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Determination of Lead and Cadmium Content in the Rice Consumed in Maracaibo, Venezuela

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Nowadays man's daily diet contains a series of residual substances, among them heavy metals, that act as contaminants and could severely upset the functions of his organism. It has been established (Friberg *et al.* 1979) that foodstuffs constitute the main source of cadmium (Cd) and lead (Pb) intake by the population not occupationally exposed to it:

Cd and Pb are widely distributed throughout the environment. It has been reported (Piscator 1985; Sherlock *et al.* 1993) that traces of these metals can be detected in all plants, animals and foodstuffs. The application of phosphate fertilizers every year deposits considerable amounts of Cd in farmlands, thus increasing its levels in soil (Ryan et al. 1982; Crisanto and Lorenzo 1993). Additionally, acid rain may increase the amount of Cd in the soil and expand the concentration of metals in agricultural products (Piscator 1985). In the case of Pb, the tetraethyl lead combustion products in gasoline are released into the atmosphere, becoming the major factors responsible for high Pb concentrations in air, water, soil and plants (Webb and Burley 1962; Burguera *et al.* 1988). The purpose of this study was to determine Cd and Pb concentration in the rice consumed in Maracaibo, Venezuela. To the best of the authors' knowledge and belief, there is no information available with respect to the toxic metals contained in the rice grown and consumed in Venezuela.

MATERIALS AND METHODS

Two samplings were taken at random from 11 commercial rice brands sold in the city of Maracaibo. Three samples were collected per brand and sampling lot, making a total of 66 samples. Almost all the rice produced in Venezuela comes from the States of Guarico and Portuguesa, located in central Venezuela.

The analytic determination of Cd and Pb in the rice samples was carried out in accordance with the "AOAC Official Methods of Analysis", using the 1990 methodology, via dry digestion followed by simultaneous quantification by differential pulse anodic stripping voltammetry.

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For each test, a sample of about 5 g of rice was exactly weighed, covered with 5.00 mL of K_2SO_4 solution at 10% p/v and sufficient deionized H_2O. The sample was kept all night in an oven at 115°C until it was thoroughly dry; it was then put into a muffle at 500°C for 10 hr. After cooling, the inner walls of the container were washed with the least possible quantity of deionized H_2O, and 2.00 mL concentrated HNO_3 was then added. The solution was dried thoroughly on a hot plate and then returned to the muffle for 30 min at 500°C. The treatment was immediately, repeated with 1.00 mL of HNO_3 and dried on the plate until a white solid, free of charcoal residues, was obtained. 1.00 mL of HNO_3 and five mL of deionized H_2O, were then added and shaken. The solution was then transferred, unfiltered, to a volumetric flask of 50 mL and diluted with deionized H_2O.

10.00 mL of the sample were transferred to an electrolyte cell containing 10.00 mL of the electrolyte (acetic acid 1.7 M, sodium acetate 1.25 M and tartaric acid 0.1 M); the pH of the solution was kept at 4.30 ± 0.30.

Differential pulse anodic stripping voltammetries were carried out on an HMDE (Princeton Applied Research polarograph, 174A), at a deposition potential of -0.800 V vs. Ag/AgCl reference electrode, sweeping range of 1.5 V, pulse amplitude of 25 mV and deposition time of 180 sec. The standard addition method was used, carrying out three determinations per sample solution. Blank solutions among 5-sample groups were analyzed. Cadmium and lead recovery percentages were assessed by spiking standard solutions on rice samples.

Analysis of variance was used for Statistical Analysis of the data (SAS. software ver. 6.04).

RESULTS AND DISCUSSION

Figure 1 shows typical anodic stripping voltammograms for a rice sample before and after adding two standard Cd and Pb solutions. The curve of the support electrolyte is also shown. When the standard additions are made, an increase in current at the same peak potential of the rice sample can be seen, indicating that the sample under study contains Cd and Pb.

The recovery mean for spiked samples was high, 90.2±8.5% for Cd and 98.0± 10.0% for Pb (0.80 µg spiked, n = 6, in each case). These values are comparable to those reported in the literature (Schumacher *et al.* 1991) when atomic absorption spectrophotometry is employed as the analysis technique.

Table 1 presents the results of Cd and Pb determination in the samples for each commercial brand of rice. The global interval for Cd was between 56.2 and 318.9 u µg/Kg with a mean of 179.3 µg/Kg. In the case of Pb, an interval between non-detectable (< 1.2 µg/Kg) and 595.0 µg/Kg, with a mean of 94.7 µg/Kg, was found. These results reveal that, on the average, the rice samples analyzed contain more Cd than Pb.

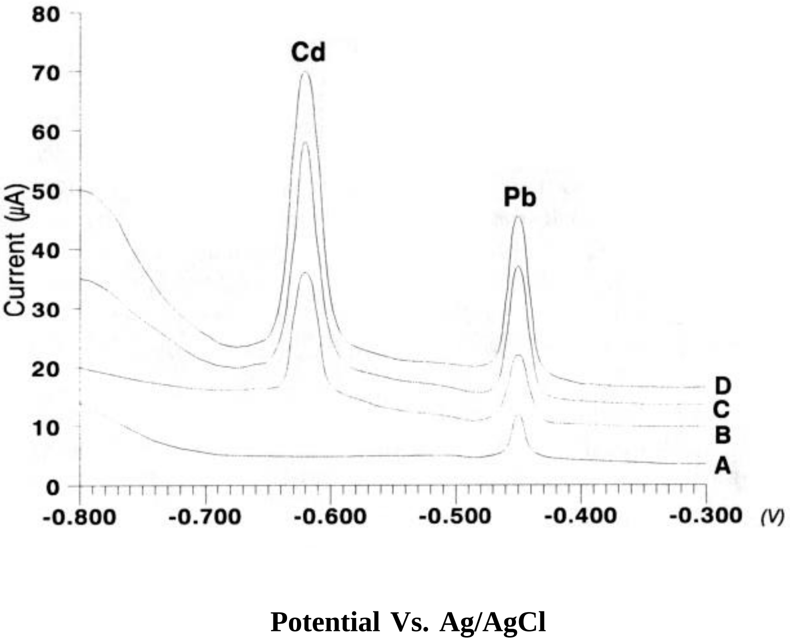

Figure 1. Typical Anodic Stripping Voltammograms for a sample of rice before the standard addition (B); After adding 0.15 µg of Pb and Cd (C); and after adding 0.30 µg of Pb and Cd (D). Supporting electrolyte (A).

The analysis of variance of mean Pb concentrations in the rice showed significant differences between the J brand (23.5 µg/Kg) and the remainder ($P < 0.05$). In the case of Cd, homogeneity was also observed between the levels of the samples analyzed. No significant differences ($P < 0.05$) were found between the mean values of the 11 brands analyzed, indicating that the cadmium content in the rice is independent of the commercial brand analyzed.

Pb levels found in the rice consumed in Maracaibo, Venezuela, are similar to those reported for rice in Spain (Schumacher *et al.* 1991). With respect to Cd, it was found that the global mean for the Venezuelan rice under study is greater than the one for rice in Japan (Rivai *et al.* 1990), but smaller than the one for Taiwan (Chen 1991)

Previous studies (Soto *et al.* 1992) have reported that daily rice consumption in Maracaibo is 60 g/person, for individuals weighing 70 Kg. This information was used to calculate the daily Cd and Pb intake, obtaining levels of 10.7 and 5.7 µg/person for Cd and Pb, respectively. These values represent 15.0% and 1.0% of the ones allowed by WHO, for the respective total daily Cd and Pb intake (60-70 µg/day and 430 µg/day, respectively). It has also been estimated (Piscator, 1985) that a total cadmium intake of 250 µg per day may cause kidney malfunction in a person weighing 70 Kg. Thus, the cadmium content found in the rice consumed in Maracaibo, represents 4.3% of the critical intake that may provoke adverse effects on the kidneys. Considering that rice represents only a small segment of its

Table 1. Cadmium and Lead (μg/Kg) in different rice brands.

BRAND	Cd Min.	Cd Max.	Cd Mean*	Cd C.V.	Pb Min.	Pb Max.	Pb Mean*	Pb C.V.
A	126.0	276.6	**190.9**	28	< 1.2	176.1	**73.6**	84
B	97.6	262.3	**179.7**	59	121.6	285.6	**214.6**	28
C	56.2	312.1	**142.0**	62	9.3	236.1	**61.7**	86
D	206.0	250.3	**221.2**	8	96.8	358.2	**146.2**	65
E	156.8	315.3	**234.6**	29	26.2	166.5	**67.0**	68
F	242.6	316.9	**266.4**	11	36.3	595.0	**126.5**	109
G	72.5	281.0	**170.1**	41	25.0	224.5	**107.9**	59
H	116.8	295.8	**185.8**	34	< 1.2	314.4	**99.4**	60
I	152.6	318.9	**230.8**	30	79.7	545.9	**192.2**	71
J	67.9	282.2	**151.0**	48	< 1.2	177.1	**23.5**	106
K	223.8	270.5	**250.4**	10	54.9	168.1	**93.9**	43

*n = 6
C.V. = Coefficient of variance.

daily diet, it is quite evident that the Cd intake through rice consumption in Maracaibo is relatively high.

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