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TRACE ELEMENT CONCENTRATIONS IN THE FRUIT PEELS AND TRUNKS OF *MUSA PARADISIACA*

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Key Word Index—*Musa paradisiaca*; Musaceae; plantain; fruit peels; trunk; trace element.

Abstract—Chemical analyses for the elementary compositions of the ashes of the fruit peels and trunks of the tropical plantain *Musa paradisiaca* have been undertaken. The elements, categorized as trace elements, generally are found to have higher mean concentrations in the fruit peels than in the trunks (except in the case of Zn). Their peel–trunk uptake ratios have been calculated and range between 1 and 4, showing normal levels of accumulations in the fruit peels over the trunks.

INTRODUCTION

The concentration and uptake of three trace elements, viz. Cu, Zn and Mn, in white clover and ryegrass have been reported [1], which record will constitute a reference point in the absence of a really comparable species with the plant under investigation. The study showed that the mean concentrations of Cu in the shoots ranged from 4.4 to 6.9 mg kg^{-1} for white clover and 2.0 to 4.0 mg kg^{-1} for ryegrass. The mean concentration of Zn in the shoots ranged from 21 to 35 mg kg^{-1} for white clover and 14 to 35 mg kg^{-1} for ryegrass, while the mean concentration of Mn in the shoots ranged from 20 to 127 mg kg^{-1} for white clover and 33 to 166 mg kg^{-1} for ryegrass. These levels of concentrations for Cu, Zn and Mn are presumed to be normal levels in these as well as most other plants.

In a previous study [2] of some plant wastes including peels and trunks of the tropical plantain *Musa paradisiaca*, elementary compositions were given for Na, K, Ca, P and Fe, but none was determined for the trace elements which are definable [3] as those elements present in amounts less than 0.1% by weight of sample. In this paper, we report the elementary composition with emphasis on the trace elements in the peels and trunks of *M. paradisiaca* especially as its fruit is an important staple in west Africa.

RESULTS AND DISCUSSION

Table 1 shows the relative concentrations of Cu, Zn and Mn in both the fruit peels and trunks of *M. paradisiaca*. The levels greatly exceed those obtained for the shoots of white clover and ryegrass. The mean concentations of Cu in the fruit peels and trunks were 12 and 9 mg kg^{-1}, respectively, compared with *ca* 6 mg kg^{-1} maximum level for white clover and ryegrass. In the case of Mn, the mean concentrations in the fruit peels and trunks were 237 and 53 mg kg^{-1} compared with *ca* 160 mg kg^{-1} maximum level for white clover and ryegrass. Similarly for Zn, the mean concentrations in the fruit peels and trunks were 295 and 597 mg kg^{-1} compared with 35 mg kg^{-1} maximum level for white clover and ryegrass. Furthermore, whereas the mean concentration levels of Cu and Mn are expectedly higher in the fruit peels than in the trunks, the mean concentration of Zn is lower in the fruit peels than in the trunks, which observation contradicts the belief that leaves and other above-ground plant parts generally are where the greater proportion of the soil-extracted elements reside [4].

The concentrations of trace elements in plant parts have been the subject of numerous researches, all of which have tended to show that there is no definite pattern for their absorption [5]. As plants are different, so also is their ability variable in elementary uptake. However, the concentrations of trace elements have often been assumed to have a uniform gradient within a given plant species. Such an assumption is based on the knowledge that the same enzymes function throughout the plant [5].

The biological roles of a number of trace elements have been reported [6]. With respect to Al, there is no evidence that it performs any essential function in plants, and it occurs in relatively low concentrations. In contrast, Mn and Fe are essential elements for both plants and animals [6]. Manganese plays a key role in photosynthesis [6]. Its normal level in plants range from 20 to 500 mg kg^{-1}. Titanium is poorly absorbed and retained by plants. The mean values for concentrations of Ti in *M. paradisiaca* (42 and 13 mg kg^{-1} in the peels and trunk, respectively) do not depict that

Table 1. Elementary compositions of the ash of peel and trunks of *Musa paradisiaca* and the calculated peel–trunk uptake ratios

	ICP-AES ($mg\ kg^{-1}$)								Peel trunk uptake ratio
	Peels			Mean value	Trunks			Mean value	
Element	1	2	3		1	2	3		
Na	460	6080	2130	2890	310	230	190	240	12
K	38 100	38 400	39 400	38 600	30 400	40 900	43 000	38 100	1
Mg	10 900	8700	8800	9470	5700	13 800	4400	7970	1
Ca	21 000	33 000	28 000	27 000	17 000	18 000	10 000	15 000	2
P	14 800	20 200	21 100	18 700	13 100	7500	5200	8600	2
Al	690	1060	610	787	260	360	200	273	3
Ti	34	56	37	42	14	15	10	13	3
Mn	260	170	280	237	90	40	30	53	4
Fe	490	750	480	573	420	680	420	507	1
Cu	10	15	11	12	9	13	4	9	1
Zn	205	351	330	295	648	768	374	597	0.5
Rb	1940	1960	1970	1960	386	756	1390	844	2
Sr	95	128	112	112	99	91	61	84	1
Ba	29	52	34	38	10	31	4	15	3
Pb	5	5	4	5	3	2	4	3	2

Ti qualifies to be described as an essential element in plants.

Normal plants contain from 5 to 20 $mg\ kg^{-1}$ of Cu [6]. Table 1 shows for *M. paradisiaca* similar levels of Cu in the peel and trunks. Normal levels of Zn in plants are 25–150 $mg\ kg^{-1}$ [6]. Table 1 gives the level of Zn in the trunk to be about four times more, and in the peels about two times more, than normal. However, Zn is classified as an essential micronutrient [7]. Table 1 shows levels of concentrations of Rb to be the highest of all trace elements evaluated for *M. paradisiaca*, and this observation calls attention to the presumption that Rb might act as a nutritional substitute for K [6].

Plants contain 1–200 $mg\ kg^{-1}$ of Sr [6]. Strontium-accumulating plants may have concentrations up to 26 $g\ kg^{-1}$, but there is no evidence that Sr is essential for plants. The mean concentrations in *M. paradisiaca* (112 and 84 mg/kg^{-1} in peels and trunks, respectively) fall within the normal levels. Barium resembles Ca chemically, and occurs in plants in highly variable concentrations. However, there is no conclusive evidence for any essential function of Ba in plants. On the contrary, it is poisonous to most plants. The mean concentrations in *M. paradisiaca* (38 and 15 $mg\ kg^{-1}$ in peels and trunks, respectively) are low. Lead is toxic and a hazard to animals and plants. Some plants show retarded growth at 10 $mg\ kg^{-1}$. Its level of concentration in the plants under study is of the order of 3–5 $mg\ kg^{-1}$.

EXPERIMENTAL

Peels of *M. paradisiaca*, which constitute domestic waste matter, were collected from three widely separated households. Similarly, plantain trunks were obtained from three widely separated farm grounds. The peels were sun-dried separately and stored in labelled sample envelopes, prior to analysis at the analytical laboratories of the Environmental Geochemistry Research Group at Imperial College, London. In the case of trunks, the sheaths were discarded to yield a central core portion. These central units were cut separately into smaller pieces and sun-dried and also stored in labelled sample envelopes. The different peel and trunk samples were pulverized with the aid of a laboratory mill, while ensuring that no contamination occurred during the milling process by thoroughly cleaning the mill after each operation.

10 g portions of powdered peel and trunk samples were placed in weighed beakers and ashed in a muffle furnace at 350–400°. Ashing was completed mostly overnight or in *ca* 8 hr, after which the samples were removed and placed in a dessicator for 2 hr and then weighed.

A 0.1 g portion of ash was accurately weighed and digested with 10 ml of 1 M HCl. The solns were shaken vigorously for 15 min and then centrifuged. Measurements were performed with an inductively coupled plasma atomic emission spectrometer (ICP-AES), model ARL 34000C. Dilution, wherever necessary, was done by taking 1 ml of the stock soln and making up to 10 ml with 1 M HCl.

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