Assessment of heavy metals in black tea produced in different agro-ecological regions of Sri Lanka

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Introduction

In recent times, many tea importing countries have either changed or are in the process of changing their food safety laws, generally resulting in lower limits for pesticide residues and heavy metals. In addition, food items such as tea, which are generally regarded as safe (GRAS) are also included in random monitoring programmes at the points of entry to those countries. Therefore, it is important that base line levels of pesticide residues and heavy metals for different types of Sri Lankan teas are re-established and precautionary measures taken, in order to to ensure that Sri Lankan tea complies with these new regulations.

The main sources of heavy metals in plants are the soil and other agricultural inputs. Therefore, one of the main factors that influence the heavy metal content is the agro-ecological region where tea is grown. Therefore, in this study black tea obtained from nine agro-ecological regions of Sri Lanka were analyzed for copper, nickel, iron and cadmium content.

Materials and Methods

Thirty five tea factories were selected from the nine Agro-ecological regions. Black tea samples of BOP grade were collected as three batches. Using AOAC procedures (AOAC, 1984, AOAC 1995), 105 number of samples were dry-ashed and after extracting with acids, they were aspirated into air-C_2H_2 flame and measured the absorbance using Atomic absorption spectrophotometer (GBC 932 plus).

The results were statistically analyzed using MINITAB (version 13.10) statistical software. The significant differences among regions were evaluated using one-way ANOVA at 0.05 probability level. Statistical analysis was done using paired samples t-test.

Results and Discussion

Cu, Ni, Fe, Cd content in black tea in main agro-ecological regions is shown in Table 1.

Copper content ranged between 16.2 and 165.7 mg/kg with a mean value of 29.4 mg/kg. There were five outlying figures from Nuwara Eliya region. This may be due to spraying of copper based fungicides and plucking of tea before the recommended pre-harvest interval of seven days. After removing these outliers the new mean value for Nuwara Eliya region was found to be 25.9 ± 6.4 mg/kg for copper. There is no significant variation

among the agro-ecological regions observed by the statistical data analysis. The Sri Lanka Tea board guideline for copper is established as 100 mg/kg [3].

Table 1 Mean copper, nickel, iron, cadmium content of black tea in agro-ecological regions

Agro-ecological region	copper	nickel	iron	cadmium
	(ppm) ±σ	(ppm) ±σ	(ppm) ±σ	(ppb) ±σ
Up country				
Nuwara-Eliya	42.1 ± 40.4	7.0 ± 7.1	141.9 ± 24.9	100 ± 40
Dimbulla	27.2 ± 5.9	5.4 ± 0.9	100.0 ± 20.0	90 ± 40
Bogawanthalawa	23.0 ± 5.8	4.3 ± 0.6	92.9 ± 14.9	30 ± 30
Agarapatana	29.2 ± 5.2	4.8 ± 0.8	101.3 ± 21.2	30 ± 10
Udupussallawa	28.2 ± 5.2	5.3 ± 0.8	106.2 ± 22.3	30 ± 30
Mid country	23.2 ± 4.8	4.5 ± 0.9	142.3 ± 59.4	240 ± 370
Uva				
Malwatta Valley	27.1 ± 0.7	6.0 ± 1.3	154.2 ± 38.8	50 ± 70
Bandarawella	29.5 ± 6.8	5.4 ± 0.9	110.0 ± 16.4	50 ± 20
Low country	20.8 ± 2.6	3.0 ± 0.6	104.8 ± 35.2	50 ± 80

The nickel content of black tea was 5.4 ± 3.8 mg/kg within the range of 0.6 to 26.4 mg/kg. Only four values were greater than 10 ppm, which were observed in Nuwara Eliya region. However, it was found that there is no significant variation of the nickel content in black tea produced in different regions. There is no maximum limit established for nickel in tea from the Sri Lanka Tea Board. The results were statistically analyzed to establish a baseline value for nickel. The nickel content was less than 8 mg/kg ($p < 0.05$).

Analysis of the iron content in black tea samples indicated that the values ranged between 49.3 and 241.3 mg/kg. The lowest mean value was found in Bogawanthalawa region. The highest mean value was found in Uva-Malwatta Valley region. The overall mean iron content is 116.8 ± 35.4 mg/kg.

The iron content in the Nuwara Eliya region was significantly different from all other up country regions and low country. There was a significant difference in mid country with Dimbulla, Bogowanthalawa, Udupussallawa, Bandarawella and low country. Uva-Malwatta Valley was significantly different from Uva-Bandarawella.

These variations may be due to soil characters and environmental factors. A proper study of iron content in soil of all regions has not been done yet. Further analysis should be carried out to find out the characters of soil, cultivar and fertilizer application, which affect the iron content in tea leaf. The Tea board guideline for iron is established as 500 mg/kg. The mean value obtained in this study is 116.8 mg/kg. Since all samples analyzed did not exceed the level of 300 mg/kg, it can be suggested to reduce the maximum limit for iron in tea from 500 mg/kg to 300 mg/kg after further experimentation.

Mean value of cadmium content in black tea was 80 µg/kg. Only one sample was observed with greater than 0.2 mg/kg of cadmium. This may be due to contamination of fertilizers with cadmium. After removing the outlier value, the new mean value of

cadmium for mid country region was 60 ± 40 µg/kg. The cadmium content of Sri Lankan black tea is not significantly different region wise ($p < 0.05$).

Conclusion

The results revealed that copper, iron, and cadmium content in black tea produced in all agro-ecological regions of Sri Lanka are well below The Sri Lanka Tea Board limits. Variation of copper, nickel, and cadmium content in black tea in agro-ecological regions is not significant. Iron content in black tea produced in different agro-ecological regions varied significantly. However, statistical analysis confirms that iron content is less than 300 mg/kg ($p < 0.05$). Therefore, it is suggested to explore the possibility of reducing the iron limit from 500 mg/kg to 300 mg/kg in Sri Lanka Tea Board guidelines after obtaining further data.

References

AOAC Official Methods of Analysis. 1984. [13th Edition]. Association of Official Analytical Chemists, Washington, DC.

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