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Short Communication

Caffeine and Total Polyphenol Contents of Market Tea Cultivated and Processed in Bangladesh

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ABSTRACT

Objective: The aim of this study was to determine the contents of caffeine and total polyphenol in six brands of market tea cultivated and processed in Bangladesh. **Methods:** Caffeine and polyphenol contents were determined by solvent extraction (AACC) and the International Organisation for Standardisation Method (ISO) 14502-1 respectively. **Results:** Caffeine contents of the different tea samples ranged between 0.99 ± 0.17% to 2.08 ± 0.16% (g/100g materials), while that of total polyphenol was from 36.90 ± 1.39% to 17.29 ± 2.30% of gallic acid equivalents (GAE). The order of caffeine concentration in tea samples was found as follows: Organic Black Tea > Taaza Tea > Organic Green Tea > Magnolia Tea > Organic Zinger Tea > Organic Tulsi Tea. The polyphenol concentration in the tea samples was highest in Organic Green Tea followed by Taaza Tea and the rest as follows: Magnolia Tea > Organic Black Tea > Organic Zinger Tea > Organic Tulsi Tea. An indicative difference in amounts of caffeine and polyphenols for different tea brand samples is seen in this study. **Conclusion:** This systematic screening provides information to producers as well as consumers on the quantities of caffeine and polyphenols in commercial tea available in the markets of Bangladesh.

Keywords: Caffeine, polyphenol, market tea, Bangladesh

INTRODUCTION

Tea is one of the most commonly consumed beverages in the world for its desirable aroma, taste and putative positive physiological functions and recognised as the world's most popular beverage other than water. In Bangladesh, tea has become one of the most dynamic agro-export industrial products and plays a vital role in its economy (Islam *et al*., 2005). Tea is rich in caffeine, flavonoids and other polyphenols that have been shown to possess a wide range of biological and pharmaceutical benefits, including anticarcinogenic, antioxidative, and hypolipidaemic activities (Yang, 1999).

The polyphenols in tea include mainly flavanols, hydroxyl-4-flavanols, anthocyanins, flavones, flavonols and phenolic acids (Mukhtar *et al*., 2000). Among the important tea flavanols are catechins

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(flavan-3-ols), of which the major ones are: (-)-epicatechin (EC), (-)-epicatechin gallate (ECG), (-)- epigallocatechin (EGC), (-)-epigallocatechin gallate (EGCG), (+)-catechin (C), and (+)-gallocatechin (GC) (Chen *et al*., 2003).

Polyphenols are associated with the prevention of chronic conditions such as cancer, atherosclerosis and neurological diseases. Caffeine acts as a stimulating agent and is attributed to a reduction in mental fatigue (Joseph *et al*., 2011). Although caffeine has several beneficial effects, it is associated with some adverse effects such as anxiety, tachycardia and insomnia, depending on the dosage consumed and sensitivity of individuals (Farah *et al.*, 2006). According to Phan, Kuban & Kracmar (2003), the upper limit of caffeine per day for healthy adults is 300-500 mg, 150-200 mg for pregnant women and 50mg for children.

This study was conducted to determine the caffeine and polyphenol contents of several samples of commercial tea that are cultivated and processed in Bangladesh.

METHODS

Six commercial tea samples of three different brands viz., Organic Green Tea, Organic Black Tea, Organic Tulsi Tea, Organic Zinger Tea marketed by Kazi & Kazi tea, Taaza Tea marketed by Unilever Bangladesh Ltds and Magnolia Tea marketed by M. Ahmed Tea & Land Co. Ltds were purchased from the local markets at Sylhet, Bangladesh. Kazi & Kazi tea had both green tea and black tea while Unilever Bangladesh Ltds and M. Ahmed Tea & Land Co. Ltds corresponded to black tea only. For each commercial tea sample studied, three bags were sampled.

Dichloromethane and sodium hydroxide (6M) were used in order to determine the caffeine content of the samples, while Folin-Ciocalteu's phenol reagent (Merck Chemicals), gallic acid (99% purity, Sigma), and anhydrous sodium carbonate (99% purity, Merck) were used to determine the total phenolic content (TPC).

Caffeine was extracted from tea samples by the solvent extraction according to AACC (2000) method. The method described by the International Organisation for Standardisation (ISO) 14502-1 (2005) was used for the extraction of polyphenols. The total polyphenol content (TPC) was determined by spectrophotometry (T60 UV Visible Spectrophotometer), using gallic acid as standard, according to the method described by the ISO 14502-1 (2005). The total polyphenol content (TPC) was expressed as gallic acid equivalents (GAE) in g/100 g material. The concentration of polyphenols in samples was derived from a standard curve of gallic acid ranging from 10 to 50 μg/mL (Pearson's correlation coefficient: r^2 = 0.9984).

Statistical analysis

Data were expressed as the means ± standard error of the mean of two independent experiments carried out in triplicate. Non-parametric Kruskal-Wallis test was carried out to analyse the association of caffeine and polyphenol contents in different commercial tea samples, while the Bonferroni method was applied for multiple comparison tests. A probability (p) value <0.05 was considered significant.

RESULTS AND DISCUSSION

Caffeine content

The amount of caffeine in different tea samples tested were in the range of 0.99 ± 0.17 to 2.08 ± 0.16% (g/100g materials) (Figure 1). No significant difference was found between the caffeine contents of the different tea samples. The result is similar to the findings of Amra *et al*. (2006), who found both black and green tea contained caffeine at 1 to 5 % on dry weight basis. The highest caffeine content was in Organic Black Tea (Kazi & Kazi Tea) at 2.08 ± 0.16% and the lowest caffeine content was in Organic Tulsi Tea (Kazi & Kazi Tea) at 0.99 ± 0.17%. The differences in amount of

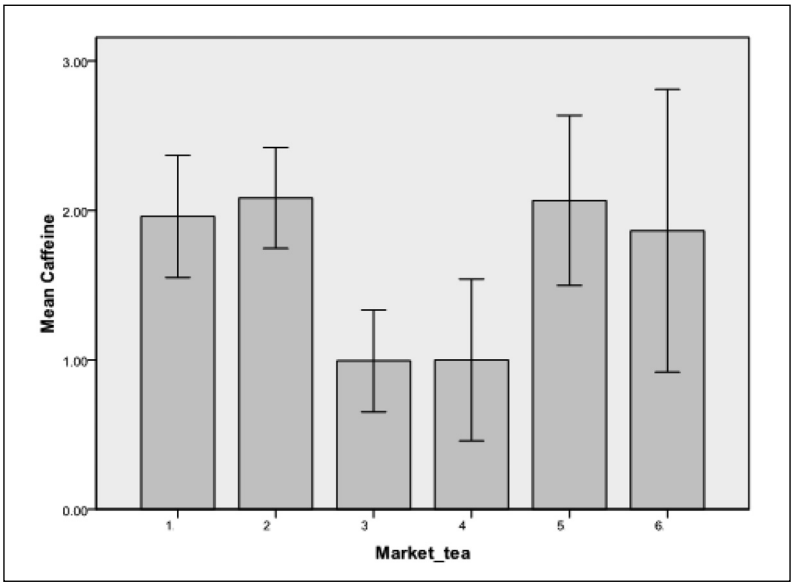

Figure 1. Caffeine contents of various market tea samples; error bars represent the SEM; Numbers (1-6) denote organic green tea, organic black tea, organic tulsi tea, organic zinger tea, taaza tea and magnolia tea respectively;
Error bar ± 2SE

caffeine may be attributed to various factors including geographical locations of the source of the raw materials, genetics and environmental variability, harvest time and processing techniques of the plant materials (Athayde, Coelho & Schenkel, 2000).

The tulsi and zinger tea were almost caffeine free, and have been associated with a wide range of beneficial effects, including improving stamina and endurance, boosting the immune system, reducing inflammation, and having antibiotic, antiviral and antifungal properties.

Total polyphenol content

Remarkable differences were found in the polyphenol contents between the tea samples analysed ($p = 0.01$). The total polyphenol contents ranged from 36.90 ± 1.39% to 17.29 ± 2.30% GAE (Figure 2). The highest polyphenol content was found in Organic Green Tea from Kazi & Kazi Tea at 36.90 ± 1.39% GAE (Gallic acid equivalents), while the lowest polyphenol content was in Organic Tulsi Tea from Kazi & Kazi Tea at 17.29 ± 2.30% GAE. The total polyphenol contents of Organic Tulsi Tea and Organic Zinger Tea were 17.29 ± 2.30% GAE and 18.07 ± 1.27% GAE respectively, with no significant difference between them. Organic Black Tea had 21.20 ± 1.26% GAE, while Taaza Tea and Magnolia Tea had 29.08 ± 1.05% GAE and 27.72 ± 1.57% GAE, respectively and substantial differences were found between the black tea and the latter samples. This may be due to different post-maturation fermentation procedures applied in the preparation of black tea. The fermentation step is absent in green tea preparation.

The total polyphenol values obtained for Bangladeshi teas were comparatively higher than those reported for different commercial brands of tea in Malaysia, which showed % GAE values of 19.13 ± 0.37 and 11.37 ± 1.48 for green tea and 8.49 ± 0.80 and 6.06 ± 0.54 for black tea (Chen *et al*., 2007). Other authors have reported the total

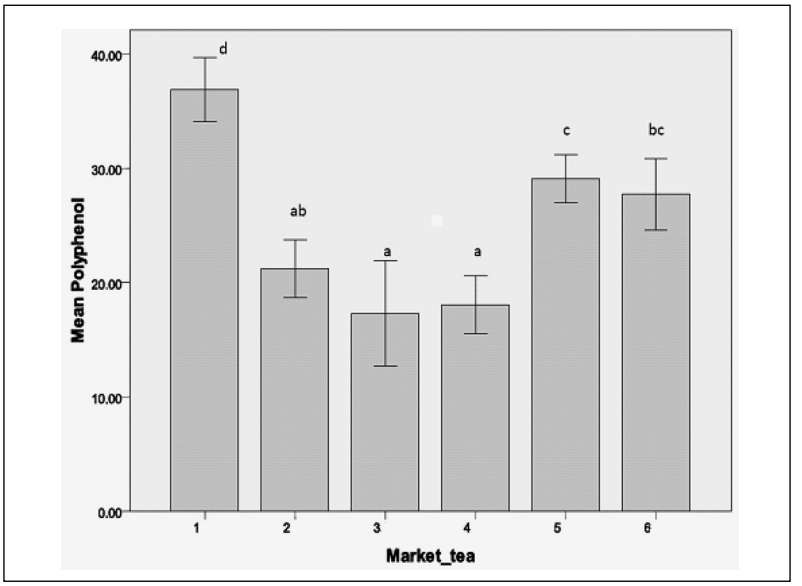

Figure 2. Total polyphenol contents expressed as gallic acid equivalents (GAE; g/100g plant material) in different market tea samples; error bars represent the SEM ; numbers (1-6) denote organic green tea, organic black tea, organic tulsi tea, organic zinger tea, taaza tea and magnolia tea respectively. Error bar ± 2SE

Note: Letters a-c denote that the significant difference were observed in polyphenol content of different market teas ($p<0.05$)

polyphenol contents in Australian black tea bags to be an average of 16%, a value comparatively lower than the average obtained in this study (22.67%) (Yao *et al*., 2006). The differences could be due to different extraction and quantification methods employed

CONCLUSION

This preliminary study showed differences in amount of caffeine and polyphenol in commercial teas that are cultivated and processed in Bangladesh. Organic Black Tea and Organic Green Tea had relatively high caffeine and total polyphenol contents while Organic Tulsi Tea had the lowest for both these compounds. This information may be of interest to discerning consumers and producers.

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