ANALYSIS OF HEAVY METALS (LEAD AND CADMIUM) CONTAINED ON THE ILLUSTRATED CERAMIC PLATE BY ATOMIC ABSORPTION SPECTROPHOTOMETER

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ABSTRACT

Objective: This study aims to determine whether there are lead (Pb) and cadmium (Cd) metals caused by the dilution of color on a locally illustrated plate.

Methods: Illustrated ceramic plates soaked for ½, 1, and 2 hrs in acidic solution were then measured using atomic absorption spectrophotometer to the availability of Pb and Cd.

Results: The results showed that in the three samples of locally made illustrated ceramic plates gave contamination of Pb and Cd. The highest Pb content of metal contamination at the time of ½ hr immersion in the sample plate of the brand B was equal to 1.2539 ppm. At the time of 1 hr immersion in the sample plate of the brand, C was equal to 0.7737 ppm. The highest Cd content of metal contamination at the time of ½ hr immersion in the sample plate of the brand B was 0.2690.

Conclusion: The results of this study indicated that the locally made illustrated plate could cause pollution of Pb and Cd. These results suggested caution in the use of decorated ceramic plates, especially, for acidic foods and the need for further research for various brands of ceramic plates display in the market.

Keywords: Illustrated plate, Acidic food, Lead, Cadmium, Heavy metal contamination, Atomic absorption spectrophotometer.

INTRODUCTION

Discoloration on the paint that coats the surface of the plate can occur due to acidic fluid from food, so it is necessary to know the extent to which this discoloration occurs. Paint generally uses basic ingredients that contain heavy metals such as lead (Pb) and cadmium (Cd) [1-3]. Paint containing Pb carbonate (white) and Pb oxide (red) as much as 5-40%. The American Standards Association in 1955 determined that the cat toys, home furnishings, and interior residence must not contain more than 1% Pb. Groceries said not contaminated by Cd when it contains <0.05 µg per gram wet weight, and the average intake per day is approximately 50 µg [4]. The food samples such as maize, sorghum, soybeans, beans, millet, fennel, and herbal materials have been reported and contaminated by heavy metals [5-7].

Known hazardous heavy metals because it has a high density and some small concentrations can be toxic and dangerous. Harmful heavy metals into the system due to bioaccumulation meaning the amount of heavy metal that accumulates faster than the amount excreted and degraded [8-10]. Various heavy metals are toxic enzymes and toxins capillaries. Its toxic effects are not only based on a reaction mechanism but also will have the effect of work, and its role is unknown [11-13]. Cd and Pb studies using atomic absorption spectrophotometry (AAS) have been known since long ago [5,14].

This study aims to determine whether there is any metal contamination of Pb and Cd due to discoloration pictorial plates, as well as measuring the levels of each of the heavy metal by the method of AAS. The results of this study are expected to provide information about the contamination of heavy metals, especially, Pb and Cd in the discoloration pictorial plates as well as information regarding safety in use.

EQUIPMENT, MATERIAL, AND METHODS

Equipment
AAS AA–6501 S (Shimadzu).

Methods
The method used was modified from Adarna and Castañares [15], Villar *et. al*. [16], and Ewing [17] as well as following Manuals of AA6501S Shimadzu.

Method sampling was done randomly from a dozen locally pictorial ceramic plate. Taken three kinds of samples of graphic plates with different brands. Each sample was soaked with 40 mL of vinegar and cook for ½ hr, 1 hr, and 2 hrs. Taken each 5 mL and was added to the vial. Assay of Pb and Cd using AAS. The method was optimized based on the proper atomic lines for Pb (283.306 nm) and Cd (228.802 nm). The standard solutions (1000 mg/L Pb and 1000 mg/L Cd) available from Shimadzu Corporation. AAS was connected to a voltage source and a stabilizer. Floppy drive inserted, and monitor power was turned on. Air blowers and gas included. Fuel gas was opened with a pressure of 0.9 kgf/cm^2. Making the standard curve using standard solution. Sample absorbance was measured and plotted on a standard curve so that the concentration of the sample was then able to be calculated.

RESULTS AND DISCUSSION

Standard curve
A standard curve for each metal was examined based on the results measuring the absorbance of the standard solution of each metal with a broad range of concentrations. Standard curve to metallic Pb and Cd was set at 2, 4, 6, and 8 ppm and 8, 10, 12, and 14 ppm, respectively. Statistical software SPSS Version 10.0 was used for data analysis. The results of the calculation of the linear regression equation give correlation coefficient (r) 0.999-0.999 for the Pb and Cd metals.

Correlation coefficient approaching a value of 1 indicated that the line forms a nearly ideal linear relationship so that it can be used as a reference in determining the levels of metal contamination in the sample. A linear relationship is achieved if the value b=0 and r=+1 or −1 depending on the direction of the line. The value of a showed sensitivity analysis of the instrument used [18].

Levels of metals in samples
From the standard curve, the concentration of each metal can be used to calculate the concentration of each metal in the sample. The results of the assay of metal contamination in the sample display ceramic plates are as follows (Tables 1 and 2, Figs. 1 and 2).

This study showed that the samples analyzed pictorial ceramic plates contained metal contamination of Pb and Cd in varying concentrations. The big difference in the average metal content of Pb in samples per hour could be due to the speed and magnitude of the corrosion process, the process of printing images, and soaking time. In sample A, B and C contained elevated levels of Pb metal contamination at the date of immersion from ½ hr to 2 hrs; this was due to the solubility of Pb ions from the corrosion process.

From the research of metal Cd, contamination in the sample pictorial ceramic plates contained elevated levels every hour to samples A, B, or C. This could be caused by Cd ion solubility of the paint on the plate for a metal readily soluble in acidic conditions increases, in this case, 25% cooking vinegar was applied. In the sample A, metal Cd little experience corrosion process with vinegar cooked 25%, so AAS does not detect it with flame AA-6501 S, this could be caused by the process of printing images on a sample of a higher quality than the sample B or sample C.

Comparison of other similar results was not able to be carried out as no other related article found. Research on analysis of Pb and Cd was mostly done in other areas, such as on plants including *Ipomoea aquatica* [19,20], Jali, *Coix lacryma* [21], Green mustard, *Brassica rapa* and carrot, *Daucus carota* [22], Seagrasses, *Enhalus acoroides* [23], and on Crops Apu-Apu, *Pistia stratiotes* L. [24].

Statistical data analysis
The outcome levels of heavy metals on the ceramic plate picture obtained from the assay using AAS with flame AA-6501 S and performed statistical analysis using factorial experimental design in the General Linear Methods with SPSS statistical software version 11.5 by a factor of brand plates and time. Here is a Table 3 of variance analysis results on samples of ceramic plates display.

In statistical testing, Pb levels of the brand plate using ANOVA and the degree of confidence of 95% obtained a significant level of 0.462. By taking the value of α=0.05, then the value of significance for 0.462>α=0.05, which led to H0, which meant that the researcher had 95% confidence that there were no differences in the levels of real metallic Pb from each brand plate. The result said that the brand plates A, B, and C had the same relative levels of Pb. If follow-up testing was done with Duncan's test, it would be known that Brand A had different levels with brand B because they were in different groups. While the brand A there were no real differences in Pb levels with brand C, meaning that the degree of Pb for the brand A was almost equal to C, because of brand A and brand C were in the same group. At the brand, there were no real differences in Pb levels with brand C, meaning that the Pb standards for the brand B almost the same as brand C, for brands B and C names were in the same group. Table 4 shows highest metal content in sample B, followed by the sample C and the smallest amounts of Pb in sample A.

Statistically, Pb levels against dipping time, at the degree of confidence of 95% obtained a significant level of 0.035. By taking the value of α=0.05, then the significance value of 0.035<α=0.05, which led to H0, was rejected. Therefore, researchers had 95% confidence that there were
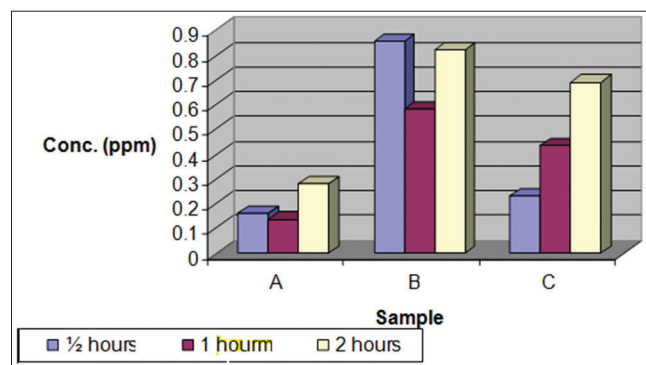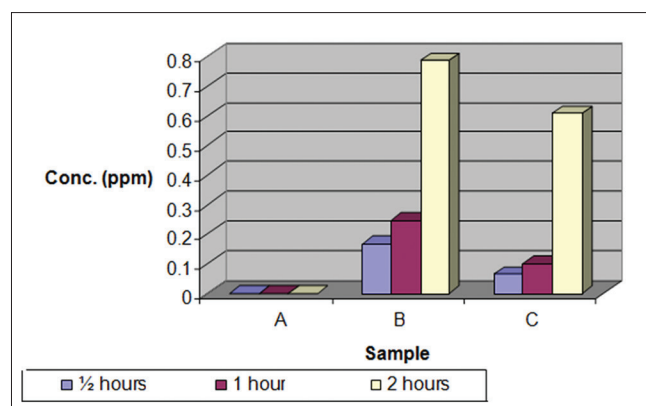

Fig. 1: Levels of lead in the ceramic sample

Fig. 2: Levels of cadmium in the ceramic sample

Table 1: Results of determination of levels of lead in illustrated ceramic samples (ppm)

Sample	Hour			
	n	½	1	2
A	1	0.1131	0.0062	0.2201
	2	0.2110	0.2722	0.3480
Mean		0.1620	0.1392	0.2840
B	1	0.4596	0.5015	0.5077
	2	1.2539	0.6667	1.1316
Mean		0.8567	0.5841	0.8196
C	1	0.3639	0.7737	0.6239
	2	0.1009	0.0978	0.7615
Mean		0.2324	0.4375	0.6927

A: Illustrated ceramic sample brand A, B: Illustrated ceramic sample brand B, C: Illustrated ceramic sample brand C

Table 2: Results of determination of levels of cadmium in illustrated ceramic samples (ppm)

Sample	Hour			
	n	½	1	2
A	1	ND	ND	ND
	2	ND	ND	ND
Mean		ND	ND	ND
B	1	0.2690	0.2906	0.8080
	2	0.0676	0.2034	0.7661
Mean		0.1683	0.2470	0.7870
C	1	0.0643	0.0997	0.6479
	2	0.0643	0.0997	0.5677
Mean		0.0643	0.0997	0.6078

ND: Not detected, A: Illustrated ceramic sample brand A, B: Illustrated ceramic sample brand B, C: Illustrated ceramic sample brand C

different levels of metallic Pb real at the time of immersion ½ hr, 1 hr, and 2 hrs. This meant that at the time of immersion ½ hr, 1 hr and 2 hrs have Pb levels were not the same. If follow-up testing was done with Duncan's test, it would be known that at the time of immersion ½ hr, 1 hr, and 2 hrs and there were no real differences in Pb levels because they were in the same group. From the results of a further test was seen that the soaking time 2 hrs had the highest standards of Pb metal (Table 5).

The interaction between Plate Brands against dipping time by using ANOVA, obtained the value of the significant level of 0.775. By taking the value of α=0.05, then the critical value of 0.775>α=0.05, which led to H0, therefore researchers had 95% confidence that there were no real differences in Pb levels due to the interaction between the brand plate with immersion time, meant soaking time did not affect the metal content of Pb in each brand plate.

Statistical methods for the Pb were also applied to the determination of Cd. It was found that there were different levels of real metal Cd from each brand plate. This meant that the brand plates A, B, and C had a metal content were not the same. By applying Duncan's test, it found that the three brands of these plates had different levels. From the results, this trial was seen that brand B had higher levels of the metal Cd was the highest, while the smallest standards of Cd metals contained in the brand A.

The significant level of 0.000 was found for Cd levels against dipping time. By taking the value of α=0.05, then the significance value 0.000<α=0.05, which led to H0, was rejected. Therefore, there were different levels of real Cd metal at the time of immersion ½ hr, 1 hr, and 2 hrs. By Duncan's test, it found that at the time of immersion ½ hr and 1 hr, there was no real difference because they were in the same group. As for the 2-hr soaking time had different levels with time soaking ½ hr and 1 hr of being in different groups. It was found that at the date of immersion 2 hrs had the highest levels of the metal Cd.

The interaction between brand dishes against dipping time using ANOVA found that there were real differences in levels of Cd because of the interaction between the brand plate with soaking time, meant soaking affected the metal content of Cd in each brand plate.

CONCLUSIONS

The results of this study indicated that the locally made illustrated plate could cause contamination of Pb and Cd. These results suggested caution in the use of illustrated ceramic plates, especially, for acidic foods and the need for further research for various brands of illustrated ceramic plates in the market. Furthermore, it can be suggested further study on the rate of accumulation of heavy metals in the blood or biological fluid after eating foods that use pictorial ceramic plates.

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Table 3: List of ANOVA for lead against metal assay brand plates and time

Sources of variation	db	JK	KT	P
Mean	1	3.932423	3.932423	
Time	2	0.158211	0.079106	0.462
Plate brands	2	0.937143	0.468571	0.035
Time*Brands	4	0.166347	0.041587	0.775
Mistake	9	0.844587	0.093839	
Total	18	6.038672		

Table 4: Duncan's test results continue to lead levels of brand plates

Sample	n	Group 1	Group 2
A	6	0.1951	
C	6	0.4536	0.4536
B	6		0.7535
Sig.		0.178	0.124

α=0.05

Table 5: Test results continue Duncan's lead levels against immersion time

Time	n	Group 1
1	6	0.3864
½	6	0.4171
2	6	0.5988
Sig.		0.280

α=0.05

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