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INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF TEA

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ABSTRACT

Concentrations of K, Br, Ce, Cs, Sb, Hg, Cr, Sc, Rb, Fe, Co, Eu and La have been determined by instrumental neutron activation analysis using a high - resolution Ge(Li) detector and 4096 multichannel gamma - ray spectrometer in various brands of tea produced in Turkey. Beside potassium, rest of the elements remained at the left - over after hot water extraction. No heavy metal enrichment has been observed.

ÖZET

Enstrumental nötron aktivasyon analizi ile Türkiye'de üretilen değişik marka çaylarda, yüksek ayırma güçlü Ge (Li) dedektörü ve 4096 çok kanallı gama - ışını spektrometresi kullanılarak K, Br, Ce, Cs, Sb, Hg, Cr, Sc, Rb, Fe, Co, Eu ve La miktarları tesbit edilmiştir. Potasyum haricinde diğer elementler demlenme neticesinde posada kalmışlardır. Hiçbir ağır metal zenginleşmesi gözlenmemiştir.

INTRODUCTION

Activation analysis has been used for many years to determine the trace and major elements in various media, as the sensitivity of this method allows detection limits of a nanogram or less for a large proportion of the elements in the periodic table.

Tea is one of the most popularly accepted beverage all over the world, and annual consumption reaches to great amounts. Although its manufacturing process has been very well studied, little is known about the trace element concentration [1], which may vary considerably from place to place where it is grown. In this work, beside the measurement of concentrations of trace elements, it was tried to determine the amount that is consumed by man after usual hot water extraction.

EXPERIMENTAL

Samples taken from different brands of tea were weighed into previously cleaned polyethylene containers and heat - sealed. Necessary

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precautions were taken in order to eliminate possible contaminations. National Bureau of standards' environmental coal standard reference material was used as standard [2].

Irradiations have been carried out in TR - 1 research reactor at a flux of about 10^{13} n/cm^2 - sec. for 4 to 6 hours. After irradiation, the samples were transported to the laboratory and cooled for about one day before taking the first spectrum (Fig. 1). Second spectrum was taken nearly one month after the irradiation (Fig. 2).

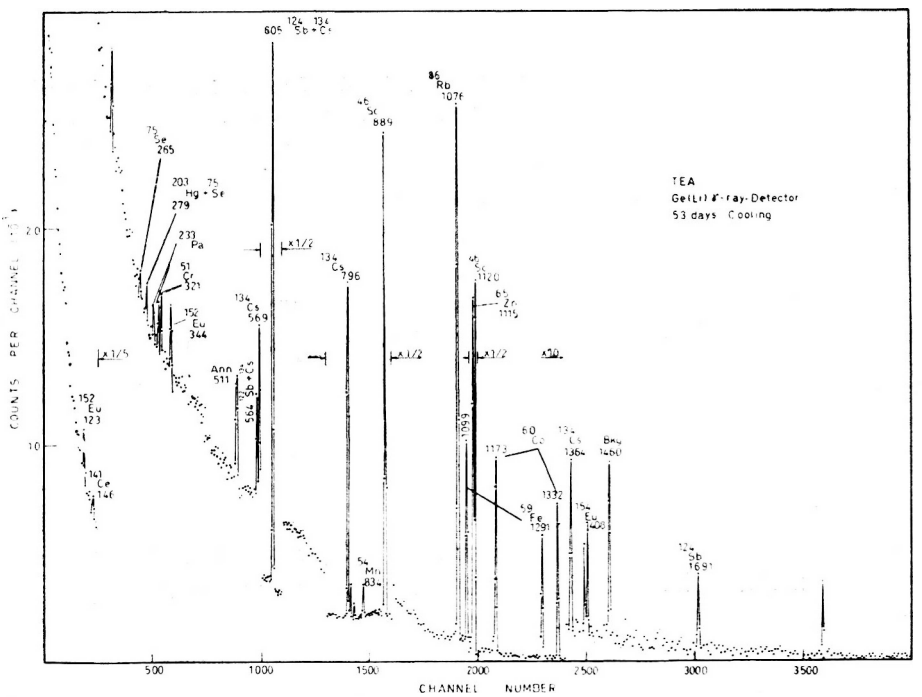

Fig. 1. Gamma - ray spectrum of tea sample after 3 days of cooling

RESULTS AND DISCUSSION

In Table - 1 production and properties of nuclides that are observed after thermal neutron activation of tea are given.

Table - 2 shows the concentration of elements determined in various brands of tea and ground coffee (for comparison). For all samples the values reported are the averages of two determinations except for coffee. As it is seen from the table there is no indication of enrichment of any element, especially from the point of view of toxic metals. For example as reported by several authors the mercury level in tea is around 0.02 - 0.1 ppm. [1, 3].

TABLE — 1. Production and Properties of Nuclides Observed

Element	Nuclear Reaction	Target Isotopic abound. (%)	Product Nuclide t 1/2 (day)	Best photopeaks for determ. (KeV)
K	^{41}K (n, γ) ^{42}K	6.88	0.52	1525
Sc	^{45}Sc (n, γ) ^{46}Sc	100.00	84.00	889,1120
Cr	^{50}Cr (n, γ) ^{51}Cr	4.31	27.80	320
Fe	^{58}Fe (n, γ) ^{59}Fe	0.33	45.00	1099, 1291
Co	^{59}Co (n, γ) ^{60}Co	100.00	1916.30	1173, 1332
Se	^{74}Se (n, γ) ^{75}Se	0.87	120.40	264
Br	^{81}Br (n, γ) ^{82}Br	49.46	1.48	554, 619, 777
Rb	^{85}Rb (n, γ) ^{86}Rb	72.15	18.70	1076
Sb	^{123}Sb (n, γ) ^{124}Sb	42.75	60.30	1691
Cs	^{133}Cs (n, γ) ^{134}Cs	100.00	748.25	796, 802
La	^{139}La (n, γ) ^{140}La	99.91	1.67	1596
Ce	^{140}Ce (n, γ) ^{141}Ce	88.48	33.00	146
Eu	^{151}Eu (n, γ) ^{152}Eu	47.82	4526.00	344
	^{153}Eu (n, γ) ^{154}Eu	52.18	5840.00	1274, 1408
Hg	^{202}Hg (n, γ) ^{203}Hg	29.80	46.57	279
Zn	^{64}Zn (n, γ) ^{65}Zn	48.89	243.80	1115
Ba	^{130}Ba (n, γ) ^{131}Ba	0.10	12.00	496
Mn	^{55}Mn (n, 2n) ^{54}Mn	100.00	313.00	834
Pa	^{232}Th (n, γ) ^{233}Th	100.00	27.40	300, 312
	^{233}Th β — ^{233}Pa			

TABLE — 2. Concentration of Elements (ppm)

Element	Tea A	Tea B	Tea C	Coffee
K[a]	1.80 ∓ 0.1	1.70 ∓ 0.1	1.80 ∓ 0.2	1.3
Sc	0.15 ∓ 0.05	0.08 ∓ 0.01	0.10 ∓ 0.01	0.007
Cr	1.28 ∓ 0.1	1.25 ∓ 0.2	0.60 ∓ 0.2	0.45
Fe	420.00 ∓ 20.0	380.00 ∓ 30.0	220.00 ∓ 40.0	64.0
Co	0.40 ∓ 0.06	0.46 ∓ 0.01	0.48 ∓ 0.01	0.17
Se	N. O.	N. O.	0.007 ∓ 0.001	N. O.
Br	4.71 ∓ 0.2	5.36 ∓ 0.2	4.38 ∓ 0.2	2.44
Rb	110.00 ∓ 5.0	130.00 ∓ 5.0	96.00 ∓ 3.0	65.4
Sb	0.18 ∓ 0.05	0.12 ∓ 0.05	0.15 ∓ 0.05	0.057
Cs	0.25 ∓ 0.1	0.47 ∓ 0.05	0.71 ∓ 0.05	0.13
La	0.59 ∓ 0.1	1.93 ∓ 0.3	2.25 ∓ 0.3	—
Ce	0.87 ∓ 0.2	0.25 ∓ 0.1	0.23 ∓ 0.1	—
Eu	0.02 ∓ 0.005	0.01 ∓ 0.001	0.01 ∓ 0.001	N. O.
Hg	0.02 ∓ 0.005	0.05 ∓ 0.01	0.03 ∓ 0.01	0.030

a. : values in %

N. O. : not observed.

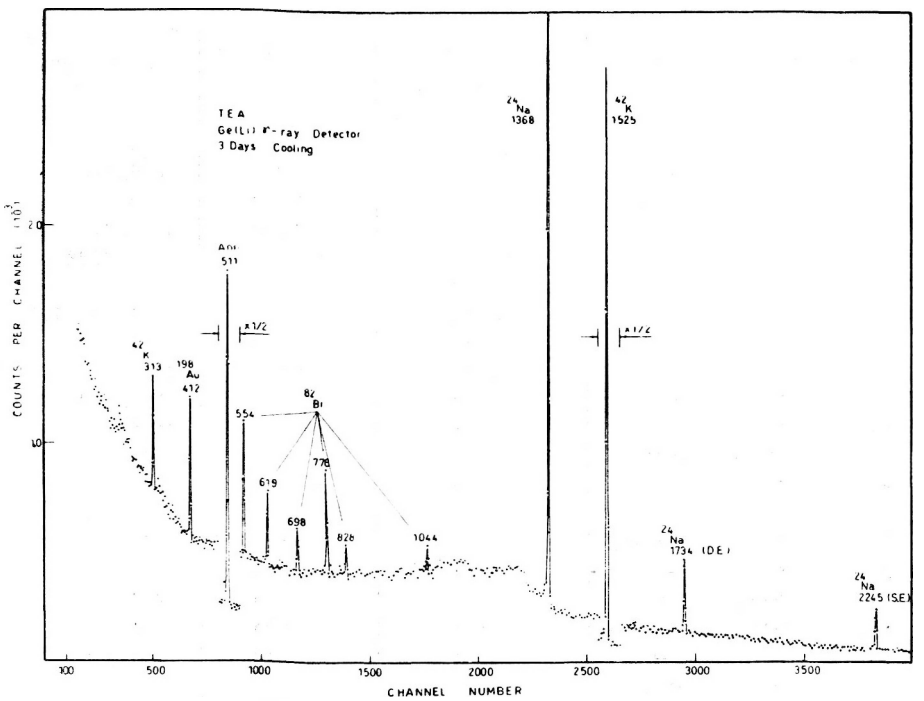

Fig. 2. Gamma - ray spectrum of tea sample after 53 days of cooling

Samples prepared by drying the leftover after hot water extraction of tea, irradiated along with the incontact samples, analyzed for minor and major elements. Beside potassium, whose 88.8 % passed into the water, non of the other elements extracted into the water phase.

The results of this work are clear enough to verify any doubt invalid about heavy metal pollution of Turkish tea. In another phase of this work, which is undertaken by the nuclear chemistry group, samples taken from each stage of tea processing and soil have been analyzed by instrumental neutron activation analysis and atomic absorption spectroscopy which will be published separately.

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