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Differences in Concentration of Essential and Toxic Elements in Peanuts and Peanut Oil

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ABSTRACT

Two varieties of peanut (Arachis hypogeaea), *which grow in two different areas of Greece, were analysed for essential and toxic elements by atomic absorption spectroscopy (AAS).*

Differences in concentrations, probably depending on the growing area, were observed for seven elements (Ca, Mg, Cu, Fe, Zn, Co and Pb).

Higher concentrations of Ca, Mg, Co and Pb were found in the oil-free material of the Serron variety (continental area), while the Kalamon variety (coastal area) showed higher concentrations of Cu, Fe and Zn.

The contents of these elements in the peanut oil are significantly different in the two varieties.

Significant variations also appear in the concentrations of the water- and fat-soluble salts of the elements studied. Discussion of the results is based on statistical treatment of the data.

INTRODUCTION

Plants usually contain essential and toxic elements in a variety of concentrations. They are also contaminated by polluted air and soil originating from industrial or domestic wastes and agriculture.

Peanuts are widely used as a food for both humans and animals (Woodroof, 1969) and have been the subject of a number of studies (De & Chatterjee, 1976; Sekhon *et al.*, 1978; Noller & Bloom, 1978).

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Several methods have been applied to the investigation of major and trace elements in peanuts. Atomic absorption spectroscopy (AAS) and wet-ashing or digestion (Yano *et al.*, 1978), wet and dry mineralization (Roszyk *et al.*, 1977), flameless AAS and AES (atomic emission spectroscopy) (Noller & Bloom, 1978) and neutron activation analysis (Kabeya *et al.*, 1979; Grimanis *et al.*, 1981) are some of these. In this investigation, AAS and wet digestion (Simpson & Blay, 1966) were applied to determine seven elements (Ca, Mg, Fe, Cu, Zn, Co and Pb) in raw and roasted oil-free peanuts of two Greek varieties (Serron and Kalamon). The same elements were determined by AAS (Guillaumin, 1966) in the peanut oil. The purpose of the present work was to determine if there are differences in the concentrations of the above elements in the two varieties of peanuts and their oil.

MATERIAL AND METHODS

Solutions

(1) Aqueous stock standard solutions of Ca (500 ppm), Mg (1000 ppm), Cu (1000 ppm), Fe (1000 ppm), Zn (500 ppm), Co (1000 ppm) and Pb (1000 ppm).
(2) 8·4N HCl solution (500 ml concentrated HCl + 220 ml H_2O).
(3) La solution, 5% w/v (5·86 g La_2O_3 dissolved in 25 ml concentrated HCl and diluted to 100 ml with H_2O).
(4) La solution, 1% w/v (5·34 g $LaCl_3 . 7H_2O$ dissolved in 200 ml of a mixture of methanol and isoamyl acetate (1:1)).
(5) Working standard solutions for the oil-free material (stock solutions properly diluted with H_2O).
(6) Working standard solutions for the oil (stock solutions properly diluted with methanol:isoamyl acetate (1:1)).

Working standard solutions of Ca were diluted with La solutions (1% La for oil and 5% La for oil-free materials).

Apparatus

A series of Soxhlet extractors for the extraction of peanut oil.

A Perkin Elmer Model 560 atomic absorption spectrophotometer for the determination of the elements.

A Memmert TYPE U 30 oven with controlled temperature for drying and roasting.

Sample preparation

(1) Roasting of the peanuts of both varieties at 180 °C for 30 min.
(2) Separated homogenization of four groups I, II (Kalamon raw and roasted), III and IV (Serron raw and roasted) and drying of ten samples from each group to constant weight (*ca.* 5 h) at 95–100 °C (AOAC, 1975).
(3) Extraction of the forty dry samples with petroleum ether for 16 h (AOAC, 1975).
(4) Each of the forty dry, oil-free samples was treated as follows: 2·0–2·5 g of the sample were boiled with 25 ml of a 8·4N HCl solution for 10 min. After cooling the sample was diluted to 50 ml with distilled water, mixed and filtered. The filtrate was analysed by AAS for Mg, Fe, Cu, Zn, Co and Pb. For Ca determination, an appropriate aliquot of the above filtrate, after addition of 10 ml of a 5% La solution and 25 ml of the 8·4N HCl solution, was diluted to 50 ml with distilled water.
(5) Each of the forty oil-samples was dissolved in a mixture of methanol–isoamyl acetate (1 : 1) and analysed. For Ca analysis the samples were dissolved in a 1% La solution.

RESULTS AND DISCUSSION

Table 1 shows the differences in water content between the two varieties, Kalamon (coastal area) and Serron (continental area), in raw and roasted samples. The oil content of the four groups I, II, III and IV seems to be about the same.

As Table 2 shows, the concentrations of the major elements, Ca and Mg, as well as of the trace elements, Co and Pb, are higher in the Serron than in the Kalamon variety. This difference, as far as Co is concerned, may be due to the composition of the soil, which, according to Labuza (1977), is poor in Co in certain coastal areas.

The relatively high concentrations of Pb in groups III and IV (Serron variety) can be related to air pollution (leaded gasoline) from heavier

traffic in the inland, compared with the coastal, areas. Higher concentrations of Cu, Fe and Zn were found in groups I and II. The results in Table 2 show, in general, no significant differences in the concentrations of the elements examined between raw and roasted peanuts, with the exception of Co, which appears to be higher in group I than in group II.

Table 3 shows the results for the concentrations of the seven elements in peanut oil. Some of the elements considered show significant, but not consistent, differences between the four groups (*t*-test for the 95%

TABLE 1
Mean Values of Moisture and Oil Contents in Peanuts[a]

Analysis of	*Group*			
	Kalamon (Coastal area)		*Serron (Continental area)*	
	Raw (I)	*Roasted (II)*	*Raw (III)*	*Roasted (IV)*
Moisture (%)	8·17 ± 0·07	1·83 ± 0·03	5·52 ± 0·06	1·58 ± 0·03
Fat (%)	51·00 ± 0·18	50·35 ± 0·29	50·29 ± 0·27	50·57 ± 0·13

[a] Errors given are the standard deviations of the mean for $n = 10$.

confidence level). A comparison of the data in Tables 2 and 3 shows, for Ca, Mg, Zn and Cu, higher concentrations in oil-free peanuts than in their oil. The reason for this difference is probably that these metals are more strongly bound to the proteins of the peanuts. Co and Pb, on the contrary, appear more strongly bound to the oil, with the exception of the Serron variety, which shows higher concentrations for Pb in oil-free material.

No strict environmental control was exercised during the growing of the peanuts and, accordingly, there is no certainty that the levels found in the present work are invariably characteristic of the peanuts examined.

The results given in the discussion are based on statistical treatment of the experimental data (average values from ten samples, standard deviations, *t*-test).

TABLE 2
Mean Metal Concentrations (ppm) in Oil-free Peanuts and Corresponding *t*-Values Between Groups[a]

Metal	*Group*							
	Kalamon		*Serron*		*t-Values (experimental)*			
	Raw I	*Roasted II*	*Raw III*	*Roasted IV*	t_{I-II}	t_{I-III}	t_{II-IV}	t_{III-IV}
Ca[b]	0·20 ± 0·01	0·21 ± 0·01	0·25 ± 0·01	0·26 ± 0·01	2·12	10·61	10·60	2·12
Mg[b]	0·29 ± 0·01	0·28 ± 0·01	0·40 ± 0·01	0·38 ± 0·01	2·12	23·33	21·21	4·24
Cu	25·13 ± 0·50	25·35 ± 0·28	20·41 ± 0·36	19·64 ± 0·41	1·15	23·19	20·08	4·23
Fe	67·58 ± 2·10	69·20 ± 2·14	57·44 ± 0·70	58·07 ± 1·03	1·62	13·74	14·06	1·52
Zn	89·37 ± 3·00	92·94 ± 1·87	78·32 ± 3·14	77·07 ± 2·65	3·02	7·63	14·68	0·91
Co	3·58 ± 0·17	3·08 ± 0·14	8·09 ± 0·40	8·65 ± 0·30	6·81	31·13	50·47	3·36
Pb	5·33 ± 0·25	5·06 ± 0·20	27·58 ± 0·72	27·17 ± 0·73	2·53	87·58	68·67	1·20

[a] Errors given are the standard deviations of the mean for $n = 10$. Critical value of t for 18 degrees of freedom and 5% probability level is 2·101.

[b] Values for Ca and Mg are percentage concentrations.

TABLE 3
Mean Metal Concentrations (ppm) in Peanut Oil and Corresponding *t*-Values Between Groups[a]

Metal	*Group*							
	Kalamon		*Serron*		*t-Values (experimental)*			
	Raw I	*Roasted II*	*Raw III*	*Roasted IV*	t_{I-II}	t_{I-III}	t_{II-IV}	t_{III-IV}
Ca	60·02 ± 1·45	64·84 ± 2·04	59·38 ± 0·98	57·84 ± 1·96	5·77	1·09	7·42	2·11
Mg	21·55 ± 0·54	21·10 ± 0·48	19·69 ± 0·41	20·34 ± 0·23	1·87	8·22	4·28	4·14
Cu	2·22 ± 0·06	2·18 ± 0·09	2·36 ± 0·05	2·34 ± 0·03	1·11	5·38	5·06	1·03
Fe	22·19 ± 0·35	23·58 ± 0·25	23·76 ± 0·38	23·20 ± 0·41	9·69	9·12	2·37	3·00
Zn	4·41 ± 0·19	4·38 ± 0·11	6·36 ± 0·23	5·36 ± 0·24	0·41	19·61	11·14	9·02
Co	9·82 ± 0·18	9·50 ± 0·16	9·05 ± 0·25	9·40 ± 0·25	3·99	7·49	1·01	2·97
Pb	25·84 ± 0·56	23·83 ± 0·38	22·50 ± 0·29	24·56 ± 0·45	8·91	15·89	3·72	11·54

[a] Errors given are the standard deviations of the mean for $n = 10$. Critical value of t for 18 degrees of freedom and 5% probability level is 2·101.

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