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Determination of Catechin Content in Seventeen Marketed Brands of Black Tea of Bangladesh

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Abstract:*Seventeen marketed brandsof black tea of Bangladesh (viz; Seylon, Tetley, Duncan, National, Fresh, Teer, Finlay, Starship, Ispahani, Cosmo, Magnolia, Danish, Shaw Wallace, Pusti, Kazi&Kazi, HRC and Lipton Taaza tea) randomly collected from the local supermarkets were evaluated for catechin status. The experiment was done in 2015, 2016 and 2017 for determining the catechins [catechin (C), epicatechin (EC), epicatechingallate (ECG), epigallocatechin (EGC), epigallocatechingallate (EGCG), gallocatechin (GC), gallocatechingallate (GCG), non-gallated catechins (NGCs), gallated catechins (GCs) and total catechins (TCs)].All the studied qualitative parameters was found to vary significantly ($P<0.05$) with the marketed brands of tea. Maximum amount of C, EC, ECG, EGC, EGCG, GC, GCG, NGCs and GCs in all the seventeen marketed brand teas of Bangladesh were determined to be 2.53 mgg^{-1} (Cosmo), 9.26 mgg^{-1} (Cosmo), 22.68 mgg^{-1} (Cosmo), 37.36 mgg^{-1} (Cosmo), 63.76 mgg^{-1} (Cosmo), 3.11 mgg^{-1} (Cosmo), 8.16 mgg^{-1} (Cosmo), 52.27 mgg^{-1} (Cosmo) and 94.61 mgg^{-1} (Cosmo) whilst the minimum amounts were detected to be 0.97 mgg^{-1} (Fresh), 3.46 mgg^{-1} (Seylon), 9.58 mgg^{-1} (Fresh), 12.44 mgg^{-1} (Starship), 19.35 mgg^{-1} (Starship), 1.66 mgg^{-1} (Fresh), 3.14 mgg^{-1} (Tetley), 20.87 mgg^{-1} (Starship) and34.29 mgg^{-1} (Starship) respectively. The maximum magnitude of total catechins (total of C, EC, ECG, EGC, EGCG, GC, GCG, NGCs and GCs) was estimated to be 146.86 mgg^{-1} in Cosmo tea and minimum magnitude was determined to be 55.16 mgg^{-1} in starship teaand followed the succession as Cosmo> Magnolia> National> Lipton Taaza>Ispahani>Kazi&Kazi> Finlay> Duncan> Shaw Wallace> HRC>Teer>Pusti> Danish> Tetley>Seylon> Fresh>Starship. Therefore, the present study concludes that among the studied marketed brand teas of Bangladesh, Cosmo tea was regarded as the most excellent one while the total catechinwas concerned.*

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I. Introduction

Tea is consumed throughout the world for its unique taste, briskness and flavour. It is cultivated commercially for use both as a beverage and medicinal purposes[1]. For thousands of years, people have used tea as a long-term beverage in long-term drinking without any toxicity or allergies, which reveals that a variety of biochemical substances, such as polyphenolic catechins and methylxanthine caffeine are safe to humans. As a beverage, tea is the oldest, most popular non-alcoholic drink globally[2,3,4,5,6] after water[7,8,9,10].

The quality of tea involves parameters such as color, appearance, flavors, and taste. Caffeine is an important factor for quality evaluation[11] in the way it indicates briskness and other taste properties[12]. The polyphenols constitute the most interesting group of tea leaf components and exhibit potent antioxidant activity *in vitro* and *in vivo*[13]. Tea has been considered a medicine and a healthful beverage since ancient times, but recently it has received a great deal of attention because tea polyphenols are strong antioxidants. Tea leaves contain 10–30% of dry weight of polyphenols,including catechins, flavonols, flavanones, phenolic acids, glycosides and the aglycones of plant pigments[14]. Polyphenols are the active components responsible for the beneficial effects of drinking black tea[15]. Polyphenols account for 20-35 % (w/w) of the dry tea, thus representing a significant proportion of the tea constituents.

Polyphenols occurring in black tea usually consist of residual green tea polyphenols such as catechins flavonols and oxidation products of green tea polyphenols such as theaflavins and thearubigins[16].Tea polyphenols or tea tannin plays an important role in the colors, briskness and taste and therefore is considered to be important for the quality of black tea. Among all tea polyphenols, especially catechins and gallic acid have been considered to be the main players in these beneficial effects on the human health. Tea appears, therefore, to be an effective chemopreventive agent for toxic chemicals and carcinogens[17]. Numerous studies have also demonstrated that the aqueous extract of the major tea polyphenols possesses antimutagenic, antidiabetic, antibacterial, anti-inflammatory, and hypocholesterolemic qualities[18,19,20].Black tea polyphenols have been extensively studied as anti-cancer compounds. In vitro experiments have supported their significant antioxidant activity[21].

Tea flavanols are a group of natural polyphenols found in green and black tea. Four flavanol derivatives are found in tea: The major tea catechins are (-) epigallocatechingallate (EGCG), (-) epigallocatechin (EGC), (-)-epicatechingallate (ECG), and (-)-epicatechin (EC)[22].Their biological benefits are due to their strong antioxidant and anti-angiogenic activity as well as their potential to inhibit cell proliferation and modulate carcinogen metabolism[23].

The major antioxidants in tea are catechins, then theaflavins, thearubigins, oxyaromatic acids, flavonols, such as kaempferol, myricetin, quercetin; flavones, such as apigenin; derivatives of gallic acid, such as tannins, etc. The most powerful antioxidant tea is green tea which is characterized by the presence of large amount of flavan-3-ols known as catechins (-). Epigallocatechin-3-gallate (EGCG) is most abundant catechin in green tea and may occur up to 50% of the catechins by weight. The result of catechins oxidation is the formation of catechins dimers, known as theaflavins. These compounds are responsible for the color and taste and also a key factor in the antioxidant activity. The known in vitro antioxidant properties of catechins and other polyphenolic compounds in tea have led to interest in the potential health benefits of tea consumption[24]. Numerous epidemiologic studies have addressed the relationships between tea consumption and the incidence of cardiovascular diseases[25]. The antioxidant activity of green tea polyphenols and, more recently, the pro-oxidant effects of these compounds, have been suggested as potential mechanisms for cancer prevention[26,27]. The effect of black tea consumption, with and without milk, on the plasma antioxidant activity in humans produces a significant increase in plasma antioxidant activity reaching maximal levels at about 60 min[21].

So far the literature review is concerned, only few experimental works[28,29,30] on the comparative evaluation of caffeine, polyphenols and nutrient contents (N, Na, P, K, Ca, Fe, sugar, fat, starch and protein) of marketed brand teas of Bangladesh have yet been done whereas no research work has yet been done on the catechin status of Bangladesh tea. With this view in mind a laboratory analyses was undertaken to screen out the comparative status of catechin contents of seventeen marketed brand teas of Bangladesh.

II. Material and Methods

Collection of commercial tea samples

Seventeen different commercial brands of black Tea (produced in Bangladesh) namely Seylon tea, Tetley tea, Duncan tea, National tea, Fresh tea, Teer tea, Finlay Premium tea, Starship tea, Ispahani tea, Cosmo tea, Magnolia tea, Danish tea, Shaw Wallace tea, Pusti tea, Kazi&Kazi tea, HRC tea and Lipton Taaza tea were collected from Bangladesh Tea Expo 2017, Dhaka, Chittagong Finlay House, Shaw Wallace trade centre, Rashid Building, Agrabad, Chittagong, various city super shop such as Swapno, Meena bazar, Agora, Well mart, Khulshi mart, Grocer, which are located in Sholoshahar, GEC circle, Probortok circle and Khulshi area of Chittagong city respectively. All the commercial brands of tea were mentioned in the present study as "marketed brands of tea".

Laboratory work

Analytical preparation

All the glassware's were soaked overnight with chromic acid solution and washed thoroughly with water and detergent, then rinsed with deionized water before use. The chemicals and reagents used in this study were of high quality. The tea samples were kept at room temperature throughout the analyses.

Determination of individual Catechins and Total Catechins

Chemicals and Reagents

Folin-Ciocalteu's phenol reagent, gallic acid, acetonitrile, acetone, trifluoroacetic acid, ethanol and methanol (HPLC grade) were purchased from Fluka (Switzerland). Anhydrous sodium carbonate was purchased from Merck (Germany). Isobutyl methyl ketone, Flavognost reagent (diphenylboric acid 2-aminoethyl ester) and 4-methyl-2-pentanone were purchased from Sigma-Aldrich (Switzerland). All chemical standards (GC, EGC, C, EC, EGCG, caffeine, GCG, ECG and CG) were purchased from Sigma-Aldrich (USA).

Determination of moisture content

Tea samples (~5 g, weighed to the nearest 0.001 g) were placed in a moisture can and heated in an oven at 103±2°C for at least 16 hr to constant weight. The percentage of moisture content and dry matter (%DM) in the samples was then calculated from the weight difference[31].

Sample extraction

Each ground tea sample (~2 g, weighed to the nearest 0.001g) was extracted with distilled water (200 ml) at 95°C. The extraction mixture was constantly stirred with a magnetic stirrer. After 10 min., the extraction mixture was filtered through Whatman No. 4 filter paper. The residue was washed with distilled water (3x10

ml). The tea solution was cooled to room temperature and adjusted to 250 ml with distilled water. All samples were extracted in triplicate[32,33].

Table 1: Price list of seventeen marketed brandsof black tea of Bangladesh along with manufacturing and expiry date.

Brand Name	Collected from	Manufacturing Date	Expiry Date	Weight (g)	MRP Tk	MRP Tk/kg
Seylon Gold Tea	Super market	22/02/2017	21/02/2019	10	5	500
Tetley Premium Leaf Tea	Super market	26/10/2016	26/10/2018	200	85	425
Duncan's Tea	Tea Expo'17	23/12/2016	23/12/2018	100	50	500
National Tea	Tea Expo'17	08/01/2017	08/01/2018	10	5	500
Fresh Premium Tea	Super market	27/04/2016	26/04/2018	200	75	375
Teer Tea	Super market	21/05/2016	21/05/2018	50	18	320
Finlay premium Tea	Finlay House	18.11.2016	17.11.2018	500	220	440
Star Ship Special Tea	Super market	17/04/2016	16/04/2018	500	158	316
IspahaniZareen Tea	Super market	27/03/2016	27/02/2018	200	88	440
Cosmo Tea	Tea Expo'17	12/07/2016	12/07/2018	50	30	600
Magnolia Tea	Tea Expo'17	15/05/2016	06/02/2017	10	5	500
Danish BOP Tea	Super market	29/12/2015	30/12/2017	500	149	298
Shaw Wallace Super Clone	SW Trade Centre	10/01/2017	10/12/2018	200	99	500
Pusti BOP Tea	Super market	04/05/2016	03/05/2018	500	149	298
Kazi&Kazi	Super market	23/11/2016	22/05/2018	200	130	650
HRC Premium Tea	Tea Expo'17	15/02 2017	15/01/2019	500	173	346
Lipton Taaza	Super market	03/04/2017	02/04/2019	200	85	425

Optimization of HPLC condition for catechins analysis

Individual catechins and total catechin (TC) content were determined by ISO method[34] as modified by[35]. The reference standards of the target compounds, that are, GC, EGC, C, EC, EGCG, CF, GCG, ECG, CG were accurately weighed and dissolved in methanol to generate a stock concentration of 1,000 µg/ml. The mixed stock standard solution was prepared by mixing 1 ml of each stock standard into a 10-ml volumetric flask and made to volume with distilled water. Working standard solutions were prepared by 1-500 fold dilution of the mixed stock solution and then filtered through a 0.45 µm PTFE filter. HPLC analysis of standards and samples was conducted on a Water 966 high performance liquid chromatography comprising vacuum degasser, quaternary pump, auto-sampler, thermostatted column compartment and photo diode array detector (HPLC: Ultimate 3000 Series, Dionex, Thermo Scientific). The column used was a Platinum EPS C18 reversed phase, 3 µm (53 x 7 mm), operated at 30°C.The analytical conditions were optimized mainly on the basis of peak resolution, baseline, elution time, mobile phase composition, flow rate, temperature and detection wavelength. Mobile phase eventually optimized was water/acetonitrile (87:13) containing 0.05% (v/v) trifluoroacetic acid (TFA) with the flow rate of 2 ml/min. Absorption wavelength was 210 nm. All injection volumes of samples and standard solutions were 20 µl.

The criteria for the identification of catechins and caffeine were established based on comparisons of the retention time and spectrum in the 190-400 nm range of an unknown compound with HPLC library data of standards. The results were expressed as g/100 g dry weight (DW). Gallated catechin was determined by the summation of EGCg, GCg and ECg; Non-gallated catechin was determined by the summation of GC, EGC, C and EC. The total catechin (TC) was determined by the summation of individual catechin (GC, EGC, C, EC, EGCG, GCG, ECG and CG).

$$\text{Individual catechin content (g/100g DW)} = \frac{(A_s - b) \times RRF_{std} \times V_s \times DF \times 100}{m \quad W_s \times 10{,}000 \quad \%DM}$$

Where

DW = dry weight (g);
A s = peak area of individual catechin in sample;
b = peak area at point of interception on y-axis of caffeine calibration curve;
RRF_{std} = relative response factor of individual catechin with respect to caffeine;
m = slope of caffeine calibration curve;
V_s = sample extraction volume (ml);
DF = dilution factor;
W_s = sample weight (g);
%DM = percentage of dry matter of sample.

Method validation

Validation was carried out in compliance with the AOAC Intl. Guidelines for Single Lab. Validation of Chemical Methods for Dietary Supplements and Botanicals[36]. Calibration graphs for the caffeine and 8 catechins were constructed using nine levels of concentration which covered the concentration ranges expected in the tea samples. The characteristics of the calibration curves, including the regression equation, correlation coefficient (r), range of linearity, limit of detection (LOD) and limit of quantitation (LOQ) were determined. The LOD and LOQ were based on a signal-to-noise (S/N) ratio as 3:1 and 10:1, respectively. Precision was determined by analyzing known concentrations of the nine standards in seven replicates. The relative standard deviation (RSD) was calculated as a measure of precision. Recoveries were carried out to investigate the accuracy by spiking three concentration levels of the mixed standard solutions to known amounts of the tea samples. The samples were then extracted and analyzed with the described method. The average percentage recoveries were evaluated by calculating the ratio of detected amount versus the added amount.

Statistical analysis

All measurements were carried out in triplicate forms. Results of the parameter determined were expressed as a mean of the triplicate determination. The data were analyzed using the one-way analysis of variance (ANOVA) tool under the Statistical Package Social Science (SPSS) 16.0 software. The ANOVA and Duncan's Multiple Range test (DMRT) were completed to compare the mean values and standard deviation among the samples.

III. Results

Catechin (C):

The results explicate that all the individual catechinas well as total catechinsvaried significantly ($P < 0.05$) with the studied brands. Maximum amount of catechin content (C)was detected to be 2.53mgg^{-1} in Cosmo tea and minimum amount was detected to be 0.97mgg^{-1} in Fresh tea. The mean value of catechin contentof the studied brands was calculated to be1.86 mgg^{-1}. In respect tocatechin content (C), all the studied brands showed the following sequence as Cosmo > Lipton Taaza> National > Magnolia >Kazi&Kazi> Finlay > Duncan > Shaw Wallace >Ispahani> HRC >Pusti> Danish > Tetley >Seylon>Starship>Teer> Fresh (Table 2). Catechin content (C)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Epicatechin (EC):

The highest amount of epicatechin content (EC)was determined to be 9.26mgg^{-1} in Cosmo tea and the lowest amount was determined to be 3.46mgg^{-1} in Seylon tea. The mean value of epicatechin contentof the studied brands was calculated to be 6.30mgg^{-1}. In case of epicatechin content (EC), all the studied brands showed the following sequence as Cosmo > Magnolia > National > Finlay > Lipton Taaza> Duncan >Ispahani> Shaw Wallace >Kazi&Kazi> HRC >Starship>Teer.>Pusti> Danish > Fresh > Tetley >Seylon (Table 2). Epicatechin content (EC)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Epicatechingallate (ECG):

The highest amount of ECGwas detected to be 22.68mgg^{-1} in Cosmo tea and the lowest amount was detected to be 9.58mgg^{-1} in Fresh tea. The mean value of epicatechingallate contentof the studied brands was calculated to be 14.64mgg^{-1}. In concerning the epicatechingallate content (ECG), all the studied brands showed the following sequence as Cosmo > Magnolia > Lipton Taaza> National > Shaw Wallace > Finlay >Ispahani> Duncan >Kazi&Kazi> HRC > Danish >Pusti> Tetley >Starship>Teer.>Seylon> Fresh (Table 2). Epicatechingallate content (ECG)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Epigallocatechin (EGC):

Maximum amount of EGCwas determined to be 37.36 mgg^{-1} in Cosmo tea and minimum amount was determined to be 12.44 mgg^{-1} in Starship tea. The mean value of epigallocatechin contentof the studied brands was calculated to be 24.61 mgg^{-1}. In case of epigallocatechin content (EGC), all the studied brands showed the following sequence as Cosmo > Magnolia > National > Lipton Taaza>Ispahani>Kazi&Kazi> Finlay > Shaw Wallace > Duncan > HRC >Teer>Pusti> Danish > Tetley > Fresh >Seylon>Starship (Table 2). Epigallocatechin content (EGC)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Table 2: Variation of individual catechin content in seventeen marketed brands of black tea of Bangladesh.

Brands	C (mgg^{-1})	EC (mgg^{-1})†	ECG (mgg^{-1})†	EGC (mgg^{-1})†	EGCG (mgg^{-1})†	GC (mgg^{-1})†	GCG (mgg^{-1})†
Seylon	1.31 ±0.08 bc	3.46 ±0.047 a	10.35 ±0.47 a	15.61 ±0.26 b	25.27 ±0.44 c	1.87 ±0.17 bc	3.97 ± 0.13 c
Tetley	1.44 ±0.06 c	4.27 ±0.042 b	12.42 ±0.52 c	18.34 ±0.47 d	28.45 ±0.36 e	1.69 ±0.08 ab	3.14 ±0.10 a
Duncan	2.16 ±0.12 fg	7.33 ±0.044 j	14.68 ±0.58 f	24.77 ±0.42 h	35.44 ±0.50 h	2.11 ±0.14 d	5.26 ±0.09 g
National	2.35 ±0.08 ij	8.18 ±0.042 m	16.76 ±0.55 h	33.46 ±0.33 m	56.42 ±0.45 n	2.76 ±0.09 hi	7.32 ±0.10 j
Fresh	0.97 ±0.08 a	4.64 ±0.042 c	9.58 ±0.52 a	16.55 ±0.22 c	23.68 ±0.51 b	1.66 ±0.11 a	4.55 ±0.30 de
Teer	1.08 ±0.06 a	5.32 ±0.035 e	11.23 ±0.42 b	22.68 ±0.42 g	31.66 ±0.44 f	2.37 ±0.10 e	4.84 ±0.10 f
Finlay	2.18 ±0.07 fgh	7.64 ±0.049 l	15.61 ±0.45 g	26.15 ±0.28 ij	38.62 ±0.44 j	2.64 ±0.11 fgh	6.78 ±0.10 i
Starship	1.22 ±0.07 b	5.53 ±0.062 f	11.27 ±0.51 b	12.44 ±0.30 a	19.35 ±0.36 a	1.68 ±0.11 ab	3.67 ±0.11 b
Ispahani	2.05 ±0.08 f	6.88 ±0.042 i	15.56 ±0.37 g	28.63 ±0.42 k	42.51 ±0.51 k	2.46 ±0.08 ef	5.88 ±0.11 h
Cosmo	2.53 ±0.08 k	9.26 ±0.036 o	22.68 ±0.49 k	37.36 ±0.53 o	63.76 ±0.43 o	3.11 ±0.14 j	8.16 ±0.20 k
Magnolia	2.31 ±0.09 hij	8.75 ±0.049 n	20.12 ±0.53 j	34.84 ±0.34 n	51.22 ±0.36 m	2.85 ±0.11 i	7.53 ±0.09 j
Danish	1.65 ±0.07 d	4.67 ±0.049 c	13.45 ±0.56 de	19.76 ±0.41 e	27.14 ±0.33 d	2.06 ±0.09 cd	4.36 ±0.09 d
Shaw Wallace	2.11 ±0.09 fg	6.69 ±0.030 h	15.63 ±0.47 g	25.78 ±0.43 i	32.65 ±0.44 g	2.34 ±0.12 e	5.72 ±0.11 h
Pusti	1.78 ±0.10 de	5.12 ±0.047 d	12.74 ±0.42 cd	21.37 ±0.24 f	26.78 ±0.53 d	2.12 ±0.14 d	5.09 ±0.16 g
Kazi&Kazi	2.23 ±0.09 ghi	6.34 ±0.044 g	14.67 ±0.50 f	26.45 ±0.33 j	42.57 ±0.46 k	2.55 ±0.12 efg	5.65 ±0.14 h
HRC	1.86 ±0.09 e	5.58 ±0.047 f	13.82 ±0.53 ef	23.19 ±0.33 g	36.43 ±0.24 i	2.46 ±0.13 ef	4.77 ±0.13 ef
Lipton Taza	2.45 ±0.09 jk	7.45 ±0.057 k	18.32 ±0.45 i	31.05 ±0.16 l	45.51 ±0.36 l	2.72 ±0.11 ghi	6.76 ±0.16 i
Mean	1.86 ±0.50	6.30 ±1.66	14.64 ±3.47	24.61 ±7.00	36.91 ±12.20	2.32 ±0.84	5.50 ±1.43

†Means (n=3) in table followed by a common letter are not significantly different (P > 0.05) according to DMRT.

Table 3: Variation of non-gallated, galleted and total catechin contents in seventeen marketed brands of black tea of Bangladesh.

Brands	NGCs (mgg^{-1})†	GCs (mgg^{-1})†	TCs (mgg^{-1})†
Seylon	22.25 ±0.39 b	39.59 ±0.87 c	61.84 ±1.22 b
Tetley	25.74 ±0.54 d	44.01 ±0.94 d	69.75 ±1.34 c
Duncan	36.37 ±0.58 i	55.37 ±1.05 g	91.74 ±1.55 h
National	46.75 ±0.35 n	80.50 ±0.93 i	127.25 ±1.27 l
Fresh	23.82 ±0.06 c	37.82 ±1.30 b	61.63 ±1.25 b
Teer	31.45 ±0.43 g	47.74 ±0.66 e	79.18 ±1.03 f
Finlay	38.62 ±0.23 k	61.02 ±0.77 h	99.62 ±0.81 i
Starship	20.87 ±0.15 a	34.29 ±0.77 a	55.16 ±0.68 a
Ispahani	40.02 ±0.36 l	63.95 ±0.46 i	103.97 ±0.60 j
Cosmo	52.27 ±0.50 p	94.61 ±0.22 m	146.86 ±0.32 m
Magnolia	48.76 ±0.35 o	78.87 ±0.32 k	127.62 ±0.48 l
Danish	28.14 ±0.53 e	44.95 ±0.32 d	73.09 ±0.74 d
Shaw Wallace	36.93 ±0.50 ij	54.01 ±1.01 f	90.92 ±1.50 h
Pusti	30.39 ±0.53 f	44.62 ±0.72 d	75.00 ±0.45 e
Kazi&Kazi	37.57 ±0.36 j	62.89 ±0.87 i	100.46 ±0.88 i
HRC	33.09 ±0.37 h	55.02 ±0.60 fg	88.11 ±0.88 g
Lipton Taza	43.67 ±0.16 m	70.6 ±0.30 j	114.26 ±0.34 k
Mean	35.10 ±9.38	57.05 ±16.74	92.15 ±25.98

†Means (n=3) in table followed by a common letter are not significantly different (P > 0.05) according to DMRT.

Table 4: Correlation coefficient matrix analysis of catechis in seventeen marketed brands of black tea of Bangladesh.

C	EC	ECG	EGC	EGCG	GC	GCG	NGCs	GCs	TCs	
-	0.85**	0.89**	0.87**	0.83**	0.83**	0.83**	0.89**	0.86**	0.88**	C
	-	0.91**	0.90**	0.87**	0.85**	0.93**	0.93**	0.90**	0.92**	EC
		-	0.93**	0.91**	0.88**	0.89**	0.94**	0.94 **	0.95 **	ECG
			-	0.96**	0.94**	0.94**	0.99**	0.98**	0.99**	EGC
				-	0.92**	0.91**	0.96**	0.99**	0.99 **	EGCG
					-	0.93**	0.95**	0.93**	0.94 **	GC
						-	0.95**	0.93 **	0.94 **	GCG
							-	0.98**	0.99**	NGCs
								-	0.99**	GCs
									-	TCs

**Significant at p<0.05 **Significant at p<0.01*

Epigallocatechingallate (EGCG):

The highest amount of EGCGwas estimated to be 63.76mgg^{-1} in Cosmo tea and the lowest amount was estimated to be 19.35mgg^{-1} in Starship tea. The mean value of epigallocatechingallate contentof the studied brands was found to be 36.91mgg^{-1}. In considering epigallocatechingallate content (EGCG), all the studied brands showed the following sequence as Cosmo > National > Magnolia > Lipton Taaza>Kazi&Kazi>Ispahani> Finlay > HRC > Duncan > Shaw Wallace >Teer> Tetley > Danish >Pusti>Seylon> Fresh >Starship(Table 2). Epigallocatechingallate content (EGCG)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Gallocatechin(GC):

The highest amount of GCwas determined to be 3.11mgg^{-1} in Cosmo tea and the lowest amount was determined to be 1.66mgg^{-1} in Fresh tea. The mean value of gallocatechin contentof the studied brands was found to be 2.32mgg^{-1}. In respect togallocatechin content (GC), all the studied brands showed the following sequence as Cosmo > Magnolia > National > Lipton Taaza> Finlay >Kazi&Kazi> HRC >Ispahani>Teer> Shaw Wallace >Pusti> Duncan > Danish >Seylon> Tetley >Starship> Fresh (Table 2). Gallocatechincontent (GC)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Gallocatechingallate(GCG):

Maximum amount of GCGwas estimated to be 8.16mgg^{-1} in Cosmo tea and minimum amount was estimated to be 3.14mgg^{-1} in Tetley tea. The mean value of gallocatechingallate contentof the studied brands was found to be 5.50mgg^{-1}. In considering gallocatechingallatecontent (GCG), all the studied brands showed the following sequence as Cosmo > Magnolia > National > Finlay > Lipton Taaza>Ispahani> Shaw Wallace >Kazi&Kazi> Duncan >Pusti>Teer> HRC > Fresh > Danish >Seylon>Starship> Tetley(Table 2). Gallocatechingallatecontent (GCG)of the studied brands of tea was found to be positive significantly ($P > 0.05$) correlated with all other individual catechins (Table 4).

Non-gallated catechins(NGCs):

The highest amount of NGCswas determined to be 52.27mgg^{-1} in Cosmo tea and the lowest amount was determined to be 20.87mgg^{-1} in Starship tea. The mean value of non-gallated catechins of the studied brands was found to be 35.10mgg^{-1}. In allowing fornon-gallated catechinscontent(NGCs), all the studied brands showed the following sequence as Cosmo > Magnolia > National > Lipton Taaza>Ispahani> Finlay >Kazi&Kazi> Shaw Wallace > Duncan > HRC >Teer>Pusti> Danish > Tetley > Fresh >Seylon>Starship(Table 3). Non-gallated catechinscontent(NGCs)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Gallated catechins (GCs):

Maximum amount of GCswas estimated to be 94.61mgg^{-1} in Cosmo tea and minimum amount was estimated to be 34.29mgg^{-1} in Starship tea. The mean value of gallated catechins of the studied brands was found to be 57.05mgg^{-1}. In respect to gallated catechin contents(GCs), all the studied brands showed the following sequence as Cosmo > National > Magnolia > Lipton Taaza>Ispahani>Kazi&Kazi> Finlay > Duncan > HRC > Shaw Wallace >Teer> Danish >Pusti> Tetley >Seylon> Fresh >Starship(Table 3). Gallated catechins

content(GCs)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

Total catechins (TCs):

The highest amount of TCswas detected to be 146.86mgg^{-1} in Cosmo tea and the lowest amount was detected to be 55.16mgg^{-1} in Starship tea. The mean value of total catechins of the studied brands was found to be 92.15mgg^{-1}. In relation to total catechins (TCs), all the studied brands showed the following sequence as Cosmo > Magnolia > National > Lipton Taaza>Ispahani>Kazi&Kazi> Finlay > Duncan > Shaw Wallace > HRC >Teer>Pusti> Danish > Tetley >Seylon> Fresh >Starship (Table 3 and Figure 1). Total catechins (TCs)of the studied brands of tea was found to be positive significantly ($P < 0.05$) correlated with all other individual catechins (Table 4).

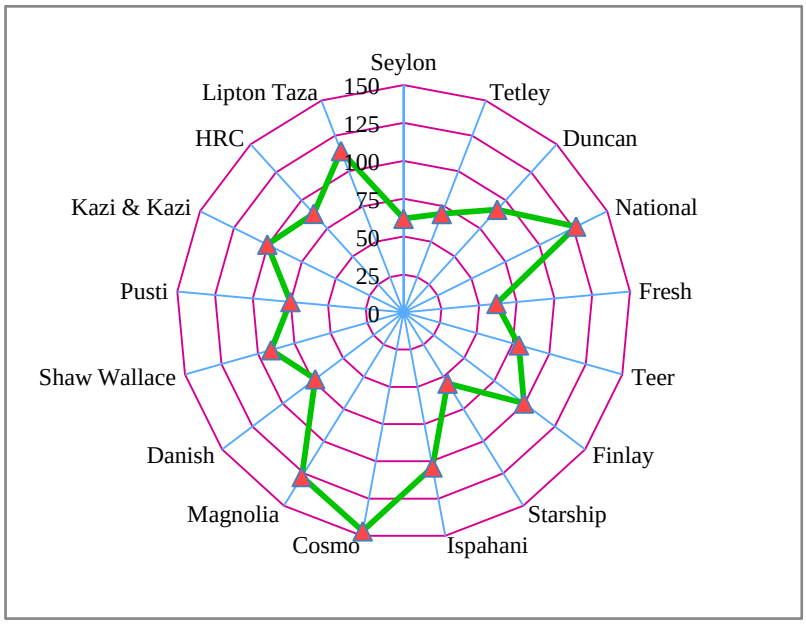

Figure 1: Profile of total catechin content in seventeen studied marketed brands of black tea of Bangladesh.

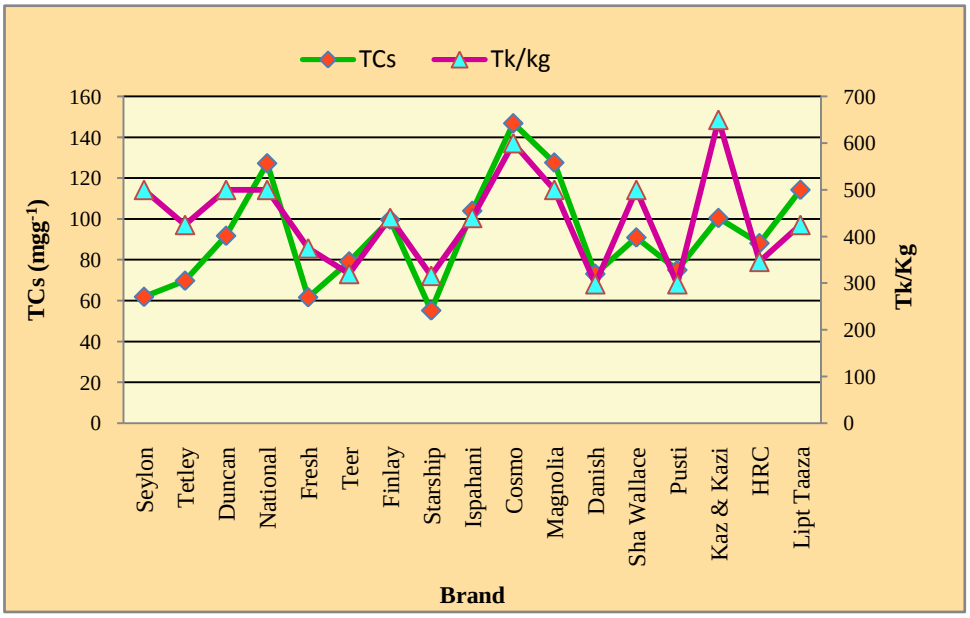

Figure 2: Comparison of total catechin status and market price of seventeen marketed brands of black tea of Bangladesh.

Comparison of price with total catechins:

The market pricesof seventeen marketed brands of black tea of Bangladesh are shown in Table 1. It is evident from the results that the maximum price/kg was observed in Kazi&Kazi tea (650Tk/kg) and the minimum price was observed in Danish tea (298 Tk/kg) and followed the sequence asKazi&Kazi> Cosmo> Duncan> National>Seylon> Magnolia> Shaw Wallace> Finlay>Ispahani> Lipton Taaza> Tetley> Fresh> HRC>Teer>Starship>Pusti> Danish (Figure 2).

IV. Discussion

Catechin (C):

The results of the catechin content of the marketed brand teas of Bangladesh corroborate with the findings of Saito *et al*., [37] who reported 8.30, 1.0-5.0 and <1.0 mgg^{-1} catechin in Japanese green tea, Chinese green tea and Indian black tea respectively. Catechin content of oolong and green tea purchased from the supermarket of Penang, Malaysia was detected to be 11.14 and 34.69 mgg^{-1} respectively[38]. Catechin content was reported to be 4.0 to 45.90 mgg^{-1} with an average of 8.20mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. Catechin status of Wissotzkyearly 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 8.10, 13.10, 16.20 and 2.70 mgg^{-1} respectively[40]. Catechin content ranged from 0.0 to 7.44 mgg^{-1} in the ten popular commercial tea brands collected from different cities of Pakistan[41]. The results of the catechin in the present study substantiate with these research findings. It is evident from the results that catechin content of the marketed brand teas of Bangladesh is a bit higher than the other countries and Cosmo tea was considered as the best tea in Bangladesh while individual catechin content is concerned.

Epicatechin (EC):

Epicatechinwas detected to be 5.27, 6.06, 8.59, 4.27, 6.06, 1.75, 1.41 and 0.49 mgg^{-1} in Longjin green tea, Jasmine green tea, Chrysenthimum green tea, Iron Buddha green tea, Japanese green tea, oolong tea Ceylon black tea and pu-erh tea respectively Ceyl purchased from the supermarkets of Singapore[42,43]. In Chinese Fujian black tea, epicatechin content was estimated to be 2.7 mgg^{-1} [44]. These findings are similar to the present result of epicatechin. The results of epicatechin are in good agreement with the findings of Cabrera *et. al.*[45] who reported that epicatechin content was found to be 14.10, 7.40, 4.0, 6.60, 9.10 and 11.40 mgg^{-1} in Sencha tea (Japan), Assam tea (India), Keemun tea (China), Ceylan tea (Srilanka), English breakfast tea (Srilanka) and Darjeeling tea (India) respectively. Epicatechin status of Wissotzkyearly 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 2.90, 5.20, 5.60 and 5.30 mgg^{-1} respectively[40] which agrees with the result of present study. The results of the epicatechin content of the marketed brand teas of Bangladesh corroborate with the findings of Saito *et al*.[37] who reported 8.80, 7.0-21.0 and 1.60 mgg^{-1} catechin in Japanese green tea, Chinese green tea and Brazilian black tea respectively. Epicatechin content was reported to be 6.20 to 14.80 mgg^{-1} with an average of 10.10 mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39].

Epicatechin content was determined to be 10.30, 7.25, 2.63 and 1.36 mgg^{-1} in Japanese Meifoo green tea, Shanghai green tea, Fujian pu-erh tea and Fujian black tea respectively[44]. Content of epicatechin (brewed up to 5 min.) determined by HPLC-MS was found to be 8.70, 8.50, 3.50, 1.30 and 0.9 mgg^{-1} in Chinese green tea, Jasmine green tea, Tie Guan Yin oolong tea, Krasno-rozovy black tea and Telley orange pekoe black tea respectively[13]. These findings are also in a good agreement with the present study. Finally it can be alleged that EC content in the marketed teas of Bangladesh is similar to the international standard and accordingly, Cosmo tea was found to be peaked in respect to EC content.

Epicatechingallate (ECG):

Epicatechingallatecontent was determined to be 21.80, 11.30, 6.06 and 4.45 mgg^{-1} in Japanese Meifoo green tea, Shanghai green tea, Fujian pu-erh tea and Fujian black tea respectively[44].Epicatechin status of Wissotzkyearly 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 2.0, 4.80, 21.30 and 4.50 mgg^{-1} respectively[40]. Content of epicatechingallate (brewed up to 5 min.) determined by HPLC-MS was found to be 9.0, 10.40, 5.90, 3.70 and 3.40 mgg^{-1} in Chinese green tea, Jasmine green tea, Tie Guan Yin oolong tea, Krasno-rozovy black tea and Telley orange pekoe black tea respectively[13]. In Chinese Fujian black tea, epicatechin content was estimated to be 8.90mgg^{-1} [44].These findings are similar to the present result of epicatechingallate.

Epicatechinwas detected to be 9.97, 12.66, 12.58, 3.35, 5.34, 3.58, 6.82 and 0.07 mgg^{-1} in Longjin green tea, Jasmine green tea, Chrysenthimum green tea, Iron Buddha green tea, Japanese green tea, oolong tea Ceylon black tea and pu-erh tea respectively Ceyl purchased from the supermarkets of Singapore[42,43]. ECG content was reported to be 0.50 to 11.70mgg^{-1} with an average of 5.80mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. These findings are also in a good agreement with the ECG status of marketed teas

of Bangladesh. The results of epicatechingallate are in good consistent with the findings of Cabrera *et al.*[45] who reported that epicatechin content was found to be 10.40, 11.50, 4.40, 9.50, 13.50 and 20.60 mgg^{-1} in Sencha tea (Japan), Assam tea (India), Keemun tea (China), Ceylan tea (Sri Lanka), English breakfast tea (Sri Lanka) and Darjeeling tea (India) respectively.

The results of the epicatechingallate content of the marketed brand teas of Bangladesh corroborate with the findings of Lin *et al.*[46] who reported 29.0, 19.50, 8.40 and 0.3 mgg^{-1} ECG in 15 Chinese green tea, 13 Japanese green tea, 9 Chinese and Taiwanese oolong tea and 1 Chinese black tea (85% fermented) respectively. Hence, it could be assumed that almost all of the marketed brands of Bangladesh maintained the national and international standard of ECG and Cosmo tea was revealed as the best marketed tea of Bangladesh in respect to ECG content.

Epigallocatechin (EGC):

The results of epigallocatechin are in good agreement with the findings of Cabrera *et al.*[45] who reported that EGC content was found to be 32.10, 3.90, 20.10, 41.70, 33.70 and 5.90 mgg^{-1} in Sencha tea (Japan), Assam tea (India), Keemun tea (China), Ceylan tea (Srilanka), English breakfast tea (Srilanka) and Darjeeling tea (India) respectively. In Chinese Fujian black tea, epicatechin content was estimated to be 11.40mgg^{-144} which shows similarity with the present result of epigallocatechin. EGCwas detected to be 28.09, 23.46, 18.62, 30.61, 36.53, 7.70, 2.84 and 0.60 mgg^{-1} in Longjin green tea, Jasmine green tea, Chrysenthimum green tea, Iron Buddha green tea, Japanese green tea, oolong tea, Ceylon black tea and pu-erh tea respectively which were purchased from the supermarkets of Singapore[42,43]. EGC content of oolong and green tea purchased from the supermarket of Penang, Malaysia was detected to be 2.99 and 16.62mgg^{-1} respectively[38]. These findings are also consistent with the present study.

Epigallocatechin status of Wissotzkyearly 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 0.0, 0.0, 11.60 and 6.20 mgg^{-1} respectively[40]. Epigallocatechin content was reported to be 6.60 to 53.30 mgg^{-1} with an average of 33.80mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. Epigallocatechin content was determined to be 27.70, 30.80, 10.0 and 5.71 mgg^{1} in Japanese Meifoo green tea, Shanghai green tea, Fujian pu-erh tea and Fujian black tea respectively[44]. These findings are in full concurrence with the EGC status of present experiment. The results of the epigallocatechin content of the marketed brand teas of Bangladesh corroborate with the findings of Wu *et. al.*[13] who reported that EGC content (brewed up to 5 min.) determined by HPLC-MS was found to be 15.20, 6.90, 6.20, 0.7 and 0.8 mgg^{-1} in Chinese green tea, Jasmine green tea, Tie Guan Yin oolong tea, Krasno-rozovy black tea and Telley orange pekoe black tea respectively. Finally it can be assumed that EGC content in the marketed teas of Bangladesh is much higher than the other countries and thus, Cosmo tea was ranked as the best commercial tea of Bangladesh in relation to EGC content.

Epigallocatechingallate (EGCG):

The results of the epigallocatechingallate content of the marketed brand teas of Bangladesh corroborate with the findings of Wu *et al.*[13] who reported that EGCC content (brewed up to 10 min.) determined by HPLC-MS was found to be 52.20, 31.50, 27.80, and 18.80 mgg^{-1} in Chinese green tea, Jasmine green tea, Tie Guan Yin oolong tea and Chinese black tea respectively. EGCGwas detected to be 35.46, 29.83, 16.85, 11.82, 18.10, 8.99, 5.52 and 0.30 mgg^{-1} in Longjin green tea, Jasmine green tea, Chrysenthimum green tea, Iron Buddha green tea, Japanese green tea, oolong tea Ceylon black tea and pu-erh tea respectively Ceyl purchased from the supermarkets of Singapore[42,43]. In Chinese Fujian black tea, EGCG content was estimated to be 7.60 mgg^{1} [44].Chen *et al.*[47] reported that EGCG contents were estimated to be 68.74, 31.80 and 2.0 mgg^{-1} in 11 samples of green, oolong and black tea purchased in Hong Kong. These findings are also in a good agreement with the present study.

The results of the EGCG content of the marketed brand teas of Bangladesh corroborate with the findings of Saito *et al.*[37] who reported 56.0-75.0, 49.0-101.00, 58.0-84.0 and 4.0-9.0 mgg^{-1} catechin in Japanese green tea, Chinese green tea, Brazilian green tea and Indian black tea respectively. The results of epigallocatechingallate substantiate with the findings of Cabrera *et al.*[45] who reported that EGC content was found to be 73.30, 27.90, 12.30, 17.80, 30.10, and 85.10 mgg^{-1} in Sencha tea (Japan), Assam tea (India), Keemun tea (China), Ceylan tea (Srilanka), English breakfast tea (Srilanka) and Darjeeling tea (India) respectively. EGCG was determined to be 33.80, 35.79, 35.58, 30.81, 1.43 and 0.08 mgg^{-1} in green tea, white tea, yellow tea, oolong tea, black tea and pu-erh tea respectively[48]. Epigallocatechingallate status of Wissotzkyearly 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 3.80, 10.90, 74.50 and 8.90 mgg^{-1} respectively[40]. These findings are in full agreement with the result of present study.Epigallocatechingallate content was reported to be 9.0 to 52.70 mgg^{-1} with an average of 28.50mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. EGCG content was determined to be 52.70, 51.10, 22.20 and 3.79 mgg^{1} in Japanese Meifoo green tea, Shanghai

green tea, Fujian pu-erh tea and Fujian black tea respectively[44]. These findings are in full consensus with the EGCG status of present experiment. Therefore, it is apparent that EGCG content in the marketed teas of Bangladesh is better comparable with the other countries and Cosmo tea was regarded as the best commercialized tea of Bangladesh in concerning EGCG content.

Gallocatechin(GC):

Gallocatechin status of Wissotzkyearly 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 3.10, 4.30, 4.30 and 3.0 mgg^{-1} respectively[40]. This finding is in full agreement with the result of present study. The result of GC corroborates with the findings of Karori*et al.*[49] who reported that GC was determined to be 2.27, 14.60 and 9.99 mgg^{-1} in Gyokuro (Japanese green tea), Sencha (Japanese green tea) and Chinese oolong tea respectively. Another report for gallocatechin shows 0.90 mgg^{-1} GCin black tea[50] which is also consistent with the result of the present study. Gallocatechin content was reported to be 2.40 to 18.0 mgg^{-1} with an average of 11.60 mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. This result also substantiate with the findings of present experiment. So, it is visible that GC content in the marketed teas of Bangladesh is similar to the other countries and all the marketed brands maintained the qualitative standard as regards gallocatechin content. As usual Cosmo tea was observed as superior among the studied marketed teas of Bangladesh in concerning GC content.

Gallocatechingallate(GCG):

The results of the GCG content of the marketed brand teas of Bangladesh corroborate with the findings of Lin *et al.*[46] who reported that GCG was detected to be 2.60, 3.80, 0.90 and 0.10 mgg^{-1} in 15 Chinese green tea, 13 Japanese green tea, 9 Chinese and Taiwanese oolong tea and 7 Chinese pu-erh tea respectively. The results of GCG substantiate with the findings of Karori*et. al.*[49] who reported that GCG was determined to be 4.47, 3.75, 2.97 and 2.71 mgg^{-1} in Gyokuro (Japanese green tea), Sencha (Japanese green tea), Chinese oolong tea and Kenyan black tea respectively.

Gallocatechingallate status of Wissotzkyearly 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 2.30, 2.0, 8.70 and 4.20 mgg^{-1} respectively[40]. GCG content of black tea, oolong tea and green tea purchased from the supermarket of Penang, Malaysia was detected to be 9.13, 33.36 and 79.46 mgg^{-1} respectively[38]. These findings are also in full agreement with the result of present study. Gallocatechingallate content was reported to be 3.10 to 8.20 mgg^{-1} with an average of 5.30mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. This result also substantiate with the findings of present experiment. Hence, it could be understood that all the marketed brands of Bangladesh tea resembled to the GCG standard of other countries and unsurprisingly Cosmo tea was revealed as the best one in relation to GCG status.

Non-gallated catechins (NGCs):

NGCs was found to be 47.12, 52.15, 55.02 and 57.11 mgg^{-1} in 1st, 2nd, 3rd and 4th plucking period respectively in Korean grown green tea[51]. This report is in good consistent with the findings of the present study. NGCs content was reported to be 19.20 to 132.0 mgg^{-1} with an average of 63.70mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. This result also substantiate with the findings of present experiment.Therefore, it could be said that the non-gallated catechins content of the marketed brand teas of Bangladesh was found to be up to the mark compared to the national and international standard. Furthermore, Cosmo tea was positioned on the top as anticipated in consideration of NGCs.

Gallated catechins (GCs):

The results of the total gallated catechins content of the marketed brand teas of Bangladesh corroborate with the findings of Yao *et al.*[52] who reported that the gross mean of total gallated catechins (GCs) in fresh green tea leaves of Australian grown tea was determined to be 154.76 mgg^{-1}. Total Gallocatechins content was reported to be 12.60 to 72.60 mgg^{-1} with an average of 39.60 mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. This result bears a resemblance to the findings of present experiment. NGCs was found to be 153.28, 148.85, 157.18 and 158.07 mgg^{-1} in 1st, 2nd, 3rd and 4th plucking period respectively in Korean grown green tea[51]. This report is also in good agreement with the findings of the present study. In fine, it is evident from the results that the status of total gallated catechins in the marketed teas of Bangladesh is analogous to that of other countries. Accordingly, Cosmo tea was ranked as the best in respect to total gallated catechins.

Total catechins (TCs):

The results of the epigallocatechingallate content of the marketed brand teas of Bangladesh corroborate with the findings of Wu *et al.*[13] who reported that TCs content (brewed up to 10 min.) determined by HPLC-MS was found to be 100.90, 68.50, 49.10, 42.10, 12.10 and 9.50mgg^{-1} in Chinese green tea, Jasmine green tea, Tie

Guan Yin oolong tea, Chinese black tea, Krasno-rozovy black tea and Tetley orange pekoe black tea respectively. TCswas detected to be 78.77, 72.01, 56.64, 50.05, 66.03, 47.76, 16.59 and 1.46 mgg^{-1} in Longjingreen tea, Jasmine green tea, Chrysenthimum green tea, Iron Buddha green tea, Japanese green tea, oolong tea Ceylon black tea and pu-erh tea respectively Ceyl purchased from the supermarkets of Singapore[42,43].

TCs was determined to be 66.38, 70.73, 72.29, 87.82, 7.79 and 4.28 mgg^{-1} in green tea, white tea, yellow tea, oolong tea, black tea and pu-erh tea respectively[48]. Zhao *et. al*.[53] reported that total catechin status of 5 white teas, 5 green teas and 5 green pu-erh teas were detected to be 213.74, 131.03 and 200.94 mgg^{-1} in China. Total catechin status of Wissotzkyearly 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 20.40, 40.40, 148.70 and 34.80mgg^{-1} respectively[40]. These findings are in full agreement with the result of present study. The results of the TCs content of the marketed brand teas of Bangladesh corroborate with the findings of Lin *et al.*[46] who reported that TCs was detected to be 130-220, 90-240, 65.10, 5.20 and 4.90mgg^{-1} in 15 Chinese green tea, 13 Japanese green tea, 9 Chinese and Taiwanese oolong tea, 1 Chinese black tea (85% fermented) and 7 Chinese pu-erh tea respectively.

Thirty types of commercial Vietnamese-brand teas (21 green teas, 5 black teas, 4 oolong teas) in Ho Chi Minh city were investigated for total catechins content and the amount of TCs was determined to be 14.50 - 98.60 mgg^{-1}, 15.20 - 19.40mgg^{-1}, 49.40 – 63.90mgg^{-1} respectively[54]. Chen *et al*.[47] reported that total catechins content were estimated to be 111.20, 45.60 and 3.80mgg^{-1} in 11 samples of green, oolong and black tea purchased in Hong Kong. These results are in good consistence with the TCs status of the marketed brands of Bangladesh.Total catechins content was reported to be 50.10 to 133.10 mgg^{-1} with an average of 100.40 mgg^{-1} in 28 samples of oolong tea manufactured in Thailand[39]. TCs content was determined to be 112.50, 100.45, 40.89 and 15.31mgg^{1} in Japanese Meifoo green tea, Shanghai green tea, Fujian oolong tea and Fujian black tea respectively[44]. These findings are in full consensus with the TCs status of present experiment.Therefore, it is apparent that Total catechins content in the marketed teas of Bangladesh is better comparable with the other countries and all the studied brands might have maintained the qualitative standard so far the total catechins content is concerned. Consequently, Cosmo tea was found to be regarded as the best commercialized tea of Bangladesh in pertaining to TCs content.

Comparison of price with total catechins:

It is obvious from the result that market price of the studied seventeen marketed brand teas of Bangladesh was almost dependent on the total amount of catechin content. The sequence of catechin contents in all the studied brands of teafollowedthe sequence of price. This result corroborates with the findings of Alam*et al.*[55] and Alam*et al.*[56]. The market price of all the studied brands of tea was found to be changed positively with the qualitative status. The results also indicate that the higher the catechin contents in the teas of brand was as the higher the price.

V. Conclusion

Catechins were found to be varied significantly ($P<0.05$) with the seventeen marketed brands of black tea of Bangladesh. Among the studied brands of tea Cosmo tea was revealed to be the best in respect to each type of catechin. The price of all the studied brands of black tea was observed to be changed positively with the sequence of catechin contents.

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