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Seasonal comparison of tin accumulation by *Solanum Tuberosum* spp grown on the degraded minefields of the Jos Plateau

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ABSTRACT

A seasonal comparison of the accumulation of tin by *Solanum tuberosum* was undertaken in this work. Values of tin accumulation of 0.525, 3.509, 1.252, 0.805, and 2.561 ppm were detected in the rainy season samples obtained from B/Ladi, Bassa, Bokkos, Jos North, and Jos South respectively. While 0.748, 0.630 and 0.623 ppm were found in the dry season samples of B/Ladi, Bassa and Bokkos respectively. Tin was not detected in samples from Jos North and Jos South for the same dry season. The results show a seasonal variation of the accumulation of tin by the crop with higher accumulation during the rainy season probably as a result of significant variation in the pH of the waters.

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INTRODUCTION

The mining and processing of cassiterite (SnO_2), an important ore of tin found in Nigeria, has been taking place on the Jos Plateau for several decades [1]. A peak production of 11,000 tons was recorded in 1950 [2]. This period however coincided with that of low agricultural production as bulk of the energetic youths had abandoned the farms for the mines [3].

Production of the metal since then has been on a steady decline largely due to the exhaustion of the high grade and easily worked ores [2]. This situation has again put the youths out of their jobs making it almost compulsory to return to the almost abandoned farms which have become severely degraded. These fields are now full of mounds of sand, wide spread alluvial tips, mine ponds and reservoirs, discarded mine tailings, abandoned machineries and mining camps/settlements in various stages of dilapidation. According to Eziashi [3], out of about 325km^2 of the farmlands damaged by the miners, only about 12.40km^2 (representing only 4%) has so far been reclaimed/managed. The reported attributed the situation of non-reclamation of the remaining 96% of the degraded mine fields on the plateau to the ineffectiveness of the 1946 mineral act which has no provision for the enforcement of the reclamation.

The environmental implication of this neglect has been attracting academic and government interests. For example an airborne geographical survey conducted by Hunting Geology and Geophysics Nigeria Limited revealed some zones of anomalously high uranium (U) and thorium (Th) concentrations (44 to 125 ± 16 ppm and 633 to 1380± 100 ppm respectively) in the degraded tin fields (GSN 1975). The anomalous concentrations of Thorium and Uranium can give rise to high radiation exposure particularly to miners and members of the general public [4]. In an on-going study on the concentration of tin on arable top soils of the area, Kim *et al* [5] had established that the concentration of the tin ranges between 577 and 1,590 ppm in the top soils. This value is by far above the world's estimated range of the metal in the earth crust put at just between 2 and 3 ppm [6]. The implication of these findings is that the accumulation of tin by crops grown on the plateau may be higher than that of similar crops grown on non-tin mining areas as a result of remarkable tin concentration differences in the soils. In this work therefore the total tin content of rainy season potatoes samples and that of dry season samples were determined by the atomic absorption spectrophotometric method and the results obtained compared.

EXPERIMENTAL

Sample collection

5 rain samples were taken at a height of 5m above the ground, consisting of one sample per local government area. 15 pond water samples were also taken, consisting of three per local government, and 60 potatoes samples were harvested from 60 different potatoes farms spread in 5 L.G.A.s of intensive mining activities at weekly intervals. The rainy season potatoes samples (30 in all) consisted of 6 each from each of the

Table 1: Rainy season concentration of tin (ppm) in samples

Samples	Control	BLD	BSA	BKK	JJN	JJS
P_1	0.103	0.194	2.583	1.401	0.548	1.956
P_2	0.096	0.350	3.261	1.244	0.660	2.093
P_3	0.092	0.220	3.524	1.046	0.970	2.535
P_4	0.096	0.127	3.162	1.302	0.833	2.590
P_5	0.093	0.403	3.979	1.390	1.289	3.186
P_6	0.104	1.858	4.544	1.131	0.530	3.008
Average P	0.097	0.525	3.509	1.252	0.805	2.561
S.D	0.005	0.660	0.683	0.142	0.292	0.485

Table 2: Dry season concentration of tin (ppm) in the samples

Samples	Control	BLD	BSA	BKK	JJN	JJS
P_A	0.000	0.000	0.000	0.754	0.000	0.000
P_B	0.042	0.000	0.000	0.875	0.000	0.000
P_C	0.023	0.760	0.760	0.866	0.000	0.000
P_D	0.034	0.770	0.770	1.241	0.000	0.000
P_E	0.012	0.910	0.910	0.000	0.000	0.000
P_F	0.004	1.365	1.338	0.000	0.000	0.000
Average P	0.019	0.748	0.630	0.623	0.000	0.000
S.D	0.017	0.660	0.531	0.509	0	0

L.G.As were collected from the August 2003 to the September, 2003 a period of peak harvest of the crop during the dry season. The dry season samples (30 in all) were collected also at weekly intervals from January, 2004 to February 2004, also a period that coincided with the season's peak harvest time. The 12 control potatoe samples were also taken at the same periods consisting of 6 for the rainy season and another 6 for the dry season. The controls were taken from Shika village near Samaru Zaria which is a rich agricultural zone but not a mining area. The samples were stored in open labeled polythene bags while awaiting further treatment

Sample treatment

The 72 potatoe samples were first washed to remove their earthy impurities using with tap water and rinsing with distilled water. They were then peeled and sliced into small pieces and rinsed again with distilled water after which they were sun dried for several days spread on a polythene mat.

The partially dried sliced potatoes were then transferred into dry porcelain crucibles and dried again in a thermostated oven at 105° C until constant weight was obtained. The dried samples were then placed in desiccators to cool, after which they were ground and transferred again into the oven for re-drying at the same temperature of 105°C till a constant weight was obtained. The very dried samples were again placed in desiccators to cool after which 0.300g of each of the samples was quickly weighted out into a clean dried porcelain crucible. 20 cm^3 of an acid mixture, 69 – 72% w/v Nitric acid, 70 - 72% w/v perchloric acid and 98% w/v sulphuric acid in the ratio 5:1:0.5, was added fast. The mixture was heated on a hot plate at a temperature of 150°C in a fume cupboard until white fumes appeared. The digests were further heated for 2 minutes and the clear colourless digests were transferred into labeled polythene bottles and stored for analysis.

Method of tin analysis

The tin concentrations of the water samples and digests were determined spectrophotometrically using a Unicam 969 spectrometer set at a wavelength of 226.6nm. Prepared 0.500, 1.000, 1.500, and 2.000 ppm for standard solutions were aspirated into the fuel rich flame (N_2O/C_2H_2) and their absorbance measured to obtain a calibration curve. The water samples and digest were also aspirated into the same flame under the same conditions and their concentrations read-off on the curve, extrapolating the measured absorbances. The results obtained are presented in Table 1, 2 and 4.

The pH of the rain and pond waters were determine using an Orion 290A pH meter. The results obtained are presented in Table 3.

RESULTS AND DISCUSSION

Table 3: pH values for pond and rain waters

Sample	BLD	BSA	BKK	JJN	JJS
PW_1	5.90	6.30	7.20	7.50	7.80
PW_2	6.60	7.20	6.90	7.30	7.50
PW_3	7.30	6.90	7.20	7.10	6.20
RW	7.05	4.40	5.90	4.80	7.00

Table 4: Total tin concentration in the pond waters (ppm)

Sample	BLD	BSA	BKK	JJN	JJS
PW_1	0.000	0.016	0.000	0.001	0.066
PW_2	0.004	0.158	0.000	0.000	0.267
PW_3	0.019	0.000	0.041	0.071	0.122

All the 30 potatoe samples analysed for the rainy season contained varying amounts of tin, ranging from 0.127 to 4.544 ppm (Table 1). On the other hand only 12 of the samples analysed for the dry season contained tin ranging from 0.760 to 1.365 ppm (Table 2). This is an indication that the accumulation of tin by *solanum tuberosum* spp is higher during the rainy season. The average tin accumulation (0.097> 0.019) by the controls during the two seasons agrees with this finding. The accumulation of tin is higher in the degraded minefields in both seasons than in Shika (a non mining area). The lower pH values of the rains favour the dissolution of cassiterite from the soils thus making it more readily available for absorption by the plants during the rainy season. The use of pond waters which have higher pH values does not favour the dissolution of the tin ore from the soils, thus making the tin in solution form to be less available to the plant in the dry season.

While tin was not detected in the rain waters (i.e the absence of wet deposition of tin from the atmosphere as a result of industrial processes), little quantities of tin were found in some of the pond waters. The continuous use of such pond waters for irrigation may lead to the accumulation of little quantities of tin by the potatoe plants.

CONCLUSION

Though the speciation of the tin has not been done in this work, it is clear that a lot more tin is ingested by man from fresh potatoe meals in the rainy season than from fresh meals of the same in the dry season. This is because the rate of tin accumulation by *solanum tuberosum* is higher during the dry season on the mine fields.

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