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# Variation of Metal Contents in Tea Plants Around oil Installation, Assam

Environment

KEYWORDS : Metal Content, Tea Plant, Oil Installation, Lakwa, Assam.

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## ABSTRACT

*The metal content in root, stem and leaves of the tea plants indicate higher association of Cu, Cr, Cd, Zn, Pb, Ni, Mn and Fe in roots, whereas, Na, K, Ca, Mg and Co were found in higher proportion in leaves of plants. Almost equal proportion of Cu, Zn and Co was observed in stem and leaves of plant. The higher association in root can be explained as the effect of restrictive translocation of metals retained by the cell walls. A portion of the higher association of metal content in leaves can be considered as the effect of aerosols because of non- stop flaring activities at the sites of oil installation.*

**Introduction:**
Tea is one of the most popular beverages after water in the world. Use of tea as folk medicine for headache, digestion, dieresis, immune defense, energizer and longevity of life is well known. Thus, the associated chemical components in tea received a notable concern as it is related to human health. Extensive study on potential health implications of heavy metals in tea has been carried out as tea bush is known to accumulate trace metals (Jackson and Lee, 1988; Kalita and Mahanta, 2006; Street et al., 2006; Mahra and Baker, 2007; Han et al., 2007; Abanuz and Tuysuz., 2009; Magalhaes et al., 2009). The main sources of heavy metals in plants are their growth media, nutrients, agro inputs and soil (Kabata-Pendias, 2000). Tea can be contaminated by heavy metals during growth period and manufacturing processes which might increase the metal contents above the tolerance limit (WHO, 2004) for human consumption. Apart from normal agricultural practices related to increase of productivity unattended industrial activities have also contributed significantly in that direction. Moreover, local dispersion in soil profiles also helps in extensive contamination of toxic metals. Several studies have shown that plants growing on soils with high metal concentrations can absorb a considerable amount of metal in them (Marcos et al., 1998; Han et al., 2007; Karimi et al., 2008; Borah et al., 2009; Abanuz and Tuyuz, 2009; Magalheaes et al, 2009). The tea plants generally grow on acidic soils where metals are easily absorbed by plant roots. Transfer of elements from soil to plants is very important for plant nourishment and for contamination of plants by heavy metal contents.

Assam, India, lying on either side of the mighty Brahmaputra River bordering Bangladesh and Myanmar occupies a prominent position amongst the tea producing countries in the world. Some of the major tea producers include China, Srilanka, Indonesia, Malawi, Kenya, Zimbabwe and Tanzania. This part of India has experiences high precipitation during monsoon as much as 10 to 12 inches (250 to 300mm) of rain per day. The day time temperature rises to about 1030F (400C), creating green-house gas like conditions of extreme humidity and heat. This tropical climate contributes to Assam's unique malty taste a feature for which this tea is well known. The total area under tea cultivation in Assam is accounting for more than 53 per cent of the country's total area under tea. There is 3,375 small tea growing gardens in the state (2009) out of the total 49,102 tea gardens in the state. With a total production of 950million Kg (2010-2011) Assam contributes around 50 per cent of total tea produced in India. Assam tea is manufactured from the plant Camellia sinensis var. assamica and known for its body, briskness, malty flavor and strong bright colour.

The objective of the present approach is to investigate the heavy metal concentration in different parts of the tea plants growing on this soil. Several studies have shown that plants growing on soils with high metal concentrations absorb these metals and pose a potential health risk. The tea plant usually grows on acidic soils where metals are easily absorbed by plant roots. Transfer of elements from soil to tea plant is very important for plant nourishment and for contamination of the plant by heavy metals. Various studies on heavy metal contamination in plants have demonstrated the relationship between concentration of elements in tea plant and soil samples and their toxic impact at conditions favourable for uptake of elements (Sposito G, 1984; Kabata-Pendias and Pendias,1992; Wong et al.,1998; Kabata-Pendias A. 2000; Krauss et al., 2001; Kalita and Mahanta, 2006; Han and Egashira, 2007; Seenivasan et al., 2008; Shi et al., 2008; Abanuz and Tuysuz. 2009; Magalheaes et al., 2009).

**Materials and Method:**
Ten number of samples collected from the tea gardens around GGS I which has evidenced the effect of oil field water. The plant samples specifically the leaves, stem and roots of the tea were washed vigorously first under running water and finally with distilled water to remove all unwanted matter specially soil and sand. The samples were then dried at 110oC in a drying oven for two hours. Dried plant samples were ground and placed in Stoppard plastic bottles (Brook, 1983). Heavy metal contents were then estimated by AAS after proper digestion and analytical procedure (Brook, 1983).

The concentrations of metals were estimated with a PERKIN ELMER Atomic Absorption Spectrophotometer (Model A Analyst -100) using Perkin Elmer Hollow Cathode Lamps (HCL) as light source.

**Results and discussion:**
Tea is one of the most popular beverages in the world and thus the chemical components in tea have received great interest because they are related to health. Moreover, many stringent laws have been imposed to restrict the concentration of heavy metals in food and beverages. Various reports have discussed the potential health implications of some chemical factors such as heavy metals in tea, particularly since the tea bush is known to accumulate higher amount of trace metals in them (Bosque et al. 1990; Anonymous, 1999; Karimi et al., 2008; Zhou, et al., 2009).

The extent to which plants take up metals (the biological availability) depends on the binding of trace analytes to soil constituents. In general, plants readily take up those species that are dissolved in soil solutions in ionic, chelated or complexed form. Although adsorption by roots is the main uptake pathway (Ross, 1994), it is also a notable observation that tissues other than roots have taken a role in absorbing nutrients including trace metals. Uptake from it depends not only on the total content of the respective metal but also on its accessibility to roots and transfer across the soil-root interphase.

The different metal contents as observed from the study are given in Table 1. The study has shown the increasing trend of metal association (mg/g) in different parts of tea plants as follows:

Leaf: Na (309.00)>K (226.20)>Mn (156.00)>Ca (116.00)>Fe (80.00)>Mg (74.20) > Zn (69.16) >Cu (10.65)>Co (8.72)>Pb (2.60)>Ni (1.20)>Cr (0.56)>Cd (0.20)

Stem: Na (218.00)>K (112.00)>Fe (124.50)>Ca (96.00)>Mn (90.20)> Zn (76.90)> Mg (31.20)> Cu (9.0)>Co (7.64)>Pb (2.54) =Ni (2.54)>Cr (0.43)>Cd (0.50)

Root: Fe (249.60)> Mn (180.65)>Ca (156.00)> Zn (79.90)>Mg (59.00)> K (18.40)> Na (14.20)>Cu (13.96)>Pb (6.02) =Ni (6.02)>Co (4.40)>Cd (0.67) >Cr (0.60)

It is clearly attributed the higher association of Na content in leaf and stem and Fe content in the root system of the tea plant under study. However, against the lowest concentration of Cd in leaf and stem Cr is the lowest components in root system. Accessibility to root depends on a variety of factors: (i) soil type, pH, drainage status, presence of organic matter, sewage sludge and microbial activity, (ii) plant: species, parts, season of collection, and (iii) metal/metalloid: chemical form, location etc. Metals present in the ionic form in the soil solution are readily available, while those which are firmly bound to rock minerals are the least available. Moreover, the study has also evidenced higher association of Zn, Pb, Ni, Fe, Mn, Cd and Cu with the root of the plants (Figures 1 A and B). The higher association of metal content with root can be considered as a restrictive translocation of metals under the existing physico-chemical conditions of soil (Wild, 1995). A part of the higher association of metal contents in leaves can be attributed as affect of aerosols generated from the non-stop flaring of oil & gas (Sharma et al., 1992; Baruah, 1996).

| Parameters | Leaf | | Stem | | Root | |
|---|---|---|---|---|---|---|
| | Mean | Range | Mean | Range | Mean | Range |
| Cu | 9.00 | 0.39-0.76 | 10.85 | 9.8-12.25 | 13.96 | 6.75-15.17 |
| Cr | 0.56 | 0.35-0.87 | 0.43 | 0.39-0.76 | 0.60 | 0.49-0.64 |
| Cd | 0.05 | 0.02-0.06 | 0.20 | 0.19-0.33 | 0.67 | 0.48-0.79 |
| Zn | 69.16 | 53.55-74.26 | 76.90 | 66.32-81.25 | 79.90 | 69.25-85.23 |
| Pb | 2.60 | 1.98-2.95 | 2.54 | 1.88-2.76 | 6.02 | 5.97-6.66 |
| Ni | 1.20 | 0.95-1.35 | 2.54 | 1.66-2.97 | 6.02 | 4.32-6.97 |
| Co | 4.72 | 7.12-9.11 | 7.64 | 6.55-8.23 | 4.40 | 3.23-4.67 |
| Fe | 80.00 | 69.20-85.60 | 124.50 | 117.20-132.40 | 249.60 | 222.3-255.8 |
| Mn | 90.20 | 79.3-95.17 | 156.00 | 135.2-162.3 | 180.68 | 167.78-187.89 |
| Na | 218.00 | 209.2-222.5 | 309.00 | 289.2-313.3 | 14.20 | 7.62-17.69 |
| K | 112.00 | 110.5-119.2 | 226.00 | 209.9-232.5 | 18.40 | 17.65-19.2 |
| Ca | 96.00 | 85.25-109.9 | 116.00 | 109.0-121.3 | 156.00 | 143.8-160.7 |
| Mg | 31.20 | 26.28-38.83 | 74.20 | 69.21-79.25 | 59.00 | 39.69-72.28 |

Values are in mg/g: Total number of observations =10

**Table 1: Variation of metal content in different parts of Tea plant.**

Accessibility of Co, Mn and Ni increases with decrease in pH, while that of Mo and Se increases with rise in pH. Uptake of metals like Cu is only marginally affected by alterations in pH of the soil. Poor drainage and also accumulation of organic matter which influences microbiological activity enhances release of Co and Ni in up taking of metal to the plants. Wide variations in metal uptake are observed in different plant species. Some plants are known to have special affinity for accumulating certain metals. Besides the root, metal may enter the plants through aerial parts including the leaf surface. High lead content may be observed in plants growing near busy traffic points. Minute particles (<2mm) of some metals/metalloids, e.g. As, Cd, Cu, Se, and Zn, emanating from combustion sources may get dissolved in rain water and enter the plant through leaf surface. Foliar application of some fertilizers may contribute to the bioavailability of Cu, Fe, Mn, and Zn with variable affinity of absorption.

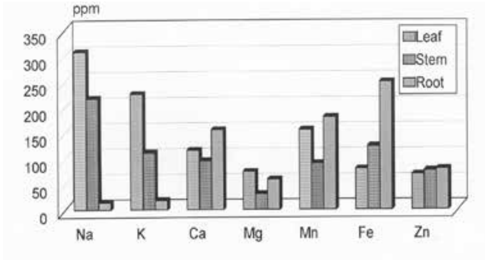


Figure 1 (A): Metal contents in different parts of the Tea plants around GGS I, Lakwa Oilfield, Assam.

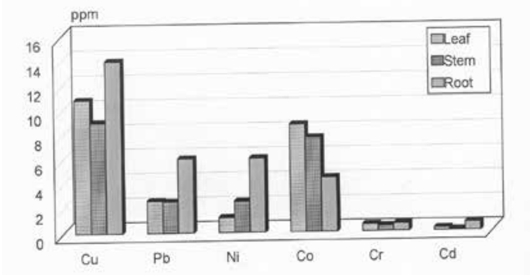


Figure 1(B): Metal contents in different parts of the Tea plants around GGS I, Lakwa Oilfield, Assam.

Plants absorb metals from soil, water and air. However, the chief source of metal absorption is soil. Uptake from it depends not only on the total content of the respective metal but also on its accessibility to roots and transfer across the soil-root interphase. The total amount of metal in a soil is in turn, affected by the inherent natural resources of the area in addition to the agricultural and industrial activities.

From the study there are ample evidences to state that a continuous biogeochemical monitoring of the area around oil installation is an utmost necessity as the reduced crop yield around these installations is becoming a common incident. Further, to evaluate possible impact of heavy metals on the tea plants and ecosystem around, a combined multidisciplinary effort covering the distribution pattern of heavy metals and their mobility in the associated physicochemical condition warrants for future studies. The ecology of NE-India is unique it should not be allowed to destabilise by the unattended industrial development. Along with the technological development the rich biodiversity of this region also should be preserved without disturbing the natural environmental attributes.

**Conclusion:**

The metal content in root, stem and leaves of the tea plants indicate relatively higher association of Cu, Cr, Cd, Zn, Pb, Ni, Mn and Fe in roots, whereas, Na, K, Ca, Mg and Co were found in higher proportion in leaves of plants. Almost equal proportions of Cu, Zn and Co were observed in stem and leaves of plant. The higher association in root can be explained as the effect of restrictive translocation of metals retained by the cell walls. A portion of the higher association of metal content in leaves can be considered as the effect of aerosols because of large scale non- stop flaring activities around oil installation.

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