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Elemental Composition of Tree Nuts

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Growing nut trees is becoming ever more popular among home gardeners and publications dealing with their culture have recently appeared (JAYNES 1969, MACDANIELS 1976). Data on the elemental composition of nuts is very limited with values reported for only a few elements (LISK 1972). Several other publications have dealt with the detection of elements in various tree parts but not nuts (WARREN and DELAVAULT 1962, ROBINSON et al. 1958, HEICHEL and HANKIN 1972, and SHEPPARD and FUNK 1975). In the work reported, a variety of common nuts was analyzed for 46 elements using neutron activation and other methods.

EXPERIMENTAL

At least a pound of each of a variety of nuts was obtained by harvesting or purchasing them locally. The nuts included acorn (Quercus ruba), almond (Prunus dulcis), black walnut (Juglans nigra), Brazil nut (Bertholletia excelsa), butternut (Juglans cinera), cashew (Anacardium occidentale), coconut (Cocos nucifera), English walnut (Juglans regia), hazelnut or filbert (Corylus avellana), hickory nut (Carya ovata), pecan (Carya illinoensis) and pistachio (Pistacia vera). The edible meat portion of the nuts was milled to a fine consistency, mixed and freeze-dried. The dry material was subsampled for analysis.

Thirty-nine elements were determined using nondestructive neutron activation analysis by the procedure described earlier (Furr et al. 1976). Lead, nickel and cadmium were determined by atomic absorption spectrophotometry following dry ashing of the samples at 475° C. Fluorine was determined by combustion of the samples in an oxygen-filled polypropylene flask followed by analysis of the absorbing solution (distilled water) using the specific fluoride ion electrode. Boron was determined by the curcumin spectrophotometric method of GREWELING (1966). Arsenic was determined by dry ashing (EVANS and BANDEMER 1954) the samples, distilling arsine and analysis using the silver diethyldithiocarbamate colorimetric procedure (FISHER SCIENTIFIC CO. 1960). Selenium was determined by the fluorimetric method of OLSON (1969).

RESULTS AND DISCUSSION

The results of elemental analysis of the nut samples are presented in Table 1. A number of elements appear elevated in

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TABLE 1
Elemental Content of Nuts.

Element	Parts per million (dry weight) in: Acorn	Almond	Black walnut	Brazil nut	Butternut	Cashew	Coconut	English walnut	Filbert	Hickory nut	Pecan	Pistachio
Al	8.2	3.2	2.9	5.0	2.6	2.0	7.2	1.1	2.6	2.6	11	9.0
As	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Au	0.001	0.001	0.001		0.001				0.003	0.001	0.001	0.002
B	18	18	4.7	2.7	7	3.2	5.2	12	21	8.5	6.5	11
Ba	0.1	2.6	8.7	1764	1.6	0.1	0.1	1.4	1.1	0.1	14	0.1
Br	1.6	20	2.5	87	1.5	1.2	4.0	76	1.8	1.4	1.5	16
Ca	947	2720	668	1592	724	355	71	1173	2591	1095	618	1066
Cd	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.05	0.08	0.03	0.04
Ce			0.4	1.2			0.2					
Cl	49	28	54	246	78	184	1007	69	41	71	46	408
Co	0.2	0.2	0.3	1.9	0.2	0.1	0.2	0.3	0.3	0.2	0.4	0.2
Cr	0.9	1.7	1.0	0.6	1.4	0.3	0.2	0.6	0.7	1.6	0.3	0.6
Cs		0.1	0.1	1.3	0.02	0.1	0.1		0.1	0.1	0.3	0.1
Cu	7.0	14	19	18	8.4	37	33	14	22	7.8	15	33
Eu	0.01	0.1	0.01	0.1	0.02	0.02	0.1	0.03	0.03	0.02	0.01	0.1
F	1.3	1.3	1.6	1.7	1.1	1.4	2.7	1.2	1.2	1.3	1.6	3.8
Fe	81	54	73	93	76	91	75	72	99	32	73	46
Hf	0.1	0.04	0.1			0.02		0.05	0.1	0.1	0.1	
Hg	0.01	0.1	0.1	0.01	0.01	0.01	0.1	0.01	0.05	0.01	0.1	0.1
I	0.1	0.1	0.1	0.2	0.1	0.1	0.3	0.1	0.03	0.1	0.1	51[a]

K	8485	6346	5154	5405	7493	5838	5915	3266	6659	5361	3971	8639
La	0.04	0.03	0.03	0.1	0.03	0.02	0.1	0.03	0.02	0.03	0.02	0.02
Lu	0.01	0.01	0.02	0.01	0.004	0.01	0.01	0.01	0.03	0.01	0.01	0.01
Mg	500	2297	1794	3370	2676	1886	770	1376	1664	900	980	949
Mn	3.9	14	30	8.0	31	8.4	9.6	12	27	58	30	3.4
Mo	0.6	0.3	0.4		0.4	0.1	0.03	0.1	0.6	0.1		
Na	6.0	20	3.1	7.2	2.7	257[a]	626	4.2	3.3	2.8	5.0	538[a]
Ni	0.4	1.6	4.8	5.8	4.3	5.0	2.1	1.1	1.8	9.8	1.6	1.1
Pb	0.01	0.4	0.6	0.4	0.3	0.3	0.7	0.4	1.7	0.4	0.3	0.8
Rb	5	13	9.3	103	2.5	35	16	2	4	4	22	10
S	1160	3520	2652		2870	4800		2470	2070	2180	800	960
Sb	0.2	0.1	0.1	0.1	0.05	0.3	0.1	0.1	0.1	0.1	0.2	0.05
Sc	0.003	0.003	0.004	0.02	0.003	0.002	0.002	0.003	0.004	0.002	0.004	0.004
Se	0.02	0.02	0.02	11	0.1	0.2	0.02	0.04	0.02	0.02	0.02	0.1
Si	20	960	1387	1770	1450	1280	370	1610	900	1180	200	
Sm	0.04	0.1	0.05	0.04	0.03	0.03	0.04	0.05	0.04	0.05	0.06	0.03
Sn	0.4	0.7	1.7	3.5	0.7	0.9	1.5	0.3	2.7	3.2	1.8	0.4
Sr	1.3	16	7.1	77	0.3	4.2	2.8	6.4	0.8	2.5	2.5	10
Ta	0.01	0.03	0.04	0.1	0.03	0.02		0.1	0.02	0.04	0.1	
Th	0.2	0.2	0.4		0.1	0.2		0.1	0.1	0.3	0.1	0.4
Ti	3.2	3.5	2.9	6.1	2.7	2.4	5.6	5.1	2.3	4.3	2.8	3.1
U	0.03		0.04						0.03			
V	0.02	0.02	0.03	0.01	0.02	0.02	0.004	0.01	0.01	0.01	0.01	0.01
W	0.1	0.1	0.1	0.1	0.08	0.1	0.3	0.1	0.02	0.04	0.05	0.1
Yb	0.03	0.1	0.1	0.2	0.04	0.02	0.1	0.1	0.03	0.1	0.03	0.1
Zn	17	32	46	41	26	48	17	26	39	46	56	30

[a] Salt had been added to these nuts as purchased.

concentration in specific samples. These include acorn: B; black walnut: Ni; Brazil nut: Ba, Br, Co, Cs, Mg, Ni, Rb, Sr and Se; butternut: Ni; cashew: Cu, Ni and S; coconut: Cu and Cl; filbert: B; hickory nut: Mn and Ni and pistachio: Cu. The normal concentrations of these elements in land plants in ppm, dry weight as given by BOWEN (1966) are: B (50), Ba (14), Br (15), Cl (2000), Co (0.5), Cs (0.2), Cu (14), Mg (3200), Mn (630), Ni (3), Rb (20), S (3400), Sr (26) and Se (0.2). Thus only the elements Ba, Br, Co, Cs, Cu, Ni and Se are higher than these average values and the normal range of these elements will expectedly vary widely depending on plant species, plant part, soil chemistry and other factors. The concentrations of Cu and Zn in various of the nuts appear comparable to the values reported by ALLEN et al. (1977).

One can only speculate as to the reasons for elevated concentrations of given elements in specific nuts. Factors that might be operative are the availability of the element in the soil as determined by, for instance, soil pH, specific element absorption by trees and total element content of the soil as determined geochemically or as a result of environmental contamination. Acid soil conditions would promote the availability of elements such as Co, Cu, Mn and Ni for root absorption. Brazil nuts appear unusual in the range of elements which are present in relatively higher concentrations and this suggests that perhaps specific element absorption by this plant species is involved. For instance, barium is usually quite unavailable in soil probably being present as insoluble barium sulfate. Yet it was found extremely high in Brazil nuts in this study and this has been reported by others (SEABER 1933, WAGNER 1936). Selenium is also far higher in Brazil nuts than in the other nut samples and this element is known to be selectively absorbed by other specific plant species (ROSENFELD and BEATH 1964). Although the concentrations of barium and selenium in Brazil nuts studied here would per se, be considered toxic (ALLAWAY 1975), the infinitesimal proportion of these nuts in the normal human diet would probably negate any such effect. The form of the element in plant tissues would also have to be considered as it determines the rate of absorption from the gastrointestinal tract. Selenium is normally present as selenoamino acids in plants which are efficiently absorbed by the body (ALLAWAY 1975). The form of barium in plants is unknown.

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