

DETERMINATION OF SOME ESSENTIAL AND TRACE ELEMENTS BY NEUTRON ACTIVATION ANALYSIS IN DIETS CONSUMED BY STUDENTS OF UNIVERSITY OF SÃO PAULO, BRAZIL.

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ABSTRACT

In the present paper, the daily intake of some essential and trace elements Br, Ca, Cl, Co, Cr, Fe, K, Mg, Mn, Na, Rb, Sc and Zn was evaluated for the meals consumed by a group of students of the University of São Paulo(USP), during a period of 19 days. The diets were analysed, separately, by instrumental neutron activation analysis, followed by high resolution gamma-ray spectrometry. The daily dietary intake values found in this work were: **Ca** (0.62 ± 0.24), **Cl** (3.0 ± 1.4), **K** (1.6 ± 0.7), **Na** (5.8 ± 1.6) and **Mg** (0.14 ± 0.07) in $\text{g}\cdot\text{day}^{-1}$; **Br** (6.9 ± 2.3), **Fe** (17.0 ± 3.9), **Mn** (1.8 ± 0.7), **Rb** (6.8 ± 2.0) and **Zn** (14.8 ± 4.0) in $\text{mg}\cdot\text{day}^{-1}$; **Co** (36 ± 16), **Cr** (540 ± 238) and **Sc** (1.3 ± 0.5) in $\mu\text{g}\cdot\text{day}^{-1}$. These values are compared with that given by RDA and WHO.

INTRODUCTION

Estimations of essential and contaminant trace element intake through the daily diet are carried out periodically in many developed countries, in order to ascertain whether bodily needs are met in the first case and the risk of exceeding the provisional tolerable weekly intakes(PTWIs) or acceptable daily intakes(ADIs), in the case of contaminants like cadmium, mercury and lead.

Total diet studies as defined and recommended by the FAO/WHO (WHO,1976,1985) have been carried out for many years in the USA(Jonhson et al 1984), The UK (Peattie et al 1983), The Netherlands(Van Dokkum et al 1989) and other countries (Barberá et al, 1989; Chen & Gao, 1993). Total diet studies are also suitable for evaluating the nutritional quality of "national"diets(Van Dokkum et al,1989).

In Brazil the results of the first study of total diets from different regions and socio-economical conditions (Fávaro et al,1994) showed that the daily dietary intake values for Cd and Hg are lower than the acceptable daily intake levels and for Cu and Se are near the recommended values. The following study concerning the daily dietary intake of the essential elements in these diets showed that there is a risk of deficiencies in elements such as Ca, Cl, Cu, Fe, K, Mn, Na and Zn in some regions(Fávaro et al, 1997).

The purpose of the present investigation was to: 1) determine by using instrumental neutron activation analysis the content of some essential and trace elements in diets collected by duplicate portion technique, during 19 days; 2) compare observed intakes of essential trace elements with recommended daily dietary intakes as assessed by the FDA and WHO; 3) compare results with those obtained from other countries.

MATERIALS AND METHODS

1) **SAMPLING.** The meals breakfast, lunch and dinner were collected (3 samples per each meal) at the Central Cafeteria in the Campus of the University of São Paulo, used by students and staff, by served portion technique. The rest of the meal was not considered, however it was observed that most of students and staff intake all the foods served in the meals, there wasn't significant rest.

2) **PREPARATION AND STORAGE OF THE DIETS.** The meals collected were then transported to the Nutrition Laboratory of the FCF-USP. The preparation procedure was the same as described in the previous work (Favaro, 1994).

3) **DETERMINATION OF MINOR AND TRACE ELEMENTS BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS.** The individual or multielemental solutions were used as primary element standards. The synthetic standard preparation was described in our previous investigation(Fávaro, 1997). The reference materials

Total Diet (NIST SRM 1548) and Citrus Leaves (NIST SRM 1572) were used for checking the precision and accuracy of the method. Aliquots of approximately 200 mg of reference material and diet samples (weighed in pre-cleaned polyethylene bags) jointly the synthetic standard were irradiated in the IEA-R1 research reactor. By means of short irradiations (2 minutes) it was possible to determine the elements Cl, K, Mg, Mn and Na, after different cooling times. For long irradiations, the samples and standards were irradiated for 8 hours at the thermal neutron flux of $10^{12} \text{ n.cm}^{-2}.\text{s}^{-1}$ and after different cooling times, the following elements were determined: Br, Ca, Co, Cr, Fe, Na, Rb, Sc and Zn.

Spectra were accumulated in two gamma counting systems plus Ge detectors.

Spectrum analysis was performed by means of the VISPECT2 Software, developed by Dr. D. Piccot, from Saclay, France in TURBOBASIC language.

RESULTS AND DISCUSSIONS

The average food consumed was $628 \pm 78 \text{ g/day}$ (dry weight).

Table 1 presents the arithmetic means and their ranges obtained for the concentration of the 13 elements by instrumental neutron activation analysis in student's diet.

Table 2 shows the results obtained for daily intake in Student's diet and also compare them to the issued values for recommended daily intake of essential elements by World Health Organization (WHO), Recommended Daily Allowance (RDA) from Food and Nutrition Board, USA and other countries. Although the recommended daily allowances, RDA's, are not established for all elements, we may say that daily intakes of the elements by the subjects studied seem to be adequate or even near the recommendations. The relatively low intake of K and Mg by students in cafeteria is probably due to the low consumption of the high K/Mg content foods, such as fruits and vegetables. Concerning the high intake of Cr we may say that this was already verified in other Brazilian diets and we concluded that this was probably due to a contamination during the drying and homogenisation process of the diets (Fávaro, 1994).

The biological interest in Rb is stimulated by its relation with K and by its high concentration in human tissues. Some studies have been developed in order to study the essentiality of this element, but it was not verified yet. (Davie & Coleman 1988). The Rb daily intake obtained in the present work was higher than that obtained in other countries.

Neutron Activation Analysis is a powerful technique that allows the determination of several essential and trace elements in diets and consequently the assessment of the nutritional status of a group of population.

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Table 1

Elemental Concentrations in dried Student's diet, arithmetic means and their ranges, by using instrumental neutron activation analysis.

Elements	X_{arith}	Range	Elements	X_{arith}	Range
Br ($\mu\text{g/g}$)	12.4 ± 5.1	5.2 - 29.4	Mg ($\mu\text{g/g}$)	719 ± 216	363 - 1128
Ca ($\mu\text{g/g}$)	1364 ± 785	554 - 6546	Mn ($\mu\text{g/g}$)	8.2 ± 1.9	4.7 - 14.3
Cl (mg/g)	13.3 ± 3.6	6.5 - 19.5	Na ($\mu\text{g/g}$)	9493 ± 2762	4455 - 15311
Co ($\mu\text{g/g}$)	0.06 ± 0.03	0.01 - 0.14	Rb ($\mu\text{g/g}$)	11.6 ± 3.6	5.0 - 25.6
Cr ($\mu\text{g/g}$)	1.18 ± 1.12	0.23 - 5.6	Sc (ng/g)	2.4 ± 1.1	0.9 - 7.1
Fe ($\mu\text{g/g}$)	29.8 ± 6.9	11.8 - 52.1	Zn ($\mu\text{g/g}$)	23.5 ± 9.4	11.6 - 53.5
K ($\mu\text{g/g}$)	7081 ± 1615	3202 - 9913			

TABLE 2

Comparison of the daily intake obtained in the present work with intake in different countries (Liu, 1992) and recommended values by WHO and RDA.

country	Taiwan	Japan	Turkey	Germany	Norway	USA	Brazil	WHO	RDA ^a
Br (mg/day)	4.16	-	2.71	2.5	-	2.75	6.9	1 ^e	-
Ca (g/day)	0.47	0.56	0.65	0.38	-	0.70	0.62	0.4 - 0.5	0.8 - 1.2
Cl (g/day)	3.50	-	-	6.00	-	-	3.0	-	0.75 ^b
Co ($\mu\text{g/day}$)	28	-	27	17	7.3	-	36	-	3 ^f
Cr ($\mu\text{g/day}$)	92	-	49	62	29	-	540	-	50-200
Fe (mg/day)	8.03	-	16.7	13.9	10.1	18.4	17.0	10 (male) 20 (female)	10 ^c 15 ^d
K (g/day)	1.68	1.9	2.38	2.40	2.54	3.45	1.6	-	2.0 ^b
Mg (g/day)	0.17	0.20	0.30	0.31	-	0.24	0.14	0.300	0.35 ^c 0.28 ^d
Mn (mg/day)	2.8	3.4	8.4	2.7	-	2.4	1.8	2 - 3	2.0-5.0
Na (g/day)	2.75	4.5	4.34	4.50	2.97	4.70	5.8	-	0.5 ^b
Rb (mg/day)	1.67	-	1.89	1.9	1.77	-	6.8	-	-
Sc ($\mu\text{g/day}$)	0.2	-	0.20	1.0	0.20	-	1.3	-	-
Zn (mg/day)	7.29	7.1	11.3	11.8	7.14	12.8	14.8	10-15	15 ^c 12 ^d

^a Recommended dietary allowance or estimated safe and adequate daily dietary intake

^b Minimum Requirements of Healthy Persons (RDA, 1989)

^c RDA values for males

^d RDA values for females

^e Br (WHO)=1mg bromide ion per kilogram body weight per day.

^f Recommended daily dietary allowances in terms of B₁₂