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Nutrients, Vitamins and Minerals Content in Common Citrus Fruits in the Northern Region of Bangladesh

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Abstract: Seventeen different common citrus fruits have been analyzed for their content of nutrients: carbohydrate, protein, lipids, vitamins, β -carotene, thiamine, riboflavin, ascorbic acid, important macro and micro minerals such as sodium, potassium, calcium, magnesium, phosphorous, iron, zinc and copper. Carbohydrate, protein and fats in citrus fruits varied from 4.60-8.50, 5.80-7.90 and 2.50-9.50 g, respectively. The content of β -carotene, thiamine, riboflavin and ascorbic acid varied different amounts in citrus fruits. The highest contents of β -Carotene fruits are orange and tomato. Among the analyzed citrus fruits pineapple content the maximum amount of thiamine ($0.20 \text{ mg } 100^{-1} \text{ g}$) and wood apple content maximum riboflavin ($0.15 \text{ mg } 100^{-1} \text{ g}$). Amla (Indian gooseberry) fruits contents the highest ascorbic acid $600 \text{ mg } 100^{-1} \text{ g}$ of fresh edible parts of fruits. Lemon contained the highest amount of calcium. The highest amount of magnesium was found in Black berry ($49.80 \text{ mg } 100^{-1} \text{ g}$ of edible portion of the fruits). Sodium present in different citrus fruits ranged from 1.0 to $28 \text{ mg } 100^{-1} \text{ g}$. Wood apple contained the highest amount of phosphorus ($98.90 \text{ mg } 100^{-1} \text{ g}$) among all citrus fruits. Tomato contained the highest amount of Potassium ($275 \text{ mg } 100^{-1} \text{ g}$). The iron content in different fruits ranged from 0.10 to $38 \text{ mg } 100^{-1} \text{ g}$. Zinc present in fruits ranged between 0.18 to $0.48 \text{ mg } 100^{-1} \text{ g}$. Copper content in different fruits analyzed ranged from 0.1 to $0.68 \text{ mg } 100^{-1} \text{ g}$ of fruits.

Key words: Citrus fruits, vitamins, essential nutrients, macro, micro elements

INTRODUCTION

Health and nutritional problem continues to be of increasing concern worldwide. Health profile of a community is greatly influenced by its nutritional status and life style. Bangladesh is one of the poor countries of the world. Eighty percent of the population lives below poverty line^[1]. Various nutrition surveys carried out in this country have documented early that inadequate calorie intake is the principal impediment to better nutrition. Nutritionists have raised concern on the nutritive value of cooking food because density of the most nutrients content like protein, carbohydrate, Vitamins and minerals are lower^[2]. Fruits are known to have included in the human diet since prehistoric time and are now in the western and developing countries there is a habit to take fresh fruits after lunch or dinner. In Bangladesh different kinds of seasonal fruits are available which are rich to content food nutrients, vitamins and minerals and also popular to all aged peoples. Particularly some seasonal citrus fruits are very delicious, nutritious and attracted by the students and other people also. Some times after

starvation of serious diseases, doctors are suggested to take some special fresh citrus fruits for fresh enzymes, vitamins and minerals which recover week health conditions by improving appetite quickly. Vitamins are accessory factors that must be present in the food in minute amounts to enable growth, health and life to be maintained. Fruits as a class are valuable chiefly for their content of vitamins. Fruits also content appreciable amount of essential minerals^[3]. Minerals are inorganic substances required by the organism in very small amount for maintenance of vital processes essential for life. At least fourteen minerals are essential for normal functioning of human body processes, each of which has its specific role to play^[4]. Fruits are generally low in natural sodium^[5]. High sodium intake has been proved to increase high blood pressure^[6]. Fruits are not considerable to be the sources of calcium but some fruits contain appreciable amount of calcium^[5]. Magnesium content of fruits is relatively high. There is some evidence for accumulating magnesium does have anticancer effects^[7]. Fruits are very poor in their content of trace materials but nutrients, fresh enzymes and co-enzymes are available.

Commonly available citrus fruits have been analyzed for a considerable period of time in order to develop a citrus food composition table in the northern region for Bangladesh. Data showing carbohydrate, protein, lipid, vitamins and mineral content of citrus fruits are quite scarce in literature. The present study describes the nutritive values by analyzing quantitatively of carbohydrate, protein, lipid, vitamins and minerals in some common citrus fruits in the northern region of Bangladesh.

MATERIALS AND METHODS

Collection of fruits and sample preparation: Seventeen different common citrus fruits were collected from different markets of Kushtia and Rajshahi city. Following collection, the whole fruits were cleaned and washed with distilled water. Weight of each fruit was recorded and then packed in a polyethylene bag, store at -20°C until analysis. Edible portion of the fruits were separated carefully and used for all analytical investigation. All the analyses were done in triplicate and the results are representing on a fresh weight basis.

Analytical procedures: The edible portions of fruits (4.0 g) were taken in a crucible and the moisture content was determined by weight loss of the sample on drying at 105°C for 6 h. Using $\text{N} \times 6.25$ calculated protein content from total nitrogen after determination of the total nitrogen by semi-micro Kjeldhal method^[7]. Lipid was determined by AOAC official method 922.06^[7]. Crude fiber was determined by the method of ICOMR^[8]. The sample was charred and ashes to a constant weight, the residue being quantified as ash by AOAC official method 942.05^[7]. The nitrogen free extracts (NFE) were considered as total carbohydrate and was calculated by the following equation: Carbohydrate (g 100^{-1} g) = $100 - (\text{moisture} + \text{protein} + \text{lipid} + \text{fiber} + \text{ash})$ g 100^{-1} g.

Thiamine and Riboflavin were estimated by the methods^[9-11]. Ascorbic acid (Vitamin-C) content was estimated by 2,4-dinitro-phenylhydrazine method^[12], β -carotene was estimated by the method of Holden^[13].

For the estimation of minerals, 5.0 g of sample was wet ashed using a mixture of 18 M sulphuric acids, 12 M perchloric acid and 16 M nitric acid [0.5: 1.0: 0.5 v/v/v]^[14]. After proper dilution, the concentration of Fe, Zn, Cu, Ca and Mg were determined by measuring atomic absorption, while sodium and potassium were determined by measuring atomic emission according to Milner and Whiteside^[15] by using an atomic absorbance

spectrophotometer (Pyr Unicam SP-9). An appropriate dilution was done with 0.5% lanthanum (w/w) to overcome ionic interference during the estimation of calcium and magnesium. Estimation of phosphorous was done calorimetrically using the method of Fiske and Subbarow^[16].

Statistical analysis: The data are expressed as the mean and standard deviation. The difference of the means values using one-way analysis of variance following by Duncan's multiple range tests (DMRT) at the level of $p < 0.05$. $n = 3$.

RESULTS

The major nutrients content in citrus fruits were analyzed (Table 1). Carbohydrate content in different fruits ranged from 23 to 6 g 100^{-1} g fresh edible parts of fruits. Pineapple contents the highest amount of carbohydrate. The highest amounts of protein and lipids contents fruits are tomato (7.1 g 100^{-1} g) and lemon (0.8 g 100^{-1} g), respectively. But the maximum fiber content fruit are pineapple, tomato and wood apple among the analyzed fruits. β -Carotene, Thiamine, Riboflavin and Ascorbic acid contents in common citrus fruits were analyzed (Table 2). The highest contents of β -Carotene fruits are orange and tomato. Thiamin and riboflavin are very poor in citrus fruits; among the analyzed citrus fruits pineapple content thiamine (0.20 mg 100^{-1} g) and wood apple content riboflavin (0.15 mg 100^{-1} g), which, were the highest amount. Amla (Indian gooseberry) fruits contents the highest Ascorbic acid 600 mg 100^{-1} g of fresh edible parts of fruits

The major minerals contents in fruits were analyzed (Table 3). Calcium present in different citrus fruits ranged from 3 to 70 mg 100^{-1} g fresh fruits. Lemon contained the highest amount of calcium. The highest amount of magnesium was present in Black berry (49.8 mg 100^{-1} g of edible portion of the fruits). Sodium present in different fruits ranged from 1 to 28 mg 100^{-1} g fruits. Wood apple contained the highest amount of phosphorus (98.9 mg 100^{-1} g) among all citrus fruits. Potassium contained varied between 65 to 275 mg 100^{-1} g in citrus fruits and tomato contained the highest amount. Trace minerals content in citrus fruits were analyzed (Table 4). The iron content in different fruits ranged from 0.10 to 38.0 mg 100^{-1} g. Zinc present in fruits ranged between 0.18 to 0.48 mg 100^{-1} g. Copper content in different fruits analyzed ranged from 0.1 to 0.68 mg 100^{-1} g of fruits.

Table 1: Mean±SD of major nutrient content in some common citrus fruits in the northern region of Bangladesh

Common name	Scientific name	Nutrient content (g 100 ⁻¹ g)				
		Moisture	Fiber	Carbohydrate	Protein	Fats
Tomato	<i>Lycopersicum esculentum</i>	93.5±1.4	5.0±0.7	14.9±0.7	7.1±0.4	0.5±0.02
Olive	<i>Elaeocarpus robustus</i>	82.2±0.6	4.5±0.4	18.4±0.9	3.8±0.2	0.3±0.01
Orange	<i>Citrus wamtium</i>	87.1±0.7	0.3±0.02	6.0±0.4	0.8±0.02	0.2±0.02
Black berry	<i>Syzygium cumini</i>	85.9±1.4	0.6±0.06	16.0±1.2	1.4±0.7	0.6±0.2
Litchi	<i>Litchi chinensis</i>	80.3±0.9	0.5±0.02	18.9±0.7	4.5±0.9	0.6±0.02
Pine apple	<i>Ananas comosus</i>	85.7±1.2	8.6±1.2	23.5±1.2	0.5±0.02	0.1
Lemon	<i>Citrus limon</i>	84.2±1.9	1.6±0.6	10.8±0.4	0.9±0.06	0.8±0.2
Amla, (Indian gooseberry)	<i>Emblia officinalis</i>	81.8±0.7	3.3±0.4	13.1±1.2	0.4±0.06	0.1
Grapes (blue Variety)	<i>Vitis vinifera</i>	85.3±0.9	2.7±0.2	9.9±0.4	0.7±0.02	0.1
Grape fruit	<i>Citrus paradisi</i>	90.7±1.4	trace	7.0±0.2	0.7±0.04	0.1
Mango green	<i>Mangifera Indica</i>	88.2±1.2	1.1±0.04	11.6±1.2	0.7±0.06	0.1
Jambu fruit	<i>Syzygium cumini</i>	77.2±2.4	0.9±0.06	19.5±0.4	0.6±0.02	0.1
Pomegranate	<i>Punica granatum</i>	77.1±0.4	0.5±0.02	9.9±1.2	1.4±0.4	0.1
Wood apple	<i>Limonia acdissima</i>	62.5±1.2	4.9±0.7	14.5±0.9	6.9±0.9	0.5±0.06
Star apple	<i>Eugenia javonica</i>	90.4±1.9	2.4±1.2	12.8±0.7	6.4±0.7	0.1
Pomeloe	<i>Citrus maxima</i>	87.0±1.2	1.6±0.02	11.5±1.2	0.6±0.06	0.1
Plum	<i>Prunus domestica</i>	89±1.9	trace	8.9±1.9	0.7±0.07	0.2±0.01

Table 2: Mean±SD of vitamins content in some common citrus fruits in the northern region of Bangladesh

Common name	Scientific name	Vitamins content (mg 100 ⁻¹ g)			
		β-Carotene	Thiamine	Riboflavin	Ascorbic acid
Tomato (ripe)	<i>Lycopersicum esculentum</i>	340±22	0.10±0.2	0.06±1.9	30±9
Olive	<i>Elaeocarpus robustus</i>	103±12	0.1±0.04	0.09±0.05	29±5
Orange	<i>Citrus wamtium</i>	345±32	0.12±0.4	0.05±0.1	62±10
Black berry	<i>Syzygium cumini</i>	50±5.9	0.12±0.6	0.06±0.2	30±6.9
Litchi	<i>Litchi chinensis</i>	120±6.8	0.14±0.4	0.06±0.04	39±5.5
Pine apple	<i>Ananas comosus</i>	18±1.9	0.20±0.5	0.12±0.2	35±1.9
Lemon	<i>Citrus limon</i>	50±10	0.02±1.9	0.01	37±179
Amla, (Indian gooseberry)	<i>Emblia officinalis</i>	8±1.2	0.03±1.9	0.01	590±22
Grapes (blue Variety)	<i>Vitis vinifera</i>	15±1.9	0.04±0.01	0.03	23±9
Grape fruit	<i>Citrus paradisi</i>	98±4	0.12±0.4	0.02	31±10
Mango green	<i>Mangifera Indica</i>	150±24	0.08±0.2	0.03	13±1.9
Jambu fruit	<i>Syzygium cumini</i>	50±9	0.03±0.01	0.01	17±1.3
Pomegranate	<i>Punica granatum</i>	97±1.2	0.06±0.2	0.10	15±129
Wood apple	<i>Limonia acdissima</i>	60±10	0.03±0.05	0.15±0.2	13±2.9
Star apple	<i>Eugenia javonica</i>	120±1.2	0.07±0.02	0.01	45±1.5
Pomeloe	<i>Citrus maxima</i>	120±20	0.03±0.02	0.03	20±7
Plum	<i>Prunus domestica</i>	166±12	0.04±0.01	0.03	10±0.2

Table 3: Mean±SD of major mineral content in some common citrus fruits in the northern region of Bangladesh

Common name	Scientific name	Major mineral contents (mg 100 ⁻¹ g)				
		Ca	Mg	Na	P	K
Tomato	<i>Lycopersicum esculentum</i>	27.0±1.2	17±1.8	5.5±0.9	28±1.8	275±2.8
Olive	<i>Elaeocarpus robustus</i>	25.0±2.8	10.0±1.2	2.6±0.2	23.0±1.1	188±1.2
Orange	<i>Citrus wamtium</i>	25.5±1.9	16.2±1.6	28.0±0.4	24.2±1.4	99.4±12
Black berry	<i>Syzygium cumini</i>	21.5±1.5	49.8±1.2	3.5±0.8	18.5±2.8	130±8
Litchi	<i>Litchi chinensis</i>	9.8±0.6	22.5±1.2	0.8±0.2	17.2±3.2	89.9±16
Pine apple	<i>Ananas comosus</i>	15.0±0.8	42.0±2.8	2.9±0.5	20.9±1.2	228±15
Lemon	<i>Citrus limon</i>	70±6.8	12±3.2	1.5±0.8	10±0.8	148±12
Amla, Indian gooseberry	<i>Emblia officinalis</i>	27.0±1.6	24.5±2.2	3.2±2.2	22.8±2.1	185±24
Grapes, blue variety	<i>Vitis vinifera</i>	30±1.8	40±0.8	4±0.8	20±1.8	249±15
Grape fruit	<i>Citrus paradisi</i>	20±5.4	10±0.8	1.0±0.8	20±0.9	200±20
Mango green	<i>Mangifera Indica</i>	18.2±1.8	25.5±1.6	1.8±0.4	19.0±1.4	131±28
Jambu fruit	<i>Syzygium cumini</i>	20.0±1.4	23±2.6	1.6±0.07	10.0±0.2	
Pomegranate	<i>Punica granatum</i>	30.0±3.8	12±0.8	4±0.8	30.0±5.8	171±12
Wood apple	<i>Limonia acdissima</i>	28.5±1.8	9.5±0.8	2.6±0.06	98.9±22	104±14
Star apple	<i>Eugenia javonica</i>	3.1±0.8	20.7±2.1	2.8±0.8	17.0±1.8	67.2±11
Pomeloe	<i>Citrus maxima</i>	10±0.8	21.6±1.9	2.7±0.01	20±2.1	106±32
Plum	<i>Prunus domestica</i>	20±8	9.8±2.4	4.1±0.08	20.0±4	129±12

Table 4: Mean±SD of trace mineral content in some common citrus fruits in the northern region of Bangladesh (mg 100⁻¹ g)

Common name	Scientific name	Fe	Zn	Cu
Tomato	<i>Lycopersicon esculentum</i>	0.9±0.01	0.19±0.02	0.06±0.01
Olive	<i>Elaeocarpus robustus</i>	0.17±0.03	0.20±0.01	0.11±0.04
Orange	<i>Citrus aurantium</i>	0.38±0.02	0.48±0.08	0.20±0.04
Black berry	<i>Syzygium cumini</i>	0.15±0.01	0.28±0.03	0.07±0.02
Litchi	<i>Litchi chinensis</i>	0.14±0.01	0.32±0.03	0.12±0.05
Pine apple	<i>Ananas comosus</i>	0.2±0.01	0.26±0.04	0.18±0.03
Lemon	<i>Citrus limon</i>	0.23±0.02	0.12±0.03	0.26±0.09
Amla, Indian gooseberry	<i>Emblica officinalis</i>	0.21±0.04	0.32±0.06	0.14±0.03
Grapes, blue variety	<i>Vitis vinifera</i>	0.4±0.02	0.23±0.09	0.08±0.01
Grape fruit	<i>Citrus paradisi</i>	0.5±0.02	0.14±0.06	0.06±0.02
Mango green	<i>Mangifera Indica</i>	4.5±0.01	0.30±0.02	0.24±0.03
Jambu fruit	<i>Syzygium cumini</i>	1.0±0.02	0.38±0.6	0.12±0.04
Pomegranate	<i>Punica granatum</i>	0.3±0.01	0.25±0.03	0.17±0.02
Wood apple	<i>Limonia acidissima</i>	0.6±0.04	0.21±0.03	0.20±0.06
Star apple	<i>Eugenia javonica</i>	0.11±0.02	0.21±0.02	0.68±0.08
Pomeloe	<i>Citrus maxima</i>	0.4±0.03	0.15±0.04	0.19±0.05
Plum	<i>Prunus domestica</i>	0.5±0.02	0.35±0.08	0.09±0.02

DISCUSSION

In this study, seventeen different kinds of locally available common citrus fruits were analyzed for their content of major nutrients, vitamins and essential minerals. The nutrients and vitamins under study are not varied significantly. In our study Pineapple contains the highest amount of carbohydrate, tomato (7.1 g 100⁻¹ g) is the highest amounts of protein and lemon (0.8 g 100⁻¹ g) is the highest lipids contents fruit. Vitamins are accessory factors, which must be present in the food in minute amounts to enable growth, health and life to be maintained. The common and easy sources of vitamins are fresh fruits. The highest contents of β-Carotene and Ascorbic acid fruits are orange, tomato and Amla (Indian gooseberry), respectively. The composition of fruits nutrients and vitamins may vary due to climate condition, nature of soil and maturity of fruits. The minerals under study comprised five major minerals (Ca, Mg, P, Na and K) and three trace minerals (Fe, Zn and Cu). The composition of fruits, especially their minerals content, may vary largely due to topographical variations. Nature of soil, heavy rainfall and maturity of fruits may also be partly responsible for this variation.

In general, fruits are not good sources of calcium. In this study, it was found that only few citrus fruits contained a significant amount of calcium. These are Lemon (70 mg 100⁻¹ g), Grapes and Pomegranate (30 mg 100⁻¹ g) and Wood apple (29 mg 100⁻¹ g). These values are very close to that reported by other studies^[17-18]. Among the common citrus fruits analyzed, Blackberry contains 50 mg, Pineapple and grapes blue variety contains 42 mg of magnesium 100⁻¹ g of fruits, respectively. These results are good agreement with reported by Gopalan *et al.*^[17]. Citrus fruits are not good sources of phosphorous as found in this study, wood apple contains (99 mg 100⁻¹ g), pomegranate and tomato

(30 mg 100⁻¹ g), respectively. And fruits are not good sources of phosphorous also as reported by Gopalan *et al.*^[17]. Potassium is found to be sufficient in all citrus fruits analyzed. The highest Potassium contents citrus fruits are Tomato (275 mg 100⁻¹ g), Grapes blue variety (249 mg 100⁻¹ g) and pineapple (228 mg 100⁻¹ g), respectively in this study. Fruits are very poor sources of iron, zinc and copper are found in this study. Mango green contains the highest amount of iron (4.5 mg 100⁻¹ g), then jambu and tomato (1.0 mg 100⁻¹ g). Similarly zinc contents citrus fruits are orange (0.48 mg) then litchi (0.32 mg), amla (0.30 mg), Mango green (0.30 mg) 100⁻¹ g of fresh edible parts of citrus fruits. The highest amount of copper contents citrus fruits are star apple (0.68 mg), lemon (0.26 mg) and mango green (0.24 mg), respectively 100⁻¹ g of fruits. Some of the citrus fruits analyzed values are very close to that reported by Begum *et al.*^[19]. Evidences are accumulating that fruits are not good sources of micronutrients. But the amount we found in our studies is satisfactory^[20]. The data presented provide most needed information about citrus fruits, which will assist nutritionists in the assessment of diet-health relationships in our country.

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