Distribution and accumulation of selected heavy metals in Tea plants

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Introduction

Tea (*Camellia sinensis (L.) O.* Kuntze) is the mostly consumed beverage in the world after the water. Currently, as a natural beverage, its demand is increasing drastically all over the world. But, with the reporting of contamination of tea from different hazardous (Heavy metal, pesticides…*etc*.), which cause adverse health consequences to human being, the attention for food safety regulations are being promoted by the different counties to protect their people. As a result different quality assurance and food safety regulations and certifications such as ISO, HACCP, GAP, MRL, Acceptable limits for heavy metals …*etc.* have been introduced to the tea industry also.

At field level due to usage of agricultural fertilizers and pesticides, migration of contaminants into a non-contaminated land as vapors and leach through soil, or as dust, or spreading of sewage sludge…*etc* cause to contamination of tea from above mentioned hazardous. Among them, contamination of tea from heavy metals has a critical issue. According to Sri Lanka Tea Board Standard acceptable limits for Fe - 500, Cu – 100, Pb – 2, Zn – 100 and Cd – 0.2 mg/kg and each country sets its own allowable limit for heavy metal in made tea.

Hence, this research was carried out as a primary study to find out the how those heavy metals are being (zinc, copper and lead) distributed and accumulated in tea plants and the impact of Glyphosate application for distribution and accumulation of those heavy metals. The ability of plants to tolerate and accumulate heavy metals can be assessed using Translocation factor (TF) which is defined as the ratio of metal concentration in the shoots to the roots ([Metal] Shoot/ [Metal] Root). Hence, Translocation factor was calculated for each treatment and metal also.

Material and Methods

Experimental unit were 18 months old tea plants (TRI 4052) which were planted in pots and for 45 days experiment was carried out in a shade house of Uva Wellassa University, Badulla. Research design was Complete Randomized Design. Control (Distilled water), Glyphosate (20 µl per pot) and heavy metal mixture (Zinc 300, copper 300 and lead 200 mg/kg per pot) were applied to plants diluting in 500 mL distilled water as treatments. Number of replications were five. Concentrations of Zn, Cu and Pb were determined in shoots, mature leaves, stem, mature roots and feeder roots using Atomic Absorption Spectroscopy after digested them. Plant tissues were digested using wet digestion procedure, thoroughly washed (from the tap water and distilled water) tea plant parts were dried at 80 °C overnight. They were ground and sieved through 1 mm mesh. 0.5 g of sample placed in a small beaker and 5 ml of Con. HNO_3 was added. Then, it was kept for overnight to digest the organic compound in plant materials. Digested samples were heated on hot plate at 100 C for three hours (until emission of NO_2 fumes has ceased). Each sample was diluted with 25 ml of distilled water and filtered through filter paper. Filtered transparent solution were analyzed using Atomic Absorption Spectrometry.

Result and Discussion

There was a significant difference ($p < 0.05$) between the treatments on accumulation of each heavy metal in different parts of tea plant. The treatment of Heavy metal mixture was significantly

difference from other two treatments. And there was no any significant difference between the control and Glyphosate treatments on accumulation of Zn, Cu and Pb each part of tea plant.

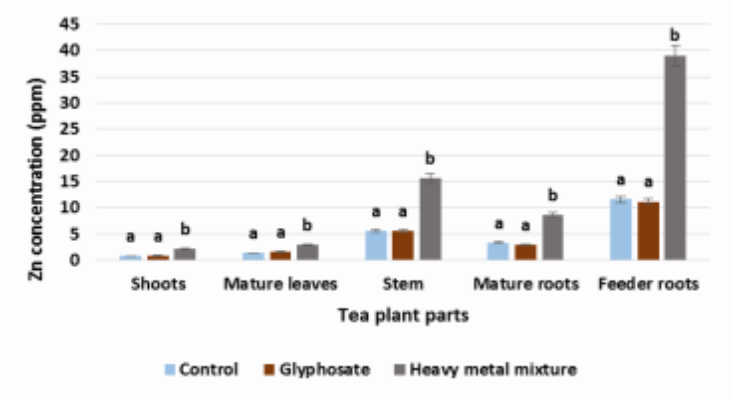


Figure 1. Zn accumulation in different parts of the tea plant

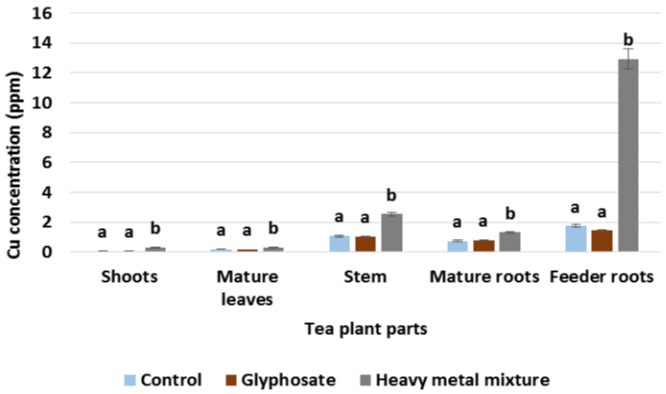
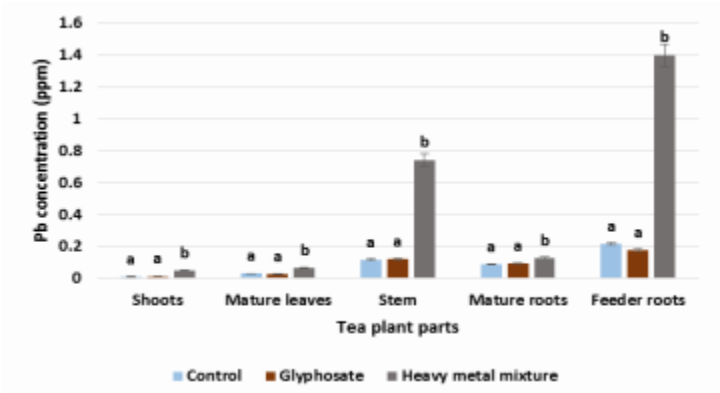


Figure 2. Cu accumulation in different parts of the tea plant



According to Figure 1, 2 and 3 the concentration of Zn, Cu and Pb in tea plants were in the order of: feeder roots > stems > mature roots > mature leaves > shoots. Most of the heavy metals were fixed in feeder roots and less amount of heavy metals transferred to the above ground parts. This implies that, there might be a mechanism to prevent heavy metals being transferred to above ground part in tea plants.

The ability of plant to tolerate and accumulate heavy metals can be assessed using Translocation Factor (TF). According to the Figure 4, it is reveal that there is a significant difference of TF values between the treatments in lead (Pb). Highest TF values were given by the Glyphosate treatments for all metals. Hence, it can be concluded that Glyphosate application has an impact on heavy metals distribution and accumulation and TF values in heavy metal mixture were lower than other treatments. It is further proved the mechanism that prevent heavy metals being transferred to the above ground parts in tea plant, under the condition of addition of external Zn, Cu and Pb to the soil.

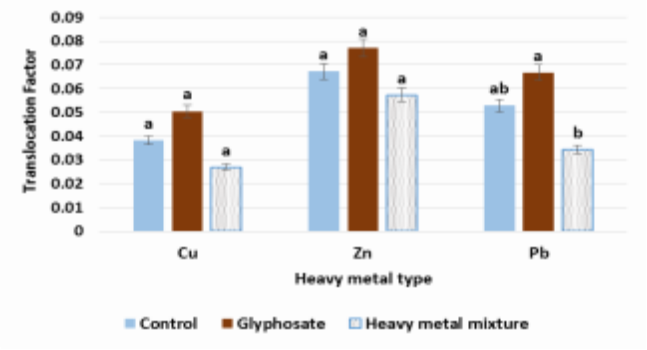


Figure 4. Translocation Factor in different treatments

Conclusion

Concentrations of Zn, Cu and Pb in tea plants from high to low levels follow the order: feeder roots > stems > mature roots > mature leaves > shoots. Feeder roots and stems were the main channels of Zn, Cu and Pb transmission in tea plants, and also the main accumulation parts and roots preserve the absorption of most Zn, Cu and Pb under the condition of addition of external Zn, Cu and Pb to the soil. Reference to TF values it can be concluded that there might be a mechanism to prevent heavy metals being transferred to the above ground part and Zn, Cu and Pb accumulation in different parts

of tea plant was not significant in Glyphosate treatment compare to control. But, Glyphosate application has an impact on heavy metals distribution and accumulation in tea plant.

References

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