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Research Article

DETERMINATION OF LEAD, MANGANESE, COPPER, ZINC, CADMIUM, NICKEL AND CHROMIUM IN TEA LEAVES

B. SRIVIDHYA[1], R. SUBRAMANIAN[2] AND V. RAJ[2]*

[1]Department of Chemistry, KSR College of Technology, Tiruchengode- 637 215, Tamil Nadu, India, [2]Department of Chemistry, Periyar University, Salem-636011, Tamil Nadu, India. Email: alaguraj2@rediffmail.com

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ABSTRACT

Tea is one of the common drinks in India. The essential and non essential elements present in black and green teas vary with respect to soil and geographical origin. Hence the aim of the study is to measure some heavy metals (Cu, Ni, Pb, Cd, Cr, Zn and Mn) in black and green tea which are commonly consumed in South India. Heavy metal contents were determined by Atomic Absorption Spectrometry (AAS). The results of analysis showed that the mean level of metals were 14.34 ± 0.49 mg/kg, Ni 11.34 ± 0.63 mg/kg, Pb 2.31 ± 0.13 mg/kg, Cd 0.89 ±0.10 mg/kg, Zn 25.39 ± 0.59 mg/kg, Mn 709.0 ± 14.18 mg/kg and Cr 704.0 ± 14.18 mg/kg for black tea and Cu 11.28 ± 0.08 mg/kg, Ni 9.09 ± 0.75 mg/kg, Cd 1.59 ± 0.26 mg/kg, Zn 26.39 ± 0.92 mg/kg and Mn 508.0 ± 44.03 mg/kg for green tea. Pb and Cr content in green tea were lower the quantification limit.

Keywords: Black tea, Green tea, Heavy metals, AAS

INTRODUCTION

Tea is one of the commonly consumed beverages in the world for its desirable aroma, taste and putative positive physiological functions[1]. The growing interest in drinking tea all over the world would be connected with polyphenol antioxidative activity, fighting the harmful influence of environmentally generated free radicals[2]. Tea leaves contain polyphenols such as epigallocatechin 3-gallate (EGCG) that exhibit antioxidant[3], lowering cholesterol[4], hepatoprotective[5] and anticancer activities[6-7]. Green tea possesses antibacterial, antitoxin, antiviral and antifungal activities[8]. The human body requires both metallic and non-metallic elements within certain permissible limits for growth and good health. Many elements play a vital role in the metabolic processes and in the general well being of humans. For example, trace level of copper is essential for human health[9]. Tea leaves are source of mineral elements such as zinc, manganese, iron, copper, magnesium, titanium, aluminium, strontium, bromine, sodium, potassium, phosphorous, iodine and fluorine. The tea infusion contains very little protein, vitamins and carbohydrates but may be a source of essential dietary metals and metal binding polyphenols[10]. Green tea contains powerful antioxidants, such as vitamin E and catechins, which can destroy free radicals[11]. The active constituents of green tea leaves belong to the polyphenol group. Some of the more important and characteristic tea polyphenols are flavanols, predominantly catechins. Catechins effectively kill bacteria, reduce cancer growth, suppress plaque and cavity formation, and prevent excessive build-up of blood cholesterol due to their strong antioxidant activity[12]. It is believed that tea catechins can react with reactive oxygen species, which may play important roles in carcinogenesis, by terminating chain oxidative reactions. The antioxidant activity in green tea is found in both polyphenol and nonpolyphenolic fractions. The non-polyphenolic fraction of residual green tea has a potent suppressive activity against hydroperoxide generation from oxidized linoleic acid. Therefore, determination of element compositions in foods and related products is essential for understanding their nutritive importance. Hence the aim of the study is to determine the Cu, Pb, Cd, Zn, Mn, Ni and Cr in black and green tea brands readily available in local market.

MATERIALS AND METHODS

Sample collection

Black and green teas were obtained from The United Nilgiris Tea Estate Co. Ltd, Coimbatore and Kannadavan Tea Estate, Moonar, Kerala. The purchased tea samples were consequently subjected to analysis.

Sample preparation

The glassware and polyethylene containers used for analysis were washed with tap water, then soaked over night in 6N HNO_3 solution and rinsed several times with ultra pure water to eliminate absorbance due to detergent[13]. The standard procedure described in AOAC was followed for the preparation of samples for analysis of heavy metals[14]. Accurately weighed (0.5 g) plant samples were transferred in to a silica crucible and kept in a muffle furnace for ashing at 450° C for 3 hours and then 5 ml of 6M HCl was added to the crucible. Further, the crucible containing acid solution was kept on a hot plate and digested to obtain a clean solution. The final residue was dissolved in 0.1 M HNO_3 solution and made upto 50 mL. Standard solutions were prepared according to the Shimazdu Perkin Elmer Pure Atomic Spectroscopy Standards guidelines (NIST traceable CRM, Perkin Elmer Corporation, USA and Merck - Germany). Working standard solutions were prepared by diluting the stock solution with 0.1 M nitric acid for checking the linearity.

Analytical procedure

Cu, Ni, Pb, Cd, Zn and Mn in two tea samples were analyzed using atomic absorption spectrophotometer (AA Analyst 800, Perkin Elmer Corporation, USA) equipped with flame and graphite furnace. Air-acetylene flame was used for determination of metal content. The instrument was operated with the following conditions in flame mode: acetylene 2 ml/min, air 17 ml/min for Cu, Ni, Zn, Mn and Cr and in a graphite furnace mode (Pb and Cd) the inert argon gas flow and the temperature parameters were followed as recommended by manufacturers (Perkin-Elmer, 2000). The absorption wavelength for the determination of each metal together with its linear working range and correlation coefficient of calibration graphs are given in Table 1. Data were rounded off suitably according to the value of standard deviation from measurements in triplicate.

RESULTS AND DISCUSSION

Heavy metals

The results of analysis of black and green tea samples are presented in Table 2. There was wide variation in the heavy metal content of black and green tea. Consumer brand teas are the blend of various individual teas from different estates across country. The results indicated that the contents of Cu, Ni, Pb, Cd, Zn, Mn and Cr in tea were different for the different agroclimatic regions. The content of Cu measured in black and green tea were 14.34 ± 0.49 mg/kg) and 11.28 ± 0.08 mg/kg. Copper is one of the native metals found in tea, central to polyphenol oxidase enzyme. The lowest value of copper was found in Nilgiris tea and the highest in Gudalur tea samples. Cu content in made tea was also reported[15-16]. It was evident from this

study that the Cu content of all the made tea samples were less than 30 mg/kg which is well below the permissible limit of 150 mg/kg under Prevention of Food Adulteration Act, 1954 (PFA), India. The Ni contents in black and green teas were 11.31±0.63 and 9.09 ± 0.75 mg/kg respectively. Nickel in the made tea sample ranged between 2.89 and 22.6 mg/kg was previously reported by other investigator[17]. Nickel content in black tea was slightly higher than green tea. Ni contamination may occur due to usage of fertilizers [18]. It is clearly evident that nickel mainly comes through the foliar and soil application of low quality fertilizers and micro nutrients. Since Ni is a toxic element, not having any tolerance limit in tea, the agro inputs used in tea fields will have to be analysed for heavy metal impurity.

The Pb content in black tea was 2.31 ± 0.13 mg/kg whereas the same content in green tea was found to be lower than the quantification limit of 0.5 mg/kg. The contents of Cd and Zn were more or less similar in both black and green tea. Highest level of Mn was reported in these teas. The Cr content in black tea was 704.0 ± 14.18 mg/kg whereas the same content in green was lower than the limit of quantification of 2.5 mg/kg. The variations in heavy metals content of tea brands may be due to geographical, seasonal changes and the chemical characteristics of the growing regions[14].

Cr is considered as a local contaminant and comes mainly through the CTC rollers during the manufacturing of black tea. Since the CTC rollers are made up of gun metals which having only trace level of Cr content. This machinery is not employed for manufacturing of green tea hence the Cr content is found to be lower the quantification limit[8].

Table 1: Operating parameters for working elements

Elements	Wavelength (nm)	Working range (mg/kg)	Correlation coefficient (r)
Cu	324.7	0.07- 5	0.9993
Ni	232.0	0.10-4	0.9996
Pb	283.3	0.005-0.10	0.9931
Cd	228.8	0.005-0.10	0.9991
Zn	213.9	0.2-2	0.9994
Mn	280.1	1-5.0	0.9990
Cr	357.9	0.08-4	0.9999

Table 2: Heavy metal levels in tea leaves

Heavy metals	Black tea (Mg/kg)	Green tea (Mg/kg)
Cu	14.34 ± 0.49	11.28 ± 0.08
Ni	11.34 ± 0.63	9.09 ± 0.75
Pb	2.31 ±0.13	< LOQ*
Cd	0.89 ±0.10	1.59 ± 0.26
Zn	25.39 ± 0.59	26.39 ± 0.92
Mn	709.0 ± 14.18	508 ± 44.034
Cr	704.0 ± 14.18	< LOQ**

LOQ* LOQ for Pb is 0.5 mg/kg

LOQ** LOQ for Cr is 2.5 mg/kg

CONCLUSION

The results shows that the heavy metals (Cu, Ni, Pb, Cd, Zn, Mn and Cr) present in black tea were higher than green tea. Heavy metal levels except Mn and Cr were found to be below the PFA limit of 150 mg/kg in black tea. It might be due to the possibility that commercial brands of black tea are made up of various individual teas from different geographical regions of the country. But the heavy metal contents in green tea were below the PFA limit of 150 mg/kg except Mn, which is in the higher limit. Hence, drinking green tea could be a benefit to the tea drinkers in addition to the drinking of black tea.

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