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Adulteration and quality of black tea in Sri Lankan market

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ABSTRACT

Adulteration of tea is becoming a severe issue in the Sri Lankan tea industry. Black tea is adulterated with sugar, glucose, sodium bicarbonate and ferrous sulphate to improve its colour and sand, iron fillings and leather flakes like physical adulterants to improve its bulk. Ceylon tea is reputed for its quality and purity. The present study examined the adulteration and the consumer preference for black tea available in the Sri Lankan market. Twenty-nine tea samples of grades BOP, BOPF and dust were collected as packed and loose forms from the local market. They were assessed for sugar and colour adulteration with the Phenol-sulphuric method and water column method. The presence of iron fillings, leather flakes and sand adulterants were assessed by shaking a magnet, flaming to feel the odour and shaking tea in water to detect sediments, respectively. Sensory evaluation was conducted with 30 untrained panellists separately for BOP, BOPF and dust tea samples. Data were analyzed using Minitab software. Absorbance values were analyzed using ANOVA, while sensory data and colour adulteration data were subjected to the Friedman test. Out of 29 tea samples tested, 83% showed an apparent colour change with normal water, confirming the colour adulteration in tea. Varying colour intensities illustrate the different levels of colour adulteration. The absorbance values of the Phenol-sulphuric method were significantly different ($p<0.05$) among samples. Among the tea samples tested, 7% were adulterated with sugar. None of the tea samples was identified as adulterated with iron fillings, leather flakes or sand. Sensory evaluation scored varying consumer preferences for different tea brands for their external and brewed characters. The present study attempts to alert the public on possible adulteration in black tea available in the local market and to ratify simple techniques to detect adulterated tea to safeguard the consumers from adverse health risks associated with consuming such tea.

Keywords: Colour adulteration, Physical adulteration, Sensory evaluation, Sugar adulteration, Tea quality.

INTRODUCTION

Tea (*Camellia sinensis* (L.) O. Kuntze) is the most widely consumed beverage in the world next to the water. The habit of drinking tea has become well established for more than half of the world's population (Amarakoon, 2004). Sri Lanka is the leading black tea producer in the world market, contributing 303.9 million kg/year (CBSL, 2019). Adulteration of tea has become one of the severe problems, mainly in the black tea industry in Sri Lanka. An adulterant is a substance that is added, mixed or packed with tea product to increase its bulk or make it appear better with more value than really it is (Johnson, 2014). Colour and appearance are two critical attributes that influence consumers to purchase tea products and determine their value (Wettasinghe, 2018).

Sugar adulteration is done to enhance the colour properties of tea in order to fetch higher prices (Jayawardhane et al., 2016; Wedagedara et al., 2019). Ferrous sulphate, potassium permanganate, and sodium hydroxide are also added to give the tea a black colour (Gamage and Jayewardene, 2018; Silva, 2020). According to Pal and Das (2018), black tea can be adulterated with artificial colours, coal tar dye and AZO colours. Exhausted tea leaves or tea waste (Wettasinghe, 2018) and sodium bicarbonate (Priyadharshana, 2014) are also added to improve the colour. Further, black tea is adulterated with iron fillings (Pal and Das, 2018), leather flakes, sand, cereal starch and powder of scorched persimmon stone (Bhatt et al., 2013) to increase bulk. The identification of adulterated tea is vital to protect the consumers from adverse health risks and safeguard the reputation of Ceylon tea in the world market. The present research evaluated the adulteration of black tea in the Sri Lankan market using simple methodologies and sensory attributes based on consumer preference.

METHODOLOGY

The research was conducted at the Faculty of Agriculture, Rajarata University of Sri Lanka. A total of 29 tea samples of grade BOP, BOPF and dust were bought from the local retail market, representing loose and packed forms with much similar date of manufacture. The packed and loose tea samples of BOP, BOPF and dust were coded as; PBOP1, PBOP2, LBOP3, LBOP4, PBOPF5, BOPF6, PBOPF7, PBOPF8, PBOPF9, LBOPF10, LBOPF11, LBOPF12, LBOPF13, PDUST14, PDUST15, PDUST16, PDUST17, PDUST18, PDUST19, PDUST20, PDUST21, PDUST22, PDUST23, PDUST24, LDUST25, LDUST26, LDUST27, LDUST28 and LDUST29. Collected samples were kept under sealed conditions until testing. Three random samples of each were taken as replicates to increase the accuracy. The collected tea samples were tested for chemical adulterants such as sugar and colour, physical adulterants such as iron

filings, leather flakes and sand. Further, they were subjected to quality assessment with a sensory evaluation with 30 numbers of untrained panellists.

Assessing sugar adulteration: The sugar adulteration was assessed by the Phenol-sulphuric method. The standard series of sucrose (20, 40, 60, 80, and 100 ppm) were used to establish the external calibration curve. Tea samples were prepared by mixing 0.1 g of crushed dry tea with 5 mL of 2.5 M HCl in a boiling tube. The mixture was kept in a boiling water bath for 3 hours and cooled to room temperature before it was neutralized by adding solid sodium carbonate until effervescence ceases and volume up to 25 mL. A volume of 0.1 mL of the sample extraction, 0.9 mL of distilled water, 1 mL of 5% phenol and 5 mL of 96% H_2SO_4 were added into the boiling tube and shaken. It was then kept in a boiling water bath for 8 minutes, followed by an ice bath for 10 minutes. Blank was prepared using 1 mL of distilled water. The absorbance values were taken at 490 nm in a UV-visible Spectrophotometer (Agrawal et al., 2015; Jayawardhane et al., 2016).

Assessing colour adulteration: Exactly 2.5 g of tea sample was added into a clean glass containing 150 mL of normal water. The colour change of the water column after 60 seconds was observed (Bhatt et al., 2013; Pal and Das, 2018) and ranked '1'-'9' using a colour chart, where '1' was given for the samples without any colour change, and '9' was given for the samples with the maximum colour change.

Iron filling adulteration: A magnet was shaken above the 10 g of tea samples spread on a glass plate to collect any iron fillings/particles (Bhatt et al., 2013; Pal and Das, 2018).

Leather flakes adulteration: Exactly 2 g of tea sample was burnt on a silver spoon to feel the odour released by the burning of leather flakes present in the tea (Mishra and Mishra, 2017).

Sand adulteration: Exactly 10 g of tea sample was mixed with 100 mL of water into a clean glass bottle and observed for the presence of sediments at the bottom of the glass bottle (Bhatt et al., 2013; Mishra and Mishra, 2017; Pal and Das, 2018).

Sensory evaluation of tea: The quality of tea was assessed by sensory evaluation with 30 untrained panellists separately for tea grades BOP, BOPF and dust. Tea samples were evaluated for external characters such as colour, aroma, external appearance and overall acceptance and brew characters such as colour, aroma, mouth feel and overall acceptance. Tea brew was prepared by brewing 5 g of black tea sample in 250 mL of boiling water at 100 °C for 3 minutes (Muhammad et al., 2013). Tea brew was then poured into a white porcelain cup for sensory evaluation. Panellists were provided with a prescribed questionnaire to record their sensory observations in which they ranked their preference; '1' – Strongly dissatisfied, '2' – Dissatisfied, '3' – Neither satisfied nor dissatisfied, '4' – Satisfied, and '5' – Strongly satisfied.

Statistical analysis: One-way ANOVA in complete random design was used to analyze the absorbance values, while the Friedman test was used to analyze ranked data. Mean separation was done with Tukey test at 95% confidence for Phenol-sulphuric method. Data analysis were performed using Minitab ver. 19 statistical package.

RESULTS AND DISCUSSIONS

Colour adulteration: According to the statistical analysis, colour development of tea samples in water was significantly ($p<0.05$) different between samples. Among the 29 tea samples evaluated, 24 tea samples showed a rapid colour development at 60 seconds with normal water, while only five tea samples did not show colour development (Figure 1). According to Bhatt et al. (2013) and Pal and Das (2018), if the tea has been dyed with water-soluble colours, the colour of water changes immediately after adding the tea into the water. Therefore, the tea samples which showed rapid colour development are considered adulterated samples. According to the present study, colour adulteration is common for all tea grades evaluated. Out of the total tea samples evaluated, 83% of tea samples had been colour adulterated. Further, findings revealed that 83% of packed and 82% of loose tea samples gathered from the local market had been adulterated with colour at different intensities.

Leather flakes adulteration: Black tea is adulterated with leather flakes to increase its bulk (Bhatt et al., 2013). The presence of leather flake can be tested by its odour released by burning a small quantity of tea sample on a spatula (Mishra and Mishra, 2017). Among the 29 tea samples tested, none of the samples was identified as adulterated with leather flakes.

Iron filling adulteration: According to Pal and Das (2018), iron filings can be added unintentionally during tea manufacturing. Further, black tea is adulterated with iron fillings to increase its bulk (Pal and Das, 2018). Iron filings can be tested by shaking a magnet over the tea samples spread on a plate, where the iron filling will be attached to the magnet (Bhatt et al., 2013; Mishra and Mishra, 2017; Pal and Das, 2018). Among the 29 tea samples tested, none of the samples was identified as adulterated with iron fillings.

Sand adulteration: Black tea is adulterated with sand to increase its bulk (Bhatt et al., 2013). Any sedimentation indicates the presence of sand in tea samples when mixing the tea sample with water (Bhatt et al., 2013; Mishra and Mishra, 2017; Pal and Das, 2018). Among the 29 tea samples tested, none of the samples was identified as adulterated with sand.

Figure 1: Colour changes with normal after 60 seconds

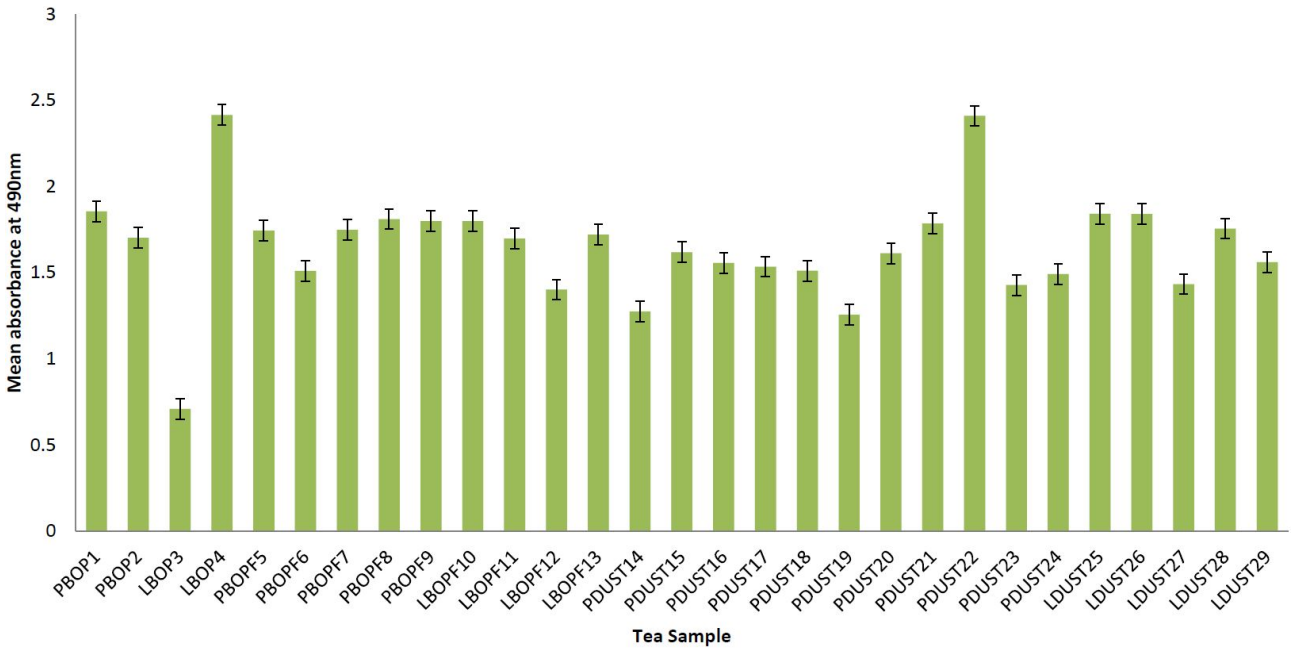

Figure 2: Mean absorbance values of BOP, BOPF and dust tea samples obtained from Phenol-sulphuric method

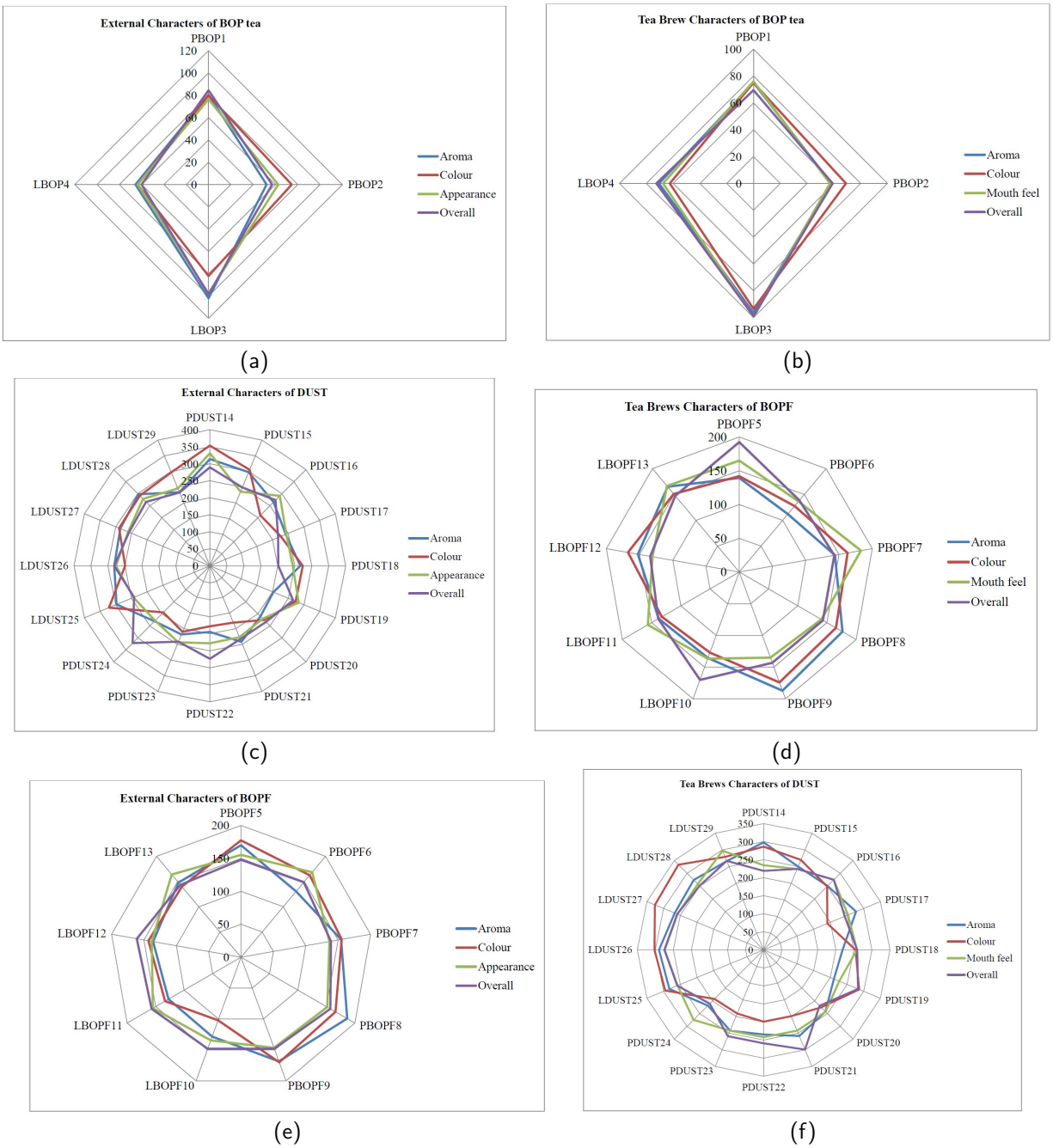

Figure 3: Sensory attributes of BOP, BOPF, and dust tea; (a), (c), and (e) External characters, (b), (d), and (f) Brew characters

Sugar adulteration: Sugar is a component that naturally exists in tea brew. Although the amount of inherent sugar content changes with the tea grade, it is not easy to detect sugar adulteration for the tea available in the local market with simple methods. Wedagedara et al. (2019) stated Phenol-sulphuric method and anthrone method showed an increasing pattern of Spectrophotometer reading with increasing levels of adulterated sugar in black tea. According to Agrawal et al. (2015) percentage of total carbohydrate increased with increasing absorbance value of the samples in the Phenol-sulphuric method. Similarly, the greater absorbance values recorded for the tea samples LBOP4 and PDUST22 indicate sugar adulteration in the present study (Figure 2). According to the statistical analysis, a significant difference ($p<0.05$) was observed for the absorbance value among the tea samples.

Sensory evaluation: Sensory evaluation scored varying levels of consumer preferences for different tea samples on its external characters; aroma, colour, appearance, overall acceptance and brew characters; aroma, colour,

mouthfeel, overall acceptance with '1'-'5' scores. A varying consumer preference was scored for both external (Figure 3(a), 3(c), and 3(e)) and brew characters (Figure 3(b), 3(d), and 3(f)) of BOP, BOPF, and dust tea samples. However, the LBOP3 (loose BOP3) sample received the highest consumer preference for external and tea brew characters.

CONCLUSION

Findings confirmed that colour adulteration is common for all tea grades evaluated. Both packed and loose forms of tea available in the Sri Lankan market had been colour adulterated. According to the present study, out of total tea samples evaluated, 83% of tea samples were colour adulterated. None of the sample was adulterated with iron fillings, leather flakes or sand. Greater absorbance values recorded by two tea samples may be an indication of sugar adulteration. Hence, among the tea samples tested, only 7% were sugar adulterated. Sensory evaluation scored varying consumer preferences for different tea brands for their external and brewed characters. However, the LBOP3 (loose BOP3) sample received the highest consumer preference for external and brewed characters. Further, the LBOP3 sample was free from sugar, colour, iron fillings, leather flakes and sand adulteration.

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