*Original Research Article*

# Estimation of Caffeine, Niacin and Calorie Content in Tea Commonly Consumed by Dhaka City Residents

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**ABSTRACT**

Tea is largest consuming drink in the world. Many health claims is attributed towards the tea due to its distinguished phytochemical array. Role of tea is well established as a neutraceutical and many studies elucidate its pharmacological worth. The objective of this study was to calculate the calorie content by determining total lipid, crude fiber, total protein and available carbohydrate contents and estimation of caffeine and niacin content in Bangladeshi teas. The lipid, crude fiber, protein and available carbohydrate contents of the tea samples were found to be in the range of 3.25-5.53, 10.15-15.41, 12.97-17.08 and 4.78-6.21 g/100g fresh weight respectively while calorie contents were found in the range of 83.54-101.46 Kcal/100g fresh weight of tea. The total caffeine and niacin content in teas ranged from 1.31 - 3.58 and 0.038 – 0.056 g/100g fresh weight respectively. Tea leaf contained the highest amount of caffeine (3.58 g/100g) and niacin (0.056 g/100g). As tea has different health effects it is essential to estimate the update nutrient contents of tea.

## Introduction

Tea is considered to be one of the most popular beverages. About three billion kilograms of tea are produced and consumed yearly [1]. It is estimated that the mean consumption of tea per inhabitant worldwide amounts to 120 mL/ day while for the Great Britain, which since centuries is famous of afternoon tea and high consumption of tea, it is 540 ml per day on average [2]. In Poland, 76-90% of population drinks tea with the majority consuming 2-3 cups in a day [3]. In folk medicine of Asian countries, tea was considered to be a medicine effective for many ailments. Furthermore, drinking tea was treated as a ceremony and philosophy of life [4, 5]. In Bangladesh, tea has become one of the most dynamic agro-export industrial products and plays a vital role in its economy [6]. Consumption of tea by Dhaka city people of Bangladesh is also increasing day by day.

Tea, derived from leaves of the plant *Camellia sinensis* can be categorized into three main types depending on the level of

oxidation: green (unfermented), oolong (partially fermented) and black (fermented) tea [7]. The chemical composition of green tea varies with genetic strain, climatic conditions, soil properties, plucking season, position of the leaf, processing and storage [8, 9]. It is widely believed that teas contain substances that are beneficial to health. Although most of the alleged benefits of tea are not supported by solid scientific evidence, teas contain a variety of biologically active compounds that might influence metabolic reactions. A putative beneficial effect of tea is its ability to induce weight loss. Support for this contention includes a controlled human trial that showed weight loss when tea was added to a dietary regimen [10] and a mouse study that showed that administration of a tea extract with a high-fat diet eliminated the weight gain observed in the absence of tea [11]. Modest increases in energy expenditure have been reported with the ingestion of oolong and green teas [12, 13]. Green tea consumption has been linked to lowering of various forms of cancers [14, 15]. Green tea constituents also have been shown to have cardioprotective, neuroprotective, antidiabetic, and

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antimicrobial properties [16, 17]. On the other hand, tea could inhibit the absorption of carbohydrate or fat. In vitro experiments have shown that constituents of tea inhibit the activities of α-amylase [18, 19] and α-glucosidase [20, 21] and of intestinal sodium dependent glucose transporters [22, 23]. The in vitro inhibition of pancreatic lipase [24, 25] by tea extracts suggests that tea might interfere with triacylglycerol absorption.

Tea, accompanied by coffee and cocoa seed, is the main vegetable source of caffeine. Caffeine is a methylxanthine of group of alkaloids, belonging to psychoactive substances. Its action consists in stimulating the central nervous system and cardiac action, which may positively affect the psychophysical capacity of a human [3]. Tea also contain considerable amount of niacin. Niacin namely vitamin B3 has various regulatory effects in body. It has cholesterol lowering capacity that connected to cardiovascular disease [26]. As having tea is our common habit it is necessary to estimate the caffeine and niacin in tea varieties.

Though tea and its impact on health attract the attention of public it is essential to determine the nutrient content of commonly consumed teas. Nutrients content in tea have been studied previously by several scientists in several countries [27, 28]. In Bangladesh, Islam et al. and Rahman et al. have studied on tea, but there is very little information available on caffeine and niacin content in tea [29, 30]. The objective of the present study was to determine the amount of caffeine, niacin, and calorie content in tea commonly consumed by Dhaka city resident.

## Materials and Methods

### Collection of Samples

The commonly consumed green tea, black tea and tea leaves were selected in this study. The experimental tea samples (green tea and black tea) were collected from different markets of Dhaka city of Bangladesh. Tea leaves were collected from three large tea gardens. For each type of tea, five samples from five different markets were collected and mixed to one homogenized tea sample. Then a portion of homogenized sample was oven dried to determine moisture and ash content where needed. The collected leaves were washed with deionized water to remove soil and waste materials. Then they were dried under sunlight for several days. After drying plant leaves were separated and cut into small portions by a scissor. All samples were mixed to make a homogenized sample and preserved carefully. Each and every sample was measured accurately before starting work. The samples were air dried, oven dried, fat/moisture free carefully when those needed. Plant extract (lipid, protein etc.) solutions were made with water.

### Estimation of Total Lipids

Total lipids were extracted according to the method described by AACC [31]. Anhydrous chloroform-methanol mixture in the ratio of (2:1) was used to extract the fat from the dry samples. The moisture free sample was taken in a conical flask and chloroform-methanol (2:1) solution was added. The sample was allowed to stand for overnight and filtered. Filter paper was washed repeatedly with chloroform-methanol solution. The filtrate was taken in a separating funnel and to it 0.58% NaCl solution was added. The separating funnel was vigorously shaken for proper mixing and allowed to stand for 4-6 hours. The lower phase was then collected and washed with sodium chloride solution repeatedly till the lower phase was clear. Finally the lower phase was collected in a dry weighed glass ampule and allowed to air dry and then dried in an oven at 105 $^0$C for 2-3 hours. Then total lipids were determined gravimetrically.

### Estimation of Crude Fibers

The crude fiber was estimated by gravimetric method developed by Mongeau and Brassard [32]. The sample was sequentially extracted with 1.25% sulphuric acid and 1.25% NaOH. The sample was first boiling with 1.25% sulphuric acid and filtered through muslin cloth. The residue was washed with distilled water and was boiling again with 1.25% NaOH. Then the solution was filtered through muslin cloth and the residue was washed with distilled water and alcohol. This residue was then dried in oven (105 °C) and muffle furnace (600 °C). The percentage of crude fiber was determined by the difference in weight from oven and furnace.

### Estimation of Total Proteins

Methods used for crude protein estimation follows the principle that nitrogen content when multiplied by the factor 6.25 provide the value for crude protein. The estimation of nitrogen was made by modified kjeldahl method [33], which depends on the fact that organic nitrogen when digested with conc. $H_2SO_4$ in the presence of catalyst ($K_2SO_4$: $CuSO_4.5H_2O$ = 98:2) was converted into ammonium sulphate. $NH_3$ liberated by making the solution alkaline was distilled into a known volume of standard acid ($H_2SO_4$) which was then back titrated with alkali (NaOH).

### Estimation of Available Carbohydrate

Percentage of available carbohydrates was calculated by subtracting the sum percentage of moisture, crude protein, total lipids, crude fiber, and ash from 100 [34]. All the calculations were carried out on fresh weight basis of the samples.

### Estimation of Calorie Content

The calorie content of the sample was calculated by multiplying the amount of available carbohydrate, crude protein, total lipid and crude fiber in gram by the energy conversion factors; 4,4,8 and 2 respectively and addition of them [34].

### Estimation of Caffeine

Caffeine was extracted from tea samples by the solvent extraction according to AACC method [31]. Dichloromethane and sodium hydroxide (6M) were used in order to determine the caffeine content of the samples.

### Estimation of Niacin

Niacin was determined by colorimetric method [35]. Niacin reacts with cyanogen bromide to give a pyridinium compound which undergoes rearrangement yielding derivatives. These derivatives couple with aromatic amines to give yellow colored pigment. Under proper conditions, the intensity of the yellow color produced is proportional to the amount of niacin present and the color is measured at 420 nm.

### Statistical Analysis

Data were expressed as the means ± standard error of the mean (SEM) of the experiments carried out in triplicate. The mean ± SEM were determined by SPSS (Statistical Package of Social Science, version 17) software.

### Results and Discussion

Plants are bestowed with varying beneficial properties in order to combat certain disordered. The health promoting properties are attributed to the presence of specific phytochemistry. Tea holds rich pytochemistry and its potential needs to be further explored. Nutrients, calorie content, caffeine and niacin contents in three different types of tea were shown in Table 1 to 3.

### Total Lipid

Green tea (3.27 g/100g fresh weight) contained the lowest amount lipids while tea leaf (5.54 g/100g fresh weight) contained the highest amount (Table 1). These results were near the findings of Islam et al. who reported 6% to 9% fat in teas in Bangladesh and similar with Imran et al. who estimated 4 to 7% fat in teas in Pakistan [28, 29]. Extended research was conducted in the similar field [36, 37]. According to Hara et al. the fat content of green leaf varies from 7 - 10% of its dry weight. While according to Millin and Rustidge the fat present in the protoplasm up to 3-7% of its dry weight that coincides with the present study.

### Crude Fiber

Tea leaf (15.41 g/100g fresh weight) was the strongest and black tea (10.15 g/100g fresh weight) was the least sources of crude fiber among the teas. These results were similar with the findings (11.23% to17.21%) of Adnan et al. while higher than the findings of Imran et al. in Pakistan who found 2% to 4% in different teas [28, 38]. A study of Shaheen et al. found 8.5 g/100g of fiber in tea in Bangladesh [39]. According to Bhuyan et al. the fiber content was 8.57 to 13.66 g/100g of tea in India [27].

### Table 1: The mean (g/100g fresh weight) concentrations of nutrient contents in tea samples

| Sample | lipid | fiber | Protein | carbohydrate |
|---|---|---|---|---|
| Green Tea (n=3) | 3.27 ± 0.11 | 12.05 ± 0.20 | 12.97 ± 0.10 | 5.51 ± 0.34 |
| Black Tea (n=3) | 4.24 ± 0.15 | 10.15 ± 0.31 | 17.08 ± 0.12 | 6.21 ± 0.41 |
| Tea Leaf (n=3) | 5.54 ± 0.16 | 15.41 ± 0.4 | 14.85 ± 0.11 | 4.78 ± 0.23 |

Results are expressed as mean ± SEM.

### Total Protein

The protein content ranged from 14.85 to 18.08 g/100g fresh weight (Table 1). Investigation of Rahman et al. showed 13% to17% of protein in teas in Bangladesh [30]. Shaheen et al. found 20.2 g/100g of protein in tea in Bangladesh [39]. On the other hand, Imran et al. reported 2% to 3% protein in teas [28]. The proteins content was 15% in various teas and decreased in long withers [40]. The black tea (17.08 g/100g fresh weight) contained the highest level of protein.

### Available Carbohydrate

Black tea (6.21 g/100g fresh weight) contained the highest and tea leaf (4.78 g/100g fresh weight) contained the lowest level of carbohydrate (Table 1).

### Calorie Content

The calorie content of green tea, black tea and tea leaf were 83.54 Kcal, 91.36 Kcal and 101.46 Kcal respectively (Table 2).

### Table 2: The total calorie content in different tea samples

| | Green Tea (n=3) | Black Tea (n=3) | Tea Leaf (n=3) |
|---|---|---|---|
| Calorie content (Kcal/100 g) | 83.54 ± 1.50 | 91.36 ± 1.71 | 101.46 ± 2.72 |

Results are expressed as mean ± SEM.

### Caffeine and Niacin

The amount of caffeine in different tea samples tested was in the range of 1.31 g/100g to 3.58 mg/100g of fresh weight (Table 3). The result is similar to the findings of Amra et al. who found both black and green tea contained caffeine at 1 to 5 % on dry weight basis [41]. Bhuyan et al. reported 2.57 to 4.64 g /100g of caffeine in teas in India [27]. Tea leaf (3.58 g/100g) was the highest contributor of caffeine.

Tea leaf (0.056 g/100g fresh weight) was the highest contributor of niacin while black tea (0.038 g/100g fresh weight) contained lowest amount.

### Table 3: The mean concentrations of caffeine and niacin in tea samples

| | Green Tea (n=3) | Black Tea (n=3) | Tea Leaf (n=3) |
|---|---|---|---|

| Caffeine (g/100g) | 1.31 ± 0.11 | 2.40 ± 0.12 | 3.58 ± 0.21 |
|---|---|---|---|
| Niacin (g/100g) | 0.046 ± 0.01 | 0.038 ± 0.01 | 0.056 ± 0.02 |

Results are expressed as mean ± SEM.

## Conclusion

Tea is one of the most popular beverages and plays a vital role as a pharmaceutical and neutraceutical agent. There are different brands of black and green tea which are commercially available in the market, having variation in their composition and quality. Difference between the key chemical parameters might be due to the processing technology, fermentation and storage period. The results of recent investigation indicate that tea is a hidden tool for enhancing the human freshness and resistance against various ailments. Maximum amounts of caffeine and niacin were observed in tea leaf in comparison to green and black tea. The study provides a better knowledge regarding the quality of tea beverage available in Bangladesh. Similarly, it provides a solid foundation for consumer's preference study regarding beverages in Bangladesh and formulating quality standards for safety point of view. Furthermore, there is a dire need for exploration of its potential that reputized its role as a functional drink that can be applied as a nutraceutical intervention.

## Conflict of interest statement
We declare that we have no conflict of interest.

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