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Nutritional Analysis of Some Locally Available Fruits and Vegetables in Chattogram, Bangladesh

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Abstract

Fruits and vegetables are very important for daily diet as they are enriched with carbohydrate, protein, fiber and micronutrients. The present study was carried out to estimate the nutrient content of some locally available fruits and vegetables in raw state. The specimens of this study were the fruit of *Averrhoa bilimbi*, tender stem of *Costus speciosus,* fruit coat of *Hibiscus subdariffia*, inflorescence (spike) of *Musa sp.* & inner part of pseudostem of *Musa sp.* which are the edible part consumed by the local people. These fruits and vegetables were investigated to determine their nutritive values which include moisture, ash, protein, fat, carbohydrate, crude fiber, vitamin C & calorie content. Three samples such as *C. speciosus*, Inflorescence (stem) of *Musa sp.* and pseudostem of *Musa sp.* were analyzed for several minerals namely K, Ca, Mg, Cu, Fe and Zn. The collected specimens were also identified by observation. *A. bilimbi* was found to contain 94.2 gm% moisture, 33 gm% ash, 2.62 gm% protein, 0.71 gm% fat, 0.7 gm% crude fiber, 1.62 gm% carbohydrate, 20.16 mg vitamin C with 23.35 Kcal of energy. *H. sabdariffa* contained 92.33 gm% moisture, 0.62 gm% ash, 0.15 gm% protein, 0.7 gm% carbohydrate, 43.75 mg vitamin C with 29.7 Kcal of energy. *C. speciosus* contained 92.3 gm% moisture, 1.4 gm% ash, 28 gm% protein. 0.2 gm% fat, 0.21 gm% crude fiber, 3.09 gm% carbohydrate, 3 mg vitamin C with 25.36 Kcal of energy. *C. speciosus* was found to contain 84 mg K, 52 mg Ca, 72 mg Mg, 0.08 mg Cu, 2.3 mg Fe and 0.4 mg Zn. Inflorescence (spike) of *Musa sp.* contained 85 gm% moisture, 1.4 gm% ash, 2.1 gm% protein, 1 gm% fat, 0.03 gm% fiber. 10.5 gm% carbohydrate, 2 mg vitamin C with 59.4 Kcal of energy. It was found to contain 61 mg K, 28 mg Ca, 38 mg Mg, 0.07 mg Cu, 1.6 mg Fe and 1.8 mg Zn. Pseudostem of *Musa sp.* contained 94 gm% moisture, 0.4 gm ash, 0.9 gm% protein, 0.1 gm%

ash, 0.42% fiber, 4 gm% carbohydrate, 1 mg vitamin C with 29.5 Kcal of energy. It was found to contain 93 mg K, 10 mg Ca, 19 mg Mg, 0.2 mg Cu, 1.3 mg Fe and 0.9 mg Zn. So these plants might be introduced all over the country to meet the nutritional demand as they contain a significant amount of nutrients.

Keywords

Fruits, Vegetables, Nutrition, Trace Elements, Minerals

1. Introduction

Bangladesh is a country of rich natural resources. More than half of the population of this country lives in rural areas. The nutritional status in Bangladesh is quite alarming with a great number of her population suffering from under nutrition [1]. Malnutrition is high in infant, under five and pregnant mothers and results in high morbidity and mortality. Nutritional status or malnutrition is expression of the degree to which physiological needs for nutrients are being met. It is the balance between nutrients intake and requirement [2]. The condition may be affected by many factors including disease, cultural pattern, eating habit, economic condition, food availability, repeated illness, lack of knowledge and information etc. [2].

In our country, low consumption due to poverty and proper or imbalanced consumption due to ignorance or traditional food habit is the cause of malnutrition, Micronutrient malnutrition including Vit A, Vit-B, Vit-C, Fe, Zn deficiency, disorder etc. About 17% of the population suffer from Vit A deficiency and 60% are at risk to suffer from Vit C and riboflavin deficiency and 50% of the 3rd degree malnourished children suffer Zn deficiency [3].

Two consecutive National Nutrition surveys (Ahmed *et al.* 1984), gave poignant revelation that average Bangladesh diet is grossly inadequate in energy and Micronutrients [1]. Food and calorie intakes are dealing with time [4]. Our calorie and protein intake are less than option, Micro-nutrients such as Vit A, Ascorbic acid (Vit C), Iron. Iodine, Calcium, Riboflavin are limiting in our diet. Traditional Bangladesh diet is largely based on cereal products, contribution to animal products which are rich in vitamins, minerals and proteins are being negligible or almost nil. Thus micronutrient malnutrition is widespread in Bangladesh, hand in hand with macro-nutrient malnutrition, more commonly known as protein energy malnutrition. The Problem is especially acute in respect to Vit A, iron and iodine. About 17% of our population suffers from vitamin A deficiency, 47% have goiter, 60% of the population are at risk to suffer from Vit C and riboflavin deficiency disorders, 77% of the population suffer from insufficient protein intake [5].

Besides cultivated plant foods, they use high proportion of uncultivated foods in their daily life. Various locally available fruits and vegetables provide additional nutrition in their diet. They are found in plenty all the year round though some

are seasonal also. Scientific research and literature claims that these are rich in food value. The nutritive values of these unconventional fruits and vegetables are not less than that of traditional costly fruits [6]. Locally available fruits and vegetables which are grown in the homestead garden by the villagers are not only tasty or delicious but also rich in vitamins and minerals as well as other nutrients. Therefore, the locally grown cheap and available fruits and vegetables could fulfill their nutrient requirements, at least partially [7].

There are many international works which deal with the nutritive value of Indian foods has already been reported [8]. Many other international data on nutritive value of raw vegetables are also available [8]. Very few data have already been reported or available on the nutrient content of the locally available fruits and vegetables analyzed in this study.

In the present study, an attempt has been taken to determine the nutritive value of five locally available fruits and vegetables in raw state. It is very important to know the nutritive value of foodstuffs that we consume. In this research work, the content of nutrient such as moisture, ash, protein, fat, crude fiber, carbohydrate and vitamin C of five local fruits and vegetables namely *A. bilimbi*, *Costus speciosus, H. sabdariffo,* florescence (spike) of *Musa sp.* and pseudostem of *Musa sp.* are analyzed. Different minerals such as K, Ca, Mg, Cu, Fe and Zn of three fruits and vegetables namely inflorescence (spike) of *Musa sp.*, pseudostem of *Musa sp.* and tender stem of *Costus speciosus*. are also estimated.

2. Materials and Methods

2.1. Collection of Samples

The present investigation was conducted on some local fruits and vegetables found in Chittagong rural areas for the determination of their nutritive values. The experimental samples were collected from different markets and areas where they grow. The sample was collected in the month of March - April 2009. The photographs of these plants (edible parts) were snapped (Figure below). The specimens were identified by consulting with the experts at the Department of Botany, University of Chittagong and through several herbarium studies by comparing herbarium specimens. The details of the fruits and vegetables used in this study are represented in **Figure 1**.

2.2. Preparation of Samples Taken for Analysis

The freshly collected materials area initially washed with tap water thoroughly until the attached dust particles, unicellular algae etc. were removed. The washed materials were stored in the 4˚C until they were needed. Finally, they were washed with distilled water. Samples used for mineral determination were washed with deionized water. The washed materials were dried with blotting paper followed by filter paper at room temperature to remove the surface water. These were immediately kept in a desiccator to avoid further evaporation of moisture from materials. The samples were then ready for the determination of

their proximate composition such as moisture, ash, protein, fat, carbohydrate and crude fiber (Table 1).

Figure 1. *Hibiscus sabdariffa* (Top left), *Averrhoa bilimbi* (Top right), *Musa sp.* (Edible Inflorescence Inset) (Middle left), *Costus speciosus* (Tender Stem Inset) (Middle right), *Musa sp.* (Edible Pseudostem Inset) (Bottom).

Table 1. Parts of Sample taken for analysis.

Sl. No.	Scientific Name	Family	Parts Taken
01	*Averrhoa bilimbi*	Avarrhoaceae	Fruits
02	*Costus speciosus*	Costaceae	Tender steam
03	*Hibiscus sabdariffa*	Malvaceae	leaves young shoots fruits
04	*Musa sp.*	Musaceae	Inflorescence (Spike)
05	*Musa sp.*	Musaceae	Inner part of pseudostem

2.3. Nutritional Analysis

To determine the moisture ash and crude fibers, standard methods were applied developed by Association of Analytical Chemists (AOAC) [9] [10]. Protein content of food stuffs was estimated by nitrogen content of the materials and multiplying the nitrogen value by 6.25 [11] [12]. Determination of fat content was carried out by using Soxhlet type of the direct solvent extraction method [13]. Petroleum ether (Boiling point 40˚C - 60˚C) was used as solvent. The crude fiber was determined by the methods described by Boussama *et al.*, 1999 (3) [11]. The calorie content of the algal material was calculated by multiplying by carbohydrate, protein and fat by 4, 4 and 9 respectively [14]. The content of the available carbohydrate was calculated by difference *i.e.* by subtracting the sum of the value (Per 100 g) for moisture, ash, protein, fat and crude fiber from 100 [14]. Ascorbic acid (Vitamin C) is estimated in the method is to titrated ascorbic acid with 2.6 dichlorophenol indophenol method [15]. All the proximate values were representing here in percentage.

2.4. Statistical Analysis

Each experiment was done on three replicate samples. The data obtained in these investigations were subjected to statistical analysis. The data was analyzed using Minitab version 16. The results are represented here as mean ± standard deviation (SD).

2.5. Determination of Mineral Content

Ground plant materials were digested and minerals were released by digestion with nitric acid and it was determined by Atomic Absorption Spectrophotometer (AAS-Perkin Elmer Model A Analyst 800). The results were obtained while using a working standard when 1000 ppm for each of the samples [14]. Mineral determination was carried out only with *Costus speciosus*, Inflorescence spike of *Musa sp.* and pseudostem of *Musa sp.* due to limited facilities.

3. Results

3.1. Nutritional Composition of Fruits and Vegetables

Nutritional analysis of selected fruits and vegetables were analyzed on wet and dry basis has been reported in **Table 1**. It shows a comparison of nutritional value of different fruits and vegetables. It was found that *A. bilimbi* contained the highest amount of moisture (94.2%) and inflorescence of *Musa sp.* contained the lowest (85%) (**Figure 2**). Comparative analysis of ash value of different fruits and vegetables shows that *C. speciosus* and inflorescence of *Musa sp.* contained the highest amount (1.4%) & *A. bilimbi* contained the lowest value (0.33%) (**Figure 2**). *C. speciosus* contained the highest amount (2.8%) of protein whereas pseudostem of *Musa sp.* contained the lowest value (0.9%) (**Figure 2**). Fat content of inflorescence *Musa sp.* found to be higher (1.0%) than pseudostem of *Musa sp.* (0.1%). The highest amount of crude fiber is significantly higher in *A. bilibmi* (0.7%)

where lowest in inflorescence of *Musa sp.* (0.03%) (Figure 3). Among the fruits analyzed the highest amount of carbohydrate content is found in inflorescence of *Musa sp.* (10.5%) whereas *A. bilimbi* has the lowest amount (1.62%) (Figure 3). Significant amount of vitamin C is found in fruits and vegetables analyzed here. Among the fruits and vegetables *Hibiscus sabdariffa* shows the highest value (43.73%) where inflorescence of *Musa sp.* shows the lowest concentration (2.0%) (Table 2).

Table 2. Proximate analysis of selected fruits and vegetables.

Name	Moisture (w) % ± S.E.	Ash (w) % ± S.E.	Protein (w) % ± S.E.	Fat (w) % ± S.E.	Fiber (w) % ± S.E.	Carbohydrate (w) % ± S.E.	Vit C (w) % ± S.E.	Kcal (w) % ± S.E.
Averrhoa bilimbi	94.2 ± 0.01	0.33 ± 0.001	2.62 ± 0.05	0.71 ± 0.01	0.7 ± 0.01	1.62 ± 0.01	20.16 ± 0.2	23.35 ± 0.5
Costus speciosus	92.3 ± 0.01	1.4 ± 0.04	2.8 ± 0.06	0.2 ± 0.01	0.21 ± 0.00	3.09 ± 0.05	3.00 ± 0.2	25.36 ± 0.01
Hibiscus sabdariffa	92.23 ± 0.001	0.62 ± 0.03	0.15 ± 0.05	0.7 ± 0.01	0.63 ± 0.02	5.7 ± 0.02	43.75 ± 0.01	29.7 ± 0.03
***Musa sp.* (*Inflorescence*)**	85 ± 0.5	1.4 ± 0.01	2.1 ± 0.02	1.0 ± 0.00	0.03 ± 0.05	10.5 ± 0.01	2.0 ± 0.2	59.4 ± 0.03
***Musa sp.* (*Pseudostem*)**	94 ± 0.01	0.4 ± 0.005	0.9 ± 0.02	0.1 ± 0.01	0.42 ± 0.07	4.0 ± 0.01	1.0 ± 0.3	20.5 ± 0.05

The values with ± refers to standard error.

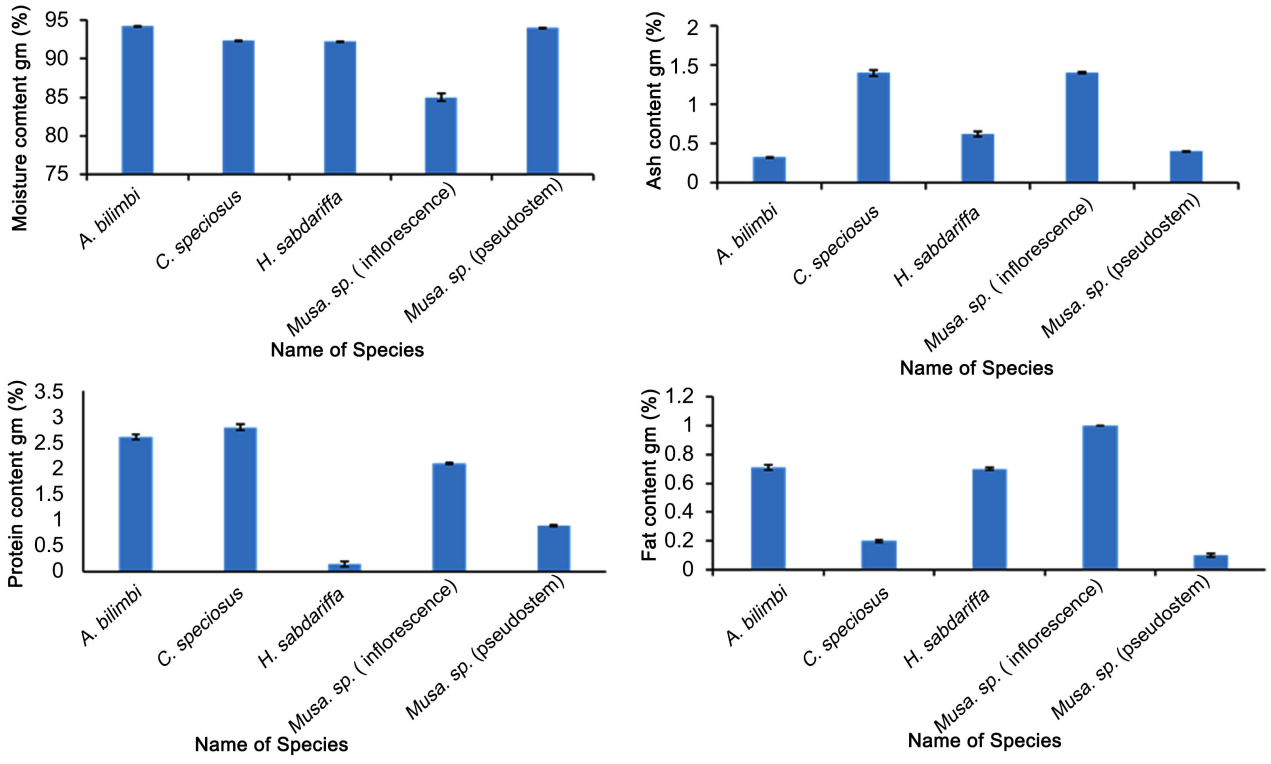

Figure 2. Nutrient analysis of different fruits and vegetable, moisture content (top left), ash content (top right), protein content (bottom left) and fat content (bottom right).

3.2. Trace Elements Analysis

The analysis of the trace elements composition of the selected fruits and vegetables

are reported here in Table 3. The data shows that the pseudostem of *Musa sp.* contained the highest concentration of potassium (K) in compare to the *C. speciosus* and inflorescence of *Musa sp.* (Figure 4). Among the trace elements calcium (Ca), magnesium (Mg) and iron (Fe) found significant amount of concentration in *C. speciosus* than inflorescence and pseudostem of *Musa sp.* (Figure 4). Pseudostem of *Musa sp.* and inflorescence of *Musa sp.* shows highest concentration of copper (Cu) and zinc (Zn) respectively whereas C. *speciosus* shows lower in both cases (Figure 4).

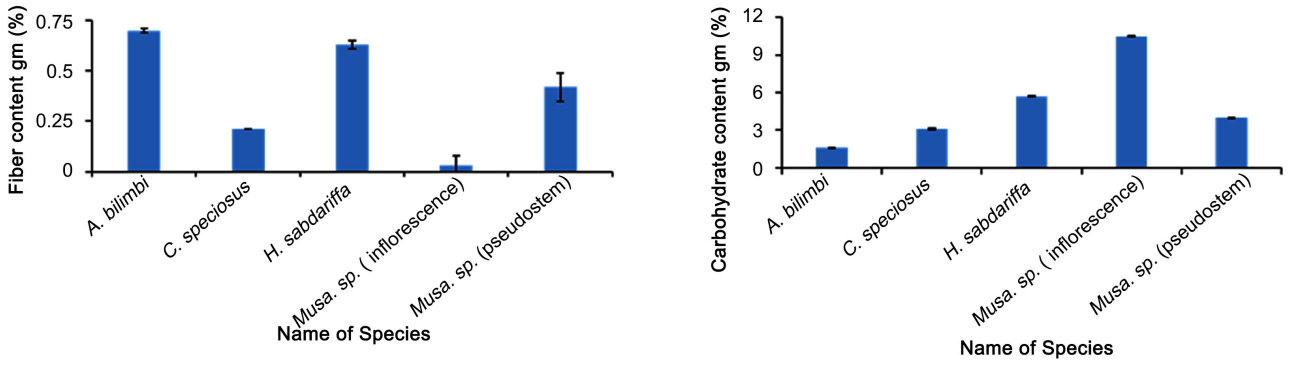

Figure 3. Nutrient analysis of different fruits and vegetables, fiber content (left) and carbohydrate content (right).

Table 3. Trace minerals analysis of selected fruits and vegetables.

Name	K	Ca	Mg	Cu	Fe	Zn
Costus speciosus	84.2 ± 0.5	52.04 ± 0.26	72.06 ± 0.03	0.8 ± 0.01	2.3 ± 0.3	0.4 ± 0.03
Inflorescence (spike) of Musa sp.	61.01 ± 0.2	28.8 ± 0.29	38.6 ± 0.05	0.071 ± 0.02	1.6 ± 0.05	1.8 ± 0.09
Pseudostem of Musa sp.	93 ± 0.1	10 ± 0.3	19.06 ± 0.00	0.2 ± 0.02	1.3 ± 0.02	0.9 ± 0.2

The values of ±refers to standard error.

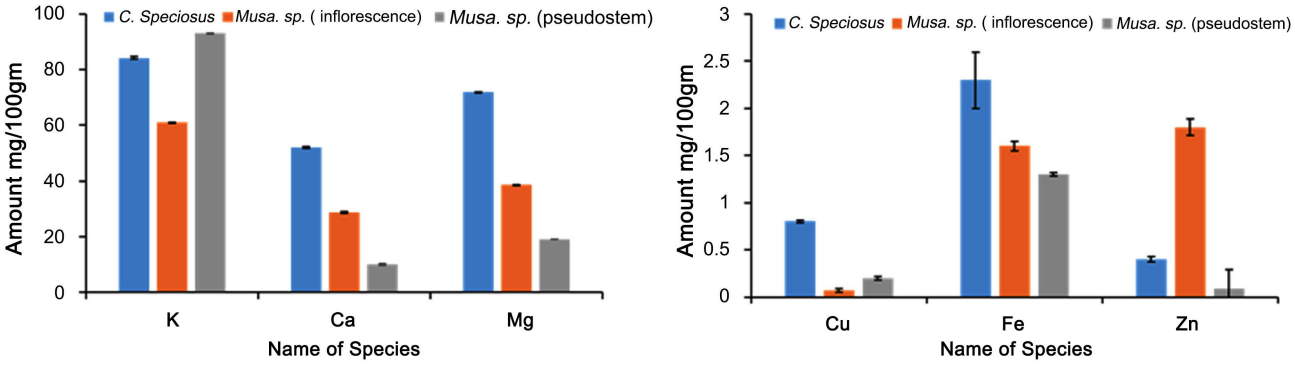

Figure 4. Trace elements analysis of selected fruits and vegetables, Potassium (K), Calcium (Ca), Magnesium(Mg) (left) and Cupper (Cu), Iron (Fe) and Zinc (Zn) (right).

4. Discussion

In this research work, five different varieties of locally available fruits and vegeta-

bles were analyzed for their nutrient contents. These include moisture, ash, protein, crude fiber, crude fat, carbohydrate and specifically 6 different minerals. These are three trace elements such as zinc, iron and copper and three major elements such as calcium, magnesium and potassium.

The moisture content of five different fruits ranged between 85% - 94% (**Table 2**). Among the fruits analyzed, *A. bilimbi* contained the highest amount of water, about 94.2%. There is evidence that moisture content of fruits ranges between 60% - 95% [16]. The range is similar to this study. Moisture content of different fruits depends on some factors. Such as rainfall, soil water and type of soil moisture supply mainly depends on rainfall [16]. Black soil, which called humic soil-increased the water holding capacity of soil [16]. Humic soil found from near sea level to heights of different country is variable and due to this reason variation occurs in moisture content.

The protein content of fruit depends on the metabolic processes of plant. Fruits contain small amount of protein. In general protein content of different fruit is not greater that 3.5% [17]. In this study it was found that protein content of different fruits ranged between 0.15% - 2.8%. In this study, it was found that the *C. speciosus* contained the highest amount of protein 2.8%. *A. bilimbi* and inflorescence of *Musa sp.* also contained good amount of protein 2.62% and 2.1% respectively. The lowest amount of protein was contained in *H. sabdariffa,* about 0.15%. This range is comparable with the food composition table of the Nutritive value of Indian Foods [18] and the Nutritive value of Bangladeshi Foods [19].

In general, fat content of different fruits is not greater that 1% [16], and in this study it was found that fat content of different fruits ranged between 0.1% - 1%. The highest amount of fat was found in inflorescence of *Musa sp.* about 1% and the lowest amount was found in pseudostem of *Musa sp.*

Fiber is the most important constituent present in fruits, particularly soluble fiber, such as pectin. In this study, crude fiber was analyzed. Crude fiber of different fruits ranged between 0.03% - 0.7%. The highest amount of crude fiber was found in *A. bilimbi,* about 0.7%. The *H. sabdariffa* and *C. speciosus* contains 0.2% and 0.6% of fiber respectively. The pseudostem of *Musa sp.* contains 0.42% fiber. Inflorescence of *Musa sp.* contains the lowest amount of fiber 0.03%.

Carbohydrate of fruit is less concentrated than cereals because of their high water content [16]. Among the fruits analyzed, the highest amount of carbohydrate was found in inflorescence of *Musa sp.* about 10% whereas *A. bilimbi* has the lowest amount, 1.62%. Fruits rich in carbohydrate provide the highest amount of energy. The Inflorescence of *Musa sp.* contained the highest calorie among the fruits and vegetables analyzed, because it has the high carbohydrate content. The other species such as *C. speciosus*, *H. sabdariffa* and *A. bilimbi* had the fair energy content because of their low carbohydrate content. The lowest calorie value was found in the pseudostem of *Musa sp.* because of their low fat and protein content.

Vitamin C is abundantly found in fruits and vegetables. Although citrus fruits are very good sources, many other fruits and vegetables are rich in vitamin C. As

vitamin C is highly vulnerable to heat and oxygen, fresh fruits and vegetables are the optimal sources [20]. In the present study, the highest amount of vitamin C was found to contain in *H. sabdariffa*, 43.75 mg and *A. bilimbi* also contained considerable amount of vitamin C, about 20.16 mg per 100 gm fw. The lowest amount of vitamin C was found in Pseudostem of *Musa sp.*, lmg per 100 gm.

Living plants consist of organic matter, water and mineral. The relative amount of these three components may vary, but for fruits, water is always present in highest proportion and the mineral in the lowest. Protein, fat, carbohydrate and fiber contents of fruits depend on the metabolic process and are genetically determined [21]. The main factor controlling the mineral content of plant material is the specific genetically fixed nutrient uptake potential for the different mineral nutrients. The second most important controlling factor of the mineral content is the availability of nutrients in the medium. So, it depends on the nature of the soil [22]. Compositions of fruits especially mineral elements varies from one continent to another, one country to another in the same continent and in the same country, variation may occur region to region. This variation may be due to change of climatic condition, nature of soil and sometimes rainfall [22].

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Potassium is available in alkaline soil [23]. Evidence shows that soil microorganism increased soil potassium. Micro-organism helps to release potassium from soil in ionic form [23]. Potassium is plentiful in fruits. The important electrolyte mineral present in the analyzed fruits and vegetables ranged between 61 mg to 93 mg per 100 gm edible portion. The highest amount of Potassium was present in Pseudostem of *Musa sp.*, 93 mg/100gm edible portion followed by *C. speciosus*, 84 mg/100gm. The minimum amount was present in Inflorescence of *Musa sp.* 61 mg/100gm.

In general, fruits are not a source of calcium [24]. Only some fruits contain a significant amount of calcium. Calcium content of fruits is difficult to compare with other country, because amount of calcium present in fruits always depends on the nature of soil. Calcium is rich in alkaline soil and poor in acidic soil [23]. Among the fruits and vegetables analyzed it was found that the highest amount of calcium was in *C speciosus*, 52 mg per 100 gm and in the Inflorescence of Musa 3 p. 28 mg/100gm. The pseudostem of *Musa sp.* was found to contain only 10 mg/100gm fw.

No such work has been done on fruit magnesium, and literature is not available in this context. Only India and W. Germany measures fruit magnesium of a limited number of fruits [18]. Magnesium is rich in alkaline soil where soil pH is high [23].

Among the fruits and vegetables analyzed it was found that the highest amount of Magnesium was in *C. speciosus,* 72 mg per 100 gm and in the Inflorescence of

Musa sp. 38 mg/100gm, The pseudostem of *Musa sp*. was found to contain the lowest amount of magnesium, only 19 mg/100gm fw.

Copper is a trace element and a very poor amount present in fruits. Among the fruits analyzed, it was found that the highest amount of copper was present in pseudostem of *Musa sp*., 0.2 mg/100gm. *C. speciosus* and Inflorescence of Musa sp. contained the lowest amount, 0.08 mg and 0.07 mg per 100 gm respectively. Variation of copper in fruit of different country may be different due to difference in soil and climatic condition. Copper is available in acidic soil and not readily available in dry soil [23].

Fruits are a very poor source of iron [24] and iron in soil often is found in a form unavailable for plant utilization. In the present study it, was found that iron content ranged between 1.3 mg to 3.2 mg. The highest amount of iron was found in *C. speciosus*, 2.3 mg/100gm and the pseudostem of *Musa sp*., contained the lowest amount, 1.3 mg/100gm.

Zinc is another trace element present in fruit in a very negligible amount. Evidence shows that fruits is the very poor source of Zinc [25]. In the present study, it was found that 1.8 mg zinc was present in Inflorescence of *Musa sp*. and *C. speciosus* contained 0.4 mg/100gm. The pseudostem of *Musa sp*. contained 0.9 mg/100gm edible portion. Zine content of fruits depends on many factors. particularly, nature of soil. Zinc is available in acidic soil [23].

In this research work, it was observed that the locally available fruits and vegetables studied were rich in Vitamin C, Carbohydrate, Minerals and Fiber. Therefore, these cheap and available food items can meet the nutritional demand of the poor people who have no affordability to buy the costly foods. The study has some limitations which are worth noting. The sample size and single region sourcing. The experimental samples used in this investigation were collected from the local markets and areas where they grow. If it is possible to collect the variety of fruits and vegetables from the different regions of the country, variation of the nutritional and trace elements content of the samples would be correlated.

5. Conclusion

From the analysis, it can be concluded that these plants might be introduced as they contain high nutrient as comparable with commonly used food sources. From the above comparative analysis, it was found that *H. sabdariffa* is a better source of Vitamin C and fiber than other fruits and vegetables analyzed. Inflorescence of *Musa sp.* is richer in carbohydrate, fat and minerals such as K, Cu, Zn than others. Moreover, *C. speciosus* is more abundant source of protein and several minerals such as Ca, Mg, Fe than other fruits and vegetables analyzed. In this research work, it was observed that the locally available fruits and vegetables studied were rich in Vitamin C, Carbohydrate, Minerals and Fiber. Therefore, these cheap and available food items can meet the nutritional demand of the Bangladeshi population partially. So, these locally available fruits & vegetables should be popularized all over the country.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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