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Glucose Content in Popular Sweetened Beverages: Soft drinks, Fruit juices, Wines

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Abstract

Glucose is found naturally in food and is often added to processed foods to sweeten them and increase flavor. It is the key source of energy for human being. It supplies almost all energy for the brain, so its availability influences physiological processes. However, consumption of excess amount of glucose contributes negatively to metabolic health. The amount of glucose contents in some popular sweetened beverages such as soft drinks, fruit juices and wine sample marketed in Kathmandu valley of Nepal were determined. The quantitative analysis was carried out by using Fehling titration method. The glucose content varied from drinks to drinks of all brands. The results showed that the concentration of glucose was more in the soft drinks manufactured by Coca-Cola Company than the soft drinks manufactured by Pepsi Company. The concentration of glucose ranged from 9.63 g/L to 43.43g/L and 8.57 g/L to 25.45 g/L in Coca-Cola and Pepsi Company, respectively. The glucose content of fruit juice varied from19.60 g/L to 138.44 g/L. It was a minimum in orange juice and a maximum in mango juice among the juice samples taken in this study. The study also showed that concentration of glucose was twice in white wine of the local brand compared to that in white wine of the international brand and the values was lie between 21 to 42 g/L.

Keywords: *glucose, fruit juice, soft drink, wine*

Introduction

Soft drinks are one of the most popular and consumed beverages across the world. They are widely use at fast food restaurants, movie theaters, dining restaurants etc. They are very popular in small gathering, get together, celebration of different ceremony such as birth day, marriage, Dashain, etc. in Nepal. Although, soft drinks are available in plastic bottles, cans, glass bottle and paper pack, in a variety of sizes, the soft drinks with plastic bottles are most commonly used. They are served either chilled or over ice cubes and sometimes at room temperatures.

Soft drinks are non-alcoholic sweetened beverages containing carbonated water, fruit acids, sweetening agents and natural or artificial flavoring and colorings agents[1]. Soft drinks contain many beneficial qualities to one's health; they provide pleasant flavor, minerals, antioxidant and fiber which are essential vehicle for hydration. They are usually absorbed by body more readily than water and can replace lost salt. They provide energy quickly and thirsty quenching rapidly[2]. Soft drinks provide constant energy when consumed because of the sweetening agents present in it[1]. All carbohydrates are important

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source of energy but soft drinks generally contain soluble sugars which are easy to administer. One of the main components of carbonated drinks is sucrose. Structurally sucrose is a disaccharide constituted by the union of the monosaccharide glucose and fructose, connected through their anomeric carbon[3]. Sucrose that is used in carbonated drinks is made from sugarcane and sugar beets. Sucrose is acidic in nature and the acidity increases when carbon dioxide is pumped into the carbonated drinks. It is pure and crystalline and it is consistently sweet without any other flavor. It is rapidly utilized in the organism serving as an easily assimilated source of energy[4]. In addition to energy, soft drinks promote the rapid uptake of body salts and water which are very important products for sports people and other requiring almost instant dehydration. Other nutritional benefits that are claimed by some producers include the delivery of essential vitamins, and minerals, especially to children[2].

After the soft drinks the most commonly consumed another beverage is the fruit juice. A fruit juice is obtained from the edible portion of a ripe fresh fruit or from a fruit kept in fresh condition by suitable means[5]. Recently, consumption of fruit juice is drastically increasing in Kathmandu, Nepal, as fruit juice is more profitable than fresh fruit. Fruit juice contains vitamins, minerals, anti-oxidants and fibers which are essential for the human diet, hence, they are often consumed for their perceived health benefits. People consume fruits juices on a daily basis as they provide benefits of various fruits.

Fructose is one of the most abundant sugars in fruit juice. Fruits, vegetables, and honey are all natural sources of fructose. Three common forms of fructose are crystalline fructose, high-fructose corn syrup, and sucrose. Crystalline fructose is derived from corn, and has the highest concentration of fructose. High-fructose corn syrup is a combination of fructose and glucose[6]. They are widely used as sweetness in soft drinks[1]. Fructose is a simple monosaccharide absorbed directly into the bloodstream during digestion. The consumption of fructose, largely in the form of high fructose corn syrup, has risen over the past several decades[7]. Some people believe that the fructose is healthier than sucrose because it is found naturally in fruit, however it can be equally harmful.

Wine is another beverage made from grapes. Glucose and fructose are the main fermentable sugar in grape juice. At the end of fermentation excess sugar remains as residual sugar in the wine. It includes, all reducing sugars including glucose, fructose and other un-fermentable sugar. It is usually measured in gram of sugar per liter of wine. The wines are classified as sweet in which sugar contents is greater than 45 g/L and medium sweet in which sugar contents range from 18 g/L to 45 g/L[8]. The subjective sweetness of a wine is determined mainly by the amount of sugar in the wine but also the relative level of alcohol, acids and tannins.

It is found that the entire commonly used beverage contains sugar/glucose. Glucose is an important energy source that is needed by all the cells and organs of the body such as muscles and brain. However, the addition of excessive quantity of sugar transforms the food in a calorie bomb with eventual pathogenic effect[4]. Although the sugar is essential for energy, the human body cannot tolerate a large amount of sugar, which may damage the vital organs. The average healthy digestive system can digest and eliminate two to four teaspoons of sugar daily, usually without noticeable side-effects. Sugar-sweetened beverages contribute to weight gain in both adults and youth and are responsible for obesity, diabetes, cardiovascular disease and fatty liver disease etc.[9,10]. The large consumption of these glucose slowly erodes the ability of cells in the pancreas to make insulin[1]. In addition, the inherent acids and sugars added in beverages have both acidogenic and cariogenic potential, which results dental caries and potential enamel erosion. Acidosis can cause kidney stones, lower growth hormones, increase body fat

and reduce muscle mass. Further, bacteria and viruses thrive in an acidic environment, hence any state of acidosis will make the body more susceptible to bacterial and viral infections.

On the other hand, the elevated concentration of sugar as well as lower concentration of the sugar in human body has harmful effect. Therefore, it is very essential to know the amount of sugar (sucrose, glucose and fructose) present in the sweet beverages, those are commonly consumed[11], to prevent excessive consumption of glucose and protect people from harmful effect. This study determines the glucose content of certain selected popular brands of soft drinks, fruit juices and wine marketed and popular in the Kathmandu valley.

Numerous methods have been reported for glucose analysis in food. However, most of the adopted methods are time consuming or costly. Currently, several devices are available for precise and prompt glucose measurements in the clinical area, but these devices are frequently designed to operate under blood serum conditions. Development of fast, cheap, practical, and selective methods for detecting glucose in food is still a research area that brings together efforts from chemistry to clinical analysis[12].

High Pressure Liquid Chromatography (HPLC) method can measure sugar components like glucose, fructose and sucrose accurately[13]. FTIR spectroscopy can potentially give information about the proportions of the three main carbohydrates such as glucose, fructose and sucrose[14].Being a cost-effective and potentially more rapid than the above mentioned methods, FTIR spectroscopy became an alternative technique for the analysis of carbohydrates in food samples.

The method employed for the determination of glucose in this study is Fehling's test. This method is simple and economic to determine amount of glucose in laboratory. Fehling's test for reducing sugars has been used since the 1800's to determine the amount of glucose and other reducing sugars (lactose in milk, for example). It is also applied in agriculture (glucose determination in corn for use in corn syrup) [14] and in medicine (glucose determination in urine for diabetes tests) [15].

Experimental Methods

Collection of samples of sweetened beverages

Sixteen samples of sweetened beverages were purchased from the local market of the Kathmandu valley. Sweetened beverages were selected according to their popularity and frequency of their consumption. Among them seven widely consumed soft drinks, such as Coke-Cola, Fanta, Sprite, Pepsi, Miranda, Dew and Seven-up were collected for analysis. Similarly, five fruit juices with different flavor such as mango, orange, litchi, apple, and pomegranate fruit juices were selected for analysis. Further four wines sample such as two white wines one from local brand and one from international brand and two red wines one from local brand and one from international brand were collected from local market of Kathmandu valley for analysis. All the soft drinks were purchased in pet bottle and fruit juices were purchased in paper pack and local wines were purchased in glass bottle whereas international wines were purchased in paper pack. The samples were diluted as per requirement.

Preparation of sample solution

Soft drinks

25 mL of each soft drink was taken from freshly open 250 mL pet bottle and transferred into 250 ml volumetric flask. Distilled water was added up to the mark to make 250 mL solution. 10 mL of thus prepared sample solution was used for titration each time with standard Fehling's solution.

Fruit juices

50 mL of each fruit juice from paper pack was transferred in a volumetric flask of 250 mL and diluted up to the mark using distilled water. 10 mL of this solution was titrated with standard Fehling's solution in order to determine the concentration of the fruit juices.

Wines

All four brands of wine sample were titrated directly with standard Fehling's solution in order to determine the concentration of glucose present in the wine sample without any dilution.

Preparation of reagents for the determination of glucose

The following standard solutions of different reagents were prepared following standard method [14,15]. All reagents used are of analytical grade.

Fehling's stock solution A

Fehling's stock solution A was prepared by dissolving 35 gram of pure hydrated copper sulphate in distilled water in a volumetric flask of 500 ml and volume was made up to mark with distilled water.

Fehling's stock solution B

Fehling's stock solution B was prepared by dissolving 175 gram of potassium sodium tartrate tetra hydrate and 50 gram of sodium hydroxide in distilled water in a volumetric flask of 500 ml and volume was made up to mark with distilled water.

Methylene blue indicator solution

One gram of methylene blue was weighted out and dissolved in distilled water in a 100 ml 3 flask and volume was made up to mark by using distilled water .

Preparation of standard glucose solution

The analytical grade of glucose was dried in an oven for 2 hours at 100 °C. Then exactly 1.25 gram of dried glucose was weighted out and dissolves in distilled water and diluted to 250 ml in a volumetric flask and mixed well.

Results and Discussions

The glucose content of popular sweetened beverages was determined by purchasing samples from the local market in Kathmandu. The seven different samples of soft drinks, five samples of fruit juices of different flavor in paper pack and two samples of wines (local brand, white and red) in glass bottles and two samples of wine (international brand, white and red) in paper packs were purchased.

Glucose content in soft drinks

The glucose content in different soft drinks manufactured by Coca-Cola Company was plotted in Figure 1. The glucose content ranges from 9.68 g/L to 43.43 g/L. The Coca-Cola contains highest amount (43.43 g/L) of glucose and sprite contains lowest amount (9.68 g/L) of glucose among the soft drinks of Coca-Cola brand. The Ventura et.al (2010)[7] reported the glucose content of 39 -50 g/L in Coca-Cola and 37-45 g/L in sprite. The glucose content in Coca-Cola measured in this study falls within the range however the glucose content of sprite is slightly lower than the reported.

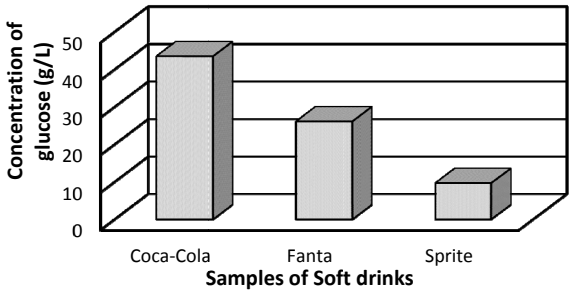

Figure 1: *The glucose content in soft drinks manufactured by Coco-Cola Company.*

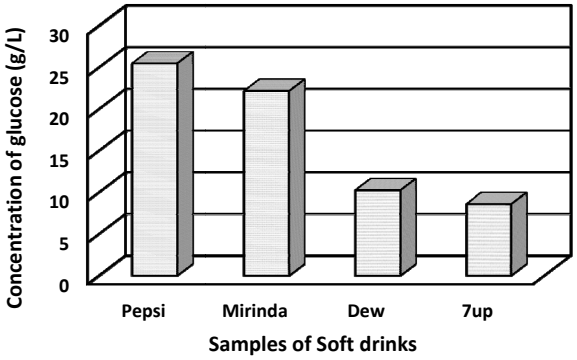

Figure 2: *The glucose content in soft drinks manufactured by Pepsi Company.*

The glucose content of soft drinks manufactured by Pepsi Company was plotted in Figure 2. The glucose content ranges from 8.57g/L to 22.45 g/L. The Pepsi contains highest amount (25.45 g/ L) of glucose and 7up contains lowest amount (8.57 g/L) of glucose among the soft drinks of Pepsi Company. The soft drinks Fanta and Mirinda contain moderate amount of glucose.

Table 1: Glucose content in soft drinks

S.N.	Soft drinks	Glucose Content(g/L)
1	Coca cola	43.43
2	Fanta	26.05
3	Pepsi	25.45
4	Mirinda	22.15
5	Dew	10.23
6	Sprite	9.63
7	7up	8.57

To compare the data more clearly the total glucose contents in soft drinks from two companies (Coca-Cola and Pepsi) measured were tabulated in Table 1. The data showed that the glucose content in the soft drinks under study varied from 8.57 g/L to 43.43 g/L. The glucose content in different brands of soft drinks are in following order. Coca-Cola > Fanta > Pepsi >Mirinda>Dew >Sprite >7up. This result showed that different soft drinks contain different amounts of glucose. The glucose content of Coca-Cola Company is more in comparison to that of soft drinks manufactured by Pepsi. The variation in glucose content may be due to the differences in composition and methods they used for the preparation of the soft drinks.

Glucose content in fruit juice

The glucose content in different types of fruit juice of different flavor marketed in Kathmandu valley are plotted in Figure 3. The Figure showed that mango juice contains highest amount (138.44 g/L) of glucose and orange juice contains lowest amount (19. 60 g/L) of glucose. The concentration varies from 19.60 to 138.44 g/L. The glucose content in mango was seven times higher than that of orange juice. The variation in concentrations of fruit juices correlated with the concentration of sugar in corresponding fruit and sugar added by the manufacturer[16].

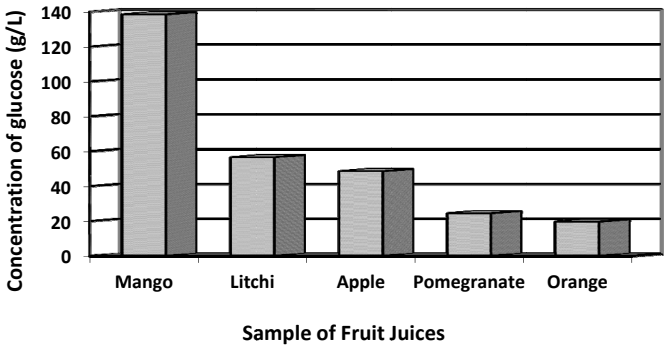

Figure 3: *The glucose content in Fruit juices*

Glucose content in wine

The results for the measurement of the glucose concentration in different wine sample are shown in Figure 4. The measurement of the glucose concentration in the wine showed that all the wine samples contain glucose. The concentration of the glucose in local wine is almost twice that of the international brand wines. The concentration of glucose in wine sample was within standard limit 18 g/L to 45 g/L as reported in Wikipedia. Different wine samples contain glucose in the following order Local white wine >Local red wine >International white wine >International red wine. The concentration of glucose in local white wine (44.30 g/L) and local red wine (42.60 g/L) is more than the international white wine (21.50 g/L) and international red wine (21.15 g/L) which is in accordance with the standard value.

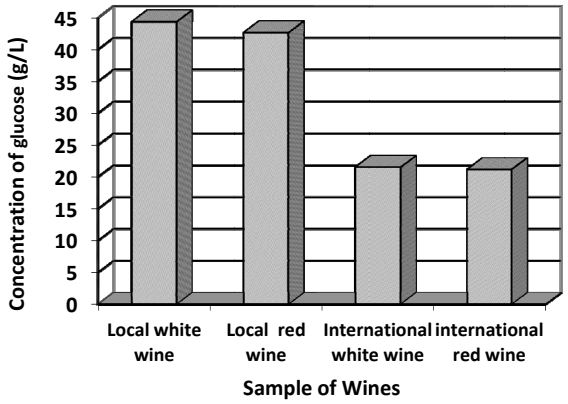

Figure 4: *Concentration of glucose in Wines.*

Comparison of glucose contents in different beverage

The comparison of highest and lowest glucose contents in soft drinks, fruit juice and wine was presented in the Figure 5. From the Figure, it is clear that fruit juice (mango) has highest glucose content and fruit juice orange has lowest glucose content. Similarly local White wine has highest glucose content and international red wine has lowest glucose content, likewise soft drink Coca-Cola contains highest concentration of glucose and soft drink 7up contains least glucose. Among the all sweetened beverages collected to measure glucose content in this study, the mango juice content highest amount of glucose and 7up contains lowest amount of glucose. The glucose content in mango juice was three to fifteen times higher than that in other sweetened beverages. It revealed that the mango juice deliberate highest amount of energy than other drinks

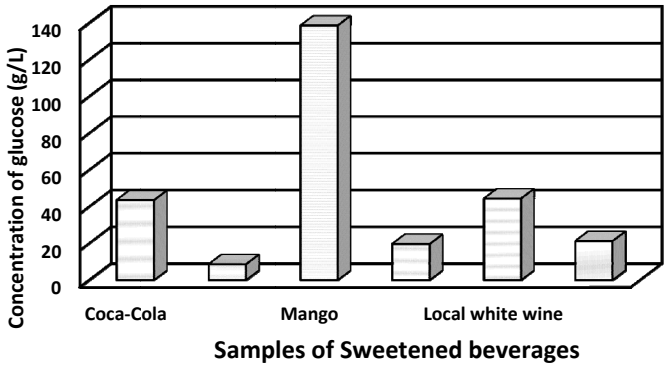

Figure 5: *Comparison of Glucose content in Sweetened beverages.*

The glucose content in Coca-Cola and Local white wine was almost equal. People use to drink Coca-Cola frequently than wine. Further, volume of Coca-Cola used to drink in each time is usually higher than volume of wine. The result attributes that the people uptake more glucose by drinking Coca-Cola than by drinking wine.

Comparison of glucose content of soft drinks of different countries

The glucose content in most widely consumed soft drinks in Nepal (this study) was compare with that in soft drinks from Australia, Europe and United States. The glucose content in soft drinks from other countries was taken from previous study[17]. The comparison of glucose content in soft drinks of Australia, Europe, United States and Nepal was shown in Figure 6. The Figure showed

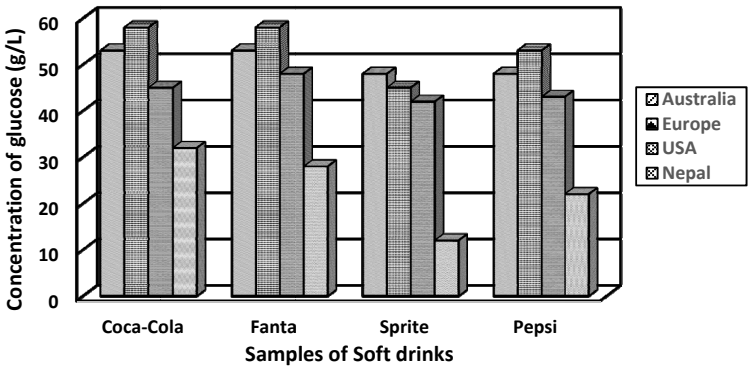

Figure 6: *Comparison of Glucose contents in soft drinks of different countries.*

that the glucose content in Fanta and Coca Cola was comparatively higher than other soft drinks in all the cases. The glucose content in Sprite was comparatively lower than that of other soft drinks. The soft drinks of Australia and Europe has high glucose concentration that of United State and Nepal. The variation of glucose contents in soft drinks in this study was almost similar to previous study, though the glucose content in soft drinks observed in this study was comparatively low. The high glucose content in other studies may be due to measurement of all reducing sugar rather than glucose only.

Conclusions

The glucose content in popular beverage such as soft drinks, fruit juices and wines was determined. The results showed that different brands of drink contain glucose at different concentration. The variation in the concentration of glucose in the drinks attributed due to the different methods employed by the manufacturing company. The concentration of glucose ranges between 8.57 g/L to 43.43 g/L in soft drinks .The concentration of glucose in fruit juices ranges between 19.60 g/L to 138.44 g/L. The all wine samples also contain glucose and the concentration of glucose ranges between 21.15 g/L to 44.30 g/L. The glucose content of mango was seven times higher than that of orange juice. The variation in concentrations of fruit juices seems to be correlated with the sweetness of the corresponding fruit.

The continuous intake of drinks containing high glucose content may be harmful, because the high sugar intake increased the risk of heart disease and weight gain, especially while lacking exercise. Further, the elevated glucose concentration contributes to serious health disorder such as diabetes (hyperglycemia), hypertension, depression and swollen of certain body parts. So continuous intake of these drinks should be avoided and it is suggested to choose soft drinks and juice as per requirements of energy rather than popularities.

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