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Evaluation for Active Components and Nutrient Elements in Six Marketed Brands of Ispahani Tea Grown in Bangladesh

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Abstract: Six marketed brands of Ispahani tea grown in Bangladesh *viz*; Best leaf, Best quality (BOP), Blender's choice, Best quality (PD), Zareen and Tea Bags were studied before expiry dates to screen out their active components that are responsible for qualitative status (viz; Caffeine, Total Polyphenol (TP), Theaflavin (TF), Thearubigin (TR), Highly Polymerized Substances (HPS), Total Liquor Colour (TLC), Briskness Index (BI), Colour Index (CI) and nutrient elements (N, P, K, Ca and Na). All the studied parameters were found to have been varied with brands. The values of caffeine and TP were found to be varied from 2.83% (Blender's choice) to 2.35% (Best leaf) and 17.70% (Best leaf) to 14.55% (Blender's choice) respectively. Similarly, the estimated values of TF, TR, HPS, TLC and CI were detected to be maximum in Blender's choice but maximum BI was in Best leaf tea whereas minimum TF, TR, TLC, BI and CI were detected in Zareen tea but minimum HPS was in tea bags. In contrast, the total amount of studied nutrient contents (N, P, K, Ca and Na) was determined to be the highest in Best quality-BOP (10.08%) and the lowest in Zareen tea (7.17%). The present study concludes that the Best Leaf tea is superior over the other brands in respect to qualitative status and all the studied brands may, therefore, be ranked as: Best Leaf > Tea bags > Best quality (BOP) > Zareen >Best quality (PD) >Blender's Choice.

Keywords: Evaluation, active components, nutrient elements, Ispahani tea, Bangladesh.

INTRODUCTION

Globally, Tea (*Camellia sinensis*) is second in line after water under popular beverages due to its phenomenal taste and outstanding benefits towards health [1]. Approximately 5000 years ago, tea was first consumed in China for its medicinal properties, while in current era tea had been widely recognized for health benefits pertaining to increased public awareness of the high flavonoid content of the tea leaves and extracts [2,3]. The study of tea chemistry may be said to have begun with the isolation of the alkaloid caffeine from tea in 1827 [4]. Tea has been valued historically for its caffeine content, which is between 2 and 5 % (w/w) depending on variety. High caffeine content in fresh leaf may be one of the important factors ensuring good quality of the resulting black tea [5]. Caffeine is regarded as an important constituent of tea, bestowing mood and cognitive-enhancing properties [6,7].

Tea leaves contain 10–30% of dry weight of polyphenols, including catechins, flavonols, flavanones, phenolic acids, glycosides and the aglycones of plant pigments [8]. Tea polyphenols behaves as natural antioxidant [9] and some studies suggest that regular consumption of tea can reduce the risk of developing a variety of cancers, namely colon, pancreatic, and stomach cancers [10,11]. Polyphenols are the active components responsible for the beneficial effects of drinking green tea [12]. A large number of polyphenol derivatives have been identified in various types of green (non-fermented), oolong (semi-fermented) and black (fully-fermented by oxidizing enzyme) teas [13].

Polyphenols occurring in black tea usually consist of residual green tea polyphenols such as catechins [14,15], flavonols [14,16] and oxidation products of green tea polyphenols such as theaflavins and thearubigins. Most of the catechins and their gallates undergo known enzymatic oxidation to form more polymeric polyphenols that are characteristic of black tea, namely theaflavins and thearubigins. Theaflavins are known as fermentation products and provide a bright, yellowish appearance to the beverage and have long been positively correlated with the quality and market value of black tea [17-19]. Theaflavin with a formula $C_{29}H_{24}O_{12}$ [20] may contain 3.5 moles of water in the crystallization [21]. The content of total theaflavins in

black tea does not usually exceed 2 % and can be as low as 0.3 % [22], whereas Graham [23] reported that theaflavins ranged 1.5-2.5 % in the dry leaf.

Further oxidation of theaflavins produces a group of brown pigments called thearubigins [17,19]. The content of theaflavins is far less than that of thearubigins in black tea (6 to 18% of dry weight), but theaflavins are of primary importance to tea quality, since they impart the specific bright and vivid colour to the liquor; and further, the ratio of theaflavins to thearubigins has been found to be responsible for the strength of the tea liquor [6]. The thearubigins, on reaction with TF and proteins, form complex highly polymerized substances (HPS). Highly polymerized substances increase the colour of the brew. Total liquor colour (TLC) is the measure of brightness of the infusion [24].

The quality of a tea is formed during the growth and development of the tea plant, when the compounds responsible for quality are synthesised [25]. Good quality teas contain less high molecular weightcompounds than those of inferior quality [26]. For black tea, a high proportion of extractable polyphenols may indicate a good quality liquor, with astringency and a bright reddish colour. As an aid to judging quality, a finely divided precipitate formed during the cooling of black tea liquor is referred to by tea tasters as the "cream down" of tea [26]. This cream consists largely of extractable polyphenols such as theaflavins and thearubigins, and other flavonoids in combination with caffeine. Interactions between caffeine and the polyphenols are primarily responsible for this cream [27]. The composition of a cream in an Assam tea infusion brewed with a tea/water ratio of 1/40 is: ca 15 % theaflavins, 65 % thearubigins, 14 % caffeine, 3 % ash and other compounds [28].

After years of research, Eden [29] concluded that the dynamics of the production of theaflavins is the most potent single factor in promoting good quality in tea. In addition, Davies [30] suggested that the content of theaflavins and the percent of extractable solids in a black tea could be used as objective measures of the tea quality. Patterns or levels of phenolic compounds in black tea liquor have been used as means of predicting price and country of origin [31]. A good quality tea possessing brightness, briskness, and good colour and body may possess a ratio of theaflavins: thearubigins of 1:10 [32].

So far the literature review is concerned; only a few comparative studies on the qualitative status of marketed brand teas of Bangladesh were done. With this view in mind, in addition to those brands of tea, a laboratory experiment was done to screen out the comparative status of quality parameters viz; caffeine, TP, TF, TR, HPS, TLC, BI, CI as well as nutrient status (N, P, K, Ca and Na) in six marketed brands of Ispahani tea of Bangladesh.

MATERIALS AND METHODS

Six marketed brands of Ispahani tea grown in Bangladesh *viz*; Best leaf, Best quality (BOP), Blender's choice, Best quality (PD), Zareen and Tea Bags were collected from the local market of Chittagong city, Bangladesh at a time.

Determination of caffeine content in tea samples

Preparation of stock solution

5g tea sample was taken in a 500ml conical flask. 10g crystal of MgO and 200ml of distilled water were added to the sample simultaneously. The mixture was then warmed in the water bath maintained at 40°c for 2hrs. Then, it was fettered through whatman- 42 and the filtrate was collected in 200 ml volumetric flask. The volume of the filtrate was made upto the mark by adding distilled water and used as stock solution.

Extraction

200ml of filtrate was taken in 500ml conical flask and 20ml diluted H_2So_4 (2ml conc. H_2So_4 + 18ml dist. H_2O) was added. This mixture of 220ml volume was then heated; at temperature 90°c ±2°c maintained in a water bath and reduced the volume of the mixture to about 50ml. The concentrated mixture was again filtered through whatman-42 and collected in the separating funnel. Then 20ml chloroform was added with the filtrate in the separating funnel and shaken well for 20 times. The separating funnel was then kept undisturbed on a stand for 10 minutes. The washed chloroform from the bottom of the separating funnel was collected in 50ml conical flask. The same filtrate was then washed thoroughly with different volumes (viz, 20, 15, 10 and 5ml) of chloroform and the total volume of the collected chloroform was washed with 5ml 1% KOH in a clean separating funnel and was collected in a 50ml oven dried conical flask which was previously weighed.

Procedure

Each conical flask was cleaned; dried (oven-dry); marked and weighed in electric balance before receiving the washed chloroform. After receiving the chloroform the respective conical flask was kept in electric oven at 70°c for complete dryness. The weight of the dried conical flask was recorded in electric balance.

Calculation

$$\text{Caffeine} = (S-B)\ \text{mg/g}$$

Where, S= weight of conical flask with caffeine after dryness, B= weight of conical flask before filtrate collection [33].

Determination of Polyphenol in tea samples

Preparation of 1000 ppm tannic acid stock solution

1g tannic acid was taken in a 1000ml volumetric flask. Then, small amount of distilled water was added and shaken well to dissolve tannic acid. Then, the volume was made up to the mark with the addition of distilled water. This solution was used as 1000 ppm stock solution. From 1000ppm stock solution 1ppm, 2ppm, 3ppm, 4ppm & 5ppm solution were prepared.

Procedure

100 mg of tea sample was boiled in a water bath with 100 ml of water for 30 minutes and filtered. 0.2 ml of the sample solution and 5ml of the reagent (100mg of $FeS0_4$. $7H_2O$ and 500mg of Rochelle salt in 100ml of water) were taken in a 25ml volumetric flask and filled to the mark with Sorensen's phosphate buffer of pH 7.5. Then the absorbance was measured at 540 nm against a blank solution substituting water for the reagent and the amount of polyphenol was determined using the correction factor (cf) obtained from the calibration curve made by using different concentration of tannic acid [34].

Black tea samples were analyzed for TF, TPC, TR, HPS and Total Liquor Colour (TLC) by following the method reported by Thanaraj and Seshadri [35]. The briskness and colour indices were worked out as suggested by Ramaswamy [36]. Nutrients (viz. N, P, K, Ca and Na) were extracted with sulfuric-peroxide (H_2SO_4+H_2O_2 digestion mixture and determined by standard method [37]. Every data was the mean value of three samples (bought one time and split into three samples) and statistical analysis was done using the computer progamme (SPSS). Means were compared using the least significant difference test (LSD) at P>0.05 [38].

RESULTS AND DISCUSSIONS

The results as presented in Table 1 exhibit that caffeine content of Ispahani tea was found to vary with brands. The maximum value of caffeine content was found to be 2.83% (Blender's choice) and the minimum value was found to be 2.35% (Best leaf) and showed the following sequence as Blender's choice > Zareen > Tea bags > Best quality, PD> Best quality, BOP> Best leaf. Tea generally contains caffeine at about 1-5% of its dry weight [39]. The average range of caffeine content in Bangladesh tea is 3.3-4.8% [40, 41] which is in full agreement with the results of present study.

Caffeine status of Wissotzky earl grey tea, Twinings English breakfast tea, Bigelow Darjeling tea and Lipton tea obtained from the supermarkets of the U.S.A were detected to be 2.71%, 4.54%, 5.51% and 3.62% respectively [42In Chinese Fujian black tea, caffeine content was estimated to be 4.3% [43]. Cabrera *et al.* [44] reported that caffeine content was found to be 3.83%, 4.74%, 4.15%, 6.18%, 6.74% and 4.5% in Sencha tea (Japan), Assam tea (India), Keemun tea (China), Ceylan tea (Srilanka), English breakfast tea (Srilanka) and Darjeeling tea (India) respectively. These conclusions substantiate with the results of present research.

Caffeine content varies with agrotypes, plucking periods and commercial brands [45]. Maximum caffeine content is found in increasing plucking period (April-June) and minimum in decreasing plucking period (October-December) [30]. It is also reported [46] that caffeine content of Bangladesh tea was found to vary from 3.87% to 4.67%, 2.53% to 3.87% and 1.73% to 2.67% in increasing, peak and decreasing plucking periods respectively. So it is evident from the result that the caffeine contents of present experiment can be ranked as medium in respect to Bangladesh standard and all the studied brands might have been harvested in between late peak plucking period (July-September) and decreasing plucking period (October-December).

The results as shown in Table 1 also exhibit that total polyphenol (TP), theaflavin (TF), thearubigin (TR), highly polymerized substances (HPS) and total liquor colour (TLC) content were found to be varied with brands of Ispahani tea. The highest amount of total polyphenol (TP) was estimated to be 17.70% in Best leaf and the lowest was 14.55% in Blender's choice tea. Total polyphenol content followed the sequence as Best leaf >Zareen>Tea Bags>Best quality, PD> Best quality, BOP> Blender's choice. Tea generally contains 15-18% of polyphenol [47]. The range of total polyphenol content in Bangladesh tea is 22-31% [40,41]. These findings agree with the TP status of the present experiment.

Table-1: Variation of caffeine, TP, TF, TR and HPS contents (%) in six marketed brands of Ispahani tea

Brand	Caffeine	TP	TF	TR	HPS	Total
Best Leaf	2.35	17.70	0.55	4.48	3.84	28.92
Best Quality (BOP)	2.36	15.32	0.52	4.41	3.75	26.36
Blender's Choice	2.83	14.55	0.58	4.57	3.96	26.49
Zareen	2.73	16.83	0.49	4.29	3.71	28.05
Tea Bags	2.62	16.16	0.51	4.35	3.69	27.33
Best Quality (PD)	2.38	15.57	0.53	4.45	3.79	26.72
LSD at P >0.05	0.28	0.48	0.08	0.22	0.33	0.53

Total polyphenol content of black tea purchased from the supermarket of Penang, Malaysia was detected to be 17.87% [48]. Total polyphenol content was determined as 8.05% - 13.49% in the Black tea purchased from the supermarkets of Great Britain [49,1]. These conclusions are in agreement with the TP status of present study.

It is also reported that total polyphenol content of Bangladesh tea ranged from 20.79 % to 23.57 %, 24.60 % to 31.54%, 6.58% to 10.74% in increasing, peak and decreasing plucking periods respectively [46]. Caffeine, TP, TF, TR, HPS and TLC contents fluctuates following climatic variations and decreases after rainy season [50]. So present experiment reveals that total polyphenol content of all the six studied brands are reasonably low and are not comparable with Bangladesh standard. The result also indicates that all the studied brands might have been manufactured from the tea shoots plucked in decreasing plucking period (October-December) or plucking standard might has not been maintained properly.

Maximum value of TF content was observed to be 0.58% (Blender's choice) and minimum value was observed to be 0.49% (Zareen tea) and showed the following sequence as Blender's choice>Best leaf> Best quality, PD> Best quality, BOP> Tea bags> Zareen (Table 1). The content of total theaflavins in black tea does not usually exceed 2 % and can be as low as 0.3 % [51], whereas Graham [52] reported that theaflavins ranged 1.5-2.5 % in the dry leaf which agrees with the results of the present investigation.

Theaflavin contents ranged from 0.96% to 2.072% at a mean value of 1.54% in the black tea of 25 different types of Kenyan tea cultivars [53]. Theaflavin content was estimated to be 0.79%, 1.54%, 1.15%, 1.47%, 1.17% and 2.21% in the marketed teas of Australia, UK, Continental Europe, Middle East, US and India respectively [54-56]. TF content was detected to be 1.70% in the Ceylon black tea purchased from the supermarkets of Singapore [57,58]. These remarks are consistent with the TF status of the marketed brand teas of Ispahani.

On the other hand TR content ranged from 4.29% (Zareen tea) to 4.57% (Blender's choice tea) and showed the following sequence as Blender's choice> Best leaf > Best quality, PD> Best quality, BOP> Tea bags> Zareen (Table 1). According to Hilton and Ellis [59] Thearubigin (TR), generally constitutes about 6 to 18% of dry weight formed during the processing of black tea but they do not occur in green tea. Thearubigin content was estimated to be 8.64%, 11.09%, 11.56%, 12.18%, 9.45% and 16.04% in the marketed teas of Australia, UK, Continental Europe, Middle East, US and India respectively [54-56]. While working on five popular marketed brands of tea produced in Bangladesh, the TR content was estimated to be ranged from 5.725% to 4.282% [60]. These observations are comparable to the findings of the present experiment.

The highest amount of HPS content was determined to be 3.96% (Blender's choice tea) and the lowest amount was determined to be 3.69% (Tea bags) and showed the following sequence as Blender's choice > Best leaf >Best quality, PD> Best quality, BOP >Zareen >Tea bags (Table 1). Literature on the HPS status of marketed teas of Bangladesh as well as world tea is very sparse. However, Alam *et al*. [45] studied on ten marketed brand teas of Bangladesh and found maximum HPS in Finlay tea (4.830%) and minimum in Fresh tea (1.924%) which is consistent with the findings of the present study. The present investigation also corroborates with the annotations of Someswararao *et al.* [61] who reported that HPS content ranged from10-22% in Indian black tea.

In contrast Blender's choice tea contained maximum amount of TLC content (1.92) and Tea bags contained minimum amount of TLC (1.79). The values of TLC showed the following sequence as Blender's choice> Best leaf > Best quality-PD> Best quality-BOP> Tea bags> Zareen (Fig. 1). The status of total liquor colour in the seventeen marketed brand teas of Bangladesh substantiates with the findings of Alam *et al*. [45] who studied on ten marketed brand teas of Bangladesh and found maximum TLC in Finlay tea (2.30) and minimum in Kazi &Kazi (1.56). Someswararao *et. al.* [61] reported that total liquor colour in Indian black tea was found to have been ranging from 3.89% to 5.7% which is consistent with the results of the present experiment. While working on five popular marketed brands of tea produced in Bangladesh, Alam *et. al*. [60] estimated the TLC content ranging from 2.56 to 3.44. This remark is in full agreement with the TLC status of the present study.

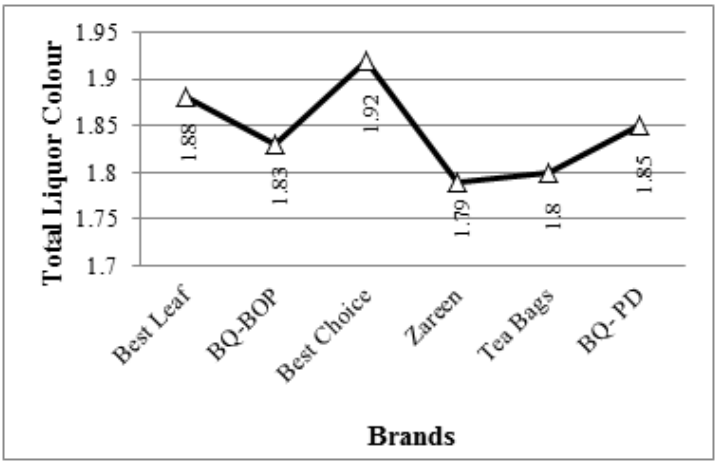

Fig-1: Total liquor colour status of six marketed brands of Ispahani tea

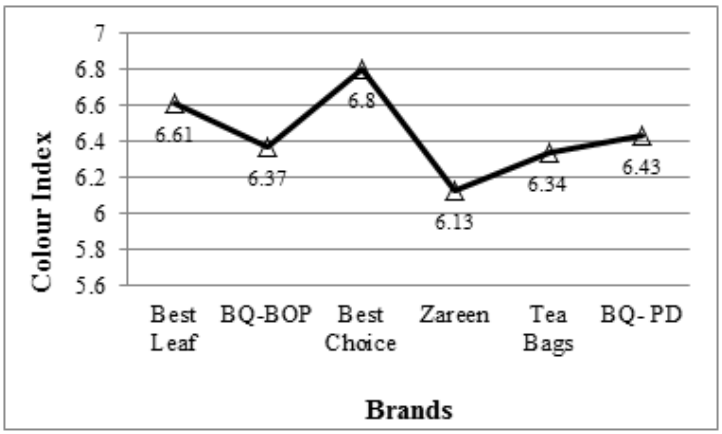

Fig-2: Colour index status of six marketed brands of Ispahani tea

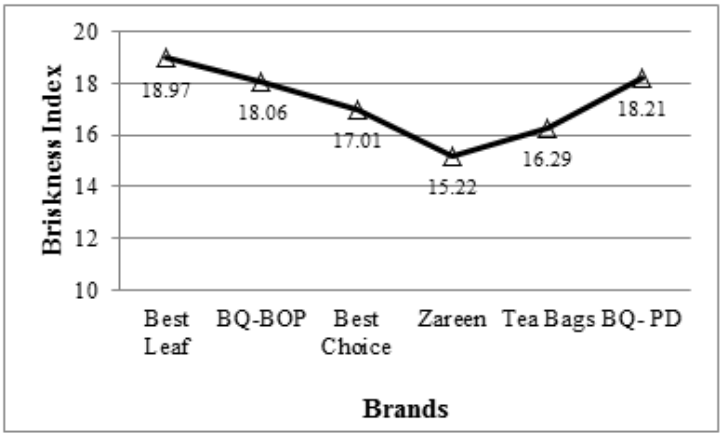

Fig-3: Briskness index status of six marketed brands of Ispahani tea

In case of Bangladesh tea, it is reported that in the tea of two leaves and a bud with third internode the average TF, TR, HPS and TLC contents were determined as 1.035%, 5.798%, 6.821% and 3.350 respectively. But all of these components trends to be decreased downward significantly in the tea of four leaves and a bud with fifth internode whilst the contents were determined as 0.733%, 4.127%, 3.956% and 2.30 respectively [62]. It is also suggested that plucking standard should be maintained up to two leaves and a bud including third internode for the production of teas having proper caffeine, TP, TF, TR, HPS and TLC contents to optimize the black tea quality [62].

Therefore, from the results of this experiment, it can be assumed that TF, TR, HPS and TLC contents of all the studied brands of Ispahani tea were not up to the mark in comparison to Bangladesh standard. Every brand possessed low TF, TR, HPS and TLC contents which were supposed to be obtained from four leaves

and a bud with fifth internode and downward plucking. So, all the studied brands might not have maintained plucking standard as well as manufacturing awareness and might have been prepared from the plucked shoots of decreasing plucking period.

Colour index also varied among the studied brands in this experiment (Fig. 2). The results expose that CI ranged from 6.13 (Zareen tea) to 6.80 (Blender's choice) and showed the sequence as: Blender's Choice> Best Leaf>Best quality, PD> Best quality, BOP> Tea bags > Zareen tea (Fig. 2). For better tea, the colour index should be between 5 and 11 in order to have the liquor balanced with colour and briskness. If the colour index value cross 11, then the tea lacks colour and when it falls below 5, the liquor will be coloured and flat with low briskness [20]. In the present study, the colour index values for all the brands were between 6 and 7. So the colour indices of all the studied brand teas were not up to the mark in respect to Bangladesh tea standard and can be ranked as medium. The status of colour index in the present investigation corroborates with the findings of Alam *et al*. [45] who studied on ten marketed brand teas of Bangladesh and found maximum CI in Kazi & Kazi tea (11.72) and minimum in Ispahani tea (5.91). While working on five popular marketed brands of black tea produced in Bangladesh, Alam *et al*. [60] estimated the colour index ranging from 8.75 to 10.94. This remark is also in full agreement with the CI status of the present study.

Briskness index (BI) of this experiment was found to be varied among the studied brands of Ispahani tea (Fig. 3). It is apparent from the result that the highest value of BI was estimated to be 18.97 (Best leaf) and the lowest value was estimated to be 15.22 (Zareen tea) and followed the sequence as Best leaf>Best quality, PD> Best quality, BOP> Blender's choice> Tea bags> Zareen (Fig. 3). The normal range of briskness index proposed for South Indian teas is 12.5 to 22.5. But, when it drops below 17.5, the liquors tend to have a harsh taste and when it exceeds 17.5 the liquor gets brisker [35]. Briskness index values of all the brand teas in the present study were between 15 and 19. So it can be said that liquors of all the studied brands were medium in briskness. Alam *et al*. [45] determined briskness index in ten popular marketed brand teas of Bangladesh and the highest BI was found to be 23.51 in Kazi & Kazi tea and the lowest was found to be 14.46 in Ispahani tea which is in full agreement with the results of present experiment. The status of briskness index in the present experiment substantiates with the observations of Alam *et al*. [60] who worked on five popular marketed brand teas of Bangladesh and estimated the briskness index ranging from 24.76 to 21.88.

Nutrient contents (N, P, K, Ca and Na) also varied with the studied brands in this experiment. The results as shown in Table 2 indicate that maximum concentration of Nitrogen was determined to be 5.7% in Best Quality (BOP) tea and minimum concentration was 3.9% in Blender's Choice tea showed the following sequence as Best Quality (BOP)> Tea Bags>Best Quality (PD) > Best leaf>Zareen>Blender's Choice. Foliar nitrogen contents of the satisfactory levels of nitrogen in first leaf is 5.0% & nitrogen contents of 4.4% & 3.8% in the first & third leaf samples respectively represent critical levels [63].

The highest amount of Phosphorus was found to be 0.175% in Best Quality (PD) tea as well as the lowest amount was found to be 0.125% in Blender's choice tea and followed the sequence as Best Quality, PD>Best leaf>Best Quality, BOP>Tea Bags>Zareen>Blender's choice (Table 2). The usual range of leaf phosphorus is between 0.6% & 0.9%, (P_2O_5) and P content of 0.25% or less indicates its starvation [64] which corroborates with the Phosphorus status of the present experiment.

Table-2: Variation of nutrient contents in six different brands of Ispahani tea

Brand	N (%)	P (%)	K (%)	Ca (%)	Na (%)	Total
Best leaf	4.20	0.165	2.76	1.55	0.058	8.733
Best Quality, BOP	5.70	0.150	2.85	1.31	0.071	10.081
Blender's choice	3.90	0.125	2.17	1.75	0.089	8.034
Zareen	4.10	0.140	1.24	1.63	0.060	7.17
Tea bags	5.25	0.145	2.54	1.36	0.065	9.36
Best Quality, PD	4.50	0.175	1.89	1.24	0.077	7.882
LSD at P >0.05	0.52	0.161	0.46	0.47	0.084	1.32

Potassium content was estimated to be maximum in Best quality (BOP) tea (2.85%) and minimum in Zareen tea (1.24%) and maintained the given sequence as Best Quality, (BOP)>Best leaf>Tea bags>Blender's choice>Best Quality (PD) >Zareen (Table 2). The concentration of potassium is higher in two leaves and a bud (about 2.0%) than the third leaf. Potassium concentration below 1.75% in first leaf with a bud, and 1.57% in third leaf are a clear indication that potassium is limiting yield [63] which is in full agreement with the results of the present investigation.

In case of Calcium content Blender's choice was found to be superior (1.75 %) but Best Quality (PD) was found to be inferior (1.24%) among the studied brands and accordingly showed the following sequence as Blender's choice>Zareen>Best leaf>Tea bags>Best Quality (BOP)>Best Quality (PD) (Table 2). Desirable

calcium content in North- East India is usually about 0.1% calcium [65]. Normal tea leaf as plucked contains an average 0f more than 0.5% Ca. The concentration of Ca is higher in third leaf (about 1.0%) than the two leaves and a bud [64] which bears a close resemblance with the results of present study.

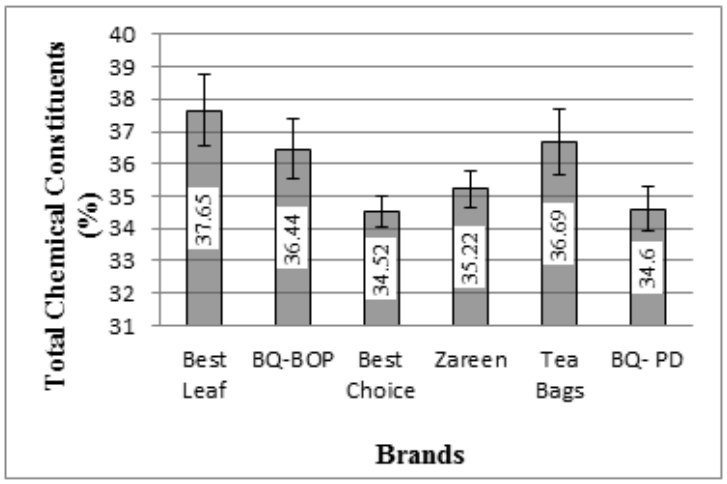

Fig-4: Variation of total contents of quality parameters (Sum of caffeine, TP, TF, TR, HPS and nutrient elements) in six marketed brands of Ispahani tea

In concerning the sodium content, maximum amount was evaluated to be 0.089% in Blender's choice and minimum was 0.058% in Best leaf and thus followed the given sequence as Blender's choice>Best Quality, PD>Best Quality, BOP>Tea bags>Zareen>Best leaf (Table 2). The sodium content in Pakistani Black Tea was found to be 0.39-0.83 mg/l [66] which is persistence with the findings of the present experiments.

Twig nutrient status was found to change with agro-types and periods. N content ranged from 4.33% - 5.76%, 6.07% - 7.51% and 3.77% - 4.99%; P content ranged from 0.194% - 0.241%, 0.124% - 0.213% and 0.181% - 0.227%; K content ranged from 1.72% - 2.39%, 1.74% - 2.93% and 0.86% - 1.31%; Ca content ranged from 1.20% - 1.77%, 0.98% - 1.30% and 1.05% - 1.47%; Na content ranged from 0.068% - 0.090%, 0.084% - 0.184% and 0.058% - 0.092% on increasing, peak and decreasing period respectively period [41]. The highest average values of N, P, K, Ca and Na contents (average of three plucking periods) were found to be 6.089%, 0.23%, 2.16%, 1.45% and 0.118% respectively whilst the lowest average values were found to be 4.75%, 0.167%, 1.47%, 1.11% and 0.071% respectively in Bangladesh tea. Twig N, K. and Na contents were found to be maximum on peak period and minimum on decreasing period but P and Ca contents were found to be maximum on increasing period and minimum on peak period [41]. Hence, in respect to nutrient contents, it can also be understood that all the studied brands of Ispahani tea might have been manufactured from the downward shoots of plucking standard and certainly the plucking time was on decreasing plucking period.

It is also obvious from the result as presented in Fig. 4 that in respect to total amount of active components (Caffeine, TPC, TF, TR, HPS and nutrient contents) so far studied in this experiment Best Leaf tea (37.65%) was found to be superior among the six different brands of Ispahani tea whilst the lowest amount was determined in Blender's Choice tea (34.52%) and consequently followed the sequence as Best Leaf > Tea bags > Best quality (BOP) > Zareen >Best quality (PD) >Blender's Choice. In a recent study, it was reported that the caffeine, TF, TR, HPS and TLC contents of Ispahani Mirzapore tea was found to be 2.78%, 0.47%, 4.202%, 3.752% and 1.8 respectively and the total of Caffeine, TF, TR and HPS was determined to be 13.004% [45].

CONCLUSION

The present study concludes that the six brands of Ispahani tea might have been harvested in decreasing plucking period (October-December). The Caffeine, TP, TF, TR, HPS, TLC, N, P, K, Ca and Na contents of six studied brands of tea were medium in quantity but comparable with qualitative standard of Bangladesh tea. Above all, the plucking standard was not maintained properly and there might have been followed the standard of a bud with four leaves or downward plucking. It can further be concluded that in respect to qualitative status so far studied in this experiment Best Leaf tea was found to be superior among the six different brands of Ispahani tea but all of the brands could be defined as medium quality tea.

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