow rate (L/min)	6 (stopped during atomizing)
Sample volume (μL)	10
Temperature program	
Drying	110^0 C (Ramp 20 s, Hold 10 s)
Ashing	300^0 C (Ramp 5 s, Hold 5 s)
Atomizing	1800^0 C (Ramp 0.8 s, Hold 1 s)
Cleaning	2000^0 C (Ramp 1 s, Hold 2 s)

Table 3
OPERATING PARAMETERS FOR GFAAS

	Lead (mg/L)	Cadmium (mg/L)
1.	0.1313	0.0072
2.	0.0130	0.0048
3.	0.0	0.0033
4.	0.0	0.0026
5.	0.0049	0.0039

surface to be tested is not to be handled after it has been cleaned.

The cups were filled with 4% (v/v) acetic acid solution to a level no more than 1 mm from the overflow point.

It was made a blank test on the reagent used for each series of determination. It is performed under appropriate conditions, determinations of lead and cadmium by atomic absorption spectrophotometry.

Results and discussions

The first results were obtained for different batches of cups manufactured in Romania and are presented in table 3.

It is obvious that the values obtained are below the lower limit allowed. For the next results, the situation will be the same.

The second results were realized for cups manufactured in China (different batches) and presented in table 4.

The last determination was made on the same batch (different cups) from Romania. The results are presented in table 5. Laboratory sample consists of 4 unique items like, identical material, shape, size.

Table 4
OPERATING PARAMETERS FOR GFAAS

	Lead (mg/L)	Cadmium (mg/L)
1.	0.0376	0.0248
2.	0.0213	0.0053
3.	0.0156	0.0011
4.	0.0	0.0012
5.	0.0	0.0029

Table 5
OPERATING PARAMETERS FOR GFAAS

	Lead (mg/L)	Cadmium (mg/L)
1.	0.0786	0.0006
2.	0.0746	0.0006
3.	0.0727	0.0006
4.	0.0763	0.0003
Average	0.07555	0.00055

Conclusions

Ceramic articles manufactured in Romania and China coming in contact with foodstuff, found on the Romania market and studied in this paper are safe from the point of view of heavy metals (lead and cadmium) content. All samples are bellow even more.

Research will continue, and in a future paper we will try to validate the method because it is an important problem for health and consumer protection.

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