Comparative Evaluation of Macro and Micro-Nutrient Element and Heavy Metal Contents of Commercial Fruit Juices Available in Bangladesh

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Abstract This study was performed to compare the macro and micro nutrient elements and heavy metal contents of ten different types of fruit juices available in Bangladesh. Physicochemical properties, vitamin, minerals, preservatives and heavy metals concentration were determined for all the samples. The results of this study suggest that the selected fruit juices are a good source of antioxidants and minerals. Heavy metals as well as concentration of preservatives were analyzed to assess the safety in terms of physical and chemical hazards associated with fruit juices. Among heavy metals, only aluminum was detected in studying fruit juices, but their concentration was lower than the permitted level. The results of this study were compared with existing results and recommendations which will be helpful for consumers to consider the nutritional quality and safety of fruit juices.

Keywords: nutrition, vitamin, minerals, micronutrients, preservatives, heavy metals, fruit juices, Bangladesh


1. Introduction

Fruit juices are widely consumed in tropical countries as part of habitual diet and are an important source of vitamins and minerals. The consumption of fruit juices has been increasing during the last decades because of its various health benefits and consumption of fresh fruit is often replaced by the fruit juices [1]. But the micronutrient contents of fruit juices are seldom taken into account, neither by doctors nor by dietitians when advising their patients about balanced nutrition or in case of supplementation. Primarily, this is due to the scarcity of reliable published data on this subject.

Juices are fat-free, nutrient-dense beverages, rich in vitamins, minerals and naturally occurring phyto-nutrients that contribute to good health. For example, orange juice is rich in vitamin C, an excellent source of antioxidant phytochemicals, which contribute to protect the cells and the body against oxidative damage [2]. This also offers protection against free radicals that damage lipids, proteins, and nucleic acids. It is well known that polyphenols, carotenoids (pro-vitamin A), vitamins C and E present in fruits have antioxidant and free radical scavenging activities and play a significant role in the prevention of many diseases [3]. A number of trace elements protect the cell from oxidative cell damage as these minerals are the cofactor of antioxidant enzymes. Zinc, copper and manganese are necessary for superoxide dismutases in both cytosol and mitochondria. Iron is a component of catalase, a heme protein, which catalyzes the decomposition of hydrogen peroxide [4]. Small amounts of micronutrients (minerals and vitamins) along with macronutrients are required to maintain a sound physical condition. Sodium, potassium, iron, calcium and many trace elements together with antioxidant vitamins and minerals are vital for the body.

On the other hand, people are getting busier day by day and hence the demand for ready to eat food/drink is increasing rapidly. To meet the increasing demand and huge opportunity to make money from this sector, a large number of new brands of fruit juices have appeared in the market. In most cases they are not aware about presence of heavy metals in the final product. Also, they are using preservatives in fruit juices to delay their decomposition and to increase the shelf life of the product. Sodium benzoate, Ascorbic acid, Citric acid, Sulphites (or sulphites) - sometimes also labeled as sulfur dioxide, sodium sulphite, sodium and potassium bisulphate, sodium and potassium metabisulphite etc. are being used as preservatives in these types of products. The existing food safety and regulatory management of Bangladesh is governed by many enactments and governmental bodies and more than dozen of laws deal with the food safety affairs excluding the common law provisions.
found in a study that the food industries are ignoring the existing food regulations in Bangladesh. The reasons like regulatory failures, choice of product, good price, lack of consumer awareness, and educational and cultural influences are accountable for the existing food safety concerns in Bangladesh. [5]

Food adulteration can prove very dangerous for the development of a healthy society and this can lead to a number of diseases such as cancer, paralysis, mental retardation and hypertension etc. Therefore, it is essential to take necessary steps to check food adulteration before it is too late. Adulteration and contamination in edibles especially beverages, bottled water, cooking oil/ ghee, spices, tea, sweeteners like sugar, sweetmeats, bakery products, milk and milk products, fruit and vegetable products are a constant threat to the health of the common people. One of the significant measures in this regard is to create awareness amongst the public regarding the safety and hygienic conditions. The kinds of impurities found in food items that are sold in the markets should be highlighted. This can only be done by more research work like this to test the deviation from the standard and by media coverage. The government should start campaigning against food adulteration, forcing the producers to change their methods of production. [6].

By considering all these facts, the present study was conducted to prepare new and updated information about the nutritional composition of fruit juices available in Bangladesh and also to magnitude the concentration of heavy metals and preservatives in fruit juices. The authors believe that this study will help consumers purchase fruit juices which have more nutritive properties and also this will give them an idea about the status of preservatives and heavy metals in fruit juices.

2. Materials and Methods

2.1. Sample Collection

This experiment was carried out at Institute of Food Science and Technology, BCBSIR, Dhaka. Ten different types of fruit juices from dissimilar producers were analyzed in this study. The selected fruit juices were collected from different markets and superstores in Dhaka city. Collected samples were fresh, sealed and free from any kind of deterioration.

2.2. Sample Preparation

The sample was homogenized and accurate amount was weighed as required for different analysis. Five samples of each type of fruit juices were selected for measurement.

2.3. Determination of Physico-Chemical Properties

The pH was determined with a digital pH meter and titratable acidity was estimated with the visual acid-base method [7]. The moisture content was determined by the digital moisture analyzer. The total soluble solid (TSS) was determined with a hand refract-meter [8]. Crude fiber, total fat was determined by the standard AOAC method [9] and the estimation of total protein was made by the method of Ronald and Ronald [10]. The content of total carbohydrate and energy was determined by the method of Osborn and Voogt [11].

2.4. Determination of Vitamin-C and Minerals

Vitamin C was determined by the method of Bessey and King [8]. Ash was determined by the process of Ranganna [7]. Sodium and potassium contents were determined by flame photometric method mentioned by Ward and Johnston [8]. Calcium [10] and Magnesium [12] were determined by titration process. Copper, Iron, Manganese, Zinc and Chromium were determined by Flame Atomic Absorption Spectrometric method [13].

2.5. Determination of Preservatives

Sulphur di-oxide was determined by titration process [14] and Sodium Benzoate was determined by the method of Ronald [10].

2.6. Determination of Heavy Metals

Aluminum, Arsenic, Mercury, Lead, Tin and Cadmium were determined by Flame Atomic Absorption Spectrometric method [13].

2.7. Statistical analysis

Statistical analyses were carried out by using Statistical Package for Social Science (SPSS) for Windows version 16.0. The results obtained in the present study are reported as mean values (obtained from the five replications) ± standard deviation (SD). The significant differences between mean values were analyzed by the Duncan multiple range test at a significance level of p<0.05.

3. Results and Discussion

This study was conducted to evaluate the quality of juices by studying their physico-chemical properties, vitamin, trace-elements, minerals, preservatives and heavy metals content. Five samples of each type of fruit juices were collected for this experiment. Each value represents the average from five replications and the outcomes expressed as mean values ± standard deviations (SD). All the results were expressed as gram (g), percentage (%), kilocalorie (Kcal), milligram (mg) and microgram (μg) per 100 g of fruit juices.

3.1. Physico-chemical Properties

Any systematic analysis of nutritional compositions of fruit juices has not launched yet in Bangladesh. Moreover, there are various types of fruit juices from different type of fruits that are available in Bangladesh. These fruit juices replaced some of our traditional foods, the nutritive values of which are not yet to be determined. The physico-chemical properties of the studied fruits are shown in Table 1 and Table 2.

Most fruits and fruit juices are composed of 70% to 90% water [15]. The moisture content of studying fruit juices ranged between 79.63 ± 0.04 % and 88.10 ± 0.02 %. The high moisture content of these fruit juices gives great impact on energy density (amount of energy in a given weight of food (kcal/g)) as water adds substantial weight to the food without adding energy and this may give the
The pH of selected fruit juices varied from 3.00 ± 0.05 to 3.50 ± 0.10. The lowest amount of titratable acidity was found in sample X, 0.12 ± 0.002%. Generally, higher TSS indicates more sugar in the pulp. The more ripe the fruits the more amount of sugar in fruit juices [15]. According to Norman, the sugar content of fruit and fruit juices ranges between 2% and 30% [8]. The total soluble solids (TSS) among ten different fruit juices were in the range of 10.50 ± 0.30% to 17.50 ± 0.40%. This range is similar to the results found by Haque et al. [15].

In this study, it was found that dietary fiber ranges from 0.06 ± 0.03 g to 0.17 ± 0.05 g. The recommended daily dietary fiber intake is 28 g/day for adult women and 36 g/day for adult men [17]. Macronutrients consist of protein, carbohydrate and fat which converted into energy, and used by the body for essential functions and when performing physical activities [18]. Carbohydrate content of fruit juices is less concentrated than cereals because of their high water content. Fruit juices rich in carbohydrate provide a high amount of energy. Sample VIII showed the highest amount of energy, 80.81 ± 0.33 Kcal due to its high carbohydrate content of 19.87 ± 0.001 g. Carbohydrate foods provide energy to the body and on the other hand it influence our blood glucose level. An important concept regarding this is the glycaemic index (GI). A high GI diet results in a high release of glucose in the blood after consumption of food, while a low GI diet results in a slow release of the glucose in the blood. It is important to mention that a diet with low GI and high fiber content is associated with the feeling of satiety to last longer and hence the risk of over consumption will decrease. [19] Fat and protein content of fruit juices is not greater than 1% and 3.5%, respectively [8] and the findings of these results are similar to the previous result. Proteins, specifically amino acids play an important role to regulate the pancreatic β-cell differentiation, replication and insulin secretion [20].

Carbohydrate content is a monosaccharide oxidation-reduction catalyst found in both plants and animals. It is also known as ascorbic acid and has antioxidant and free radicals scavenging activities and plays an important role in the prevention of many diseases. The structure of vitamin C is shown in Figure 1. As humans cannot produce this in their body so they have to obtain this from the diet [22,23].

### Table 1. Physico-chemical properties of studied fruit juices

<table>
<thead>
<tr>
<th>Sample</th>
<th>n</th>
<th>Moisture content (%)</th>
<th>pH</th>
<th>Titratable acidity (%)</th>
<th>TSS (%)</th>
<th>RS (g)</th>
<th>TS (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample I</td>
<td>5</td>
<td>85.33 ± 0.01a</td>
<td>3.5 ± 0.08a</td>
<td>0.25 ± 0.001</td>
<td>12.00 ± 0.90a</td>
<td>2.52 ± 0.04</td>
<td>6.54 ± 0.04</td>
</tr>
<tr>
<td>Sample II</td>
<td>5</td>
<td>85.18 ± 0.01a</td>
<td>3.5 ± 0.07b</td>
<td>0.19 ± 0.01</td>
<td>13.00 ± 0.80a</td>
<td>4.15 ± 0.05a</td>
<td>7.97 ± 0.05</td>
</tr>
<tr>
<td>Sample III</td>
<td>5</td>
<td>85.70 ± 0.05b</td>
<td>3.5 ± 0.05b</td>
<td>0.57 ± 0.002</td>
<td>12.00 ± 0.85b</td>
<td>3.98 ± 0.01</td>
<td>8.29 ± 0.20b</td>
</tr>
<tr>
<td>Sample IV</td>
<td>5</td>
<td>86.20 ± 0.02a</td>
<td>3.5 ± 0.07b</td>
<td>0.38 ± 0.01</td>
<td>11.10 ± 0.76a</td>
<td>2.74 ± 0.04</td>
<td>6.90 ± 0.40b</td>
</tr>
<tr>
<td>Sample V</td>
<td>5</td>
<td>84.83 ± 0.09a</td>
<td>3.2 ± 0.06b</td>
<td>0.32 ± 0.02</td>
<td>12.00 ± 0.87b</td>
<td>6.14 ± 0.36a</td>
<td>8.64 ± 0.05</td>
</tr>
<tr>
<td>Sample VI</td>
<td>5</td>
<td>86.90 ± 0.01a</td>
<td>3.3 ± 0.04a</td>
<td>0.25 ± 0.001</td>
<td>10.90 ± 0.41a</td>
<td>10.96 ± 0.16a</td>
<td>9.43 ± 0.70a</td>
</tr>
<tr>
<td>Sample VII</td>
<td>5</td>
<td>88.10 ± 0.02a</td>
<td>3.3 ± 0.04a</td>
<td>0.96 ± 0.02</td>
<td>10.50 ± 0.30a</td>
<td>4.72 ± 0.12a</td>
<td>5.78 ± 0.28a</td>
</tr>
<tr>
<td>Sample VIII</td>
<td>5</td>
<td>79.63 ± 0.04a</td>
<td>3.5 ± 0.10c</td>
<td>0.32 ± 0.02</td>
<td>17.50 ± 0.40c</td>
<td>3.45 ± 0.05c</td>
<td>5.60 ± 0.31c</td>
</tr>
<tr>
<td>Sample IX</td>
<td>5</td>
<td>85.04 ± 0.04a</td>
<td>3.0 ± 0.05b</td>
<td>0.45 ± 0.01</td>
<td>12.10 ± 0.10</td>
<td>6.14 ± 0.03</td>
<td>8.64 ± 0.05</td>
</tr>
<tr>
<td>Sample X</td>
<td>5</td>
<td>84.38 ± 0.10ab</td>
<td>3.3 ± 0.03c</td>
<td>0.12 ± 0.002</td>
<td>12.50 ± 0.50b</td>
<td>6.09 ± 0.01</td>
<td>10.96 ± 0.25c</td>
</tr>
</tbody>
</table>

Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly (p<0.05) different from each other.

### Table 2. Physico-chemical properties of studied fruit juices

<table>
<thead>
<tr>
<th>Sample</th>
<th>n</th>
<th>Crude Fiber (g)</th>
<th>Total Carbohydrate (g)</th>
<th>Total Energy (Kcal)</th>
<th>Total Protein (%)</th>
<th>Total Fat (g)</th>
<th>Ash (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample I</td>
<td>5</td>
<td>0.06 ± 0.03</td>
<td>14.50 ± 0.002</td>
<td>58.58 ± 0.38a</td>
<td>0.08 ± 0.01</td>
<td>0.02 ± 0.001</td>
<td>0.16 ± 0.04</td>
</tr>
<tr>
<td>Sample II</td>
<td>5</td>
<td>0.17 ± 0.05a</td>
<td>14.46 ± 0.09a</td>
<td>58.53 ± 0.29a</td>
<td>0.07 ± 0.01</td>
<td>0.04 ± 0.04</td>
<td>0.07 ± 0.002</td>
</tr>
<tr>
<td>Sample III</td>
<td>5</td>
<td>0.15 ± 0.02</td>
<td>13.86 ± 0.08a</td>
<td>56.92 ± 0.19b</td>
<td>0.07 ± 0.02</td>
<td>0.13 ± 0.05a</td>
<td>0.08 ± 0.05a</td>
</tr>
<tr>
<td>Sample IV</td>
<td>5</td>
<td>N.D.</td>
<td>13.70 ± 0.001</td>
<td>55.35 ± 0.90a</td>
<td>0.04 ± 0.01</td>
<td>0.04 ± 0.02</td>
<td>0.01 ± 0.002</td>
</tr>
<tr>
<td>Sample V</td>
<td>5</td>
<td>0.11 ± 0.02</td>
<td>14.96 ± 0.09a</td>
<td>60.09 ± 0.49a</td>
<td>0.06 ± 0.01</td>
<td>0.005 ± 0.001</td>
<td>0.03 ± 0.006</td>
</tr>
<tr>
<td>Sample VI</td>
<td>5</td>
<td>0.08 ± 0.01</td>
<td>12.65 ± 0.15a</td>
<td>50.97 ± 0.23b</td>
<td>0.06 ± 0.007a</td>
<td>0.01 ± 0.003</td>
<td>0.29 ± 0.05a</td>
</tr>
<tr>
<td>Sample VII</td>
<td>5</td>
<td>N.D.</td>
<td>11.39 ± 0.03</td>
<td>46.12 ± 0.52ab</td>
<td>0.05 ± 0.02</td>
<td>0.04 ± 0.01</td>
<td>0.42 ± 0.002</td>
</tr>
<tr>
<td>Sample VIII</td>
<td>5</td>
<td>N.D.</td>
<td>19.87 ± 0.001</td>
<td>80.81 ± 0.33a</td>
<td>0.12 ± 0.003</td>
<td>0.09 ± 0.02</td>
<td>0.28 ± 0.05a</td>
</tr>
<tr>
<td>Sample IX</td>
<td>5</td>
<td>0.13 ± 0.03</td>
<td>14.33 ± 0.02</td>
<td>58.13 ± 0.62ab</td>
<td>0.19 ± 0.001</td>
<td>0.02 ± 0.006a</td>
<td>0.29 ± 0.01</td>
</tr>
<tr>
<td>Sample X</td>
<td>5</td>
<td>0.14 ± 0.03</td>
<td>15.33 ± 0.12b</td>
<td>61.97 ± 0.12a</td>
<td>0.09 ± 0.04</td>
<td>0.03 ± 0.002</td>
<td>0.02 ± 0.002</td>
</tr>
</tbody>
</table>

Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly (p<0.05) different from each other, N.D. = Not Detected.

### 3.2. Vitamin-C and Trace Elements

Vitamin-C and trace-element content of the studied fruit juices is revealed in Table 3. Vitamin C, a water soluble vitamin and is a monosaccharide oxidation-reduction catalyst found in both plants and animals.
In this study it was observed that sample VI is a rich source of vitamin C (ascorbic acid), 325 ± 0.01 mg. The North American Dietary Reference Intake recommends 90 mg/day and no more than 2 g (2,000 milligrams) of vitamin C per day [19]. Vitamin C reacts with oxidants present in cell cytosol and blood plasma. It is also needed for the conversion of procollagen to collagen by oxidizing proline residues to hydroxyproline. In other cells, it is maintained in its reduced form by reaction with glutathione, which can be catalyzed by protein disulfide isomerase and glutaredoxins [24]. Vitamin C improves heme iron absorption in the gut as well as regulates cellular iron uptake and metabolism. Ascorbate modulate iron metabolism in the gut by stimulating ferritin synthesis, decreasing cellular iron efflux and inhibiting lysosomal ferritin degradation [25]. A recent study in mice shows that vitamin C plays a protective role against alcoholic liver injuries through regulating the iron metabolism-related gene expression [26].

Oxygen can be a highly reactive molecule by producing reactive oxygen species which damages living organisms while antioxidants work to prevent oxidative damage to cellular components such as DNA, proteins and lipids. Generally antioxidants work either by preventing these reactive species from being formed or by removing them before they can damage vital components of the cell. On the other hand, these reactive oxygen species also have some beneficial cellular functions, such as redox signaling. In this context, the function of antioxidant systems is not to remove oxidants completely, but instead to keep them at a balanced level [24].

Table 3. Vitamin-C and Trace-element content of the studied fruit juices

<table>
<thead>
<tr>
<th>Sample</th>
<th>n</th>
<th>Vitamin-C (mg)</th>
<th>Trace Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Copper (mg)</td>
<td>Iron (mg)</td>
</tr>
<tr>
<td>Sample I</td>
<td>5</td>
<td>15.00 ± 0.90a</td>
<td>0.006 ± 0.001</td>
</tr>
<tr>
<td>Sample II</td>
<td>5</td>
<td>20.00 ± 0.50b</td>
<td>0.007 ± 0.004</td>
</tr>
<tr>
<td>Sample III</td>
<td>5</td>
<td>25.00 ± 0.50b</td>
<td>0.005 ± 0.107</td>
</tr>
<tr>
<td>Sample IV</td>
<td>5</td>
<td>5.00 ± 0.20c</td>
<td>0.005 ± 0.004</td>
</tr>
<tr>
<td>Sample V</td>
<td>5</td>
<td>100.00 ± 0.05d</td>
<td>0.072 ± 0.01</td>
</tr>
<tr>
<td>Sample VI</td>
<td>5</td>
<td>325.00 ± 0.01</td>
<td>0.034 ± 0.001</td>
</tr>
<tr>
<td>Sample VII</td>
<td>5</td>
<td>225.00 ± 0.03</td>
<td>0.014 ± 0.002</td>
</tr>
<tr>
<td>Sample VIII</td>
<td>5</td>
<td>10.00 ± 0.01</td>
<td>N.D.</td>
</tr>
<tr>
<td>Sample IX</td>
<td>5</td>
<td>15.00 ± 0.05d</td>
<td>0.032 ± 0.006</td>
</tr>
<tr>
<td>Sample X</td>
<td>5</td>
<td>20.00 ± 0.03</td>
<td>0.029 ± 0.002</td>
</tr>
</tbody>
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A good antioxidant should offer protection against the oxidation (loss of electrons) by the transfer of electrons to the oxidised molecules to reduce them and restore a non-oxidised and non-toxic environment [27]. In addition, a good antioxidant should not be toxic in its own oxidised form, and it should be capable of regenerating itself to recover its electrons from another source. In this context, ascorbic acid works as an excellent antioxidant. For example, the oxidised form of ascorbic acid, monodehydroascorbate radical is a very stable molecule which can be turned into another non-radical molecule dehydroascorbate as shown in Figure 2 [28].

Trace elements are any substance that when present at low concentration compared to those of an oxidisable substrate significantly delays or prevents oxidation of that substrate. Trace elements protect the cell from oxidative damage as these minerals are the cofactor of antioxidant enzymes. Copper, manganese and zinc are necessary for superoxide dismutases in both cytosol and mitochondria. Iron is a constituent of catalase, a hemeprotein, which catalyzes the decomposition of hydrogen peroxide [23]. Antioxidant functions are associated with decreased DNA damage, diminished lipid peroxidation, maintained immune function and inhibited malignant transformation of cells [29].

The trace elements that were found in selected fruit samples are copper, iron, manganese and zinc. The highest amount of copper was found in sample V, 0.07 ± 0.01 mg. The highest amount of zinc and iron was found in sample I and II, 0.27 ± 0.002 mg and 0.79 ± 0.001 mg respectively. Manganese was not detected in the selected samples. These minerals are also called micro-minerals which also worked as antioxidants, and are required in amounts less than 100 mg/day. Recommended Dietary Allowance (RDA) for copper is 900 μg/day for both adult male and female [30]. Most fruits and fruit juices contain a small amount of copper ranging from 0.005 ± 0.004 mg to 0.072 ± 0.01 mg. 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 liver injuries through regulating the iron metabolism-related gene expression [26].

![Figure 2. Antioxidant mechanism of vitamin C](image1.png)

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![Figure 1. Vitamin C (Ascorbic acid)](image2.png)
deficiency in most individuals [30]. The highest amount of zinc was found 0.27 ± 0.002 mg in the sample I and lowest level found 0.02 ± 0.0001 mg in sample IX. The iron content of selected fruit juices were varied from 0.03 ± 0.0001 mg to 0.79 ± 0.001 mg. According to USDA, the daily recommended intake of iron is 8 mg for adult male and 18 mg for adult female. Thus, consumption of these fruit juices can be suggested as a food based strategy to alleviate or improve the unsatisfactory dietary iron intake of adolescents.

Epidemiological studies suggest that consumption of polyphenol-rich foods and beverages is associated with a reduced risk of cardiovascular diseases, stroke and certain types of cancer in which polyphenol is linked to the antioxidant properties [31]. In Europe, apple juice is a highly-consumed product, in second place after orange juice. Among the most important constituents of apple juice are polyphenolic that has the ability to increase its anti-oxidant potential. Polyphenolics also affect lipid metabolism [32] and the absorption of cholesterol [33]. The consumption of dietary trace-elements will help to prevent free radical damage. Trace-elements have the ability to scavenge free radicals by inhibiting the initiation step or by interrupting the propagation step (oxidation of lipid) and as a preventive antioxidants which slow down the rate of oxidation by a number of actions [34].

### 3.3. Minerals

Minerals play an important role in maintaining proper function and good health in the human body. According to Hendricks, approximately 98% of the calcium (Ca) and 80% of the phosphorus (P) in the human body are found in the skeleton [35]. Inadequate intake of minerals in the diet is often associated with an increased susceptibility to infectious diseases due to the weakening of the immune system. Plants, animal foods and drinking water are an important source of essential elements [36]. Table 4 shows the mineral content of studied fruit juices.

<table>
<thead>
<tr>
<th>Sample</th>
<th>n</th>
<th>Sodium (mg)</th>
<th>Potassium (mg)</th>
<th>Calcium (mg)</th>
<th>Magnesium (mg)</th>
<th>Chromium</th>
<th>Sodium Benzoate (%)</th>
<th>Sulfur dioxide (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample I</td>
<td>5</td>
<td>6.75 ± 0.001</td>
<td>7.92 ± 0.002</td>
<td>7.39 ± 0.001</td>
<td>2.16 ± 0.12</td>
<td>N.D.</td>
<td>0.04 ± 0.03</td>
<td>0.12 ± 0.002</td>
</tr>
<tr>
<td>Sample II</td>
<td>5</td>
<td>36.89 ± 0.002</td>
<td>11.45 ± 0.001</td>
<td>13.67 ± 0.002</td>
<td>5.79 ± 0.20</td>
<td>N.D.</td>
<td>0.06 ± 0.001</td>
<td>0.16 ± 0.02</td>
</tr>
<tr>
<td>Sample III</td>
<td>5</td>
<td>10.18 ± 0.004</td>
<td>4.11 ± 0.02</td>
<td>3.42 ± 0.003</td>
<td>1.36 ± 0.04</td>
<td>N.D.</td>
<td>0.06 ± 0.001</td>
<td>0.01 ± 0.003</td>
</tr>
<tr>
<td>Sample IV</td>
<td>5</td>
<td>8.59 ± 0.002</td>
<td>0.25 ± 0.003</td>
<td>2.38 ± 0.01</td>
<td>0.94 ± 0.002</td>
<td>N.D.</td>
<td>0.10 ± 0.01</td>
<td>0.16 ± 0.02</td>
</tr>
<tr>
<td>Sample V</td>
<td>5</td>
<td>8.67 ± 0.003</td>
<td>5.88 ± 0.001</td>
<td>6.14 ± 0.33</td>
<td>2.82 ± 0.21</td>
<td>N.D.</td>
<td>0.06 ± 0.002</td>
<td>0.08 ± 0.01</td>
</tr>
<tr>
<td>Sample VI</td>
<td>5</td>
<td>7.32 ± 0.006</td>
<td>5.90 ± 0.02</td>
<td>7.88 ± 0.003</td>
<td>1.96 ± 0.11</td>
<td>N.D.</td>
<td>0.04 ± 0.01</td>
<td>0.09 ± 0.04</td>
</tr>
<tr>
<td>Sample VII</td>
<td>5</td>
<td>14.17 ± 0.005</td>
<td>12.39 ± 0.002</td>
<td>12.68 ± 0.03</td>
<td>7.46 ± 0.42</td>
<td>N.D.</td>
<td>0.06 ± 0.001</td>
<td>0.07 ± 0.001</td>
</tr>
<tr>
<td>Sample VIII</td>
<td>5</td>
<td>8.59 ± 0.005</td>
<td>3.66 ± 0.04</td>
<td>3.11 ± 0.001</td>
<td>1.39 ± 0.003</td>
<td>N.D.</td>
<td>0.02 ± 0.001</td>
<td>0.08 ± 0.02</td>
</tr>
<tr>
<td>Sample IX</td>
<td>5</td>
<td>5.53 ± 0.007</td>
<td>2.43 ± 0.003</td>
<td>8.03 ± 0.02</td>
<td>3.42 ± 0.03</td>
<td>N.D.</td>
<td>0.04 ± 0.01</td>
<td>0.09 ± 0.02</td>
</tr>
<tr>
<td>Sample X</td>
<td>5</td>
<td>21.71 ± 0.002</td>
<td>7.94 ± 0.001</td>
<td>7.61 ± 0.002</td>
<td>1.86 ± 0.001</td>
<td>N.D.</td>
<td>0.03 ± 0.02</td>
<td>0.12 ± 0.002</td>
</tr>
</tbody>
</table>

Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly (p<0.05) different from each other, N.D. = Not Detected.

These fruit juices were also enriched with minerals like sodium, potassium, calcium, magnesium and chromium. Sodium content of selected fruit juices were ranged between 5.53 ± 0.007 mg and 36.89 ± 0.002 mg per 100g of edible portion. Sodium variability of fruits sometimes relies on soil sodium, black soil contains a fair amount of sodium [37]. Among the fruit juices analyzed, the highest quantity of potassium was found in sample VII, 12.39 ± 0.002 mg for the healthy adult, the RDA for sodium and potassium intake is not more than 2,400 mg and 4700 mg respectively per day [17]. The highest amount of calcium was found in sample II, 13.67 ± 0.002 mg. Calcium with the name of “super nutrient” has been proven clinically associated with reduced risk of various non-communicable diseases such as osteoporosis, cardiovascular diseases and it also helps to reduce colorectal cancer risk by promoting the apoptosis in human colorectal epithelium that reduce colorectal neoplasm [37]. The highest amount (7.46 ± 0.42 mg/100 g) of magnesium was found in sample VII. The amount of chromium was not detected in studied fruit juices.

Micronutrient deficiency is a common occurrence not only in developing countries but also in developed countries. According to WHO (World Health Organization), iodine, iron and vitamin A deficiency are the most widespread micronutrient deficiencies which in together affects about one third of the world’s population. [38] The best way to deal with this is to take foods rich in micronutrients. But this is not possible for all and hence comes the option of food fortification which is a nice way to fight against micronutrient deficiency diseases. The main motive of food fortification is to provide nutrients so that it will help to trim down nutritional deficiency diseases. None of the fruit juices studied in this experiment were fortified. Food fortification can be of two types as mandatory and voluntary. Mandatory fortification is that type of fortification which is permitted by the law but it completely depends on the producers whether to fortify or not [39].

Addition of nutrients to food is necessary to assist trade of the product and nowadays it is a profitable way of earning money for the producers. A double-blind placebo-controlled study was conducted on 1000 children and
3.4. Preservatives

The selected samples were tested for sodium benzoate and sulfur dioxide, which acts as preservatives. Benzoic acid and its salts are used as a food preservative represented by the E-numbers E210, E211, E212, and E213. Benzoic acid inhibits the growth of mold, yeast and some bacteria. The efficacy of benzoic acid and benzoate is thus dependent on the pH of the food. Sodium benzoate is most suitable for use as an antimicrobial agent in foods and beverages which naturally are in the pH range below 4.5 %; it is not recommended as a preservative at pH ranges higher than 4.5. Sodium benzoate content of selected fruit juices were varied from 0.02 ± 0.001 mg to 0.10 ± 0.01 mg. Sulfur preservatives, such as sulphites and Sulfur di-oxide inhibit the growth of microorganisms and prevent discoloration of fruit juices. Sulfur di-oxide content of selected fruit juices were varied from 0.07 ± 0.001 mg to 0.16 ± 0.02 mg. Checking food labels for sulphites, sulfur dioxide and E-numbers in the range of 220-228 is helpful; however, companies are only required to list sulphites as an ingredient when the amount is above 10 mg/liter or 10 ppm. The problems include stomach ache, hives, bronchospasm and even anaphylactic shock.

3.5. Heavy Metals

Nowadays some growers as well as traders in Bangladesh are commercially using some chemicals, namely Ripen, Gold-Plus, Profit etc. for the ripening of fruits which ultimately come into the juices made of those fruits. Children’s are the foremost consumers of fruit juices and they are at particular risk of the harmful side effects of food adulteration, which may lead to serious liver and kidney diseases including various forms of cancer and hepatitis [42]. Heavy metals are harmful and become toxic to health if they are taken above the limit of daily dietary allowance recommended. The heavy metals content of the studied fruit juices is given away in Table 5.

Among the fruit juices analyzed, the highest amount of aluminum was found in sample II; 21.56 ± 0.02 mg and the lowest amount of aluminum was found in sample VII, 0.03 ± 0.001 mg. The European Food Safety Authority (EFSA) has established for the lifelong intake of aluminum a tolerable weekly intake (TWI) of 1 milligram (mg) per kilogram body weight [43]. Elevated aluminum level in fruit juice may caused by the incorrect storage of juices in aluminum containers that were not coated with varnish. As aluminum is dissolved by acid-containing and Salt-containing food, the metal was able to migrate to the juice. Arsenic, mercury, lead, tin and cadmium were not found in selected samples.
Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly (p<0.05) different from each other. N.D. = Not Detected.

Heavy metals are used as food contact materials, mainly in processing equipment, containers and household utensils, but also in foils for wrapping foodstuffs. They play a role as a safety barrier between the food and the exterior. They are often covered by a surface coating, which reduces the migration in foodstuffs. When they are not covered by these food contact materials can give rise to migration of metal ions into the foodstuffs and therefore could either endanger human health if the total content of the metals exceeds the sanitary recommended exposure limits, if any, or bring about an unacceptable change in the composition of the foodstuffs or a deterioration in their organoleptic characteristics. Despite the fact that aluminum was found in selected fruit juices, but their concentration was lower than the safe level.

4. Conclusion

The findings from the present study indicates that, the fruit juices are rich source of vitamin C, minerals and TSS, TS, RS. Preservatives added to fruit juices may be considered harmful if it is used beyond tolerable limits. Bringing a change in packaging material, processing method and storage system may be helpful to reduce the aluminum level in the fruit juices. People are becoming more and more conscious of the fact that consuming safe and nutritious food is important and this knowledge is migrating rapidly into the thoughts of people all over the world. This is also influencing the way people think before purchasing a product specially processed food and beverage. Hence, the authors believe that this study will be helpful to create awareness among consumers, government, media and manufacturers to improve and uphold the nutritional quality and safety of fruit juices.

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References


