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Comparative analysis of physicochemical parameters and Bio-accumulation between *Musa* species

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Abstract

Banana plant plays a significant role in the north-eastern population of India. The plant can be truly called a *kalpvriksh* since all parts of this plant have been used by the people in Assam since ancient time. The plant and its products are also thought to have therapeutical application for treatment of gastrointestinal disorders, against worms, as antiseptics etc. The people in the north-eastern states eat various parts of the plant either as raw (fruit) or in cooked (pseudo stem) form. The pseudo stem is also used to make food additives (*kolakhar*) that is also used abundantly in the Assamese cuisines. It was thus thought worthwhile to investigate the physicochemical properties of this and a variety of other plants in comparison to the soil as well as water sources in the vicinity for the purpose of understanding their physicochemical properties, mineral accumulation capabilities so as to be correlated to their use in day to day life of the natives of Assam. The work reveals that out of the five most significant elements, Vanadium accumulation was observed to be higher in *M. balbisiena* Colla whereas higher zinc accumulation was seen in *M. acuminata*. The level of accumulation may increase in the next level in food chain, especially in the animals / humans of that region.

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Introduction

Water is one of the most essential components for the survival of every living organism on earth. The quality of the usable water is of major concern with regard to human health. In India most of the population depend on groundwater for their daily needs as it is considered to be relatively cleaner and safer than the other sources (Patil and Patil, 2010). With the rapid industrialization and population throughout the globe, the safety and quality of the water for human consumption is a major concern.

Use of fertilizer, pesticide, deposition of effluent has spoiled the quality of soil as well as water. This increases the need for periodic assessment of their quality.

Bioaccumulation is another factor which is increasing the risk for human health. The chemicals present in trace amount in soil and water, get accumulated in plants in higher amount. These plants when consumed by herbivores, as well as human, raises the risk further. Prolonged consumption of the same may be a causative factor for its related diseases.

Assam is situated in the North-East part of India. Due to its geographical region the soil type is laterite in hilly areas and alluvial near the river banks. The pH of the low lying region is less acidic than the hilly areas. The soil quality has affected the water quality also. Various assessments have been carried out so far regarding the quality of water from several parts of the state. Various drinking water sources of Kamrup district have been reported to be contaminated with cadmium, manganese and lead as well as slight elevation in arsenic level (Chakrabarty and Sarma, 2011). In Barpeta district, iron, manganese and lead level exceeds the WHO recommended levels in some location whereas zinc concentration was found to be within the limits (Haloi and Sarma, 2012). This raises the concern regarding their accumulation in plants.

Banana plant varieties have been investigated in this experiment as these absorb large amount of water which positively indicate higher bioaccumulation of the chemicals. Banana species is widely spread in various parts of the globe. Almost every part of the plant is used directly or indirectly for consumption (Mohapatra *et al*, 2010). The plant has various medicinal properties (Mohammad and Saleha, 2011). Indigenous people of Assam use the fruit, flower as well as young pseudo stem for direct consumption. The extract of young pseudo stem of *M. balbisiena* (indigenous seedy variety of banana) is also given to the patient with stomach disorder. The mature pseudo stem of the same variety is cut, sun-dried and burned to ashes. The water extract of the ashes called *kolakhar* is preserved and used as edible soda to make specific cuisines (Deka and Talukdar, 2007).The banana leaves are also used to make special snack delicacies.

Hence it becomes essential to assess the chemical and elemental composition of banana plants.

In the present experiment, physicochemical as well as elemental analysis of soil, water and plants from Assam has been carried out.

Materials and methods

Sample preparation

Five different varieties of *Musa* species were collected from Guwahati, Assam. The mature pseudo stem was cut into thin slices, sun-dried for a week and burned to ashes. 50% water extract from ash of each sample were collected for analysis. Groundwater sample was collected from an open well from the same area. Soil from plantation area was also collected (rhizosphere region) and water suspension was prepared. Table1 contains the sample details.

Physicochemical analysis

All the samples were tested for physicochemical characteristics namely pH, electrical conductivity (EC), TDS, Total alkalinity, Total hardness, Na^+, K^+ and Cl^-. The reagents used were of AR grade and deionized water was used for reagent preparation.

Elemental analysis

All the samples were analysed for Zn, Pb, Cd, As and V using Inductively Coupled Plasma Atomic Emission Spectroscopy (AAS). The analysis was carried out in SAIF (IIT, Bombay).

Table 1. Samples collected from Kahilipara, Guwahati (Assam).

Sample name	
A	50% water extract of ash of *M. balbisiena*
B	50% water extract of ash of *M. splendida*
C	50% water extract of ash of *M. paradisiaca*
D	50% water extract of ash of *M. acuminata*
E	50% water extract of ash of Dwarf Cavendish
F	Rhizosphere soil
G	Groundwater from open well near the field

Result and discussions

Physicochemical analysis

The average result of all the physicochemical parameters studied, has been presented in table 2.

The ground water of the region (G) under study is found to be safe for drinking purpose. All the values of studied parameters are found to increase in the soil (F) (except potassium) indicating the accumulation level. In the plants (A to E) the accumulation level however increases in much higher level. The potassium and chloride are getting deposited in the *Musa* sp. in very high amount. And this causes high alkalinity in them which justify their medicinal uses.

Elemental analysis

Table 3 shows the metal content in all the samples under study. The report suggests that out of all the metals under study, vanadium is getting accumulated in the *Musa* varieties and at higher rate in *M. balbisiena*. Zinc has also shown to be accumulating in the plants and especially in *M. acuminata* in higher amount. Arsenic was not found at significant amount in the plants although the region has been reported for its high content. Lead and cadmium accumulation is also insignificant as in soil and water.

Table 2. Average results of physicochemical parameters.

Sample	pH	TS (ppm)	EC (uS cm^{-1})	Total alkalinity (ppm)	Total hardness (ppm)	Chloride (ppm)	Na+ (ppm)	K+ (ppm)
A	13.0	289700	84500	45500	940	24850	16.5	1740
B	11.8	333800	107900	51500	960	26980	12	1880
C	11.5	266400	108500	36000	4600	28400	13	1720
D	11.7	268600	102500	40000	4600	24850	13.5	1920
E	10.1	125600	89500	13000	4800	29110	12	1020
F	7.9	3000	2280	250	720	177.5	57.5	05
G	7.3	520	888	150	348	63.9	210	10

Table 3. Elemental analysis results (by AAS).

Samples	Zn(ppm)	Pb(ppm)	Cd(ppm)	V(ppm)	As(ppm)
A	0.027	<0.01	<0.01	0.4	<0.01
B	0.028	<0.01	<0.01	0.153	<0.01
C	0.016	<0.01	<0.01	0.147	<0.01
D	0.048	<0.01	<0.01	0.25	<0.01
E	0.047	<0.01	<0.01	0.171	<0.01
F	0.043	<0.01	<0.01	0.217	<0.01
F	<0.01	<0.01	<0.01	<0.01	<0.01
G	<0.01	<0.01	<0.01	<0.01	<0.01

Conclusion

The alkalinity in plants of *Musa* species is attributed to the higher amount of accumulation of carbonates of potassium, sodium etc. The hardness of the samples is because of much higher concentration of magnesium, rather than calcium, especially in dwarf Cavendish. Vanadium and zinc accumulation is quite significant in banana plants, which makes its consumption in any form, to contribute to our dietary needs.

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