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Full Length Research Paper

Quality of Black Teas in Indian market

Ch. Someswararao*, P. P. Srivastav and H. Das

Agricultural and Food Engineering Department, Indian Institute of Technology, West Bengal 721302, India.

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Tea (*Camellia sinensis*) is the second most popular consumed drink in the world after water. Tea has numerous medicinal benefits mainly due to its antibacterial and antioxidant properties. In this study, the levels of Theaflavin (TF), Thearubigin (TR), high polymerized substances (HPS) and total polyphenols (TPP) of different tea brands found in Indian market were determined using UV/Vis spectrophotometric methods. Four brands of black teas were selected [Tata tea (CTC), Red label tea (CTC), Lipton Darjeeling tea (orthodox, Meri Chai and (CTC tea bag)]. Among the different market teas Lipton Darjeeling (orthodox) tea was found to have greater amount of 19.57% polyphenols and Darjeeling tea was found to have the highest aroma index of 15.9.

Key words: *Camellia sinensis*, Red label tea CTC tea, orthodox tea, polyphenols, aroma index.

INTRODUCTION

Tea (*Camellia sinensis*) is the most widely used ancient beverage in the world. Tea, consumed as a beverage worldwide, is prepared from systematically processed dried tea leaves by boiling in water (milk and/or sugar are added sometimes) (Sharma and Rao, 2010). India is the major producer, consumer and exporter of tea. India accounts for almost 31% of the global production of tea. Teas are usually classified as black tea, green tea, Oolong tea, yellow tea, white tea and dark compressed tea. Black tea is the most important one consumed across the world. Black tea quality depends mainly on the components and colour of the tea infusions and tea prices vary greatly, depending on the quality which has traditionally been assessed by a tea taster who has developed a language of his own to describe various quality attributes of a tea infusion (Liang et al., 2003). The quality and prices of tea are different according to different brands in the market. Borse et al. (2002) generated a chemical and bio chemical finger print to assess the intrinsic characteristics of black teas from different regions of India. Tata Tea, Brooke Bond Red Label Tea, Taj Mahal Tea, Lipton Tea are some of the leading tea brands in India. In the present study theaflavin (TF), thearubigin (TR), high polymerized substances (HPS) and total liquor color (TLC), total polyphenols, *L, a, b* color values and aroma index of some Indian market teas (CTC, Orthodox and Tea bag) were determined.

*Corresponding author. E-mail: chsomeswararao@gmail.com. Tel: 919775727858.

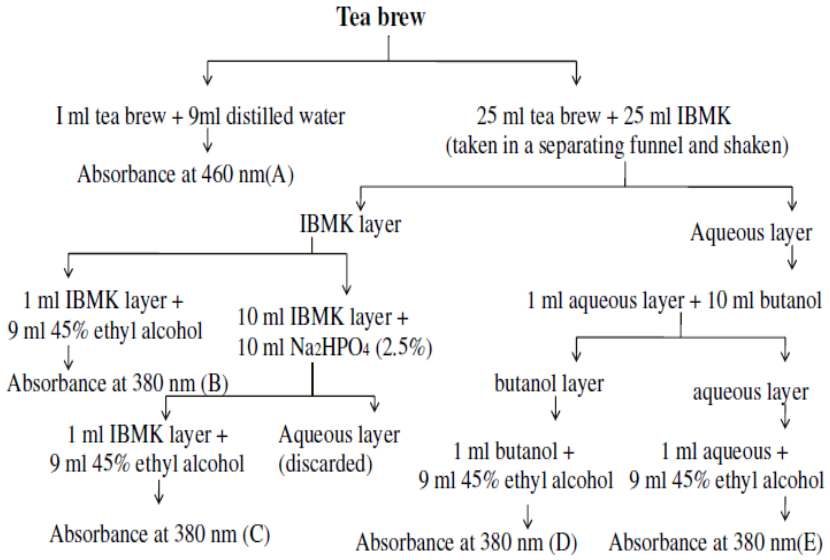
MATERIALS AND METHODS

Determination of soluble solid content

The soluble ingredients in black tea accounts for as much as 30% of the tea weight. Tea polyphenols constitute the major portion of the soluble ingredients. Tea catechins are the primary polyphenols in the tea, and accounts for 75 to 80% of soluble ingredients. The enzyme pectinase improved the extractable-solids-yield up to 11.5%, without much improvement in polyphenols recovery, while tannase pre-treatment showed a significant improvement in polyphenols recovery (14.3%) along with an 11.1% improvement in extractable-solids-yield (Chandini et al., 2011b). About 2.5 g of black tea was added to 150 ml of boiled water in a beaker. The beaker was then covered with a lid and allowed to brew for 5 min. The mixture was filtered through whatman No.4 filter paper. The liquor was then cooled to room temperature and weighed. An aliquot of liquor was removed, placed in a pre-weighed vessel and evaporated to constant weight in an oven at 105˚C for 24 h. From the weight of residue, the amount of soluble solids in the extract was obtained (Liang and Xu, 2001).

Determination of TF, TR, HPS and TLC of tea samples

The theaflavin (TF), thearubigin (TR), high polymerized substances (HPS) and total liquor color (TLC) of the tea samples were determined by the process shown in Figure 1. The tea samples were analyzed for various chemical constituents by standard procedure (Masoud et al., 2006).



TF (%)	=	4.313 x C	TR (%)	=	13.643 x (B+D-C)
HPS (%)	=	13.643 x E	TLC	=	10 x A
TF	=	theaflavin	TR	=	thearubigin
HPS	=	high polymerized substances	TLC	=	total liquor color
IBMK	=	iso-butyl methyl ketone			
Na_2HPO_4	=	disodium hydrogen phosphate			

Figure 1. Method for determination of TF, TR, HPS and TLC.

Determination of total polyphenols of tea samples

For determination total polyphenols two grams of tea is added to 200 ml of water in a 250 ml conical flask and boiled in a water bath at 90˚C for 10 min. The solution was filtered and then cooled to room temperature and finally diluted to 250 ml with distilled water (Yao et al., 2006). 1 ml of tea solution, 4 ml of distilled water and 5 ml of tartarate solution were taken in a volumetric flask and then diluted to 25 ml with phosphate buffer solution. The mixture absorbance was measured at 540 nm using spectrophotometer.

$$\text{Total polyphenols (\%)} = \frac{3.914\ E\ Vo\ 100}{1000\ V1\ w}$$

Where, E = absorbance reading; V_o = total volume of the solution (250 ml); V_1 = the volume used for the measurement (1 ml), and W = dry weight of the tea sample.

The infusions were prepared by adding 2.5 g of tea granules to 150 ml of boiling water. Hunterlab calorimeter was used to measure the *L, a, b* values of 30 ml of each of the tea infusion. 'L' indicates lightness (L = 100 white, and L = 0 black), 'a' indicates redness when positive and greenness when negative and 'b' indicates yellowness when positive and blueness when negative. Flavour and aroma are important quality attributes of tea. Tea tasters usually assign scores to samples of tea under evaluation in a scale of 1 to 10 depending on the flavour, aroma and appearance of the sample. Electronic nose is a unique tool that is capable of sensing the volatile compounds of the tea sample and reliably predicts tea taster like scores with a high degree of accuracy. Neural network based soft computing techniques are used to tune near accurate co-relation smells print of multi-sensor array (aroma index) with that of tea tasters' scores. The aroma index of tea samples were determined by integrated electronic nose and vision (ENV) system developed by CDAT, Kolkata. The mean values of TF, TR, HPS, TLC and total polyphenols were analyzed for statistical significance by SPSS using one- way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The soluble components of tea are responsible for the taste, aroma and strength. Table 1 shows the average soluble solids in a cup of different tea infusions viz. Tata tea (CTC), Red label tea (CTC), Lipton Darjeeling tea (orthodox), and Meri chai (CTC tea bag). Meri chai (CTC tea bag) was found to have the highest average soluble solids of 0.231 g/g dry solids followed by Tata tea (CTC), Lipton Darjeeling (orthodox) and Red Label (CTC) with 0.22, 0.201 and 0.187 g soluble solids/g dry solids respectively (Table 1). In a cup (150 ml) of tea liquor Meri Chai (CTC tea bag) was found to have 0.515 g soluble solids, followed by Tata tea (CTC), Lipton Darjeeling (orthodox) and Red Label (CTC) with 0.486, 0.478 and 0.432 g soluble solids respectively (Table 1). Manson and Zhao (1994) reported similar results in extraction of tea soluble solids using ultrasound. Chandini et al. (2011a) also observed an increase in extractable-solids-yield in black tea extracts with increase in water-to-tea ratio and extraction time.

The enzyme polyphenol oxidase is responsible for oxidizing the catechins to the aflavins (TF) and thearubigins (TR), the tea pigments responsible for the colour and taste of black teas (Sharma et al., 2005). The tea samples were analyzed for various chemical

Table 1. Soluble solids in a cup of different tea infusions.

Tea sample	Average soluble solids (g/g dry solids)	Average soluble solids in a cup (150 ml) of tea liquor (g)
Tata tea	0.220^{bc}	0.486^{bc}
Red Label tea	0.187^{a}	0.432^{a}
Lipton Darjeeling tea	0.201^{ab}	0.478^{ab}
Meri Chai	0.231^{c}	0.515^{c}

All data are presented as the mean of three experiments; within columns, different superscripts indicate significant differences ($P < 0.05$).

Table 2. TF, TR, HPS and TLC of tea sample.

Tea sample	TF (%)	TR (%)	HPS (%)	TLC	TF:TR
Tata tea	0.335^{a}	9.121^{a}	14.453^{a}	4.765^{a}	0.036
Red label tea	0.263^{b}	7.296^{b}	14.899^{b}	3.893^{b}	0.036
Lipton Darjeeling tea	0.397^{c}	1.843^{c}	10.824^{c}	2.519^{c}	0.215
Meri Chai	0.283^{d}	6.451^{d}	22.169^{d}	5.733^{d}	0.044

All data are presented as the mean of three experiments; within columns, different superscripts indicate significant differences ($P < 0.05$).

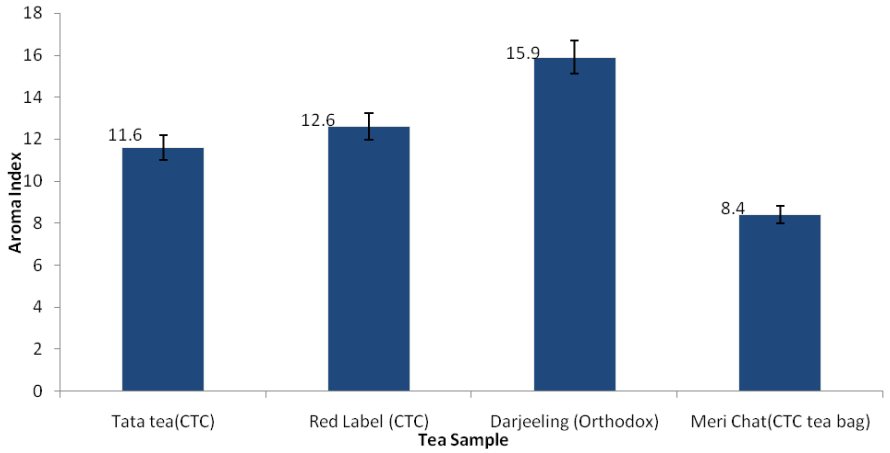


Figure 2. Aroma index of tea samples.

constituents by standard procedure (Masoud et al., 2006). The results are shown in Table 2. The TF:TR ratio should be within 0.08 to 0.1 for a good quality tea. The TF:TR ratio of Tata Tea, Red Label tea, Darjeeling Tea and Meri Chai are 0.036, 0.036, 0.215 and 0.044, respectively. Low TF content in black tea may be due to over fermentation and/or long periods of storage (Yao et al., 2006). Similar observations were made by Masoud et al. (2006) on different manufactured orthodox and CTC teas.

The primary polyphenols are oxidized during the fermentation process and the oxidized polyphenols in black tea are responsible for briskness, strength, colour, taste and pungency of the black tea infusion. Among the different market teas, Lipton Darjeeling (orthodox) tea was found to have a greater amount of polyphenols (19.57%), followed by Tata tea (CTC), Meri chai (CTC tea bag) and Red Label (CTC) with 15.56, 15.11 and 13.66% total polyphenols, respectively (Table 3). As each tea was processed from different tea cultivars that were grown in various agro-climatic conditions, the difference in polyphenol content of these various teas be reasonable.

The *L, a, b* values of different tea infusions are shown in Table 4. Darjeeling tea was found to have the highest *L* and *b* value of 13.28 and 18.96 and lowest *a* value of 12.65 compared to other teas.

The major quality attributes of tea are flavor, aroma, color, and strength. Out of these, flavor and aroma are the most important attributes (Bhattacharyya et al., 2008). Darjeeling tea was found to have the highest aroma index of 15.9, followed by Red label (12.6), Tata tea (11.6) and Meri chai (8.4) (Figure 2).

Table 3. Total polyphenols of tea samples.

Tea sample	Total polyphenols (%)
Tata tea	15.56[a]
Red Label tea	13.66[b]
Lipton Darjeeling tea	19.57[c]
Meri Chai	15.11[d]

All data are presented as the mean of three experiments; within columns, different superscripts indicate significant differences ($P < 0.05$).

Table 4. *L, a, b* values of tea infusions.

Tea sample	*L*	*a*	*b*
Tata tea	16.84	21.73	10.92
Red Label tea	19.16	19.97	12.32
Lipton Darjeeling tea	31.28	12.65	18.96
Meri Chai	15.47	19.82	9.96

Conclusion

In conclusion Meri chai (CTC tea bag) was found to have the highest average soluble solids of 0.231 g soluble solids/g dry solids and Lipton Darjeeling (orthodox) tea was found to have the greatest amount of polyphenols (19.57%). Darjeeling tea was also found to have the highest aroma index of 15.9 among different market teas. Darjeeling tea is of superior quality both in chemical composition and liquoring characteristics compared to other market teas.

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