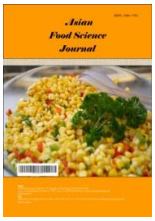

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Determination of Ascorbic Acid Concentration in Commercially Available Fruit Drinks in Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Author MRA had designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors MAH, PC and LCS collected the samples and did laboratory analysis. Author AAM helped with literature research and statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Ascorbic acid (vitamin C) is the most important food constituent because of its antioxidant and functional activity. The study aims to determine the Vitamin C content in commercially available fruit drinks collected from selected shops in Bangladesh.
Study Design: This study is an experimental study.
Place and Duration of Study: The present study was conducted in the food analysis laboratory of Department Food Technology and Nutrition Science, Noakhali Science and Technology University, from January 2019 to May 2019. In the present study, a total of 22 branded different fruit drinks samples (orange, mango, lichi) were collected from the local market of Noakhali, Bangladesh.
Methodology: Vitamin C was analyzed with the titrimetric method and Sugar content, pH was also successfully determined by refractometer, pH meter respectively.
Results: The analyzed Vitamin C was found in the range of 2.96 to 70 mg/100 ml. Sugar content, pH was also successfully determined from the samples. The majority of the samples were found less in vitamin C concentration while only two samples (samples 3, 18) were found high the vitamin C concentration.
Conclusion: From the above study, titrimetric analysis proves itself as a scientific method in the determination of vitamin C concentration in the samples.

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Keywords: Vitamin C; pH; fruit juice; sugar content; titrimetric method.

1. INTRODUCTION

Fruits have been an important part of the human diet and food supplements over the years. They are decent sources of essential elements that are very important for our body to make the body function properly, such as water, vitamins, minerals, and organic compounds [1]. Fruits are also great sources of antioxidants, which are responsible for scavenging free radicals. Because of their high perishability, fruits become rotten quickly and preservation is so essential to make them available for a long period [2]. Fruits can be consumed as beverages such as fruit juice (orange, apple, grape, etc). Juices are less fatty, nutrient-dense beverages rich in vitamins, minerals and naturally occurring phytonutrients that contribute to good health. Fruit juices help to detoxify in the human body [3]. Fruits are industrially processed to produce fruit juices, jams, jellies, *etc*. Juices are found in their natural concentrations or processed forms. Fruit juice is mainly made by mechanically pressing fresh fruits or by water extraction. Most of the commercially prepared juices are fat-free, nutrient-dense beverages rich in vitamins, minerals, and naturally occurring phytonutrients [4]. Vitamins are vital and very important for the survival and smooth functioning of human bodies. Vitamin C can't produce or stored in the human body, therefore, the supply of ascorbic acid on regular basis is essential for a healthy body. Vitamins don't provide any direct energy but they function in combination with other substances in the body to supply energy [5-7]. Vitamins are also needed only in a very small quantity to maintain good health. Around 30 different vitamins including eight B vitamins are essential that are required to our body on a daily basis. The recommended daily intake of ascorbic acid is 60 mg in aggregate [8,9]. Fruit juices are important for their nutritive value, mineral and vitamin content. They are beverages that are consumed for their nutritional value, thirst-quenching properties, and stimulating effect or their medicinal value. The low pH of fruit juices greatly limits the number and the type of bacteria that can survive or grow at this low pH but some bacteria that their pH is lower than that of the fruit juice can grow at this condition [10]. Vitamin C, also known as ascorbic acid, is a valuable food constituent because of its antioxidant and therapeutic assets. It helps the body in forming connective tissues, bones, teeth, blood vessels and plays a vital role as an antioxidant that forms part of the body defense system against reactive oxygen species and free radicals, thereby stopping tissue destruction [11]. Different analytical methods have been reported for the determination of AA. One of the common methods used for the quantitative determination of various nutrients is the titration method. The amount of ascorbic acid in an unknown sample can be determined with the help of iodometric titration. In this method, iodine (I_2) reacts with ascorbic acid to produce dehydroascorbic acid which is a colorless product. I_2 also reacts with starch to produce a dark blue product (Fig. 1).

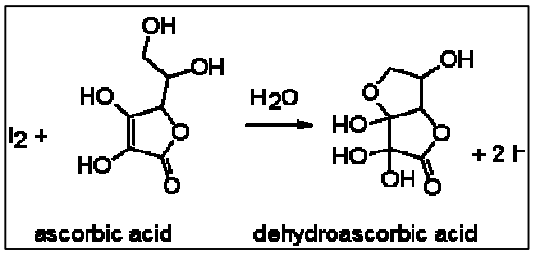

Fig. 1. Conversion of ascorbic acid to dehydroascorbic acid in the presence of the oxidizing agent

This work aims to determine the Vitamin C or ascorbic acid content in commercially available fruit drinks (orange, mango, lichi) collected from selected shops in Noakhali, Bangladesh.

2. MATERIALS AND METHODS

The present study was conducted in a laboratory of the Department of Food Technology and Nutrition Science, Noakhali Science and Technology University. A total of 22 commercial fruit drink brands were used in this study.

2.1 Selection of Samples

In the present study, commercially available fruit drinks were selected as samples. The samples were purchased from the local market of Noakhali, Bangladesh and stored at 40ºC.

2.2 Standardization of Iodine

Iodine solution changes rapidly because I_2 is a halogen gas that evaporates quickly. Therefore, iodine solutions need to be standardized all the time during the experimental procedure. Ascorbic acid is also susceptible to oxidation by

atmospheric oxygen over time. For this reason, the sample was prepared immediately before the titrations. A solution of iodine can be standardized by titration against a known concentration of sodium thiosulfate according to the following equation:

$$I_2(aq) + 2S_2O_3^{2-}(aq) -> 2I^-(aq) + S_4O_6^{2-}(aq)$$

Where

I_2 (aq) = iodine
$S_2O_3^{2-}$ (aq) = thiosulfate ion
I^-(aq)= iodide ion
$S_4O_6^{2-}$(aq) = tretrathionate ion

This solution is used to determine the exact concentration of iodine solution which is used to determine the concentration of Vitamin C in commercial fruit juices.

2.3 Measurement of Vitamin C Concentration

Aliquot of the sample (20 ml) solution prepared above transferred into a 250 ml conical flask, 2 ml of oxalic acid, about 150 ml of distilled water and 1 ml of starch indicator solution. Samples were titrated against 0.005 molL−1 iodine solution. The endpoint of the titration was identified as the first distinct trace of a dark blue-black color due to the formation of the starch-iodine complex (Fig. 2). Titration was repeated with further aliquots of sample solution until concordant results (titers agreeing within 0.1 ml) were obtained.

Calculation of Vitamin C concentration:

ascorbic acid + I_2 -> 2 I^- + dehydroascorbic acid

Therefore 1 mol of I_2 reacts with 1 mol of ascorbic acid

The molar mass of ascorbic acid ($C_6H_8O_6$) = 176.12 g mol^{-1}

X (average titrated value) mlof W (molecular weight) M of I_2 solution contains = W * X mol of I_2

Therefore 20 ml of juice contains = W* X ml *176.12g mol^{-1}= mg of Vitamin C

2.4 Measurement of Sugar Content

The refractometer (ATC brand) was used for the measurement of percent Brix, or relative sugar concentration. Depending on the amount of sugar in the sample, the refractometer gives a reading on the index. The sugar level was determined by comparing it with the index.

2.5 Measurement of pH

pH of fruit juice was measured by pH meter (PL-700AL brand).

Fig. 2. Titration result of the Vitamin C concentration; (Right side) before of titration (Left side) after of titration

3. RESULTS AND DISCUSSION

3.1 Determination of Vitamin C from the Fruit Drink Samples

A total of 22 commercial fruit drink brands were used in this study (Fig. 3). Each of the samples was titrated with 0.005 molL-1 iodine solution three times and then the mean of titrate was calculated with standard deviation. From the result of Mean ± SD, we could see that all of them contain a low standard deviation, which means most of the titrate values are close to the average. According to that, vitamin C in fruit drink samples, therefore, found to be in the range of 2.96 to 70 mg/ml. wide variations in the calculated readings were observed. The highest amount of vitamin C *i.e*. 70 mg/ml was found in sample 3 (orange), whereas the lowest amount of vitamin C *i.e*. 2.96 mg/ml was found in sample 19 (lichi). Among other samples no. 18 and sample no. 6 were also possessed a high content of vitamin C or ascorbic acid, and the amounts are respectively 49.2 mg/100 ml and 24.31 mg/100 ml. All the other 19 samples were found to relatively contain low amount of vitamin C or ascorbic acid, such as sample no. 1, 4, 5, 8, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21 contain less than 10 mg/100 ml and sample no. 2, 7, 9,

22 contain Vitamin C content within 10 to 15 mg/ml.

One of the studies conducted in Ethiopia reported that the vitamin C content of freshly prepared Orange juice was 41.4 mg/100 ml [12]. While the other study conducted in Valencia indicating that vitamin C content of orange juice ranged from 33 to 50 mg/100 ml was obtained by squeezing the fruits [13]. There are considerable differences in the values of vitamin C obtained in the present study. The vitamin C found to be important for the health however if taken in excess quantity it may possess adverse health effect to human and less amount of vitamin C are not enough for a healthy life.

3.2 Determination of Sugar from Fruit Drinks Sample

The result of the refractometric determination of reducing sugar in the samples is as shown (Fig. 4). According to that, reducing sugar the fruit drink samples were found to be in the range of 12.3 to 14.7%. The highest percentage reducing sugar i.e. 14.7% was found in sample 11 (mango), whereas the lowest percentage reducing sugar i.e. 12.3% was found in sample 21 (orange). These amounts were on the high side when compared with the highest value of 9.9% in mango juice and lowest of 2.24% recorded in some studies [4]. The high amount of reducing sugar observed in the samples indicated possible sugar additives.

Packaged juices contain a high amount of added sugar i.e., sucrose, which is highly cariogenic, unlike fructose and glucose which are considerably less carcinogenic [14].

3.3 Determination of pH from Fruit Drinks Sample

The pH content in the fruit drinks samples was found to be in a range of 2.7 to 4.8 (Fig. 5). Different pH values were found in all the samples

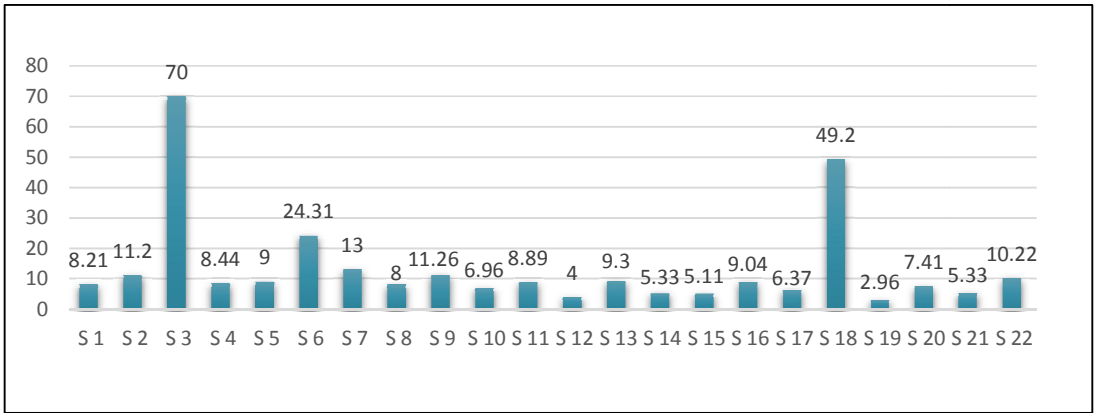

Fig. 3. Amount of vitamin C in the fruit drink samples (mg/100 ml)

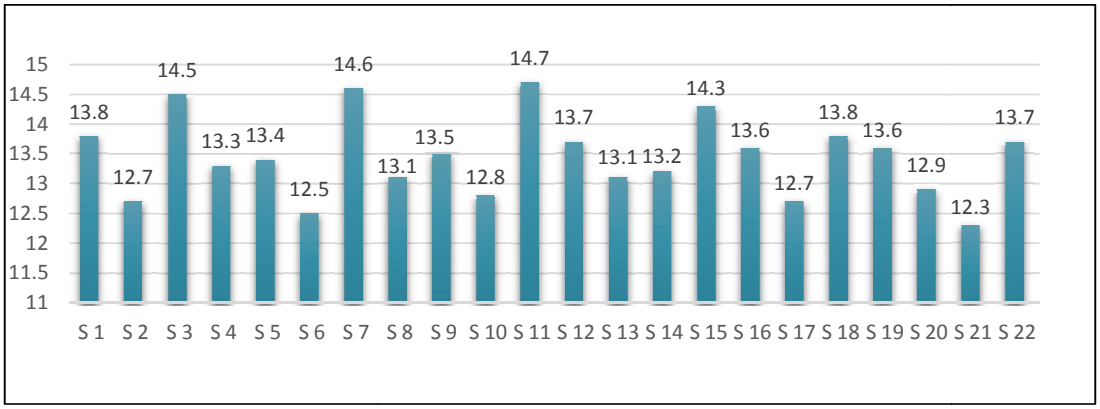

Fig. 4. Amount of sugar content (%) in the fruit drink samples

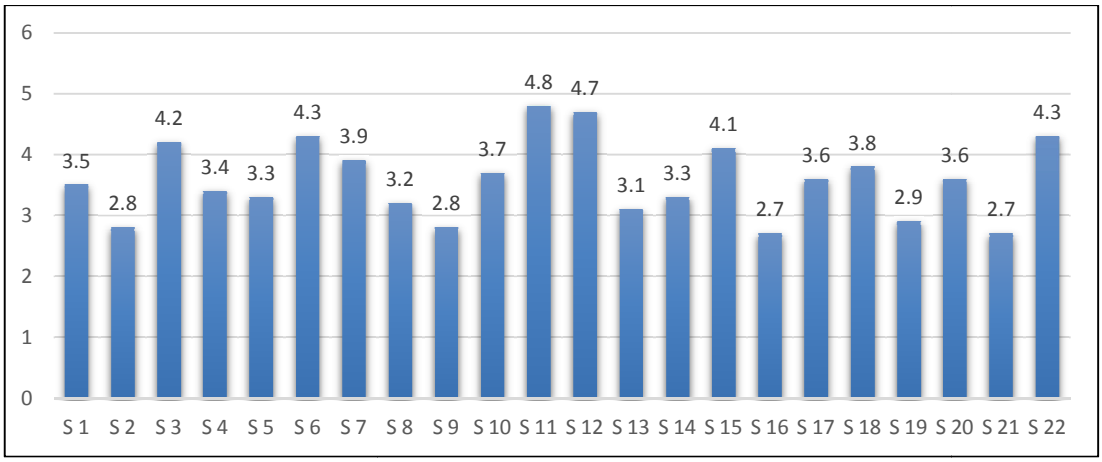

Fig. 5. Amount of pH in the fruit drink samples (mg/100 ml)

with only some small variations. The same amount of acid i.e. 2.7 was observed in sample 16 and sample 21 (mango). The highest concentration i.e. 4.8 of was observed in sample 11 (orange). The sour taste of most of the fruits drinks could be mainly due to the presence of acids.

Unlike fresh fruit juices which have a more neutral pH level the commercial fruit juices, demonstrated a higher acidic content [15]. The increase in intake of fruit juices and other acidic fruit drinks is believed to be the leading cause of dental erosion in children and adolescents. The critical determinant of a liquid's erosive capabilities is pH, according to the researchers. It is also reported that beverages with a pH of less than 4 is considered potentially erosive and can potentially contribute to tooth decay if consumed regularly [16].

4. CONCLUSION

From the obtained results, it can be concluded that maximum samples were proved to contain a low content of Vitamin C determined by the titrimetric method. If consumers used commercially fruit drinks as a main dietary source of Vitamin C that will not be meet the recommended daily requirement. The high amount of reducing sugar was observed in the commercial fruit drink samples. This high amount of added sugar can be harmful to health. From the above study, titrimetric analysis can be used for the identification of vitamin C. For future study, more specific and accurate techniques such as High-Performance Liquid Chromatography, Ion Chromatography can be used for quantitative and qualitative analysis of fruit drinks.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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