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Gross Alpha and Beta Activity Concentrations and Annual Effective Doses due to Intake of Bangladeshi market Tea

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Abstract: Bangladesh is an important tea-producing country. It is the 10th largest tea producer in the world. A wide-ranging study was planned and carried out to analysed gross alpha and beta activity concentrations and evaluate the annual effective dose equivalent. Total nineteen Black and green tea samples of different brand were collected from local market of Dhaka city in and analysed by ZnS (Ag) scintillation detector counting namely Low Background Gross Alpha/Beta Counting System. The Measured activity concentrations ranging from 2.11±0.035 $mBql^{-1}$ to 6.90±0.048 $mBql^{-1}$ for the gross α and 47.96±0.35 $mBql^{-1}$ to 124±0.99 $mBql^{-1}$ for gross β were observed in branded tea samples, respectively. The gross α and total β activity concentrations for all tea samples are lower than WHO's recommended level and the Environment Conservation Rules, 1997 of Bangladesh. The obtained result showed that the annual effective dose equivalent from alpha and beta emitters did not exceed WHO recommended reference level for alpha and beta annual dose in food and drinking samples. The p^H values in infusion black tea and green tea samples ranged from 4.87±0.02 to 5.93±0.02 and 6.51±0.03 to 6.78±0.02. This research work could help to create a public awareness about the total or gross alpha and beta activities in tea samples and the radiological impact on the public health.

Keywords: Tea sample, ZnS (Ag) scintillation detector, gross alpha and beta activity concentrations, p^H and annual effective dose equivalent.

1 Introduction

Tea has been gaining further popularity as an important 'health drink' in view of its purported medicinal value since centuries which is originated from the evergreen leaves of a shrub camellia sinensis. It is prevalent among low-income groups as well. According to legend, tea has been known in China since about 2700 bce. At present more than sixty countries in the world grow tea with Asian countries producing 90% of the world's total output. In 2020, global consumption of tea amounted to about 6.3 billion kilograms and is estimated to reach to 7.4 billion kilograms by 2025. Tea is the second most consumed drink in the world, after water. Economic and social interest in tea is clear from the fact that about 18–20 billion tea cups are consumed daily in the world [1,2]. Tea represents one of the important agricultural products in Bangladesh. It is the second largest export oriented cash crop of Bangladesh. It is the 10th largest tea producer in the world. At present, there are 167 commercial Tea Production Estates and Tea Gardens on 2,79,507.88 acres of land in Bangladesh. The industry accounts for 3% of global tea production, and employs more than 4 million people [3].

Drying and roasting the leaves produces green tea, black tea is obtained after a fermentation process. The chemical composition of tea and tea leaves is the object of broad scientific studies from, e.g., a medical, toxicological or environmental point of view. Tea has become an integral part of our culture and everyday life due to taste, together with a refreshing and mildly stimulant effect. The frequency of consumption is mostly 2-3 cup of tea per day in Bangladesh [4]. Tea drinking is now being associated with cell-mediated immune responses of the human body and reported to improve the growth of beneficial microflora in the intestine. It is served as morning drink for nearly 2/3rd of the world population daily. Acute health effects of radiation, appearing with symptoms of nausea vomiting, diarrhoea, weakness, headache, anorexia leading to reduced blood cell counts and in very severe cases to death, occur at high doses of exposure of the whole body or large part of the body. For millennia it was a medicinal beverage obtained by boiling fresh leaves in water, but around the 3rd century CE it became a daily drink, and tea cultivation

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and processing began [5]. The radionuclides contributing significantly to the ingestion dose via consumption of water are emitting alpha radiation and emitting beta radiation. Waters contain a number of both alpha such as ^{238}U, ^{226}Ra and ^{210}Po and beta emitters such as ^{40}K, ^{228}Ra and ^{210}Pb. Among the radionuclides of terrestrial origin, ^{40}K and the constituents of the ^{238}U and ^{232}Th series enter the human body largely by food and water ingestion, being the total exposure per person 0.29 mSv, of which 0.17 mSv due to the ^{40}K and 0.12 mSv due to the radionuclides of the ^{238}U and ^{232}Th series [6]. The dose arising from the intake of 1 Bq (by ingestion) of radioisotope in particular chemical from can be estimated using a dose conversion factor. It is not always necessary to identify specific radionuclides when the concentrations are low [7]. In such cases, measurements of gross α and gross β activities may serve to demonstrate that the radio toxicity level is acceptable. Only a limited number of studies on internal dose assessment have been performed in Bangladesh. According to WHO's recommendation, if the gross alpha and gross beta activity do not exceed 0.5 BqL^{-1} and 1 BqL^{-1}, it can be assumed that the annual total indicative dose is less than 0.1 mSv per year [8].

The key objective for this current research is to establish a baseline data for gross alpha and beta activity concentrations in different branded tea samples from the local market tea of Dhaka city, Bangladesh which will be used as finger print for the comparison of radioactivity level and evaluate the annual effective dose equivalent for the radiological impact of public health in future. Efforts to determine activity concentrations of gross alpha and beta will help in the development of guidelines for the protection of the human beings.

2 Excremental Method

2.1 Collection and preparation of samples

In general, gross alpha and beta analysis, one of the simplest radio analytical procedures, is used as the first step as a screening method, for being a very fast, safe and low-cost method. In order to measure gross alpha and gross beta activity in tea sample, seventeen brands of black tea and two brands of green tea which commonly consumed in Bangladesh were collected randomly from different local markets of Dhaka city. The collected tea samples were transferred to the environmental radioactivity monitoring laboratory and coded appropriately from BT1 to BT 17 for black tea and GT 18 & GT19 for green tea. Measurements of gross α and β activity concentrations in different tea samples were carried out by Zinc Sulphide Scintillation Detector. Digestion method commonly used for preparation of tea was adopted for this study to assess the actual amount of gross α and β activity reach human body through drinking such beverages. Samples were weighed using analytical weighing balance. The required weight of the sample for analysis was 0.5g. Portions of 0.50 g of each branded tea sample were digested using 10 ml of a mixture (2:1 v/v) of concentrated HNO_3 and HCl in 50 ml capacity of Pyrex beaker. To avoid contamination, total thirty-eight 50ml & 200ml capacity of Pyrex beakers were washed with distilled water and 1N HNO_3, then left to dry. The mixture was heated on water bath until the solution turned into white colour and gives out white fumes. The digest sample was filtered and transferred into 200 ml beaker and added 100 ml distilled water into the mixture. Then the solution was slowly evaporated on water bath at 70°C to 80°C in order to reduce its volume [7]. During evaporation of water sample, the Pyrex beaker was covered with watch glass. The solution was brought to a known volume, and an aliquot was transferred to a 2-inch stainless steel counting planchet and dried under IR lamp. This method involved evaporating the sample until to a thin and uniform layer of solid residue in a stainless-steel planchet. The heating rate was controlled so that the sample did not spatter. The planchet was allowed to cool and preserved in desiccators to avoid moisture [6]. Then, the dry residue of tea samples was analysing alpha and beta particles emitted from the source using ZnS (Ag) scintillation detector counting namely Low Background Gross Alpha/Beta Counting System. The benefit of this method is its rapidity and relatively low-cost in comparison to performing radionuclide specific analysis.

2.2 Zinc Sulphide Scintillation Detector

The method used is the benchmark method for gross alpha and gross beta radioactivity determinations. ZnS Scintillation counter, ZnS (Ag) is a dual phosphor detector or dual scintillation detectors coupling two scintillating materials to a photomultiplier tube. This detector is designed with a zinc sulphide layer bonded to a plastic scintillator and the combination is optically coupled to a PMT. The outermost layer detects alpha particles, and the inner layer detects beta particles. The DP (phoswich) detector offers equivalent alpha efficiency, and slightly lower beta efficiency. Background performance is very much dependent on the environment (Manual MPC-2000-B-DP). Calculations must be performed on the raw data in order to produce a meaningful report. Each sample was counted five times and the mean used in computing the activity. The operational modes used for the counting were the α-only mode for the alpha counting and the β-only mode for the beta counting. These calculations convert the raw counts from counts per minute (CPM) into disintegration per minute (DPM) and finally into unit of activity per sample as BqL^{-1}. The counting time was 120 minutes for gross alpha and gross beta activities for each counting period [6]. A blank planchette was used for background count. Subtraction of the background count from the sample count gives the net count of the tea sample.

2.3 Calibrated Factors

In order to accumulate counts in terms of activity, several conversion factors constitute the instrument calibration.

Once determined, conversion factors must be revalidated on a routine basis to insure instrument stability. This is accomplished by collecting counts per day from a standard and comparing the results to those obtained during the calibration. If these results repeat within statistical expectations, the instrument is stable and the calibration conversion factors are valid [6]. To report results in terms of disintegrations per minute (DPM) or other units of activity, the appropriate Conversion factors must be entered. Before counting "real" samples efficiency factors will be determined by counting standards with known levels of activity. Backgrounds will be determined by counting blank samples [6]. In the present study, known activity standard source ^{239}Pu (alpha source) and ^{90}Sr (beta source) were used as calibration sources for MPC-2000-B-DP. The efficiency of the detector for gross alpha is 96.8% and for gross beta is 41%. The counting time was 120 minutes for gross alpha and gross beta activities for each counting period.

2.4 p^{H} Meter

A BOECO BT600 Laboratory Microprocessor p^{H}/ORP was used for measuring the pH values of tea samples which were collected from different markets of Dhaka city. The wetting cap must be pulled off for the calibrating and measuring operations. To ensure precise calibration, hot steam sterilized, certified buffer ampoules in accordance with DIN 19 266 are used. The refilling hole of the pH combination electrodes with liquid electrolyte must be open during the calibrating and measuring operations [6].

2.5 Data Analysis

Gross Alpha and Beta Activity calculation

The activity concentration of gross alpha/beta in prepared thin layer solid tea sample was calculated using the following equation:

$$dpm = \frac{net\ cpm \times 100}{60 \times efficiency \times V} \qquad (1)$$

Where, dpm = alpha/beta disintegration per minute, net cpm= Net alpha/beta count per minute, efficiency = alpha/beta efficiency in percent and V= volume.

Each count rate includes standard deviation and the standard deviation of the net count rate can be expressed as:

$$\sigma = \pm\sqrt{\frac{A_s}{T_s} + \frac{A_b}{T_b}} \qquad (2)$$

Where, σ = standard deviation, A_s = sample count rate in cps, A_b = background count rate in cps, T_s = sample count time and T_b = background count time. The standard deviation is also a measure of the dispersion of a collection of numbers. It can apply to a probability distribution, a random variable, a population or a data set. The standard deviation is usually denoted with the letter σ. The measurement errors represent one-sigma uncertainties.

Minimum Detection Level (MDL)

The Minimum Detection level is defined as the smallest amount of activity that can be detected for comparison with regulatory limits. MDL values also provide a basis for predicting the least amount of radiation which can be detected by the instrument in the given counting time with the given set of calibration factors and sample variables [6]. MDL calculation is derived from the definition of counting sensitivity as given in the National Interim Primary Drinking Water Regulation. These equations were developed by applying probability theory to the counting statistics with pre-selected levels of reporting confidence. The equation is shown below:

$$MDL = \left\{1.92 + \sqrt{(3.69 + 7.68TR_b)}\right\}/TE \qquad (3)$$

Where, R_b is Background Count Rate; T is Background count time and E is counting efficiency.

Annual effective dose equivalent

The following equation was used to calculate the annual effective dose,

$$DR_w = A_w \times IR_w \times IDF \qquad (4)$$

Where DR_w annual effective dose equivalent (μSv yr^{-1}), A_w gross α and gross β activities (mBql^{-1}), IR_w intake of water for person in one year. The annual effective dose equivalents were assessed for adults' people of Bangladesh who drink average 2.50 cup of tea per day (2 g leached in 100ml boiled water in each one cup) that means adults drink 912.5 cups of tea per year. The total indicative dose was calculated for adults using the following approach. IDF annual effective dose conversion factors (mSvBq^{-1}). The gross α activities were assumed to be from ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Po, ^{232}Th, respectively. The gross β activities were assumed to be from ^{210}Pb and ^{228}Ra. For the calculations of annual effective dose equivalent from alpha and beta emitters, the following dose conversion factors are applied which published by the WHO 4.50×10^{-5} mSvBq^{-1} for ^{238}U, 4.90×10^{-5} mSvBq^{-1} for ^{234}U, 2.10×10^{-4} mSvBq^{-1} for ^{230}Th, 2.80×10^{-4} mSvBq^{-1} for ^{226}Ra, 1.20×10^{-3} mSvBq^{-1} for ^{210}Po, 2.30×10^{-4} mSvBq^{-1}

for ^{232}Th, 7.20×10^{-5} mSvBq^{-1} for ^{228}Th, 6.90×10^{-4} mSvBq^{-1} for ^{210}Pb, and 6.90×10^{-4} mSvBq^{-1} for ^{228}Ra [7].

3 Results and Discussion

3.1 Measurement of Gross alpha and beta activity concentrations

The calculated results for gross alpha and gross beta activity concentrations in black and green tea samples from different local market are tabulated along with their errors ± in Table 1.

Table 1: Gross alpha and gross beta activity in black and green tea samples collected from different local market of Dhaka city.

Code Number of Tea Sample	Gross Alpha Activity (mBq/L)	Gross Beta Activity (mBq/L)
BT-01	6.72±0.074	98.21±0.66
BT-02	4.91±0.071	57.33±0.41
BT-03	5.81±0.040	104±1.09
BT-04	6.90±0.048	74.21±0.55
BT-05	3.83±0.062	69.07±0.36
BT-06	2.93±0.026	123±1.17
BT-07	4.81±0.022	77.01±0.43
BT-08	6.52±0.038	96.04±0.48
BT-09	5.91±0.026	91.11±0.54
BT-10	5.42±0.031	87.07±0.33
BT-11	3.63±0.039	58.79±0.29
BT-12	4.74±0.052	76.32±0.31
BT-13)	5.76±0.041	124±0.99
BT-14	2.11±0.035	88±0.27
BT-15	3.77±0.053	83.34±0.45
BT-16	4.51±0.036	63.27±0.32
BT-17	3.37±0.028	77.45±0.41
GT-18	2.73±0.047	65.21±0.33
GT-19	3.47±0.044	47.96±0.35
Mean ± SD	4.62±1.42	82.18 ±20.78
Turkey	5.00	80.70
WHO	0.5 Bql^{-1}	1 Bql^{-1}
ECR, Bangladesh	0.01 BqL^{-1}	0.1 BqL^{-1}

These values are to be used for screening only. The Measured activity concentrations ranging from 2.11±0.035 $mBql^{-1}$ to 6.90±0.048 $mBql^{-1}$ for the gross α and 47.96±0.35 $mBql^{-1}$ to 124±0.99 $mBql^{-1}$ for gross β were observed in prepared thin layer tea samples on planchette. The measured average gross alpha and gross β activities in consumed tea samples are 4.62 ± 1.42 $mBqL^{-1}$ and 82.17 ± 20.79 $mBqL^{-1}$ respectively. The Minimum Detection levels (MDL)of the counter for gross alpha is 0.58 $mBql^{-1}$ and for gross beta is 2.44 $mBql^{-1}$. The activity of gross alpha and gross beta in the tea samples are compared with the value of Turkey tea sample in Table 1. This comparison has been shown that the measured mean gross alpha activity in tea samples of Bangladesh is lower than Turkish market tea sample which is 5.00 $mBql^{-1}$ and the gross beta activity in tea samples of Bangladesh is a little higher than Turkish market tea sample which is 80.70 $mBql^{-1}$ following the digestion method. Table -1 also represents that total α and total β activity concentrations for all tea samples are lower than 0.5 Bql^{-1} for α and 1 Bql^{-1} for β which is WHO's recommendation. If the gross alpha and gross beta activity do not exceed 0.5 BqL^{-1} and 1 BqL^{-1}, it can be assumed that the annual total indicative dose is less than 0.1 mSv per year [8].

From logarithmic bar diagram figure-1, it is experiential that the highest gross alpha and gross beta activity concentrations are observed in Black Tea-4(BT-4) and Black Tea-13(BT-13) whereas the lowest gross alpha and gross beta activities are detected in Black Tea-14(BT-14) and Green Tea-19

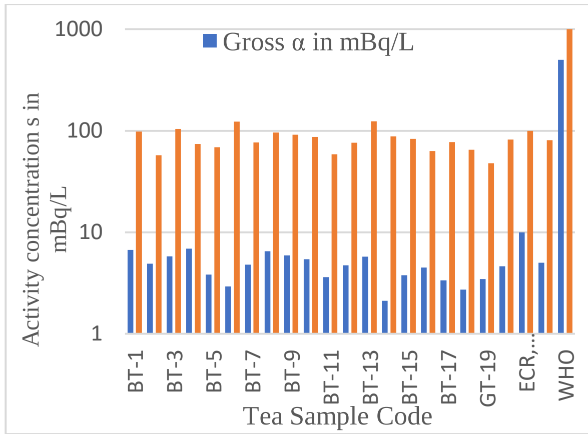

Fig. 1: Logarithmic figure for comparing gross α and gross β activity concentrations in studied tea samples.

(GT-19) among the tea samples collected from different local market in Dhaka city. The measured data revealed that the gross beta activities in all samples always are much more the gross alpha activities. From the present study, it is also observed that the measured gross alpha and gross beta activities in aqueous tea samples in Bangladesh are also lower than the Environment Conservation Rules, 1997 of Bangladesh which recommended levels for gross alpha activity is 0.01 BqL^{-1} and gross beta activity is 0.1 BqL^{-1} [9]. The radioactivity levels in tea have received great interest because they are related to human health. In terms of the market of tea samples for infusion, it is very important to determine the level of radioactivity values in these products to ensure consumer safety.

3.2 Annual Effective Dose Equivalent

Natural radioisotopes as ^{40}K and the nuclides from the ^{238}U and ^{232}Th series are the greatest source of internal and external exposure in human beings. Among the radionuclides of terrestrial origin, ^{40}K and the constituents of the ^{238}U and ^{232}Th series enter the human body largely by food and water ingestion. The main emitters of alpha that can be present in water are the ^{238}U, ^{234}U, ^{232}Th, ^{226}Ra and ^{210}Po and beta ^{40}K, ^{228}Ra and ^{210}Pb, in different concentrations.

Table 2: The annual effective doses (μSvy-1) from alpha and beta emitters in different branded tea samples.

Sample Code	Annual effective doses(μSv/y)								
	Alpha Emitters							Beta Emitters	
	U-238	U-234	Th-230	Ra-226	Po-210	Th-232	Th-228	Pb-210	Ra-228
BT-1	0.028	0.030	0.128	0.172	0.736	0.141	0.442	6.184	6.184
BT-2	0.021	0.0219	0.094	0.125	0.538	0.103	0.323	3.610	3.610
BT-3	0.024	0.026	0.111	0.148	0.635	0.122	0.381	6.551	6.551
BT-4	0.028	0.031	0.132	0.176	0.755	0.145	0.453	4.677	4.672
BT-5	0.016	0.017	0.073	0.097	0.416	0.080	0.250	4.352	4.352
BT-6	0.012	0.013	0.056	0.074	0.318	0.061	0.191	7.744	7.744
BT-7	0.020	0.021	0.092	0.123	0.525	0.101	0.315	4.849	4.849
BT-8	0.026	0.029	0.125	0.166	0.712	0.136	0.427	6.047	6.047
BT-9	0.024	0.026	0.113	0.151	0.646	0.124	0.388	5.737	5.736
BT-10	0.022	0.024	0.103	0.137	0.591	0.113	0.354	5.482	5.482
BT-11	0.014	0.016	0.069	0.091	0.394	0.075	0.236	3.701	3.701
BT-12	0.019	0.021	0.090	0.121	0.514	0.098	0.308	4.805	4.805
BT-13	0.023	0.025	0.109	0.145	0.624	0.119	0.374	7.807	7.807
BT-14	0.009	0.009	0.040	0.054	0.229	0.044	0.137	5.541	5.541
BT-15	0.015	0.016	0.071	0.095	0.405	0.077	0.243	5.247	5.247
BT-16	0.018	0.020	0.086	0.115	0.493	0.094	0.296	3.984	3.984
BT-17	0.014	0.015	0.063	0.084	0.361	0.069	0.217	4.876	4.876
GT-1	0.011	0.012	0.052	0.069	0.296	0.056	0.177	4.106	4.106
GT-2	0.014	0.015	0.065	0.087	0.372	0.071	0.223	3.019	3.019
Mean	0.019	0.021	0.088	0.117	0.503	0.096	0.302	5.174	5.174
±SD	0.006	0.006	0.027	0.036	0.156	0.030	0.094	1.308	1.308

The gross alpha activity is defined as the total activity of all the alpha emitters (including ^{226}Ra) once the radon has been eliminated. The gross beta activity is the activity of all beta emitters excluding ^{3}H, ^{14}C and other weak beta emitters (6). The calculated annual effective dose equivalents values for alpha and beta emitters from tea samples are presented in table 2.

The annual effective dose equivalent is estimated based on the dose conversion factors of each radionuclide and both gross alpha and beta activity concentrations related to different types of tea drink.

From the present study, it is found that the mean annual effective doses from alpha and beta emitters such as ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Po, ^{232}Th, ^{238}Th, ^{210}Pb and ^{228}Ra from the consumed tea samples are 0.019, 0.021, 0.088, 0.117, 0.503, 0.096, 0.030, 1.31 and 1.31 μSvy^{-1} for adults in Bangladesh. Table -2 presents that the values of annual effective dose equivalent from alpha emitters are lower than beta emitters. The results from this study indicate that the values of annual effective doses are lying within the limit of

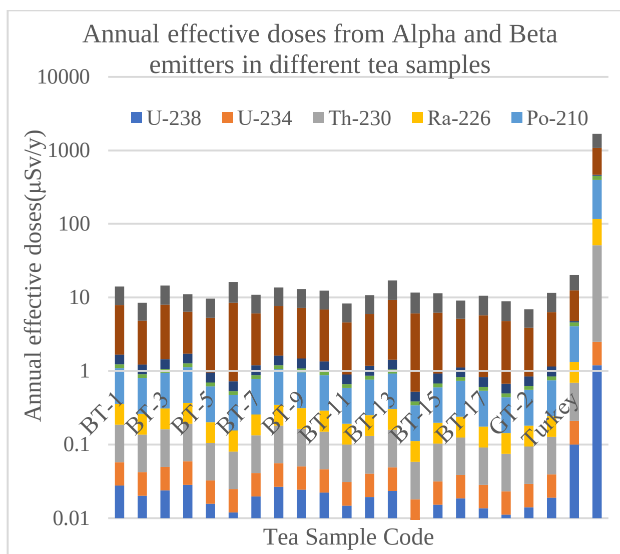

Fig.2: Annual Effective Doses from Alpha and Beta emitters in tea samples collected from different local market of Dhaka city.

annual radiation dose from natural sources (0.2 to 0.8 $mSvy^{-1}$) for beta annual dose and still below the WHO recommended reference level of 0.3 $mSvy^{-1}$ for alpha annual dose in food and drinking samples [10].

A comparing logarithmic bar diagram of annual effective doses from alpha and beta emitters in tea samples collected from different local market of Dhaka city in Bangladesh and other countries is shown in figure 2. This comparison has shown that the reported mean to total annual effective dose equivalent from ^{238}U, ^{234}U, ^{230}Th,^{226}Ra, ^{210}Po, ^{232}Th, ^{238Th}, ^{210}Pb and ^{228}Ra are 1.20, 1.30, 49.00,7.70, 6.30, 16.70, 60.70 and 60.70 μSvy^{-1} for different tea samples in Egypt which are considerable higher than present study [11]. The above logarithmic bar diagram also showing that the contributions of the infusion tea sample to total annual effective dose equivalent from ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Po, ^{232}Th, ^{238}Th, ^{210}Pb and ^{228}Ra are 0.10, 0.11, 0.48, 0.64, 2.74, 0.53, 0.16, 7.74 and 7.74 μSvy^{-1} for adults in Turkey [7] which is also higher than the studied different tea samples in Bangladesh. So, it is estimated that the different branded tea samples which are available in the local market of Dhaka city in Bangladesh are safe for public health.

3.3 Measurement p^H in Tea samples

A BOECO BT600 Laboratory Microprocessor p^H/ORP was used for measuring the p^H values of branded tea samples which were collected from different markets of Dhaka city. Infusion method used for preparation of aqueous tea samples was preferred for this study to assess the actual amount of p^H reach human body through drinking such beverages. The presence of more acidic or alkaline in drinking tea does affect its taste. In this method, 100 ml of hot distilled water was added to 2 g of black tea sample. The mixture left to cool at room temperature for 5 min and then p^H/ORP was used for measuring the p^H values of the solution in infusion tea samples. The p^H value of drinks and beverages causes dental erosion without the presence of bacteria. The low value of pH indicates the acidity of the drink. These drinks cause the chemical dissolution of teeth that results in dental cavities and decay. The frequent consumption of high acidic or low p^H drinks is harmful to all ages in human beings [12]. From table-3, it is found that the p^H values in infusion black tea and green tea samples ranged from 4.87±0.02 to **5**.93±0.02 and 6.51±0.03 to 6.78±0.02. Most of black teas are mildly acidic. The table-3 also revealed that black tea is more acidic than green tea samples. The observed values of p^H in infusion green tea samples are comparable with Turkish herbal tea ranged from 6.47 to 7.24, respectively [13].

Table.3: The value of p^H in tea samples collected from different local market of Dhaka city.

Infusion Tea Sample Code	$p^H \pm$ SD
BT-1	5.42±0.02
BT-2	5.25±0.02
BT-3	5.51±0.02
BT-4	5.32±0.02
BT-5	5.61±0.02
BT-6	5.74±0.01
BT-7	4.98±0.02
BT-8	5.67±0.03
BT-9	5.56±0.01
BT-10	5.16±0.02
BT-11	4.87±0.02
BT-12	5.34±0.03
BT-13	5.06±0.01
BT-14	4.94±0.01
BT-15	5.93±0.02
BT-16	5.20±0.01
BT-17	4.96±0.03
GT-1	6.51±0.03
GT-2	6.78±0.02

4 Conclusions

Tea is the most popular hot beverage worldwide. In the present study, gross α and β activity concentrations in seventeen brands of black tea and two brands of green tea samples purchased from the local market of Dhaka city are analysed and total annual effective doses equivalent from alpha and beta emitters in tea samples are estimated. The measured gross alpha and gross beta activities in aqueous tea samples in Bangladesh are lower than WHO recommended level and the Environment Conservation Rules, 1997 of Bangladesh. The results from this study indicate that the values of annual effective doses are lying within the limit of annual radiation dose from natural sources (0.2 to 0.8 $mSvy^{-1}$) for beta annual dose and still below the WHO recommended reference level of 0.3 $mSvy^{-1}$ for alpha annual dose in food and drinking samples. So, it is estimated that the different branded tea samples which are available in the local market of Dhaka city in Bangladesh are safe for public health. The p^H values in infusion black tea and green tea samples ranged from 4.87±0.02 to 5.93±0.02 and 6.51±0.03 to 6.78±0.02. Most of black teas are mildly acidic than green tea. The data gathered in this study will provide base–line radiometric values of branded tea samples in this region that can be used to evaluate the possible changes in future.

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