A QUALITATIVE ELEMENTAL ANALYSIS OF MATURE TEA LEAVES FROM SOME TEA GARDENS OF SONITPUR DISTRICT, ASSAM, INDIA

Parag Moni Baruah*

Angur Begum**

S.Bardaloi***

Ananta Madhab Dutta****

Abstract: *The objective of this study was to unfold the existence of different elements particularly, the toxic elements qualitatively in the mature tea leaves collected from some tea gardens of two sub-divisions of Sonitpur district, Assam ,India by comparing the elemental constitution of associated soil, tender tea leaves and organic tea. The study was carried out using X-Ray fluorescence technique (XRF). Qualitative XR F spectrometric analyses of different tea and soil samples have shown that the samples of mature tea leaves of the two study areas contained 15 different elements viz. K, Ca, S, P, O, Mn, Fe, Mg, Si, Rb, Al, Cl, Ni, Zn, Na and their associated soil samples were found to contain 16 elements viz., Si, Fe, Ca, Mg, P, Zr, Sr, Ti, O, Na, P, Ni, Mn, S, Rb and Cl with varying intensities. The results so obtained have shown that there is no any significant difference in the elemental constitution of the tea leaves collected from the two surveyed areas. Moreover, no traces of any known toxic elements were detected in tea and soil samples. Keeping in view the low intensities exhibited by certain elements viz., Al, Ni and Si in the analyzed tea samples that may otherwise become potentially toxic if present in high concentration either in associated soil or in the tea leaves, it is assumed that the tea samples analyzed were not in a toxic state.*

Keywords: *Toxic elements, X-Ray fluorescence, mature tea leaves, tender tea leaves, organic tea.*

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*Lecturer, Department of Biology, Swadeshi Academy Jr. College, Guwahati, Assam, India.

**Associate professor, Department of Zoology, Pragjyotish College, Guwahati, Assam, India.

***Scientific Officer, SAIF, Department of Instrumentation and USIC, G.U., Assam, India.

****Professor of Chemistry, Assam Down Town University Guwahati, Assam, India.

1. INTRODUCTION:

It is an observed fact that all the elements found in plants are not essential for plants. An essential element is the one which has a specific structural or physiological role and without which plants cannot survive or complete their life cycles. In general, the mineral elements required by all higher plants for growth and completion of their life cycle are: Nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, boron, chlorine, iron, manganese, zinc, copper, nickel and molybdenum and they are considered essential elements [1]. In addition to these essential elements, certain elements promote growth in many plant species but are not absolutely necessary for completion of the plant life cycle. These include: Silicon, sodium, cobalt, selenium and are called beneficial elements [1]. Apart from the above elements certain non-mineral elements found to be essential for plants are: Carbon, Hydrogen and Oxygen [1].The elements such as Al, Cd, Cr, Fl, Li, Ni, Se and Si may become potentially toxic for plants if present in high concentrations in the soil [4]. It was also reported that presence of elements like Ni, Cd and Pb in trace amounts in various medicinal plant samples may be due to the pollution arising from automobile and industrial activities [5]. Lead is one of the important constituents of automobile exhaust. Exhaust emissions from leaded petrol driven vehicles not only pollute the air, but also settle on soil which is likely to be absorbed by the plants and gets accumulated in different plant parts. It is reported that Fertilizer plant's liquid effluent contains elemental arsenic. Its compounds had been used as insecticides and herbicides [6]. Moreover, according to a UNICEF report published in Assam Tribune, dated 8th May, 2012, the ground water of 18 districts of Assam has been affected by Arsenic. Sonitpur district in the Northern bank of the River Brahmaputra is one of the affected districts in which the ground water of 109 habitations is found to contain Arsenic [7]. In view of the above facts, it was indeed very essential to go for an analysis of mature tea leaves of the local tea gardens for probable existence of toxic elements as the tea products, both CTC and Orthodox grades are widely consumed as a beverage by almost all sections of the people of this region.

2. MATERIALS AND METHODS:

The primary data relating to the existence of different elements including the toxic ones in mature tea leaves in comparison with the associated soil, tender tea leaves and handmade organic tea were collected through the following methods and techniques.

2.1. Collection of samples:

Fresh mature tea leaves were collected (plucked) from tea plants of some tea gardens of Tezpur (Latitude: 26° 36' 34" North, Longitude: 92° 49' 37" East) and Gohpur (26° 53' 0" North, 93° 38' 0" East) sub-divisions of Sonitpur district about ten days after the application of pesticides. Soil samples under the individual tea plants from which leaves were plucked were also collected. Tender tea leaves were collected from gardens before application of pesticides. Handmade Organic black tea was procured from Meen Mohan Tea Garden, Madhupur village, Lakhimpur, Assam, a reknown producer and exporter of organic tea of the state. In order to determine the existence different elements qualitatively in the mature tea leaves, the technique of X-Ray fluorescence (XRF) was employed.

2.2. Pretreatment of samples:

The tea leaves collected were placed in between two pieces of news paper sheets. The leaves thus arranged were moderately sun dried for three days and kept in shade for another four months to ensure complete loss of moisture content. The dried leaves were crushed in a mortar with pestle, sieved repeatedly to pass through a 2mm sieve and the powdered leaves thus obtained were kept in airtight containers. The procedure was adopted for mature tea leaves collected from each garden and also for the tender tea leaves. The soil samples collected were also adequately sun dried prior to XRF analysis. No any pretreatment was required for the organic handmade tea as it was already free from moisture content being firmly packed in waterproof pouches.

2.3. Sample preparation:

After pre-treatment of the samples as mentioned above, samples were further pulverized. For each sample, a sample cup made of aluminum of the size 4 cm (outer diameter) and 3.5 cm (inner diameter) was taken with its bed filled up with boric acid. After that 1 gm of already pulverized sample was mixed with 0.5 gm of boric acid (H_3BO_3) and placed over the aluminium cup. The whole thing was then inserted in a hydraulic press and a load of 50 kilo Newton was applied for 3 minutes. All tea samples, after the above treatment were solidified. The prepared solidified samples (figure 2) were then analyzed using Axios PANalytical XRF Spectrometer.

Table: 1. Samples of mature tea leaves and associated soil collected for analysis.

Sample name (Mature tea leaves)	Collection region:	Associated soil samples:
T1	Tezpur (Tezpur sub-division).	PARAG SOIL S1
T 2	Tezpur (Tezpur sub-division).	PARAG SOIL S2
T3	Tezpur (Tezpur sub-division).	PARAG SOIL S3
T4	Tezpur (Tezpur sub-division).	PARAG SOIL S4
T5	Tezpur (Tezpur sub-division).	PARAG SOIL S5
G1	Gohpur (Gohpur sub-division).	PARAG SOIL S6
G2	Gohpur (Gohpur sub-division).	PARAG SOIL S7
G3	Gohpur (Gohpur sub-division).	PARAG SOIL S8
G4	Gohpur (Gohpur sub-division).	PARAG SOIL S9
G5	Gohpur (Gohpur sub-division).	PARAG SOIL S10
T-C (Tender tea leaves)	Tezpur (Tezpur sub-division).	----
T ORG (Organic black Tea)	Lakhimpur.	----

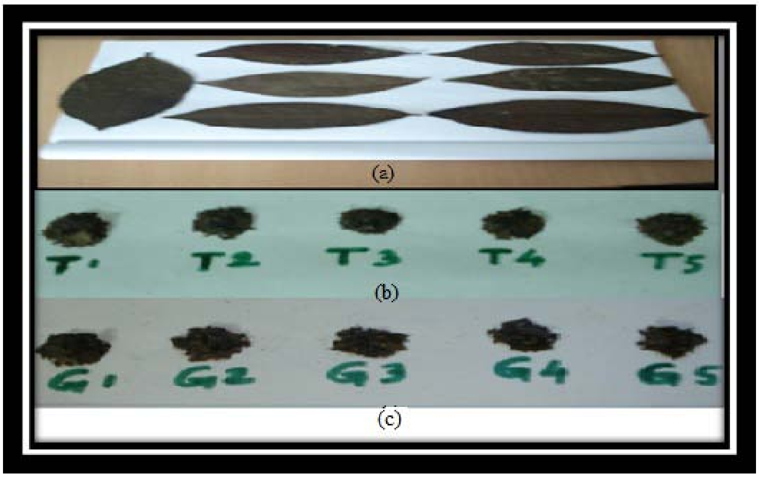
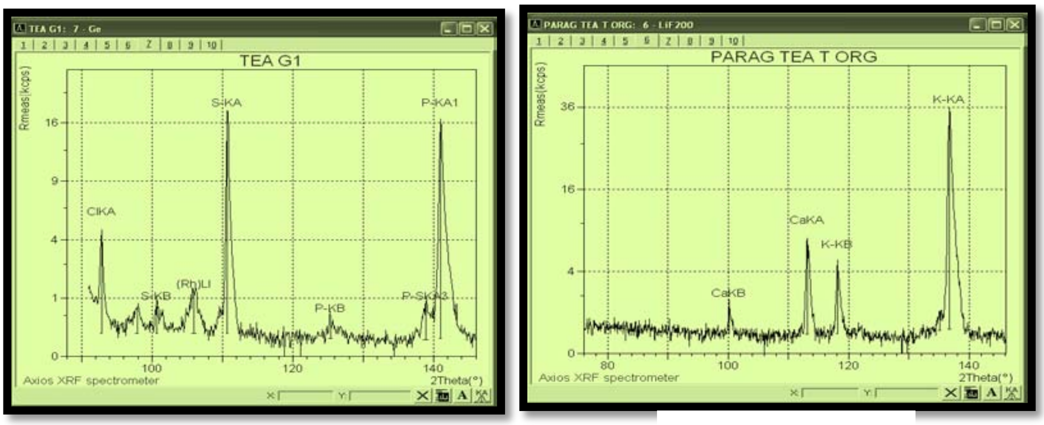


Figure 1.(a) A few mature tea leaves after drying;(b) & (c)- dried, crushed mature tea leaves (Photograph by the author at SAIF, G.U.).

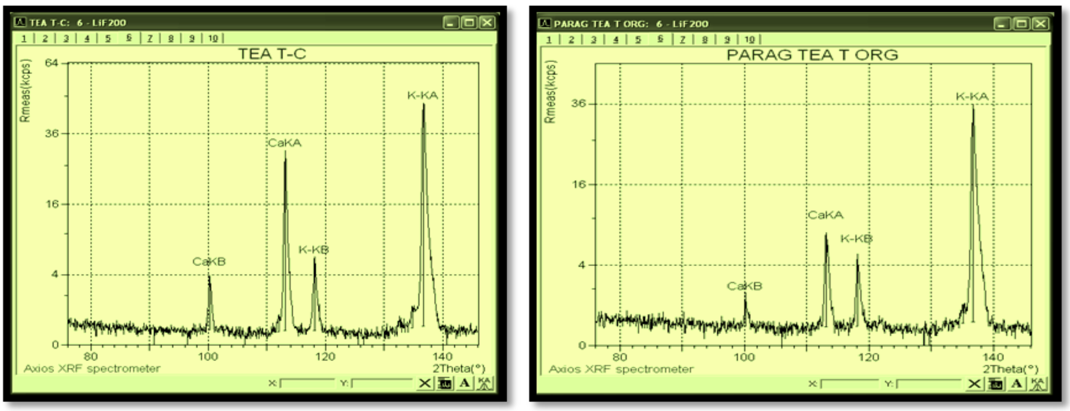
Figure 2 showing some solidified samples (Pallets) ready for XRF analysis.

(Photograph by the author at SAIF, G.U.).



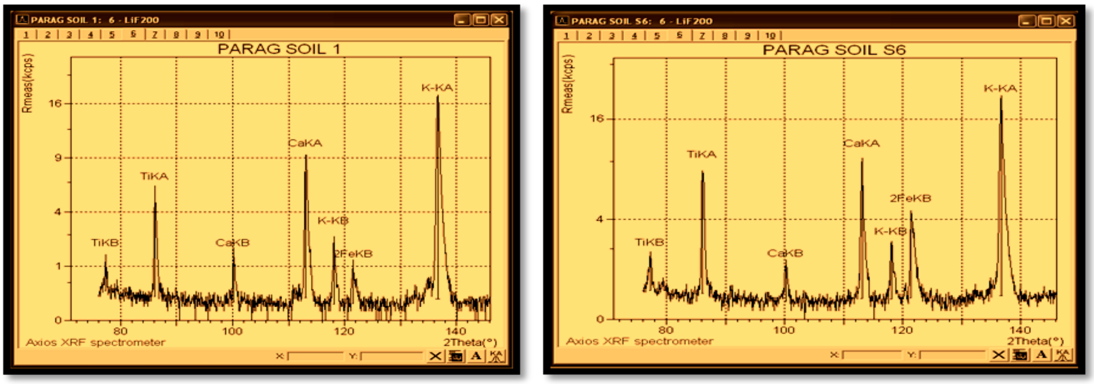
(a) (b)

Figure 2. XRF spectrometric graphs of two tea samples from Tezpur (a) and Gohpur (b)



(a) (b)

Figure 3 showing XRF spectrometric graphs of tender tea leaves (a) and organic tea (b).



(a) (b)

Figure 4 showing XRF spectrometric graphs of two soil samples from Tezpur (a) and Gohpur (b) regions.

Table 2 showing the elemental composition of different tea samples analyzed and the intensities (in kcps) of different elements in each sample.

ELEMENTS:	SAMPLE NAMES WITH MAXIMUM INTENSITIES (kcps) OF DIFFERENT ELEMENTS:											
	T1	T2	T3	T4	T5	G1	G2	G3	G4	G5	T-C	T-ORG
1. Potassium.	64	64	74.5	64	43	64	50	64	64	53.7	50	36
2. Calcium.	16	16	17	16	10.9	16	16	16	16	16	31	8.6
3. Phosphorus	16	16	12.5	-	8.8	16	22	-	13.4	-	19	4.0
4. Oxygen	8.0	4.5	2.2	3.2	1.7	9.0	4.3	3.4	3.9	4.3	5.5	1.3
5. Sulphur	6.5	16	16	15	7.8	17	18	14	13	11.2	19	3.6
6. Manganese	5.2	4.5	5.0	5.2	3.5	2.8	4.2	3.5	4.0	3.0	5.0	1.5
7. Rubidium	5.5	8.0	-	-	-	-	-	5.5	-	-	-	10.5
8. Chlorine	3.9	3.0	3.0	3.3	2.4	5.0	5.0	2.5	3.0	2.8	7.0	-
9. Iron	2.0	2.2	3.5	1.9	2.0	2.5	1.4	2.7	1.5	2.3	-	3.0
10. Aluminium	1.0	-	-	2.4	-	2.6	-	-	-	-	-	-
11. Magnesium	2.4	5.0	3.6	3.8	2.0	7.0	4.0	3.6	3.5	3.0	5.0	1.1
12. Silicon	-	4.0	3.9	3.1	3.5	4.0	-	-	2.0	4.0	-	4.8
13. Nickel	-	-	18	-	-	-	-	3.8	-	-	-	-
14. Zinc	-	-	0.9	-	-	-	-	-	-	-	-	-
15. Sodium	-	-	-	-	-	0.5	-	0.5	-	-	0.8	-

ELEMENTS:	SAMPLE NAMES WITH MAXIMUM INTENSITIES (kcps) OF DIFFERENT ELEMENTS:									
	S1	S2	S3 A	S4	S5	S6	S7	S8	S9	S10
1.Silicon	316	262.5	351	272.6	308	400	359	400	200	321.3
2. Iron	33.6	35.13	74.3	116	57.4	64	60.5	36	32.7	33.8
3. Calcium	9.0	13.8	18.1	6.8	55.8	11.4	8.2	14.8	16	18.5
4. Magnesium	9.0	2.8	5.5	3.8	14.4	7.4	7.4	4.5	3.1	3.3
5.Potassium	17.3	16.0	18.5	12.9	19.5	18.7	15.6	17.1	16	14.5
6. Zirconium	6.7	6.5	7.8	6.3	6.5	5.0	5.2	5.2	-	5.8
7. Strontium	6.7	3.5	3.5	-	3.4	3.5	5.2	5.2	-	3.6
8. Titanium	6.5	5.3	6.8	11.7	6.8	9.8	9.0	5.8	2.0	6.9
9. Oxygen	4.2	1.9	2.7	1.9	5.1	2.1	7.0	2.5	3.0	3.3
10. Sodium	3.4	1.5	0.9	-	2.9	2.6	7.0	2.2	1.2	1.6
11.Phosphorus	2.3	1.8	0.9	1.6	2.7	1.1	1.2	1.2	1.3	1.3
12.Nickel	2.7	-	-	-	-	-	-	-	2.5	-
13. Manganese	1.9	2.0	2.3	7.6	2.3	2.3	2.0	-	2.5	2.3
14. Sulphur	1.7	0.5	0.8	0.8	4.8	1.3	1.3	0.85	1.4	2.3
15.Rubidium	-	-	-	-	-	3.0	-	-	-	-
16.Chlorine	-	-	-	-	-	-	-	-	0.86	-

Table 3 showing the elemental composition of different soil samples analyzed and the intensities (in kcps) of different elements in each sample.

3. RESULTS:

The comparative elemental study of the tea samples of the surveyed areas has shown that altogether 15 elements viz., K, Ca, S, P, O, Mn, Fe, Mg, Si, Rb, Al, Cl, Ni, Zn and Na were present in the tea samples while their associated soil samples were found to contain 16 elements viz., Si, Fe, Ca, Mg, P, Zr, Sr, Ti, O, Na, P, Ni, Mn, S, Rb and Cl (Table 2and 3). In Tezpur region, a total of 14 elements such as K, Ca, S, P, O, Mn, Fe, Mg, Si, Rb, Al, Cl, Ni, Zn and in Gohpur region 14 elements- K, Ca, S, P, O, Mn, Fe, Mg, Si, Rb, Al, Cl, Ni, Na were detected. Of the total 15 elements occurring as a whole in the tea samples, the first 13 are common in the samples of the two areas. Out of the remaining two elements Zn and Na, the element Zn detected in one of the tea samples (T3) of Tezpur region was not detected in the tea samples of Gohpur region. Again, the element Na detected in two tea samples (G1 and G3) of Gohpur region was not found in the tea samples of Tezpur region. In comparison with the samples of mature tea leaves of the two surveyed areas, the tender tea leaves were devoid of the elements: Rb, Fe, Al, Si, Ni and Zn while organic tea sample (T-ORG) was free from elements like Cl, Al, Ni, Zn and Na.

4. DISCUSSION:

All essential elements except Nitrogen, Boron, Copper and Molybdenum were found to occur in the tea samples of Tezpur region. Al was detected in two samples T1 and T4 of Tezpur region with intensities 1 and 2.4 kcps respectively which is much lower as compared with the intensities shown by other elements. This finding is contradictory to what the tea samples marketed in Iran has shown as Al as a whole, was found in highest amount in the analyzed samples (Karimi et.al , 2008). The element K was found to show highest intensity in all the tea samples with a maximum value of 74.5 kcps which was in agreement with the result obtained in some brands of tea sold in Kano, Nigeria (Mohammed and Sulaiman, 2009). Ni was detected in only one sample T3 of Tezpur region with an intensity of 18 kcps. Si was detected in the samples: T2, T3, T4 and T5 with intensities 4.0, 3.9, 3.1 and 3.5 kcps respectively.

All essential elements except Nitrogen, Boron, Copper, Molybdenum and Zn were found to occur in the tea samples of Gohpur region. Al was detected in only one sample (G1) of Gohpur region with an intensity of 2.6 kcps which is slightly higher in comparison with the samples T1 (1.0 kcps)) and T4 (2.4 kcps) of Tezpur region. Like Tezpur region,the element K was found to show highest intensity in all the tea samples with a maximum value of 64 kcps. The element Na which is not included as an essential element was found to occur in the two tea samples (G1 and G3) of Gohpur region. Ni was detected in only one sample G3 of Gohpur region with an intensity of 3.8 kcps which is much lower than what sample T3 (intensity 18 kcps) of Tezpur region showed. Si was detected in the samples: G1, G4 and G5 with intensities 4.0, 2.0, and 4.0 kcps respectively.

In the tea samples of both Tezpur and Gohpur regions, Al and Ni were detected in low intensities and as such there was less chance of Al and Ni toxicity. Moreover, the element Al was not found in the soil samples of both the regions. The element Si, though found in high intensities in all the associated soil samples, the amount of Si in the tea leaves was found to be much lower, showing a maximum intensity of 4.0 kcps in both Tezpur and Gohpur regions.

5. CONCLUSION:

From above findings, it can be concluded that there was no any significant difference in the quality of the samples of tea leaves of the two areas in terms of elemental constitution and no traces of any known toxic elements were detected in tea and soil samples. Keeping in view the low intensities exhibited by certain elements such as Al, Ni and Si in the tea samples that may become potentially toxic for plants in high concentration, it is assumed that the samples analyzed were not in a toxic state. However, a definite conclusion regarding any beneficial or harmful impact of these elements on human health needs further investigation through quantitative analysis that would help to assess the degree of purity of tea leaves produced in the concerned region of the state and establishing an idea about their suitability for use in CTC or Orthodox grade tea manufacture for local as well as international market.

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