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Aluminium Dissolved from Kitchen Utensils

E. Nagy, K. Jobst

Department of Clinical Chemistry, University School of Medicine, H-7623 Pécs, Hungary

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It was hardly more than 30 years ago that low-molecular weight amphoteric aluminium (Al) was found not to be a biologically indifferent element (Gruskin 1988, Röllin et al. 1991). In patients undergoing haemodialysis osteomalacia, dystrophy and encephalopathy have been described (Alfrey et al. 1947; Wills et Savory 1983). It has been established that generally, Al is deposited chiefly in the muscles and the brain; and, in larger amounts, in Alzheimer's disease (Crapper McLachlan et al. 1989). Animal experiments and tissue cultures have thrown light on the accompanying ultrastructural and biochemical changes (Bertholf et al. 1989).

While studying the kinetics of Al absorption on human material (Nagy and Jobst 1993) we used water boiled, by mistake, in an aluminium instead of a glass vessel. The high Al content of the water found on that occasion led to the present study.

MATERIALS AND METHODS

We examined the Hungarian "Alufix-Lucullus" products, which are commercially available kitchen utensils, aluminium pots and pans etc; also the aluminium coffee percolator made by the Hungarian MEIE factory and the soda water siphon made by the Lehel factory (Jászberény, Hungary) and widely used in Hungary. In order to remove Al_2O_3 from the aluminium utensils, they were treated with 0.1 M HCl for 5 minutes before every new boiling test. This was, however, not done in the case of the percolator and the siphon.

For comparison, enamelled and non stick pots, pans etc ("Teflon" - Polytetrafluoroethylene) and also glassware were used. As solvents, tap water from the water-supply of the city of Pécs (Hungary), distilled water, 2 % acetic acid and milk were chosen. In all cases 100 mL of each different solvent was boiled for 15 minutes in the different pots, pans. After cooling the volume was made up to 100 mL, which was followed by determination of the Al content (Poe et al. 1949; Trap and Cannon 1981; Inoue et al. 1988). We measured the amount of aluminium dissolved, under the effect of boiling hot water, in the material of an aluminium espresso percolator when filled with coffee and when empty. Before the aluminium determination the soda water prepared in aluminium or glass siphons was stored in a refrigerator at +5 °C for one week. Lipton tea and Coca-Cola, stored at temperatures between +5 - +25°C, as well as the "Garden" , Fruit Family juices (Hungary) with fibre, sold in paper boxes lined with Al foil and an apple juice with fibre from Germany were examined.

Correspondence to: K. Jobst

The measurements were made on a Varian SpektrAA20 atomic absorption spectrometer equipped with a GTA-96 graphite tube atomizer. The results are given in μg/L. Sensitivity of the method was 15 ng/L. The analytical method was validated by standard addition of aluminium. Repeated determinations showed the coefficient of variation to be less than 5 % (n=5).

RESULTS AND DISCUSSION

The amount of Al dissolved during the boiling of water (e.g., for tea) in an Al kettle was surprisingly high. In Hungary many dishes (e.g., stuffed cabbage) are prepared using definitely acidic ingredients, which occasionally are cooked for hours. If this is done in an Al vessel, particularly preferred for boiling milk the population may consume significant amounts of Al, which is not desirable.

The amount of Al dissolved from the material of a coffee percolator is shown in Table 2, while the Al content of soda water prepared in a "Lehel" aluminium siphon can be found in Table 3. Al was found in both drinks.

Table 1. Aluminium in liquids before and after boiling in different pots (μg/L) to methods.

		TYPE OF POT					
	SOLVENT	Aluminium		Teflon		Enamel	
Tap water	4.8	586	120X*	7.1	1.5X*	59.4	12X*
Distilled water	0.7	279	398X*	1.8	2.5X*	29.1	41X*
2% Acetic acid	1.9	1797	945X*	18	9.5X*	43	227X*
Milk	17.8	1920	108X*	25	1.4X*	32	1.8X*

* times pretreatment solvent value

Table 2. Aluminium in tap water and coffee before and after boiling (μg/L) to methods.

	TYPE OF VESSEL		
SOLVENTS	Teflon coffee pot	Aluminium percolator	
Tap water	7.1	175	25X*
Coffee	30.9	306	10X*

* times pretreatment solvent value

Table 3. Aluminium concentration in soda water prepared in glass and aluminium siphons stored in a refrigerator at +5 °C for one week (μg/L).

		TYPE OF SIPHON			
	SOLVENT	Chech glass		Hungarian "LEHEL" aluminium	
Tap water	4.8	6.6	1.4X*	368	77X*

* times pretreatment solvent value

The extremely high Al content present in some soft drinks (Table 4.) was surprising.

Table 4. The aluminium content of various soft drinks (μg/L).

KIND OF BEVERAGE	Aluminium concentration
"Lipton Eis Tee" (Lipton tea with lemon juice; FGR)	1800
Apple juice (FGR)	53
Grape juice (Hungarian "BB")	437
Apple juice (Hungarian "Heyho")	511
Pear juice (Hungarian "Garden")	910
Fruit Family (Hungarian)	550
Coca Cola	70

According to present-day knowledge Al does not rank among the essential elements (Gruskin 1988). In the Al industry, the toxic effect of Al taken up by inhalation is well known. With oral administration only about 10% of the Al salts is absorbed and then excreted by a healthy kidney (Henry et al. 1984). A problem may be posed by declining renal function. Under such conditions, increased storage of Al as a result of decreased clearance by a pathological or senile kidney is not out of the question (Bakir et al. 1986). Anyway, our experimental results caution us against the present extensive distribution and use of Al cooking utensils, on which our opinion needs revision.

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