Journal of Scientific Research & Reports
11(6): 1-8, 2016; Article no.JSRR.28541
ISSN: 2320-0227

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Proximate and Water Soluble Vitamin Contents in Some Selected Bangladeshi Fruits and Vegetables

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Authors' contributions

This work was carried out in collaboration between all authors. Author MM designed the study, wrote the protocol, executed the experiment, performed the statistical analysis and wrote the first draft. Author ATMAR reviewed the design and supervised the study. Authors MNH and MSHK reviewed each draft of the manuscript and final proof submission. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2016/28541
Editor(s):
(1) Surapong Pinitglang, Department of Food Science and Technology, School of Science and Technology, University of the Thai Chamber of Commerce, Thailand.
Reviewers:
(1) Jorge Isaac Castro Bedrinana, National University of the Center of Peru, Peru.
(2) Uttara Singh, Government Home Science College, Chandigarh, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/16025

Original Research Article

Received 24th July 2016
Accepted 14th August 2016
Published 2nd September 2016

ABSTRACT

Fruits and vegetables are generally valued for their rich content of vitamins and minerals. The present study has been undertaken to determine the proximate composition (moisture, protein, fat, total ash and total dietary fiber) and water soluble vitamins (Thiamin, Riboflavin, vitamin C and vitamin B_6) contents in selected key fruits and vegetables of Bangladesh. Proximate composition of analyzed fruits and vegetables showed that the moisture content in all analyzed samples was very high ranging 81-95%. Results showed that all the analyzed food samples contain as expected less amounts of fat and available carbohydrate except banana (19% available carbohydrate). Total dietary fiber content varied widely (1.6-7.2 g/100 g) of which jackfruit was found rich in it (7.2 g/100 g edible portion). Water soluble vitamin analysis of fruits and vegetables showed that thiamin content in analyzed samples was highest in jackfruit and the lowest in egg plant. Riboflavin is ranging from 0.043-0.144 mg/100 g edible portion. Tomato contained the lowest amount of

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pyridoxine while jackfruit contained the highest amount (0.049-0.313 mg/100 g edible portion, respectively). L-Ascorbic acid content of the vegetables revealed that green chili contained the highest amount as expected (102 mg/100 g edible portion) whereas banana contained the lowest (0.104 mg/100 g edible portion). The findings of this study provided valuable and reliable data of water soluble vitamins that can be expected to contribute in diet calculation for ideal and therapeutic uses.

Keywords: Fruit; moisture; protein; vegetable; vitamin.

1. INTRODUCTION

A large number of tropical fruits and vegetables were grown in Bangladesh have a high nutritional value and play an important role in human nutrition [1] and also enriched in antioxidant, minerals, vitamins and dietary diversification [2]. A healthy diet should compose of fruits and vegetables and sufficient amounts of regular consumption could help to avert major chronic diseases. Fruit and vegetables are vital source of natural antioxidants which provide safety against diverse types of diseases and other health reimbursement [3]. High consumption of fruits and vegetables reduced the threat of chronic degenerative diseases is well recognized [4-7].

Fruits and vegetables are cherished for their contents of vitamins, minerals, dietary fiber, and bioactive compounds. Vitamin B and vitamin C together represent the water soluble vitamin group. Vitamins are very important for the control of body chemical reactions. Vitamin C is a highly efficient antioxidant is essential for the production of collagen and neurotransmitter, norepinephrine which affects mood. Recent research also suggests that vitamin C is involved in the metabolism of cholesterol to bile acids, which may have implications for blood cholesterol levels and the incidence of gallstones [8]. Unfortunately the content and composition of these nutrients especially B-vitamins are not available in most of the food composition tables available in Bangladesh for majority of the local fruits and vegetables. Moreover, new cultivars of fruits and vegetables with high-yielding characteristics are constantly poured into the agriculture system of the country with no or negligible information on their nutrient composition. This is a concern of the food and nutrition profession personnel working on the improvement of the nutrition status of our population.

This work was aimed to screen a number of selected fruits and vegetables consumed in the local diet in Bangladesh with respect to their proximate composition and water soluble vitamins content.

2. MATERIALS AND METHODS

2.1 Key Foods Selection

Food items that contribute up to 75% of any one nutrient to the dietary intake of the population are known as key foods. According to this definition, the selected vegetables and fruits which have been analyzed for the determination of proximate nutrient and water soluble vitamins (B_1, B_2, B_6 and Vitamin C) in the present study are given below:

Table 1. Selected 10 key foods for analysis

Foods	Bengali name	English name	Scientific name	Food description
Vegetables				
1	Shim	Bean	*Dolichos lablab*	Seeds and pods, raw
2	Gajor	Carrot	*Daucus carota*	Light orange, raw
3	Begun	Egg plant	*Solanum melongena*	Purple, long, raw
4	Kancha Morich	Green chili	*Capsicum frutescens*	Green, with seeds, raw
5	Piaj	Onion	*Allium cepa*	Local, medium, raw
6	Alu	Potato	*Solanum tuberosum*	CN* Diamant, raw
7	Tomato	Tomato	*Lycopersicon esculentum*	Red, ripe, raw
Fruits				
8	Kola	Banana	*Musa paradisiaca*	CN* Sagar, ripe, raw
9	Kathal	Jackfruit	*Artocarpus heterophyllus*	Ripe, raw
10	Aam	Mango	*Mangifera indica*	CN* Langra, yellow flesh, ripe, raw

**CN: Cultivar name*

2.2 Preparation of Composite Sample

For preparation of composite sample, collected samples were washed with tap water followed by distilled and deionized water. Kitchen towel was used for soaking extra water from samples and then dried in air. Equal amount of sample of different place was taken and homogenized by food processor. Then samples were weighed in plastic petri-dish and kept in -20℃ for freeze drying. These composite samples were used for laboratory analysis.

2.3 Analysis of Proximate Composition

Proximate analysis for moisture, protein, fat, total ash and total dietary fiber were done according to the Association of Official Analytical Chemist (AOAC) [9] from selected vegetables and fruits. For analysis of protein, micro Kjeldahl method was used.

2.4 Estimation of Fat Content

The Soxhlet procedure described in method no 991.36; AOAC [9] was used to estimate total crude fat. About 2-5 g of predried sample was taken into a predried extraction thimble, with porosity permitting a rapid flow of ethyle ether. The sample was taken into a filter paper, folded into square size and dipped into the extraction tube. A Soxhlet apparatus was placed and anhydrous ether was placed in the boiling flask. Boiling flask, Soxhlet flask and condenser were assembled together. Soxhlet extractor was extracted at a rate of 2 or 3 drops per second condensation for 16 hrs by heating solvent in boiling flask. After finishing the task boiling flask was dried with extracted fat in an air oven at 100℃ for 30 mins. Finally, the desiccator was cooled and weighted for final result.

2.5 Estimation of Moisture

The edible part of the each selected fruits and vegetables (10 to 11 g) was taken in a constant crucible (pre-washed and dried at 105℃). It was then kept 100-105℃ temperature in an oven for 5 hours and cooled in desiccators and weighted again. Heating, cooling and weighing were continued until a constant weight was obtained.

2.6 Estimation of Ash Content

Ashing of samples were done using the AOAC [9] method. 2-5 g of weighted sample was taken into a clean crucible. Crucibles were placed in an oven and heated at 100-105℃ for 4 hours as sample was rich of moisture. After that dried crucibles were placed in cool muffle furnace. This process was ignited for 3-6 hours at 600℃. To ensure formation of complete ash, the crucible was again heated at the muffle furnace for half an hour, cooled and weighed. This step was repeated until two consecutive weights were same and the ash was almost white in colour.

2.7 Calculation of Carbohydrate

The content of available carbohydrate in the food sample was determined by difference. Carbohydrate was calculated by subtracting the sum percentage of moisture, protein, fat, ash, crude and dietary fiber [10]. The nitrogen free extract (NFE) was obtained by subtracting the sum of the values for moisture, protein, fat and ash from 100 [11]. This value was considered as "total carbohydrate" and was calculated by following equation.

Carbohydrate (NFE g %) = 100 - (Protein + lipid + moisture + ash + TDF) g/100 g

2.8 Determination of TDF (Total Dietary Fiber)

The procedures for the determination of total dietary fiber are based on the methods of AOAC 991.43 [12]; AOAC 985.29 [13].

2.9 Analysis of Water Soluble Vitamins

Water soluble vitamins were determined by following the ASEANFOODS [14].

2.10 Determination of Energy Level

To calculate the total energy value, used the generally accepted factors that are expresses in terms of amount of available energy per unit of weight. Then multiply the amount of carbohydrate, protein, fat and edible fiber with the respective factors and add the results together.

2.11 Statistical Analysis

The assays were run in triplicate for each sample and the results expressed as mean values ± standard deviation (SD).

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Vegetables

Results showed that the range of energy level (16-66 Kcal), moisture (81.71-95.01%), protein (0.92-2.77), fat (0.06-0.26), available carbohydrate (1.4-14.0), total dietary fiber (1.7-4.7), ash (0.60-1.04) of all selected vegetables. Among them, potatoes contain the highest energy level, available carbohydrate (66 Kcal, 14.0 g/100 g, respectively) and the lowest amount of moisture (81.71 g/100 g). Moisture content of any food is an index of its water activity and is used as a measure of stability and susceptibility to microbial contamination [15]. The high moisture content in vegetables makes them vulnerable to microbial attack, hence spoilage [16]. This high moisture content also implies that dehydration would increase the relative concentrations of other food nutrient and therefore improve the shelf-life and preservation of the fruits [17]. There is also need to store the fruit in cool condition if they are to be kept for a long period without spoilage especially in the tropics were wastage of vegetable crops is estimated to be around 50% due to high moisture content [16]. Tomatoes contain the highest moisture content (95.01%) which was also contain the lowest energy level, available carbohydrate, total dietary fiber (16 Kcal, 1.4 g/100 g, 1.7 g/100 g, respectively). The average moisture content holding capacities were found to be dependent on the nature of the plant and environment [18]. The high content of moisture in the samples suggested that they have high perishability [19]. Ash contain all the important nutritional ingredients especially minerals, both micro and macronutrients, which are very important for the normal physiological functions of the body [18]. The main functions of proteins are growth and replacement of lost tissues in the human body [20]. Nwofia et al. [16] reported that diet is nutritionally satisfactory, if it contains high caloric value and a sufficient amount of protein. It have been shown that any plant foods that provides about 12% of their calorific value from protein are considered good source of protein [21,22]. Dietary fiber promotes the growth and protects the beneficial intestinal flora. Moreover, high intake of fiber reduces the risk of colon cancer [23]. The protein, total dietary fiber and ash content in green chili was 2.77, 4.7, 1.04 g/100 g, respectively which was highest compared to other vegetables. The highest fat (0.26 g/100 g) was found from carrot which was deficient in crude protein (0.92 g/100 g) and ash (0.60 g/100 g). The amount of ash present can be translated to the quantity of minerals present in the samples [24]. Dietary fats function in the increase of palatability of food by absorbing and retaining flavors [25]. Excess consumption of fat have been implicated in certain cardiovascular disorders such as atherosclerosis, cancer, and aging, whereas a diet providing 1-2% of its caloric of energy as fat is said to be sufficient to human beings [26], in this regard, the consumption of carrot should be encouraged to reduce the risk of above diseases in man. Egg plant was deficient in fat (0.06 g/100 g).

3.2 Water Soluble Vitamins Contents of Vegetables

Results of some of the water soluble vitamins namely thiamin, riboflavin, and ascorbic acid are shown in Table 3. Thiamin content in analyzed vegetables was highest in bean and lowest in egg plant. Riboflavin was ranging from 0.043-0.136 mg/100 g of edible portion (tomato and onion, respectively). Among these vegetables tomato was containing lowest amount of vitamin B_6 and potato highest. L-Ascorbic acid content of the vegetables revealed that green chili contained highest amount (102 mg/100 g) whereas, egg plant contained the lowest (1.287 mg/100 g).

Table 2. Mean value of proximate nutrients (g/100 g edible portion) of fresh vegetables

Sl. no.	Foods	Energy (Kcal)	Moisture	Protein	Fat	Available carbohydrate	Total dietary fiber	Ash
1	Bean	29	90.02	2.41	0.11	2.5	4.3	0.65
2	Egg plant	24	91.35	1.90	0.06	2.0	4.1	0.07
3	Carrot	34	89.71	0.92	0.26	6.0	2.6	0.60
4	Green chili	45	85.51	2.77	0.13	5.9	4.7	1.04
5	Onion	59	83.73	1.37	0.07	12.2	1.9	0.68
6	Potato	66	81.71	1.19	0.16	14.0	2.1	0.87
7	Tomato	16	95.01	1.11	0.25	1.4	1.7	0.54

Table 3. Content of water soluble vitamins (mg/100 g edible portion) of fresh vegetables

Sl. no.	Foods	Vitamin B_1 (Thiamin)	Vitamin B_2 (Riboflavin)	Vitamin B_6 (Pyridoxine)	L-Ascorbic acid (Vitamin C)
1	Bean	0.083 ± 0.001	0.087 ± 0.002	0.063 ± 0.003	9.633 ± 0.55
2	Egg plant	0.028 ± 0.001	0.070 ± 0.001	0.079 ± 0.002	1.287 ± 0.46
3	Carrot	0.044 ± 0.001	0.085 ± 0.003	0.133 ± 0.005	1.436 ± 0.16
4	Green chili	0.034 ± 0.001	0.050 ± 0.001	0.230 ± 0.006	102.267 ± 3.30
5	Onion	0.044 ± 0.002	0.136 ± 0.010	0.168 ± 0.005	4.500 ± 1.13
6	Potato	0.081 ± 0.005	0.093 ± 0.010	0.277 ± 0.004	19.067 ± 5.70
7	Tomato	0.038 ± 0.001	0.043 ± 0.010	0.049 ± 0.010	12.287 ± 2.82

Results are expressed as Mean ± SD

3.3 Proximate Composition of Fruits

Proximate compositions of 3 selected fruits are presented in Table 4. Gopalan et al. [27] reported that, moisture content of different tropical fruits varied from 79.1 to 86.1%. Results of this study showed that, mango contained the highest amount of moisture (78.439%) and the lowest was in banana (75.219%). The pulp was very high in moisture content and this may underscore its high perishability and susceptibility to microbial infections; and this is indicative of low solid matter in the pulp. High moisture content characterizes the freshness of a fruit since fruits kept for some time tend to lose moisture [28]. Fruits in general are usually not considered as excellent sources of proteins [29-31]. While analyzing protein content of three fruits, the result showed that, banana had the highest concentration of protein (1.258 g/100 g) as compared to other species and mango gave the lowest result (0.790 g/100 g). It was reported that in fruits, maximum protein content ranges 1.57-5.42% but in the different varieties tropical fruits it varies from 0.4-0.8% [27]. Usually fat content of different fruits is not greater than 1% [32]. Among the analyzed fruits, the highest energy level (95 Kcal), crude fat (0.838 g/100 g), available CHO (19.2 g/100 g) were determined from banana and the lowest content (74, 0.203, 13.3 g/100 g) was found from jackfruit. The carbohydrate content ranged from 8.49-12.68% which is low and cannot be a good source of energy [19]. The ash content is a measure/reflection of the nutritionally important mineral contents present in the food material [33,34]. In this study, total dietary fiber and ash content varied widely from 1.6-7.2 g/100 g and 0.756-1.084 g/100 g, respectively which were in mango and jackfruit, respectively. Present study revealed that, the fiber content is relatively high which may suggest that consumption of jackfruit will can improve its digestibility and absorption processes in large intestine, helping to stimulate peristalsis, thereby preventing constipation [35]. Interest in fiber evaluation has increased due to the recent information on the potential role of dietary fiber in human nutrition [36]. Evidences from epidemiological studies suggest that high fiber consumption may contribute to a reduction in the incidence of certain diseases like diabetes, coronary heart disease, colon cancer, high blood pressure, obesity, and various digestive disorders [37]. Dietary fiber is known to alter the coronary environment in such a way as to protect against colorectal diseases [38]. It provides protection by increasing fecal bulk, which dilutes the increased colonic bile that occurs with high fat diet [39,40]. When found in excess, it may bind some essential trace elements leading to deficiency of some minerals such as iron and zinc [41]. Therefore, jackfruit is considered as a main source of crude fiber.

3.4 Water Soluble Vitamins Contents of Fruits

The result of water soluble vitamin analysis shows variant concentrations of composite sample of selected fruits (Table 5). Thiamin content in analyzed fruits was highest in jackfruit (2.066 mg/100 g) and lowest in mango (0.925 mg/100 g). On the other hand table shows that, riboflavin content of three fruits were mango (0.144 mg/100 g) > banana (0.080 mg/100 g) > jackfruit (0.045 mg/100 g). That means mango had the highest amount of riboflavin and jackfruit contained the lowest amount. In case of vitamin B_6, highest source was jackfruit and lowest was in mango. For L-Ascorbic acid, mango was the rich source which contained 102.977 mg/100 g (Langra variety) whereas, banana contained the lowest (1.033 mg/100 g).

Table 4. Mean value of proximate nutrients (g/100 g edible portion) of selected fresh fruits

Sl. no.	Foods	Energy (Kcal)	Moisture (%)	Protein	Fat	Available carbohydrate	Total dietary fiber	Ash
1	Banana	95	75.219	1.258	0.838	19.2	2.6	0.843
2	Jackfruit	74	76.990	1.194	0.203	13.3	7.2	1.084
3	Mango	82	78.439	0.790	0.411	18	1.6	0.756

Table 5. Content of water soluble vitamins (mg/100 g edible portion) of selected fresh fruits

Sl. no.	Foods	Vitamin B_1 (Thiamin)	Vitamin B_2 (Riboflavin)	Vitamin B_6 (Pyridoxine)	L-Ascorbic acid (Vitamin C)
1.	Banana	0.939 ± 0.020	0.080 ± 0.030	0.104	1.033 ± 0.152
2.	Jackfruit	2.066 ± 0.060	0.045 ± 0.003	0.313	3.433 ± 4.324
3.	Mango	0.925 ± 0.010	0.144 ± 0.001	0.062	102.977± 3.96

Results are expressed as Mean ± SD

4. CONCLUSION

Present study indicates that available vegetables and fruits of Bangladesh are affluent sources of proximate nutrients and as well as water soluble vitamins. This study will help the people to maintain their dietary requirements of nutrients through consumption of available vegetables and fruits. Regular intake of vegetables and fruits may alleviate the prevalence of nutrient deficiency problem from Bangladesh and this information will enrich the food composition database for Bangladesh which is essential for health, nutrition and food policy program planning.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/16025