Original article

Nutritional Profile of Some Tropical Fruits in Bangladesh: Specially Anti-Oxidant Vitamins and Minerals

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Abstract

Objective: Fruits and vegetables are important for the daily diet as these contain micronutrients, fiber, potassium, folate, Vitamin C, vegetable proteins, carotenoids and polyphenols, which act as antioxidants within the body as well as bio-functional components. The aim of the study is to establish nutritional profile specially antioxidant vitamins and minerals of tropical fruits in Bangladesh. ***Methodology:*** Nutritional composition and physico-chemical properties, such as pH, titratable acidity, moisture, total soluble solid, crude fibre, total carbohydrate, total protein, total fat, total energy, vitamin C, beta-carotene, ash, sodium, potassium, iron, zinc, copper, manganese, phosphorus, calcium and magnesium content of ten tropical fruits namely Blackberry, Java apple, Jack fruit, Pineapple, Carambola (Star fruit), Golden apple, Mango, Melon, Monkey jack, Star gooseberry were determined according to standard methods. ***Results:*** Results of this study suggest that the tropical fruits of Bangladesh were excellent source of antioxidant vitamins and minerals like vitamin C, beta- carotene, iron, zinc, copper and manganese. These fruits were also good source of potassium, phosphorus, calcium and magnesium but poor source of protein and fat and sodium. ***Conclusion:*** Present study strongly suggests that star gooseberry, monkey jack, pineapple and golden apple were antioxidant vitamins and minerals enriched tropical fruits.

Key words: Antioxidant vitamins and minerals, micronutrients, tropical fruits.

Introduction

Consumption of fruits and vegetables is vital for a diversified and nutritious diet. Increasing dietary diversification is the most important factor in providing a wide range of micronutrients and this requires an adequate supply, access to and consumption of a variety of foods. However, food surveys show continuing low consumption of fruits and vegetables in many regions of the developing world[1]. The total fruit availability per person per day is 155g which is much higher than the current consumption of 34 g per person per day in Bangladesh[2].

Adequate consumption of fruits and vegetables provides both essential nutrients and compounds that provide other beneficial physiological effects, not all of which are known. Consumption of fruit and vegetables, as well as grains, has been strongly associated with reduced risk of cardiovascular disease, cancer, diabetes, Alzheimer disease, cataracts, and age-related functional decline[3, 4, 5, 6, 7]. Heart disease, cancer, and stroke are the top three leading causes of death in the United States and most industrialized countries. It is estimated that one third of all cancer deaths in the United States could be avoided through appropriate dietary modification [7, 8].

In the report on diet and cancer, the National Academy of Sciences included guidelines emphasizing the importance of fruit and vegetables in the diet. The value of adding

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citrus fruit, carotene-rich fruit and vegetables, and cruciferous vegetables to the diet for reducing the risk of cancer was specifically highlighted[9]. Several trace elements protect the cell from oxidative cell damage as these minerals are the cofactor of antioxidant enzymes. Zinc, copper and manganese are required for superoxide dismutases in both cytosol and mitochondria. Iron is a constituent of catalase, a hemeprotein, which catalyzes the decomposition of hydrogen peroxide[10].
Small amounts of micronutrients (minerals and vitamins) are needed for good health along with energy food and protein. Sodium, potassium, iron, calcium, phosphorus and many trace elements including antioxidant vitamins and minerals are essential for the body. Fruits and vegetables, especially leafy, have significant amounts of calcium, iron and potassium along with vitamins including vitamins A and C[2].

Information about the composition of food is essential for dietary recommendation and supplementation of food. It is also necessary for nutritional education, training and research[11]. There is a world wide call to develop a national food composition database. However, in our country the food composition tables currently used are nearly forty years back and taken from other country, people of which have different culture, food habit, weather etc[12]. Nutritional data of fruits in Bangladesh is not available [11]. The purpose of this study is to prepare a new and update nutritional information of tropical fruits which would be related with our food habit. Dietary diversification through fruits and vegetable intake and supported by nutrition education is seen as a sustainable approach to fighting micronutrient malnutrition.

Materials and Methods

This experiment was carried out at Institute of Food Science and Technology, BCSIR, Dhaka. Ten types of fruits were analyzed in this study. These are Blackberry, Java apple, Jack fruit, Pineapple, Carambola (Star fruit), Golden apple, Mango, Melon, Monkey jack, Star gooseberry. The selected fruits were collected from different local markets in Dhaka city. Collected samples were fresh, matured, and free from insect's bites and other organoleptic deterioration. The freshly collected sample was washed with deionized water to eliminate visible dirt and removed the water quickly with a blotting paper. Then the sample was cut into small pieces, homogenized and accurate amount was weighed as required for different analysis. Three samples from each fruit was selected for measurement of various parameter and the analytical data were present the average value on a wet weight basis.

The p^H was determined with a digital p^H meter [13] (Ibrahim 2002) and titratable acidity was estimated with the visual acid-base method[14]. Moisture content was determined by digital moisture analyzer. The total soluble solid (TSS) was determined with a hand refractometer[15]. Crude fiber was determined by AOAC official method of analysis[16]. The total fat content of sample was determined by the standard AOAC method[17] and the estimation of total protein was made by Kjeldahl method[18]. The content of total carbohydrate was determined by the following equation:

Carbohydrate (%) = 100- {Moisture (%) + Protein (%) + Fat (%) + Ash (%)}
The gross food energy was estimated by using the equation[19, 20]:
FE = (% CHO x 4) + (% CF x 9) + (% CP x 4)
Where: FE = Food Energy in Kcal /g, CF = Crude Fat, CP = Crude Protein.

Vitamin C was determined titrimetrically using 2,6-dichliorophenolindophenol[21,22]. Beta carotene content of the tropical fruit samples was estimated by using spectrophotometer after chromatographic separation of pigments[14]. Ash was determined by heating sample at 600^{o}C for six hours or until a constant weight was reached[14]. Sodium and potassium contents were determined by flame photometric method[23]. Zinc and copper was estimated by using spectrophotometer[24]. Manganese, iron and phosphorus content were determined spectrophotometrically by AOAC official methods of analysis[24]. Calcium[18] and Magnesium was determined titrimetrically[25].

Results and Discussion

In Bangladesh, any systematic analysis of nutritional compositions of fruits and vegetable have not launched yet. Farther more, there are so many high yielding fruits and vegetables have been cultivated with the improvement of agricultural technology. These fruits and vegetable replace some of our traditional foods, the nutritive values of which are not yet to be determined. The results of the investigation on nutritional and physico-chemical parameters especially antioxidant vitamins and minerals of ten tropical fruits are given in the table I and table II.

The p^H among the tropical fruits varied from 3.0 to 6.2. The lowest p^H was found in carambola, 3.0 and the highest amount of titratable acidity was seen in golden apple, 0.9%. On the other hand the highest p^H was observed in java apple, 6.2 and the lowest amount of titratable acidity was found in melon, 0.12%. It was found that the p^H range of ripe fruits was 4.5 to 5.35 [26].

Most fruits and vegetables are composed of 70% to 90% water[12]. The moisture content of ten different fruits ranged between 83.76% and 94.89%. Among the fruits analyzed, melon contained the highest amount of water around 94.89% and the minimum amount of moisture was found in pineapple, 83.76%. Moisture content of different fruits depends on some factors including rainfall, soil water and type of soil. Soil moisture supply mainly depends on rainfall[27].

The total soluble solid (TSS) among ten different fruits were 8% to 19 %. The highest amount of TSS was found in jackfruit, 19% and the lowest in java apple, 8%. Generally higher TSS indicates more sugar in the pulp. The more ripe the fruits the more amount of sugar in fruits[12]. According to Norman, the sugar content of fresh fruits ranges between 2% and 30% [28]. This range is as similar to the present study.

In this study, it was found that dietary fiber, the important constituent of fruit ranges from 0.32% to 2.69% Fiber content found the maximum in Golden apple, 2.69% and the minimum amount was observed in melon, 0.32%. The recommended daily dietary fiber intake is 28 g/day for adult women and 36 g/day for adult men[29]. Most health advisory groups provide guidance for obtaining the recommended levels of fiber consumption from foods, especially fruits, vegetables, and whole grains[29, 30].

Carbohydrate of fruit is less concentrated than cereals because of their high water content. In the study, total carbohydrate present in fruits ranges between 3.23% and 11.94%. The highest amount of carbohydrate was present in pineapple 11.94% and the lowest amount of carbohydrate was present in melon 3.23%. Fruits rich in carbohydrate provides high amount of energy. Pineapple showed the highest amount of energy, 53.88 kcal/100g due to its high carbohydrate content. Melon provides the lowest amount of energy, 16.85 kcal/100g because of its lower carbohydrate content.

Fruits contain small amount of protein. In general, protein content of different fruits is not greater than 3.5%[28]. In this study, it was found that protein content of different fruits varied between 0.42% and 1.91%. This range supports the reference value. Usually fat content of different fruits is not greater than 1% [28]. In this study it was seen that fat content of different fruits ranged between 0.14% and 0.87%. The highest amount of fat was found in carambola, 0.87% and the lowest amount was found in golden apple, 0.14 %.

In this study it was observed that fruits are rich sources of vitamin C (ascorbic acid). Monkey jack (171.07mg/100g), blackberry (151.51mg/100g), and star gooseberry (135.34mg/100g) contained high amount of vitamin C. The maximum amount of vitamin C was found in monkey jack, 171.07mg/100g and the lowest amount was present in Melon, 33.93 mg/100 g. The North American Dietary Reference Intake recommends 90 milligrams per day and no more than 2 grams (2,000 milligrams) of vitamin C per day [31]. So daily 50-90 g of monkey jack, blackberry or star

gooseberry is enough to meet the daily requirements of vitamin C.

There is no RDA for beta-carotene or other provitamin A carotenoids. The IOM (Institute of Medicine) states that consuming 3 - 6 mg of beta-carotene daily (equivalent to 833 IU to 1,667 IU vitamin A) will maintain blood levels of beta-carotene in the range associated with a lower risk of chronic diseases[32]. In the present study highest amount of beta carotene found in jackfruit, 4401.82µg (4.40mg) and lowest amount found in blackberry, 1112.38 µg (1.11mg).

The amount of total ash (mineral) present in selected fruits ranges between 0.68 % and 2.13 %. Ash content was found the highest in Monkey jack, 2.13% and the lowest in carambola 0.68%. Gardner et al. (1939) observed that the total content of mineral salt as ash in fruits varied from 0.2% to1.5% [33]. This range is closer to the present study except monkey jack (2.13%) and star gooseberry (1.61%).

Literature available indicated that fruits contain negligible amount of sodium[34]. In the present study, it was observed that sodium present in different fruits ranges between 9 mg and 66 mg/100g of edible portion. The highest amount of sodium was found in jackfruit, 66 mg/100g and the lowest amount was in java apple, 9 mg/100g. Sodium variability of fruits sometimes relies on soil sodium. Black soil contains fair amount of sodium. Potassium is plentiful in fruits[35]. In the present study, the highest quantity of potassium was observed in monkey jack, 785 mg/100 g. Melon contains the lowest amount, 211mg/100g. These values were found different from the previous reports[36, 37]. For the healthy adult, the USDA Recommended Daily Allowance (RDA) for sodium and potassium intake not more than 2,400 mg and 4700 mg respectively per day[29].

Iron content was found higher in monkey jack, 15.09 mg/100g and lower in carambola, 3.27 mg/100g. Iron present in fruits analyzed ranges between 3.27mg and 15.09 mg/100g. These results are close to the previous results[36, 38, 39]. According to USDA the daily recommended intake of iron is 8mg for adult male and 18mg for adult female. The U.S. recommended dietary allowance (RDA) for zinc is listed by gender and age group, the RDA for zinc (8 mg/day for adult women and 11 mg/day for adult men) appears sufficient to prevent deficiency in most individuals [32]. Most fruits contain a small amount of zinc as the zinc in whole grain products and plant proteins is less bioavailable due to their relatively high content of phytic acid, a compound that inhibits zinc absorption[40]. The highest amount of zinc found 1.75 mg% in pineapple and lowest level found 0.48 mg% in carambola. RDA for copper is 900 µg/day for both adult male and female[32]. Most fruits contain a small amount of copper. Present study shows highest quantity of copper in monkey jack (1.31 mg%) and lowest quantity in carambola (0.39mg%). Results showed that the tropical fruits contained a rich amount of manganese. Jackfruit, Golden apple and monkey jack contained high amount of manganese. The highest amount of manganese was found in monkey jack (3.76mg%) and lowest amount found in melon (1.48mg%). RDA for manganese is 2.3mg/day for adult male and 1.8mg/day for female[29].

Phosphorus amount in the tropical fruits ranged from 36.08 to 143.48, whereas maximum amount found in mango (143.48 mg %) and minimum amount found in java apple (36.08 mg %). The results of the present study show the similar to those reports by the previous results for phosphorus[36, 37].

Tropical fruits are rich source of calcium and magnesium. Calcium amount in the tropical fruits ranged from 15 to 51 mg/100g. Golden apple (51 mg %), monkey jack (47 mg%) and mango (35 mg%) contained high amount of calcium. Amount of magnesium in tropical fruits ranged from 20 to 55 mg%. Monkey jack (55 mg%) and carambola (20 mg%) contained the highest and lowest amount of magnesium respectively. The present study shows, several values which are different to previous reports[39, 41]. In this study, calcium level of mango, jackfruit and pineapple have found 35, 29 and 27 mg% instead of 16, 20 and 18 mg%

respectively in previous study. On the other hand amount of magnesium found in pineapple 41 mg% instead of 80 mg% and blackberry 47mg% instead of 30 mg%.

Conclusion

This study indicates that the tropical fruits of Bangladesh are excellent source of antioxidant vitamins like vitamin C, beta-carotene and antioxidant minerals such as zinc, copper, manganese, iron. These fruits are rich source of fiber but poor source of protein and fat. These are also rich source of potassium, phosphorus, calcium and magnesium. Carbohydrate and brix content as well good in tropical fruits. The major findings of this study include that star gooseberry, monkey jack, pineapple and golden apple are very rich in antioxidant vitamins and minerals, mango, blackberry, jackfruit and carambola are also rich whereas melon and java apple are insufficient in antioxidant vitamins and minerals.

Although local fruits contain ample amount of micronutrients, Bangladeshi people have a tendency to purchase the high cost foreign fruits due to ignorance, and unavailable of food composition table of fruits. This study will help the people to measure nutrient content and fulfill the daily requirement by cheap and local food items. If we enhance the regular intake of fruits, then it is possible to alleviate prevailing micronutrient deficiency problem from Bangladesh.

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Table I: Nutritional and physicochemical parameters of selected ten tropical fruits (Result expressed as per 100g of edible portion)

English name	Local name	Scientific name	pH	Titratable Acidity (%)	Moisture (%)	TSS (%)	Crude fiber (g)	Total Carbohydrate (g)	Total Protein (g)	Total Fat (g)	Total Energy (Kcal)	Vitamin C (mg)	Beta-carotene (µg)
Blackberry	Kalojam	*Syzygium cumini*	3.2	0.89	85.25	9.5	0.85	11.24	0.87	0.54	53.30	151.51	1112.38
Java apple	Jamrul	*Syzygium samarangense*	6.2	0.13	89.81	8	1.56	6.94	0.67	0.21	32.33	40.22	1715.51
Jack fruit	kanthal	*Artocarpus heterophyllus*	5.5	0.30	86.21	19	1.27	9.11	1.91	0.18	45.70	35.32	4401.82
Pineapple	Anarash	*Ananas comosus*	3.9	0.44	83.76	12	1.03	11.94	1.08	0.20	53.88	104.81	1858.73
Carambola (Star fruit)	Kamranga	*Averrhoa carambola*	3.0	0.70	89.27	9	1.63	7.07	0.48	0.87	38.03	65.00	1340.87
Golden apple	Amra	*Spondius mangifera*	3.1	0.90	87.69	13	2.69	6.85	1.12	0.14	33.14	128.78	2377.06
Mango	Aam (Fazli)	*Mangifera indica*	4.7	0.35	86.64	17	1.02	9.04	1.23	0.62	46.66	55.56	3504.61
Melon	Bangi (Phuti)	*Cucumis melo*	4.4	0.12	94.89	11.8	0.32	3.23	0.42	0.25	16.85	33.93	1850.00
Monkey jack	Deophal (Deua)	*Artocarpus lakaocha*	4.9	0.34	84.25	16	2.41	9.47	1.03	0.71	48.39	171.07	3718.16
Star gooseberry	Orboroi	*Cicca acida*	5.6	0.29	90.42	12.5	1.12	5.12	1.37	0.36	29.20	135.34	2107.89

Each value represents the average from three replications

Table II: Minerals content of selected ten tropical fruits. (Result expressed as per 100g of edible portion)

English name	Local name	Scientific name	Ash (g)	Sodium (mg)	Potassium (mg)	Iron (mg)	Zinc (mg)	Copper (mg)	Manganese (mg)	Phosphorus (mg)	Calcium (mg)	Magnesium (mg)
Blackberry	Kalojam	*Syzygium cumini*	1.25	28	285	4.76	1.55	1.02	2.62	45.39	24	47
Java apple	Jamrul	*Syzygium samarangense*	0.81	9	221	3.85	0.58	0.41	1.86	36.08	15	23
Jack fruit	kanthal	*Artocarpus heterophyllus*	1.32	66	623	5.08	1.13	0.87	3.07	50.72	29	35
Pineapple	Anarash	*Ananas comosus*	1.79	34	538	10.23	1.75	0.92	2.65	57.82	27	41
Carambola (Star fruit)	Kamranga	*Averrhoa carambola*	0.68	27	248	3.27	0.48	0.39	1.55	71.17	18	20
Golden apple	Amra	*Spondius mangifera*	1.53	23	675	7.62	1.23	1.12	3.11	116.28	51	38
Mango	Aam (Fazli)	*Mangifera indica*	1.45	47	497	4.29	0.87	1.05	2.92	143.48	35	28
Melon	Bangi (Phuti)	*Cucumis melo*	0.89	42	211	8.51	0.65	0.57	1.48	96.68	28	21
Monkey jack	Deophal (Deua)	*Artocarpus lakaocha*	2.13	46	785	15.09	1.68	1.31	3.76	66.06	47	55
Star gooseberry	Orboroi	*Cicca acida*	1.61	32	727	5.42	1.44	0.62	2.32	82.31	33	29

Each value represents the average from three replications

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