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Determination of major constituents in Commercial Brands of Carbonated soft drinks

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Abstract:

Carbonated Soft drinks (CSD) are consumed daily in all over the world due to its sharpness, mouth feel, flavor, refreshment and thirst quenching potential. The increasing demand of CSD needs to ensure high quality during its production otherwise it can cause health risk to the consumers. The present study was carried out to determine the major constituents in Commercial Brands of CSD in Bangladesh. For this purpose Commercial branded CSD samples (coded as A, B, C , D and E) were purchased from various retail shops in Bangladesh. Major constituents that affect the quality of drinks like Carbonation volume, P^H, Titratable Acidity (TA), Brix and Inverted Brix (IB) content were determined. The magnitudes of levels were found as Carbonation Volume 3.12-3.90, pH 3.2-4, TA 9.15-12.29, Brix 10.52-13.35 and IB 11.14-13.72. A comparison of level of those quality parameter were done among different brands of CSD. The levels of those constituents were found within permitted range of different approved authorities. But in some samples those limit exceeded the limits which can cause health risk to humans. Therefore, routine inspection and quality assurance and control should be ensured during production. High quality raw materials need to use during production of CSD. Monitoring and controlling program for the quality of the CSD necessary in order to ensure safe consumption and minimize the possible underlying risk.

Key words: Carbonated Soft Drinks, Carbonation, Brix, Inverted Brix, Quality control, Quality assurance.

1. INTRODUCTION

Commonly, a soft drink refers to almost any cold drink that does not contain alcohol [1]. Soft drinks usually contain carbonated water, high fructose corn syrup or sucrose, caramel color, phosphoric acid and flavors [2]. The drinking of carbonated soft drinks (CSD) is as old as human history, and the serving of drinks for profit is as old as the concept of profit itself. In most cultures over the centuries, these have been accepted as an essential part of everyday life.

CSD are consumed mainly for refreshment. Refreshment is very important to people of all ages at work and play. Sugar sweetened soft drink contains energy giving carbohydrate, which is a refreshing addition to a balanced diet [3]. These can also be psychologically refreshing during stress. Soft drinks contribute to the healthy and enjoyable diet. Soft drinks in addition to water also meet the fluid requirement. Besides water, body needs other nutrients for growth, energy and good health. Selected beverages can provide this vital combination of protein, carbohydrate, fat, vitamins, minerals and water. Hence, soft drinks provide part of the total daily intake of liquid and energy. The second area of nutritional significance is the ability of soft drinks to promote rapid uptake of salts and water by body. Soft drinks are the part of balanced diet and healthy lifestyle as these contain health elements like vitamins and calcium. The consumers choose the soft drinks that best suit their lifestyle, tastes, nutritional needs and physiological constraints [4].

The origin of soft drinks lies in the development of fruit-flavored drinks. In 1767, Englishman Joseph Priestley first discovered a method of infusing water with carbon dioxide to make carbonated water. His invention of carbonated water (also known as soda water) is the major and defining component of most soft drinks [1],[5]. At present the global beverages industry exceeded $1 trillion. Like other countries of the world, beverages have become part of our culture and serve as social enjoyment. Bangladesh has a relatively hot weather and people tend to be thirstier. So they prefer to take soft drinks most of the time. Carbonated beverage entered into Bangladesh market in the later part of 1980s [6]. At that time, there were only a few companies in Bangladesh. But with the change of time and by western cultural influences it has become very popular in

Bangladesh. By 2000, more than 12 Beverage Companies started business in Bangladesh and most of them are foreign companies [7].

Since a wide range of beverages industry emerged, increasing demand of CSD needs to ensure high quality during its production. The levels of major constituents like carbonation volume, P^H, Titratable Acidity (TA), Brix and Inverted Brix (IB) must be under routine inspection and must confirm with different approved authorities standards. Numerous studies have been published. Manufacturing process of carbonated soft drinks was reported by Stevenson and Howell (1986) [4]. Formulation and unit operation of beverage production was explained by Mitchell (1990) [8]. Ashurst (2005) describes the different quality parameter of CSD [1]. Vasanti *et al.* (2010) explained the correlation between Sugar-Sweetened Beverages and Risk of Metabolic Syndrome and Type 2 Diabetes [9]. Ran *et al.,* (2009) reported Dental erosion and severe tooth decay related to soft drinks [10]. Those studies illustrated mostly formulation and manufacturing of CSD and relationship between high content of major constituents and health risk. But studies that evaluated the quality parameter of CSD are limited in numbers. Therefore, the main objective of this study was to determine major constituents in Commercial Brands of Carbonated soft drinks (CSD) and comparisonal quality analysis among different commercial brands.

2. MATERIALS AND METHODS

2.1. Sampling

Commercial branded Carbonated Soft Drinks samples (coded as A, B, C , D and E) were purchased from various retail shops in Bangladesh. Samples were coded to overcome the sampling biasness.

2.2. Sample preparation

Degassing was performed to remove carbonation from the beverage in order to obtain accurate Brix, pH and TA measurement. Air line with filter enclosed with pressure regulator and flow control is used for this purpose. Degassing of samples followed some sequential steps: Collection of samples and warmed it to 20 – 25^{0}C. Then 300 ml of the carbonated beverage poured into a clean, dry 500 ml beaker. The air was turn on. Make sure all water or product from previous testing has been blown from pipe of diffuser. Then insert the air tube or diffuser until it rests on the bottom of the beaker. Bubble the air through the beverage at a fixed flow and for the optimum time. Ensured that there was no cross contamination with other samples (e.g. splashing).

2.3. Carbonation Measurements

Amount of carbonation in a beverage sample measured as a number of gas volumes with Zahm-Nagel Handshake Tester (Somex Ltd, Ballyvourney, Macroom, Co. Cork, Ireland) according to the procedure described in Steen (2005) [11]. Samples were taken and adjust temperature to 4^{0}C. The samples were equilibrated by gently inverting 15 times in 30 seconds. The bottle was placed under the tester and followed the method of carbonation measurement. Then maximum pressures and the temperature reading were recorded. Adjust pressure reading with attitude Correction factor if applicable. Corrected Pressure = Gauge Pressure – Altitude Correction Factor. Adjust temperature reading with correction factor, if needed, from the temperature calibration check. Convert pressure and temperature to gas volumes using the Carbonation Volumes Chart or Carbonation Volume slide rule.

2.4. Determination of P^H and Titratable Acidity

P^H was measured using a digital P^H meter (Jenway 3510 pH Meter). The value was shown automatically on the screen. The titratable acidity of the CSD was obtained by titration method. Burette filled with 0.1 Normal sodium hydroxide solutions to the zero line. Then Pipette 100.0 ml of degassed sample beverage into a clean and dry 250-mL beaker. Carefully place a clean, dry, stirring bar into the beaker. Place the beaker on the magnetic stirrer, and turn the stirrer on so the sample is gently agitated. Rinse the electrode with de ionized water then immerse the bottom 1/3 of the electrode in the sample. Allow the pH reading to stabilize and record the beverage P^H. Titrate the sample slowly with the 0.1N NaOH. The burette spout should be over the beverage, and slightly below the top of the beaker. Continue to add NaOH until the pH meter reads constant 8.75. Be careful not to overshoot 8.75 pH. Close the burette valve. Read the liquid level in the burette to the nearest 0.05ml. Consider this reading as the titer. If the NaoH solution normality is 0.100 N, then no correction is needed. If the sodium hydroxide solution normality is not 0.100 N, then multiply the titer by the correction factor. Calculations: Actual TA = Titer x NaOH Correction Factor.

2.5. Determination of Brix and Inverted Brix

Brix measurement was done with digital refract meter in temperature compensation mode (Model J157, Rudolph Research Analytical, USA). It measures the weight of dissolved solids in final beverages. Degassed CSD samples were directly placed in Clean and dry prism of refractometer. Then Close the top, if so equipped and wait about 20 seconds for temperature stabilization. Brix reading was taken.

Brix inversion was also done with bench refract meters. It measures the change of sucrose molecule into the simple molecule of glucose and fructose. For measurement of Brix inversion degassed CSD samples were then transferred into a sealable vival. About 0.4ml of 2.5N HCl per 35 ml sample to all non-carbonated beverages was added. Those were capped and sealed the vial to ensure no moisture loss or gain during the hot water bath. Samples were then placed in 100^{0}C water bath for 40 minutes. Then sealed samples were removed and placed in cooling bath until samples temperature were approximately 20^{0}C. Gently shaken vial to mix any condensed water collected along the inside. Sample testing was done as described in the appropriate Brix test procedure.

2.7. Statistical Analysis

The obtained data were stored in Microsoft Excel 2007 and then exported into SPSS Version 16.0 software (SPSS Inc., USA) for statistical analysis. Descriptive analysis was performed by using percentages, mean and standard deviation for different variables. Finally one -way ANOVA was used to compare the level of major constituents in CSD. The level of significance was set ≤ 0.05.

3. RESULTS AND DISCUSSIONS

3.1. Carbonation Volume

Carbonation Volume of CSD in five commercial brands were estimated and the results are illustrated in Figure 1.

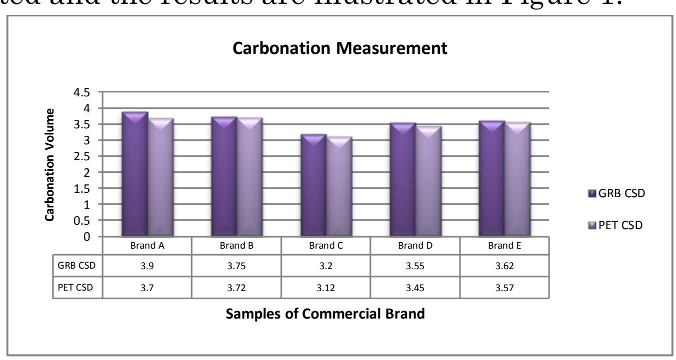

Figure 1. Carbonation Volume of Carbonated Soft Drinks

Carbonation Volume of CSD in five commercial brands was found in the range 3.12-3.90. The higher Carbonation Volume was obtained in samples of Brand A (3.90±0.2) and low in sample C (3.12±0.4) as presented Figure 1. These values are more than 2.4 volume reported by Ayres et al. (1980), more than 3.2 volume reported by Ranganna (1977) and more than the range of 2.8- 2.9 volume recorded by Omer (2004) [12], [13], [14].

Soft drinks contain water, sweetener (8-12%, w/v), carbon dioxide (0.3-0.6% w/v), acidulants (0.05-0.3% w/v), flavorings (0.1-0.5% w/v), colorings (0-70 ppm), chemical preservatives, antioxidants (<100 ppm), and/or foaming agents (e.g., saponins up to 200 mg/mL) [15]. Some types of soft drink use Sugar substitutes are also added by some types of CSD if Consumption in large quantities of CSD ingredients may be hazardous to health. At present there is a trend to produce ever wider ranges of more specialists CSD, but there is also pressure to minimize the use of, in particular, artificial and synthetic additives and ingredients. The carbonation of CSD varies from 1.5 to 5 g/L. Carbonation process utilizes physical characteristics such as temperature, pressure, surface area and contact time to facilitate the absorption of carbonation into the beverage. The most common system in use is the saturation or carbonation tank. In this system beverage is distributed over cooling plates in a pressure CO2 atmosphere. As the beverage is chilled, it absorbs carbonation. This process provides extra sparkle, mouth feel, flavor and sharpness to the drink [16]. It also makes the drink more acidic and helps preserve soft drinks for longer time [17]. As CSD intended for human consumption are covered by national and international regulations based on codes and standards, the ingredients that are used in CSD must comply with all applicable safety requirements.

3.2. P^H and Acidity

P^H and Acidity of CSD in five commercial brands were estimated and the results are illustrated in Figure 2. P^H of CSD in five commercial brands was found in the range 3.2-4.0. The higher P^H was obtained in samples of Brand A, D, E (4) and low in Brand B (3.2) as presented Figure 2. These values are more than what was reported by Ranganna (1977) and Ayres et al. (1980), which were 3.01 and 3.0, respectively [12], [14]. These results are within the range of 2.5-4.03 reported by Mohamed and Mustafa (1978) and the range of 3.7-3.9 recorded by Omer (2004) [13], [18].

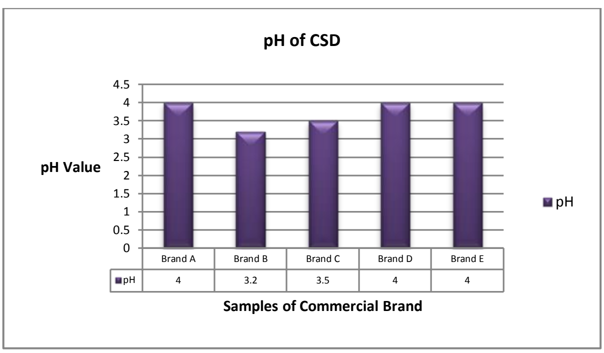

Figure 2. P^H of Carbonated Soft Drinks

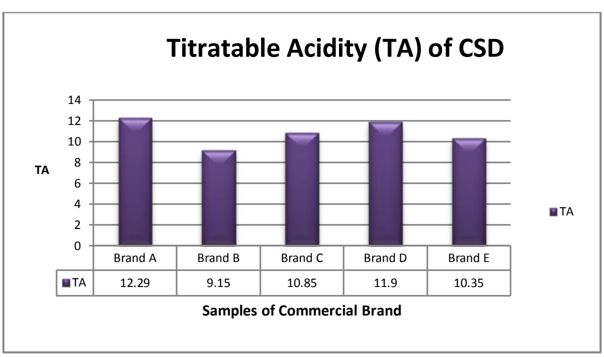

Figure 3. TA of Carbonated Soft Drinks

TA of CSD in five commercial brands was found in the range 9.15-12.29. The higher P^H was obtained in samples of Brand A

(12.29±0.2) and low in Brand B (9.15±0.2) as presented Figure 3.

Acidity regulators or acidulants are used in CSD to improve their taste by balancing the sweetness. The acidulants stimulates the flow of saliva in the mouth due to their thirst-quenching properties. The acids act as mild preservatives as they reduce the pH level of the product. Citric acid (E 330) is the first choice for use as an acid regulator in most of the CSD. The addition of citric acid has several additional benefits, such as enhancing the activity of beneficial antioxidants and adding aroma. When strong flavor enhancement is required then malic acid (E 296) is used. Phosphoric acid (E 338) has a strong effect on pH and is commonly used to give a specific taste to drinks [15]. High amount of acidulants intake is associated with adverse health effects such as "hyperphosphatemia," that can lead to kidneys damage, mineral abnormalities, vascular calcification and cardiovascular disease. As low acid concentration has importance in killing gastrointestinal bacteria in the body but low pH could cause teeth erosion [19]. The effect of low pH has been shown in so many studies to be responsible for tooth decay especially when the acidity (acid concentration per litre) of the soft drink is high [20] . So the acidity of CSD must be low to minimize the risk of causing tooth erosion and make soft drinks relatively save for consumption.

3.3. Brix and Inverted Brix

Brix and Inverted Brix of CSD in five commercial brands were estimated and the results are illustrated in Figure 4.

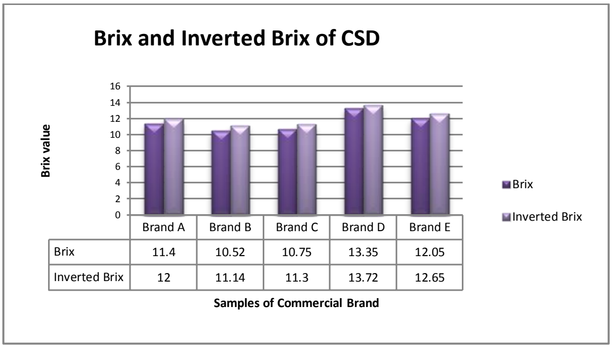

Figure 4. Brix and Inverted Brix of Carbonated Soft Drinks

Brix of CSD in five commercial brands was found in the range 10.52-13.35. The higher P^H was obtained in samples of Brand D (13.35±.20) and low in Brand B (10.52±0.2) as presented Figure 4. Inverted Brix of CSD in five commercial brands was found in the range 11.40-13.72. The higher P^H was obtained in samples of Brand D (13.72±0.3) and low in Brand B (11.14±0.3) as presented Figure 4. These values are similar to the values reported by Ayres *et al.* (1980) and Ranganna (1977) which were 12.6 Brix and 11.04 Brix respectively [12], [14]. This result is within the range of 10.3- 17.8 Brix reported by Mohamed and Mustafa (1978) and below the range of 15.5-16.1 Brix reported by Omer (2004) [13], [18].

Soft drinks usually contain between 1% and 12% sugar (w/w) with the exception of zero calorie products. It is well known, overconsumption of sugars can cause negative health effects, such as obesity, diabetes mellitus, or nonalcoholic fatty liver disease, weight gain [21]. Fructose consumption through CSD leads to the formation of advanced glycation end products, which may be factors in the onset of diabetes, hasten aging processes, and cause thickening of artery walls [22]. Due to health concern of consumer, the Brix content must be within approved standard of regulatory authorities.

4. CONCLUSIONS

The variation present in major constituents among commercial brands of CSD gives it the characteristic taste which justifies its frequent consumption. Sometimes the values were above the accepted limits for consumption. However, high concentration of these major constituent in CSD along with high consumption gives room for the health risk. As such, soft drink consumption may constitute a major public health concern and thus, there is need for regulatory bodies to monitor and control the quality of the carbonated soft drinks in order to ensure safe consumption and minimize the possible underlying risk. Manufacture needs to ensure standard limits of the major constituents in carbonated soft drinks. Quality assurance and control should be ensured during production. High quality raw materials need to use during production of carbonated soft drinks. Therefore, it will convey beneficial to consumers.

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