

## Studies on the Chemical Constituents of Different Varieties of Black Tea

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(Received 14th October, 1995, revised 26th November, 1996)

**Summary:** This study reports chemical constituents of 28 varieties of tea imported from 15 different countries. Water extract, total ash and fiber ranged between 35.3 - 47.4, 4.7 - 6.39 and 7.11 - 17.23 percent (w/w) respectively. These values correspond to the standards established by the International Standards Organization (ISO). Caffeine in all the varieties was at the lower side of the required value ranging from 1.08 - 2.38/100 g. Tannins varied between 5.9-11.9% (w/w). Tea merchants in Pakistan should import tea containing appreciably high amounts of Caffeine so that after blending, tea brands of good Caffeine contents may be produced.

### Introduction

Tea is one of the most widely consumed beverage, not only in Pakistan but all over the world. Its popularity is attributed to the pleasant flavour combined with the stimulating effects. There are many types of tea, including green tea, black tea and oolong tea [1]. In 1984-95 annual world production of tea has been reported 1.3 million tonnes [2]. Pakistan is not a tea growing country but its demand is increasing day by day. To meet the demand, it has to be imported from tea growing countries, such as Kenya, Tanzania, Indonesia, Srilanka, China, Malawi etc. In Pakistan, the import of "tea and mate" amounted to Rs. 3.7 billion in 1990-91 [3].

The varieties of tea imported are numerous, but it seldom reaches the consumer unmixed. In the local market, wholesale tea merchants prepare tea blends by mixing different varieties of tea and sold under different brand names. Tea has little food value, except for that given by added foodstuff.

Tea is prized for its quality which depends on its fragrant aroma, delicate flavour and taste due to polyphenols, volatile oils, and its stimulating physiological effect, which depends on the Caffeine content. Tsunoda *et al* [4] reported a compound in tea extract which is lacking in caffeine. This compound is found to stimulate the growth of Bifidobacterium (e.g. *B. adolescentis*) and inhibit the hazardous intestinal bacteria (e.g. *clostridium perfringens*). The adulteration of tea with foreign substances such as roasted and ground cereals, beans etc. are not uncommon in Pakistan.

The present study was undertaken to determine the chemical constituents of tea varieties in order to ensure quality and to assist Pakistan Standards Institution in revising the standards for the home market.

### Results and Discussion

Chemical constituents of tea samples are presented in Table-1 and the recommended standards in Table-2. Water extract in different varieties ranged from 35.3 to 47.4 g/100g. Srilankan and New Guinain tea contained the highest and the lowest amount respectively. Indian specifications (Table-2) allow a minimum of 38.0% of water extract. Four varieties of tea namely from Argentina, Mauritius, Bangladesh and from Papua New Guini have water extract less than this standard. While much higher average values of China, Ceylon and Indian tea, 43.1, 44.1 and 46.4% respectively have been reported by Throps and Whitely [5]. According to the Canadian regulations, unblended black tea packaged in the country of origin, may have water soluble solids content as low as 25% [6]. International Standards Organisation (ISO) recommends a minimum of 32% extractable solids for tea in international trade (Table-2).

Tea is unique in that only its hot water extract is valuable to the consumer and the spent leaves are waste product. Water extract is a measure of the soluble matter in tea, and of much importance compared to other constituents in a cup of tea and is clearly related firstly to the amount

Table-1: Chemical Constituents of Black Teas of Different Origins

S.No.	Origin	Garden/Grade	Water extract %	Total ash %	Ratio of soluble ash to total ash %	Alkalinity of soluble ash as K <sub>2</sub> O %	Acid insoluble ash %	Crude fibre %	Caffeine %	Tannin %
1	2	3	4	5	6	7	8	9	10	11
01	Argentina	Cas Fuentes - BTD	37.0	5.38	28.95	1.24	0.056	17.33	1.51	6.3
02	Argentina	Flor De oro - BOP	36.0	5.18	27.30	1.56	0.069	12.12	1.41	10.0
03	Zaire	Ngex - PFI	41.3	6.05	42.72	1.70	0.092	9.00	1.90	11.7
04	Zaire	Chivage - PF	37.9	5.23	49.84	3.22	0.079	10.20	1.25	7.7
05	Malawi	Nchima - PF	40.0	5.63	45.92	1.80	0.311	14.30	1.86	5.9
06	Malawi	Limbuli - FI	44.4	5.34	40.22	2.16	0.118	10.92	1.66	9.9
07	Malawi	Esperenza - PFI	42.6	5.47	33.14	2.82	0.218	8.71	2.05	7.7
08	Tanzania	Esperenza PFI	40.7	4.90	45.92	2.54	0.1908	9.96	1.73	8.9
09	China	Fasanings PFI	44.9	5.26	51.58	2.52	0.459	9.72	1.91	10.8
10	Rwanda	Fasanings FI	39.6	5.82	59.98	2.79	0.091	11.45	1.86	6.3
11	Indonesia	Fasanings STD	38.9	5.66	44.72	4.33	1.0	9.25	1.94	11.9
12	Indonesia	101 Dust								
12	Indonesia	Fasanings BT2	40.2	5.49	59.22	2.85	0.075	10.01	1.46	11.3
13	Indonesia	Fasanings BP2	41.2	5.46	54.45	2.106	0.120	12.13	1.97	8.7
14	Indonesia	Grade PF	40.7	5.02	60.99	3.48	0.145	10.13	2.30	8.9
15	Indonesia	Grade BP	42.0	5.55	46.95	2.63	0.240	9.53	1.89	10.49
16	Srilanka	Grade PB2	47.4	6.15	33.28	2.48	0.303	13.43	1.11	9.7
17	Tanzania	Grade D <sup>2</sup>	45.6	5.83	65.32	2.38	0.245	11.90	1.63	9.0
18	Rwanda	Grade F <sup>1</sup>	44.4	4.76	52.42	3.66	0.155	11.20	1.62	9.2
19	Bangladesh	Grade FOF	37.2	5.91	60.97	3.96	0.403	11.48	1.81	7.6
20	Bangladesh	Khusboo								
20	Bangladesh	Grade PF STD <sup>2</sup>	40.4	5.88	59.65	2.23	0.146	12.54	1.52	6.7
21	Papua Newguini	Grade D <sup>2</sup>	35.3	6.15	51.60	1.97	0.247	11.49	1.08	7.8
22	Mauritius	BP <sup>1</sup>	37.3	5.30	61.21	4.61	0.126	10.76	1.50	6.0
23	Brundi	PF <sup>1</sup>	41.9	6.19	59.61	1.71	0.06	9.91	2.05	7.3
24	Ceylon	BOP	43.4	5.33	62.04	4.00	0.137	7.83	1.32	7.4
25	Ceylon	BOFF	42.6	5.88	66.42	2.55	0.039	9.57	1.30	11.2
26	Kenya	PF <sup>1</sup>	41.9	6.39	63.24	2.99	0.057	7.11	1.65	11.6
27	Kenya	Dust	41.1	6.17	63.01	3.14	0.1403	8.94	1.59	11.2
28	Ceylon	Dust	44.8	5.73	63.60	1.24	0.302	10.36	1.83	10.3
		Range	35.3-47.4	4.76-6.39	27.3-66.42	1.24-4.67	0.039-0.403	7.11-17.33	1.08-2.3	5.9-11.9

(All varieties were analysed in duplicate and mean values were reported)

Table-2: Recommended Standards for Black Tea

Chemical Constituents	Indian Standard*	International Standards organization Standard**
Total ash	4.8 - 7.0	4 - 8%
Ratio of water soluble ash to total ash	Min. 50.0%	
HCl insoluble ash	Max. 0.6%	
Alkalinity of soluble ash	1.4 - 2.0	
Water soluble extract	Min. 38.0%	32% Min.
Crude fibre	Max. 12.0%	16.5 Max.
Caffeine	Min. 2.5%	
Tannin	6.0 - 12.0%	

\* Values adopted from Modern Food Analysis by F. Lenie hart, A.M. and Harry Johnstone Fisher, Page 97, U.S.A. (1971).

\*\* Values adopted from Encyclopedia of Food Science and Technology, by Y.H. Hui, A. Wiley - Interscience Publication, U.S.A. Vol. 4, page 2533 (1991)

present in the original leaf and secondly to the solubility of the constituents under the conditions pertaining during brewing. Total ash content

varied from 4.76 to 6.39% (w/w) with the maximum of PFI Kenyan and the minimum in F<sub>1</sub> Rwandan. Ash content, in all the samples were found within the recommended ranges of 4.8-7.0% (w/w) by Indian standard (Table-2). Thrope and whitely [5] reported a higher range varying from 5.73-7.41 percent by weight. The range recommended by ISO is 4-8%. (Table-2).

The ash content can be regarded as a general measure of tea quality and often is a useful criterion in identifying the authenticity of food. According to Blyth and Blyth [7] percentage of ash in genuine tea seldom reaches 8%. Tea having ash beyond 8 percent, is probably adulterated.

Ratio of soluble ash to total ash varied considerably in different varieties of tea, ranging from 27.3 to 66.42% with minimum and maximum amount in Argentinian and ceylonian BOPF grade

respectively. It was noted that BTB grade of Argentinian tea also contained lower amount 28.95% of water soluble ash. Minimum water soluble ash recommendation for Indian tea is 50 percent by wt. (Table-2). Ten varieties of tea had lower content of water soluble ash percent by wt. from this recommended specification.

Alkalinity of soluble ash (as  $K_2O$ % ranged from 1.24 - 4.43%. The lowest in Argentina and in Ceylon tea samples, while the highest in Mauritius tea. Indian tea specification requires a range of 1.4 to 2.0% (Table-2). Alkalinity calculated as  $K_2O$  or  $K_2O_3$ , is often useful when considered in conjunction with total ash or confirming other results in relation to the original composition. A decreased quantity of alkali salts in the ash may indicate adulteration. Conversely an increase in the alkalinity character may indicate chemical treatment similar given to Cocoa. Acid insoluble ash ranged between 0.039% in one of the ceylonian BOPF grade and 0.404% for Bangladeshian FOF Khushoo grade. Values for all the varieties examined were within the recommended range for Indian tea (Table-2). Acid insoluble ash is a measure of sandy matter in tea. Sand may be used as one of the adulterants in order to increase its weight.

Crude fiber levels ranged between 7.11% for Kenyan FFD grade and 17.33% for Argentina-Casa Fuentes BTB grade. With the exception of Argentinian tea, all other sample examined were within the standard of 16.5%. Maximum laid by the International Organisation (Table-2). Four varieties namely from Argentina, Malawi, Sri Lanka and Bangladesh were found to contain crude fiber higher than 12% maximum allowed by Indian specification. Fiber content is also one of the important constituent in determining the adulteration.

Caffeine is the most important constituent and active principle of tea for the sake of which tea is consumed. Caffeine values ranged between 1.08% in New Guini tea and 2.3% in Indonesian PFI grade. The caffeine was found in the lower specified range in the samples with an average of 1.65%. Wide variations in Caffeine levels among different varieties of tea have been reported. The variations have been related to the time of picking

and to the season. (An analysis of Caffeine in 23 samples of tea [7] have been reported, having mean value of 1.9% with a minimum of 1.36% and maximum of 3.0%). Another analysis of 16 samples [8] showed a mean value of 1.35%. Winton and Winton [8] reported Caffeine content in the range of 1.0 to 2.85%. According to Collier's Encyclopedia [2] the tea leaves contain 1 to 3 percent caffeine, while Geoffrey and David [9] reported Caffeine level of 1-5 percent in black tea. It has been reported [10] that the caffeine content of a cup (150 ml) of normal infusion varied from 50-80 mg. Its pharmacopoeial dose is 60 to 300 mg. so many cups (approx. 150 ml cup) have to be consumed before this maximum is exceeded. Caffeine and its metabolites do not accumulate in the body but are demethylated, oxidised and excreted mainly as methyluric acid [9]. Tea has a diuretic effect on kidneys, and stimulates gastric secretion. It has a well known effect on the central nervous system, stimulating mental alacrity, relieving mental fatigue [11]. Caffeine in combination with an analgesic such as aspirin, is widely employed in the treatment of ordinary headache [12].

Caffeine adds zest to tea and tannin the pungency and colour [13]. Tea tannins are the polyphenolic substances, including, "catechins and catchin-tannis" [5] Poly phenols are important to the flavour, colour and mouth feel of tea.

Tannins, levels ranged between 5.9-11.9% in Malawi-Nchima PF grade and Indonesia STD Dust grade respectively. These levels compare well with the Indian recommended allowance Data indicates that tea from Kenya, Ceylon, Indonesia, China and Zaire have higher tannin content compared to other varieties.

Geoffrey V. Stagg and *et al* [9] reported that soluble polyphenols constitute about 13 percent w/w of black tea. The composition varies according to the variety of tea, its geographical origin, environmental conditions and a agronomic situation. Much of this fraction is derived by oxidation of flavonols flavandiol and theogallin during conversion of fresh leaf to black tea. Hollingsworth *et al* [10] reported the analysis of many varieties of black tea. They found the tannin content of a cup (150 ml) of infusion to vary from 60-280 mg.

The overall quality of the tea samples from different countries are comparable to the standards laid down by International Standards Organisation (ISO) as guideline for international trade, but caffeine, which is the most important constituent for which tea is consumed is present in relatively lower side of the recommended of range (1.08 to 2.3 g/100 g), against an acceptable range of 1-5 percent [9].

### Experimental

A total of 28 samples of different varieties and grades of imported black tea were procured through the courtesy of Pakistan Standard Institution. Representative samples were ground to pass No. 30 sieve packed in polythene bags and stored at  $27 \pm 2^\circ\text{C}$  for analysis. A large variation in the appearance of the leaves not only in colour but also in their size and shape was noted. Caffeine, tannin, ash (alkalinity and acidity of soluble ash and acid insoluble ash), crude fiber and water extract were estimated according to the AOAC [14].

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