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Determination of Glucose Concentrations and Acidity in Selected Soft Drinks Marketed in Port Harcourt Nigeria

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Abstract Selected soft drinks were screened for glucose concentrations and pH using Fehling solution and pH meter by Extech. The results showed that the glucose concentrations ranged between 8.39g/l and 48.95g/l. The study showed the presence of glucose in all the soft drinks. The soft drinks were found to be acidic in nature with pH ranging from 2.50 to 3.26. These results suggest that soft drinks contribute to major public health problems such as diabetes, atherosclerosis, acidogenic and cariogenic potential that result in dental caries and potential enamel erosion. Thus, quality control during the production process especially at the stages of sterilization and purification as well as adding clean alkaline water to soft drinks before use and total avoidance were recommended.

Keywords Glucose, Soft Drinks, Open Markets, Acidity

Introduction

The era of soft drinks began in 1952 but the industrialization in India marked its beginning with launching of Limca and Goldspot by Parley group of companies. Since, the beginning of soft drinks was highly profitable and luring, many multinational companies launched their brands such as Pepsi and Coke in India. Nowadays, it is observed in general that majority of people viewed Sprite, Miranda, and Limca to give feeling of lightness while Pepsi and 7Up to activate pulse and brain [1].

In Nigeria today, soft drinks are one of the most consumed beverages. The consumption of non-alcoholic beverages in Nigeria was rated at 15.98k/person/day in 2007 [2]. Soft drinks are becoming accepted by Nigerian population due to its convenience nature. It provides constant energy when consumed because of the glucose contents present in the various drinks.

Soft drinks exist in various forms and brands and are marketed by different brewery industries across the country [3-4]. These drinks are readily consumed on daily bases especially when undergoing tedious activities like hard work and sport [5]. Also, with the relatively affordable prices, they are highly consumed during leisure and relaxation outings and serve the general public in celebrations such as traditional marriages, weddings, funerals etc [6].

The high consumption rate of soft drinks is attributed to the characteristic taste and flavour as well as their thirst quenching potential [7]. These characteristics are defined by the constitutions present such as sugar which is responsible for its sweetness, carbonated water which is water compressed with carbon dioxide to make it an ultimate thirst quencher and flavouring agents to add flavour to the drinks [8]. In addition to taste satisfaction, Table 1 shows that soft drinks contain other constituent such as vitamins, phosphates, acids, antioxidants, etc which are of nutritional and health benefits to the body [9].

The primary function of glucose is to provide energy for physiological processes such as respiration, muscle contraction and relaxation, heart rhythm and the regulation of body temperature. Glucose slowly erodes the ability

of cells in the pancreas to make insulin. High levels of blood sugar can cause changes that lead to a hardening of the blood vessels (atherosclerosis) [3, 10-11].

Soda or soft drinks contain several types of acid, which may include citric, phosphoric, malic, carbonic, and tartaric acids. These produce an extremely damaging effect and can soften and demineralize enamel. Acids have a low pH, which makes them highly corrosive and detrimental to tooth structure. The higher the acid content of the soda, the faster erosion will occur. Frequent consumption of soda is directly related to rapid wearing away of enamel. This causes lesions to form on the tooth surface, leading to decay and loss. Soft drinks have many potential health problems. The inherent acids and sugars have both acidogenic and cariogenic potential resulting in dental caries and potential enamel erosion. Bacteria and viruses thrive in an acidic environment, and any state of acidosis will make the body more susceptible to bacterial and viral infections. Acidosis can cause kidney stones, lower growth hormones, increased body fat and a reduction in muscle mass. The body constantly works to maintain a proper pH balance between 7.35 and 7.45. As a reference, the pH of pure water is 7. When the pH levels fall below 7.35, clinically it causes acidosis and depression of central nervous system. If the body pH level falls below 7, it implies severe acidosis, which can cause a coma and ultimately become fatal. When the body pH level rises above 7.45, it implies alkalosis. Alkalosis makes the nervous system hypersensitive, resulting in muscle spasms and convulsions [12].

Glucose is an important energy source that is needed by all the cells and organs of the body such as muscles and brain. Soft drinks are sold in almost all public and private schools and dentists have noticed a condition in teenagers that used to be found only in the elderly-a complete loss of enamel on the teeth, resulting in yellow teeth. Since elevated concentrations of sugar in carbonated soft drinks may be responsible for negative health effects, it is important to evaluate soft drinks in our locality to ascertain their glucose concentrations and create awareness in the area. This study aims to determine the concentrations of glucose and the pH level in various brands of soft drinks marketed in Port Harcourt.

Table 1: Brands of Soft Drinks and Constituents Claimed by Manufacturers

S. No.	Brand	Nafdac Reg. No.	Constituents claimed by manufacturer
01	Coca-Cola	01-0251	Carbonated water, sugar, caramel, colour, phosphoric acid flavouring and caffeine.
02	Pepsi	01-0 163	Carbonated water, sugar, caramel, colour, phosphoric acid, caffeine, gum Arabic and natural flavour.
03	Sprite	01-0261	Carbonated water, sugar, citric acid, flavouring, sodium salt, sodium benzoate
04	Fanta	0 1-0260	Carbonated water, sugar, citric acid, and ascorbic acids, stabilizer, flavoring, sodium benzoate, colourants, sunset yellow and tartrazine.
05	7up	01-0 164	Carbonated water, sugar, caramel, colour, phosphoric acid, caffeine, gum Arabic and natural flavour.
06	Marinda	01-0 159	Carbonated water, Sugar, citric Acid, gum Arabic, sodium benzoate, ester gum, natural flavours, yellow (Sunset yellow), ascorbic acids, yellow (tartrazine), propylene glycoi.
07	Bitter Lemon	A1-3098	Citric acid

Source: [13]

Materials and Methods

Selection and Identification of Soft Drinks

Seven brands of soft drinks (SD) locally called minerals were selected for this study. The soft drinks were identified as (i) SDC (ii) SDF (iii) SDS (iv) SDU (v) SDP (vi) SDM (vii) SDB. All these products are registered and licensed in Nigeria by their respective companies.

Glucose will be determined by standard method on the basis of its reaction with Fehling's solution [14].

Preparation of Fehling's solutions

(i) Solution A – Exactly 6.93g of pure hydrated Copper II sulphate ($CuSO_4.5H_2O$) was dissolved in water and made up to 100ml in a measuring flask.

(ii) Solution B – Exactly 34.6g of crystalline sodium potassium tartrate (Rochelle Salt, $C_4H_4O_6$ NaK_4H_2O) was dissolved in warm water. Also 12g of sodium hydroxide (NaOH) was dissolved in water. The two solutions were mixed and made up to 100ml in a measuring flask.

When the Fehling's solution was required, just before the experiment, equal volumes of solutions A and B were mixed and shaken thoroughly.

Standardization of Glucose

Pure anhydrous glucose, 1.25 g was dissolved in distilled water and made up to 250 ml in a standard flask. This solution was placed in a burette. Exactly 25 ml of the Fehling's solution was placed in a conical flask and diluted with 25 ml of distilled water. The Fehling's solution was heated till boiling and the glucose solution, 0.1 ml at a time was added to the boiled solution until the blue colour disappeared. The solution was allowed to cool at intervals to allow the red copper (1) oxide precipitate to settle. The contents of the flask were heated again. The end point of the titration is shown by the disappearance of the blue colour in the supernatant liquid. The titration was repeated until the titre values are consistent.

Calculations

(i) Concentrations of Glucose in soft drinks

25.0ml Fehling solution = titre volume of standard glucose solution

Also, 25.0ml Fehling solution = titre volume of soft drinks

The concentration of glucose in the soft drinks

$$= \frac{(\text{conc. of the std. glucose soln})\ (\text{titre volume of std. glucose soln.}}{\text{titre volume of soft drinks}}$$

Thus 250ml of standard glucose solution contains 1.25g glucose

Hence 1000ml of standard glucose solution contains $\frac{1000 \times 1.25}{250}$ = 5.0g glucose/liter

Therefore the concentration of glucose in the soft drink will be:

$$\frac{5.0\text{g} \times \text{titre volume of std glucose}}{\text{titre volume of soft drinks}} = \text{g/litre}$$

Determination of pH

An *in situ* measurement of the soft drinks was made using Extec DO.700 meter after calibration with buffer solutions 4 and 7.

Results and Discussions

The results of glucose concentrations and pH levels measured in selected brands of soft drinks are presented in Table 1 and Figs. 1and 2.

Table 1: Glucose Concentrations and pH Levels Measured in Selected Brands of Soft Drinks

S/N	Soft Drinks	Observation	Glucose contents (g/l)	pH	Conclusion
1.	SDB	Reddish brown ppt.	48.95	2.53	Glucose Present
2.	SDC	Reddish brown ppt.	39.17	2.50	Glucose Present
3.	SDF	Reddish brown ppt.	29.38	2.77	Glucose Present
4.	SDP	Reddish brown ppt.	23.50	2.50	Glucose Present
5.	SDM	Reddish brown ppt.	19.58	2.74	Glucose Present
6.	SDS	Reddish brown ppt.	9.79	3.25	Glucose Present
7.	SDU	Reddish brown ppt.	8.39	3.26	Glucose Present

The results of glucose concentrations in the soft drinks under study varied between 8.39 g/l in SDU and 48.95 g/l in SDB. The concentrations of glucose in the various brands of soft drinks showed the following trend: SDB > SDC > SDF > SDP > SDM > SDS > SDU. The results further showed that all brands of soft drinks contain glucose at various concentrations. The variations in glucose concentrations could be attributed to differences in composition and methods for the preparation of the soft drinks by the different factories.

The amount of glucose the normal human body needs on a fasting day which is approximately 8 hours should be 70 and 99 mg/dl and on a normal day without fasting it should be less than 140 mg/dl [15]. The Standard Organization of Nigeria [16] recommended limit range of 7-14 g/100ml for soft drinks. All the soft drinks were below the stated recommended limits. However continuous intake of soft drinks could lead to accumulation of glucose contents in the body especially when lacking exercise and that can lead to certain illness such as diabetes and also hardening of the blood vessels, what doctors call atherosclerosis which causes problems such as kidney failure, strokes, erectile dysfunction and vision loss e.t.c.

The results further showed that all the soft drinks under study were very acidic with pH values ranging from 2.50 in SDC and SDP to 3.26 in SDU. Generally SDC and SDP were found to be more acidic while SDU was the least acidic. This is in agreement with the report in www.livestrong.com. Excess of acid in the human body can lead to shock, coma or death, headache; stomach upset e.t.c. [17]. The variations in pH of the soft drinks showed the following trend: SDU > SDS > SDF > SDM > SDB > SDC = SDP.

A study by [18] reported as follows that soft drinks are little more harmful than sugar solution as they contain sugar in large amount which cause problems in diabetes patients. Also soft drinks can cause weight gain as they interfere with the body's natural ability to suppress hunger feeling.

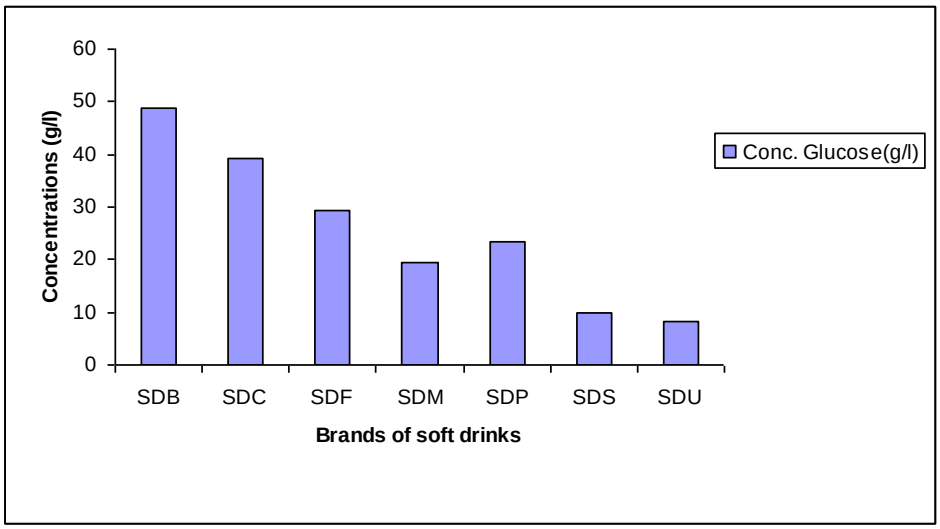

Figure 1: Concentrations of Glucose in Soft Drinks

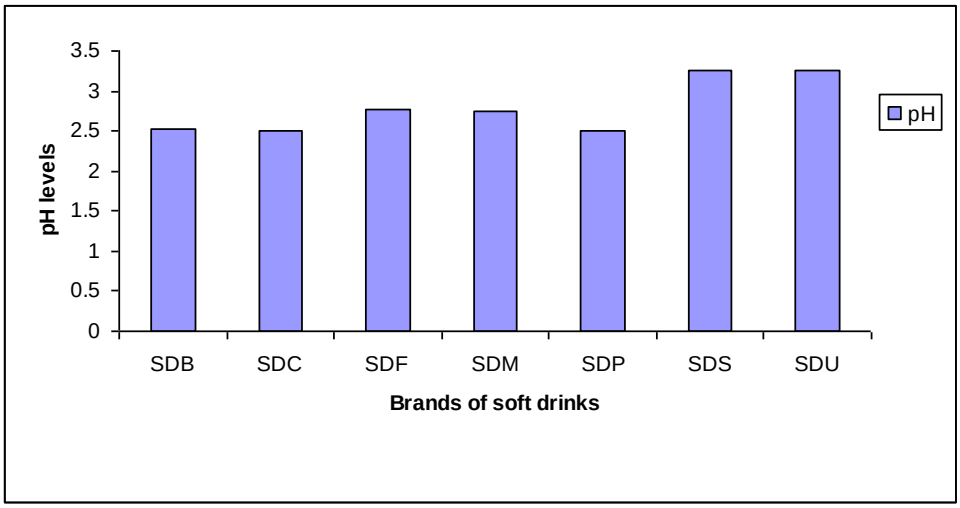

Figure 2: pH Levels in Soft Drinks

Conclusion and Recommendations

Conclusion

The findings of this study has shown that all the soft drinks contain glucose and are acidic having given positive tests with Fehling's (A & B) solution and low pH values.

Recommendations

Based on the findings of this study it is recommended that the intake of soft drinks should either be limited or avoided completely, soft drinks should be diluted with clean/ alkaline water before consumption and Government agencies should ensure proper quality control during the production process especially at the stages of sterilization and purification.

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