Comparison of heavy metals (Pb and Cd) present in green tea and black tea

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Abstract :   The current study is aimed to determine the concentrations of lead and cadmium (heavy metals) in samples of green tea and black tea and to compare them. Two samples of each green tea and black tea were taken. The investigation was performed using the atomic absorption spectrometer (AAS). The estimated daily intake (EDI)of Pb and Cd was compared with allowable daily intake (ADI). Results showed that one black tea sample contained both Pb and Cd which could be detected and it was found to be in permissible limit. Determining heavy metal content is still very important, because these metals are present in soils due to increased industrial activity and the use of pesticides and fertilizers.

Keywords   : *Heavy metals, tea, AAS, EDI, ADI.*

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Introduction :

Tea is a product of the leaves of the "Camellia Sinensis" plant. The records show that the first tea factory was built in 1932 in Lahijan. Day-by-day the number increased and there were 162 activated factories in 2010. Unfortunately, despite a lot of activities, the tea industry has not been observed in improving its quality in recent years. The beneficial effects of drinking tea, such as the prevention of cancer because of the presence of polyphenolic substances, the reduction of serum cholesterol (Salahinejad and Aflaki, 2010), the prevention of low-density lipoprotein, and decreased instance of cardiovascular disease, have made it one of the most popular beverages (Chung et al., 2003; Fung et al., 2009; Salahinejad and Alfaki, 2010). Studies have also shown that the regular consumption of tea can contribute to the daily dietary requirements of some elements (Karak and Bhagat, 2010). Black tea is the most common type of tea. It is processed in five steps: withering, rolling, fermentation, firing

and sorting (Fung et al., 2009). The contamination of soils from the use of pesticides and fertilizers and increased industrial activities has caused the contamination of tea. Thus, knowing the content of heavy metals in tea is important because of their adverse effects on human health. For example, Cd and Pb can reduce cognitive development and intellectual performance in children. It can also damage kidneys and reproductive systems (Baars et al., 2001; Johri et al., 2010). Cadmium is toxic to all organisms. Its cumulative poison in mammals causes renal failure, hypertension, anaemia and disorders of bone marrow. Lead could affect the development of the brain and nervous system. Exposure to high levels of lead may cause anaemia, weakness and kidney and brain damage. Very high lead exposure can cause death. It can irreversibly damage mental and physical development. Because of the importance of heavy metals in tea, several studies have been carried out to determine their contents in tea.

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. They are generally defined as metals with relatively high densities, atomic weights or atomic numbers. Examples of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), and lead (Pb). Among these, lead and cadmium are the two most abundant toxic metals in the environment. These metals are called 'heavy' because of their high relative atomic mass which persist in nature and can cause damage or death in animals, humans, and plants even at very low concentrations.

In the present study, the heavy metal contents(Pb and Cd) of four samples; two of green tea and two of black tea were investigated.

Materials and Methods :

The sampling of tea was conducted between July and August 2018. There were four samples two each of green tea and black tea. The chemicals used were 65%(w/w) HCL and 65%(w/w) HNO$_3$ and the standard solutions of Pb and Cd. The tea samples were at first dried in oven to remove moisture. Then the samples were grinded in mortar pestle and 0.5gm of each sample was weighed. The samples were then digested (acid digestion) in digester. They were then filtered and levelled to 25ml in the volumetric flask. The prepared samples were then analysed by AAS.

Results and Discussion :

The results obtained showed that the amount of heavy metals present in green tea and black tea were in permissible limit. Out of the four samples, two of black tea and two of green tea, both lead (Pb) and cadmium (Cd) concentration could be detected only in one black tea (Table 1 and 2) while in all the rest, the amount of these metals were below detection limits and this stated that the concentration of the heavy metals in tea for daily intake were below safety levels.

From the results, it could also be concluded that among green tea and black tea, the metal contents in green tea were comparatively lesser. So, green tea is preferably better. The concentrations of heavy metals in tea especially lead is a matter of concern for both producers and consumers. The concentrations of Pb and Cd were below detection limits (Table 1 and 2); this could be because the dissolution of lead from tea leaves is limited. But the lead contamination in tea leaves remains a concern, and practices should be developed to avoid problems in future.

It was reported that the sources of heavy metal pollution in agricultural soils mainly came from the effluent of the waste air, water and residue from industry, the tail gases emitted by automobiles, sewage irrigation and the use of agrochemical materials (Shang et al. 1996; Zhu and Zhou 1999; Zheng et al. 2006). The excessive use of chemical fertilizers and organic manures can lead to the accumulation of heavy metals in agricultural soils.

The use of modern farming methods is a proposal to be considered to reduce the accumulation of heavy metals in the soil of tea.

Table 1. Concentration of Lead (Pb) present in green and black tea samples

Sample Label	Conc. (µg/L)	%RSD	Mean Abs.
B 1	0.011	HIGH	0.0012
B 2	ND	HIGH	−0.0008
G 1	ND	HIGH	−0.0028
G 2	ND	HIGH	−0.0030

Table 2. Concentration of Cadmium (Cd) present in green and black tea samples

Sample Label	Conc. (µg/L)	%RSD	Mean Abs.
B 1	0.003	HIGH	0.0080
B 2	ND	HIGH	-0.0015
G 1	ND	HIGH	-0.0012
G 2	ND	HIGH	-0.0019

Conclusion :

A comparison of the results of the current study with standard values indicated that both studied heavy metal contents (Pb and Cd) were within standard ranges. It is necessary to determine the heavy metal contents in tea samples, alternatively, because of the adverse effect of heavy metals on human health. On the whole, the quality of tea samples studied were acceptable for heavy metal contents and the green tea was preferably better than black tea.

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