

Macro- and Microelements in Green Tea and Its Infusions

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Abstract. The aim of studies was to determine 14 elements, i.e. magnesium (Mg), calcium (Ca), Potassium (K), sodium (Na), phosphorus (P), iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), chromium (Cr), cobalt (Co), nickel (Ni), lead (Pb) and cadmium (Cd) in green tea from China. According to the latest RDA standards, percentage of realization of daily intake for analysed elements was calculated. Determination of heavy metals such as Pb and Cd allowed on estimation of health hazard associated with green tea consumption in view of the provisional tolerable weekly intake (PTWI) regulations.

Keywords: Green tea, trace elements, AAS, RDA, PTWI.

1. Introduction

Tea is the second most popular beverage after water consumed by people all over the world [1]. The greatest producer of tea in 2011 was China [2]. Nowadays, 80% of the global consumption constitutes the most popular black tea [3]. However, over the years there can be observed growing interest in green tea. Green tea is produced from nonfermented leaves of *Camelia sinensis*, which quality depends on the conditions of cultivation, the soil on which it grows and numerous meteorological conditions [4]. The Chinese have known about the medicinal benefits of green tea since ancient times. Many studies have concluded that green tea has beneficial effects on health, including prevention of many diseases such as skin cancers [5], Parkinson's disease, cardiovascular diseases [6], coronary artery [7] and regulation of blood sugar and promotion of digestion [8].

The composition of green tea includes polyphenols, proteins, carbohydrates, lipid components, vitamins and trace elements which play a vital role in the metabolic processes and general well being of human body.

The aim of our study was to determine 14 elements (Mg, Ca, K, Na, P, Fe, Cu, Zn, Mn, Cr, Co, Ni, Pb, Cd) in green tea available in local markets and tea shops in Gdańsk (Poland). In order to estimate intake of minerals through green tea consumption, the percentage of leaching of elements to infusions was estimated. Based on the obtained results the percentage of the Recommended Daily Intake (RDA) as well as Provisional Tolerable Weekly Intake (PTWI) for heavy metals (Pb, Cd) was estimated.

2. Material and Methods

19 tea samples were collected from markets and tea shops in Gdańsk. There were two groups of analysed tea samples, i.e. commercial brand samples and tea (marked Chinese green tea) of certified origin (original Chinese green tea). About 10 g (± 0.0001 g) of homogenized products portions were weighed and transferred to quartz crucibles. Then they were ashed in an electric furnace at 540 °C. Mineralization was performed with 1.5 mL of HCl (Tracepure 36%) and 2-3 drops of HNO₃ (Tracepure 63%). In the case of infusions 2 g of tea (± 0.0001 g) were weighed and transformed to 250 mL beaker. Tea brew was prepared with 200 mL boiling water and infused for 5 minutes. The solution was filtered and transferred to a quartz crucible. Then

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tea infusion was evaporated on water bath to dryness and burned in furnace. Finally, ashed infusion was prepared with the same procedure as with dry sample [9].

The levels of thirteen metals (Mg, Ca, K, Na, Fe, Zn, Cu, Mn, Cr, Co, Ni, Pb, Cd) were determined by flame atomic absorption spectroscopy (FAAS) using Thermo Scientific i3000. Phosphorus was determined with spectrophotometric method on UV-Vis spectrometer [10]. The accuracy and precision of the analytical measurements were checked by analysis of the certified reference material (Tea, NCS ZC73014). Recovery of the elements studied ranged between 84-103 %, and the RSD was 0.1-8.3 %. Limits of detection (LODs) of the method applied for Pb, Cd, Cr, Ni and Co in the analysed samples were as follows: 0.01, 0.001, 0.02, 0.1 and 0.001 mg/100 g, respectively. The LOD was established according to Konieczka and Namieśnik [11].

3. Results and Discussion

The analysed products characterised by a variable contents of Mg, Ca, K, Na, P, Fe, Zn, Cu, Mn, Cr, Co, Ni, Pb and Cd. Among macroelements the highest levels were found in case of K (1906 mg/100 g), P (287 mg/100 g) and Mg (231 mg/100 g). Similar macroelements levels were determined by McKenzie *et al.* [4], Malik *et al.* [12] and Li *et al.* [13]. Green tea was also good source of Mn - 96 mg/100 g and Ca - 93 mg/100 g. Much lower values were determined for Fe (35 mg/100 g), Na (9 mg/100 g), Zn (3.7 mg/100 g) and Cu (1.9 mg/100 g), which are comparable to the results presented by Pełal *et al.* [14], Al-Othman *et al.* [15] and Görür *et al.* [16]. The obtained results are in agreement with the fact that green tea as an unprocessed product contains mainly elements found in soil, i.e. macroelements (K, P, Mg, Ca) and Mn. As it can be observed on Fig. 1a and Fig. 1b, there are statistically significant differences in macroelements and some microelements (Mn, Fe) concentrations in original and market Chinese green tea.

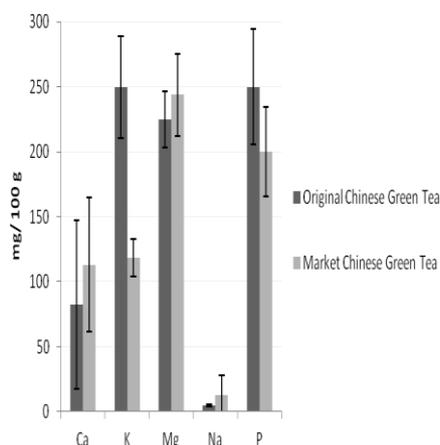


Fig. 1 a: Macroelements concentrations in green teas

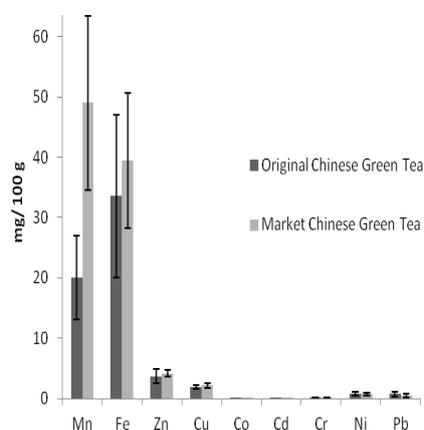


Fig. 1 b: Microelements concentrations in green teas

With respect to the fact that green tea is consumed as a beverage it was necessary to estimate the percentage of leaching metals to infusions. The highest percentage of extraction was calculated for K (59%)

and Co (57%). The lowest percentage of leaching was obtained for Fe (7%). The percentage of extraction from tea leaves to infusions, increased in the following order: Fe < Na < Cd < Pb < Ca < Cu < Mn < P < Mg < Ni < Zn < Cr < Co < K.

Based on essential elements concentration in the studied tea, the percentage of realization of the recommended daily intake of each metal was estimated for an adult person (Fig. 2).

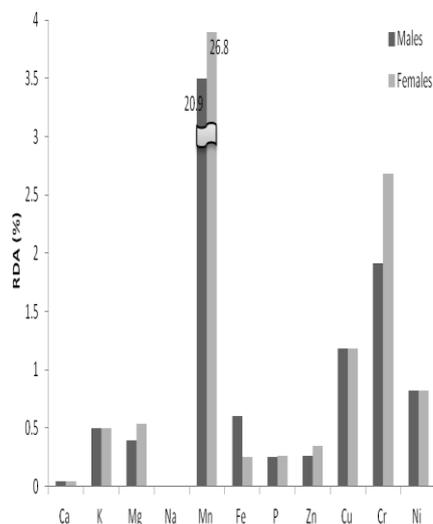


Fig. 2: Percentage of realization of RDA for macro and microelements for an adult person

According with RDA, consumption of one glass of green tea supplies to human body, on average, with 0.04% for Ca, 0.5% for K, 0.4 – 0.54% for Mg, 0% for Na, 20.9 – 26.8% for Mn, 0.25 – 0.6% for Fe, 0.25 – 0.26% for P, 0.26 – 0.35% for Zn, 1.18% for Cu, 1.91 – 2.68% for Cr and 0.82% for Ni.

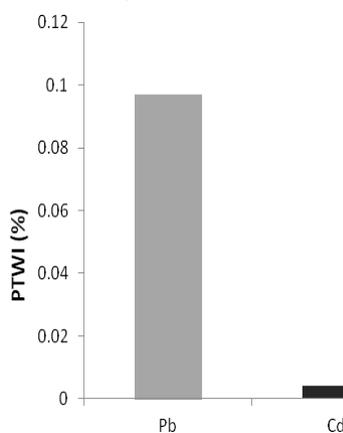


Fig. 3: PTWI realization by consumption of 200 mL of green tea by a person weighing 70 kg

PTWI dosage for Pb and Cd was fulfilled in 0.097 and 0.004 %, respectively. It can be stated that drinking green tea doesn't cause a risk to human health.

4. Conclusion

Green teas have proven to be a rich source of K, P, Mg, Mn and Ca. However, the greatest percentage of leaching was obtained for Co and K. Based on RDA calculated for the analysed elements it was observed that Mn complies the recommended standards to the highest degree. Along with the recommendations of the FAO/WHO [17] it was found that there is no health hazard associated with exposure to heavy metals (Cd, Pb) via consumption of green tea from China.

5. References

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