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Levels of Benzoic Acid, Sulphur (IV) Oxide and Sorbic Acid in Carbonated Drinks Sold in Lagos, Nigeria

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Abstract Residual sulphite as sulphur dioxide causes severe systemic reaction characterised by difficulty in breathing and cardiovascular collapse. Few studies have described exposure of humans to excessive preservatives from food and beverage products in Nigeria. Little is also known about the levels of preservatives such as benzoate, sorbates, sulphur (IV) oxide, sorbic acid and ascorbic acid in carbonated drink (CD) ,fruit juices (FJ), sport drinks(SD) and dairy drinks. Commonly consumed carbonated drinks (14), fruit juices (14), sport drinks (2) and dairy drinks (3) purchased in various markets in Lagos metropolis were analysed for the preservative contents using standard methods. Residual sulphite levels expressed as sulphur (IV) oxide in CD ranged from 4.0 – 15.2 mg/L, FD ranged from ND-13.6 mg/L. SD ranged from 3.6-13.6 mg/L while in DD it ranged from ND – 4.7 mg/L. Benzoic and citric acid contents for CD, FJ, SD and DD ranged from 222-702 mg/L & 0.38-0.89% ^{m}/v ; 168-799 mg/L & 0.26-0.89% ^{m}/v; 451-494 mg/L & 0.24-0.32% ^{m}/v; 132-318 mg/L & 0.36-0.7% ^{m}/v, respectively. The pH of the drinks ranged from 2.46-5.58. 55% of the samples analysed have benzoic acid content below the regulatory limit. Values of pH, ascorbic acid and sulphur (IV) oxide for all samples were in conformity with standards. Benzoic acid and ascorbic acid concentration was higher in Sport drinks than other samples while levels of sulphur (IV) oxide and citric acid were more in carbonated drinks. The citric acid values of about 21% of the samples analysed had value above required limit of 0.5%^{m}/v. The sum total of the preservatives levels are within the regulatory limit, however, 71.4% of the carbonated and 100% of the fruit drinks have benzoic acid level above the national permitted level of 250 and 150 mg/L respectively.

Keywords: *preservatives, carbonated drink, fruit juice, benzoic acid, citric acid*

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1. Introduction

Juice beverages are among food products which are highly consumed in Lagos, Nigeria and these beverages contain preservatives. They are beverages that are consumed for their nutritional value, thirst-quenching properties and simulating effect or their medicinal value [1]. Preservatives are the substances that increase the shelf life of foods and beverages. Preservatives inhibit growth of spoilage microorganisms and chemical degradation of food components [2]. Numerous chemical compounds such as benzoic acid, sulphite as Sulphur dioxide, citric acid and sorbate are able to inhibit the growth of microorganisms. Benzoic acid is a known and commonly used food preservative. It is most suitable for foods, fruit juices and soft drinks that are naturally in an acidic pH range [3] and present naturally in some materials [4]. Benzoic acid also used as preservative in food, beverages, tooth pastes, mouth washes, dentifrices, cosmetics and pharmaceuticals at regulated dosage [5]. Potassium sorbate is another established food preservatives, its effectiveness is 5 to 10 times of sodium benzoate and is used in quantities in which there is no known adverse health effect [6]. Sulphur dioxide is widely used in the food and drinks industries for its properties as a preservative and antioxidant. Whilst harmless to healthy persons when used in recommended concentrations, it can induce asthma when inhaled or ingested by sensitive subjects, even in high dilution [7]. The constituents of processed juices are mainly water, sugar, preservatives, colour, and fruit pulp [8]. Fruit juices are rich in Vitamin A,C, and minerals such as calcium, magnesium, zinc, iron, potassium, and could be fortified with more minerals and vitamins [1,8-13]. The anti-oxidant components of fruit juice have beneficial long term health effects, such as decreasing the risk of cancer and heart disease [14]. Iron (Fe) is required for energy and endurance because it delivers oxygen throughout the body. Iron is said to be an important element in the diet of pregnant women, nursing mothers, infants, convulsing patients and the elderly to prevent anaemia and other related diseases [15]. Increased iron absorption from food by Vitamin C is essential for

children who consume diet with low iron bioavailability [16,17,18].

Fruit juices, soft drinks and dairy drinks are available in essentially the same form almost anywhere in the world. From polar bases to the tropics and from the largest developed countries, fruit juices are available in bottles, cans, Polyethylene terephthalate (PET) bottles, Plastics bottles, laminated paper packs, pouches/satchets, Tetra paks, cups, and almost every other form of packaging known. In recent years these juices have been included significantly in the diet of most people, irrespective of age [8].

Most fruits drinks, soft drinks etc contain sufficient nutrients that could support microbial growth. Several factors encourage, prevent or limit the growth of microorganisms in juices, soft drinks; the most important are pH, hygienic practice and storage temperature and concentration of the preservative. Despite the benefits, they have also been linked to food toxicity/poisoning, immune-depression and cancer in human. Few studies have described exposure of humans to excessive preservatives from food and beverage products in Nigeria. Little is also known about the levels of preservatives such as benzoic acid, sorbic acid, sulphur dioxide and citric acid in fruit juices, soft drinks and dairy drinks.

In view of this, the need to monitor the levels of preservatives in commonly consumed fruit juices, soft drinks and dairy drinks in Lagos metropolis is important. The aim of the study is to determine the preservatives contents; quality parameters and compliance of commonly consumed fruit juices, soft/carbonated drinks, dairy drinks and sport drinks to regulatory standard values/requirements.

2. Materials and Methods

Sample selection was based on most demanded and only samples within the expiry date as stipulated on the labels by manufacturers was analyzed. Commercially available carbonated drinks (CD), fruit juice (FJ), dairy drinks and sport drinks (SD) packed either in plastics bottles, pet bottles, sachets, plastic/metallic can and tetra pack were purchased from open markets and super markets. Samples were kept in the refrigerator at 4^0C prior to analysis. Table 1 shows the physical characteristics of the samples analysed.

Table 1. The physical characteristics of the samples analysed

Sample Code	No analysed	Colour	Shelf Life (Months)	Type of Package
CD 1	1	Golden yellow	6	PET bottle
CD 2	1	Orange	12	PET bottle
CD 3	3	Lemon green	6	PET bottle
CD 4	1	Lemon	6	PET bottle
CD 5	2	Lemon	6	PET bottle
CD 6	1	Black	12	PET bottle
CD 7	1	Colourless	12	PET bottle
CD 8	1	Black	6	PET bottle
CD 9	1	Cloudy lemon	12	Metallic can
CD 10	1	Golden yellow	12	Metallic can
CD 11	1	Orange	6	PET bottle
CD 12	1	Colourless	6	PET bottle
CD 13	1	Deep wine	12	PET bottle
CD 14	1	Dark brown	12	PET bottle
FJ 1	1	Cloudy yellow	12	Metallic can
FJ 2	5	Cloudy yellow	9	Satchet
FJ 3	3	Cloudy yellow	9	Satchet
FJ 4	3	Light yellow	12	Pet bottle
FJ 5	1	Cloudy yellow	9	Tetra pak
FJ 6	2	Wine	12	Tetra pak
FJ 7	1	Golden yellow	12	Pet bottle
FJ 8	4	Wine	12	Tetra pak
FJ 9	5	Cloudy yellow	9	Tetra pak
FJ 10	5	Light yellow	9	Tetra pak
FJ 11	4	Cloudy yellow	9	Tetra pak
FJ 12	1	Light yellow	9	Tetra pak
FJ 13	2	Light wine	12	Tetra pak
FJ 14	1	Cloudy orange	6	Tetra pak
SD 1	1	Golden orange	9	Tetra pak
SD 2	1	Red wine	9	Tetra pak
DD 1	6	Creamy light	6	Plastic
DD 2	2	Light yellow	6	Plastic can
DD 3	3	Milky yellow	6	PET bottle

Note: CD- Carbonated Drink; FJ- fruit Juice; SD- Sport Drink; DD- Dairy Drink.

2.1. Physical and Chemical Analysis

The physical parameters determined in the samples are pH, sugar content and specific gravity while the chemical parameters are benzoic acid content, ascorbic acid, sulphur (IV) oxide, citric acid and sorbic acid content.

Prior to the analysis, the samples were thoroughly shaken and allowed to attain the room temperature. The pH of the samples was determined using pH meter (Orion SA520 model). The parameters were determined by standard methods. The ascorbic acid was determined by titrimetry method. The benzoic and sorbic acid were determined by the UV method according to ISO no. 5518 and 6560 procedure [19,20] after extraction with organic solvent. The chemical used were of analytical grade purchased from BDH chemicals.

2.2. UV Instrumentation

Benzoic acid and sorbic acid were determined using the spectrum lab 752C UV/Visible Spectrophotometer at 226nm and 250nm respectively after extraction.

2.3. Quality Assurance

Triplicate analysis was done and recovery was carried out using sodium metabisulphate. 90.3% recovery was obtained on spiking samples without sulphur (IV) oxide with known concentration of sodium metabisulphate.

2.4. Statistical Analysis

The data obtained from the analysis were analysed by SPSS software version 19 (SPSS Inc., Chicago, IL, USA). The data represented a mean value for each of the parameters determined and were statistically analyzed using one-way analysis of variance (ANOVA) followed by Least Significant Difference test at $p \leq 0.05$.

3. Results and Discussion

The pH range for carbonated drinks (CD), fruit juice (FJ), sport drinks (SD), and dairy drinks [21] were 2.46-4.10; 2.54-3.86; 2.59-2.61 and 3.83-5.21 respectively as shown in the (Figure 1). Generally, the drinks are acidic; this might inhibit the growth of the bacteria. Acidic drinks lower the pH level of oral cavity therefore their consumption causes the teeth to demineralise [22]. The Sport drink is more acidic compared to other drinks studied; this could be attributed to the types of preservatives used. The result recorded for carbonated drink is similar to what reported by [23,24]. The pH of FJ observed is similar to study of [23]. The sugar level is in the order of sport drink > carbonated drink >fruit juice > dairy drink. The high level of sugar in sport drink may be because it is required to supply energy for sporting activities. The specific gravity is the same for the various types of drinks analysed as shown in (Figure 1).

The pH of carbonated drink and fruit juice with 12 months shelf life is more acidic compared with the 6 months shelf life (Figure 2). The sugar level in 6 month shelf life product for fruit juice is higher compared with 12 months shelf life while 9 months shelf life had the least content of sugar level. The specific gravity is generally the same in all the various shelf life studied.

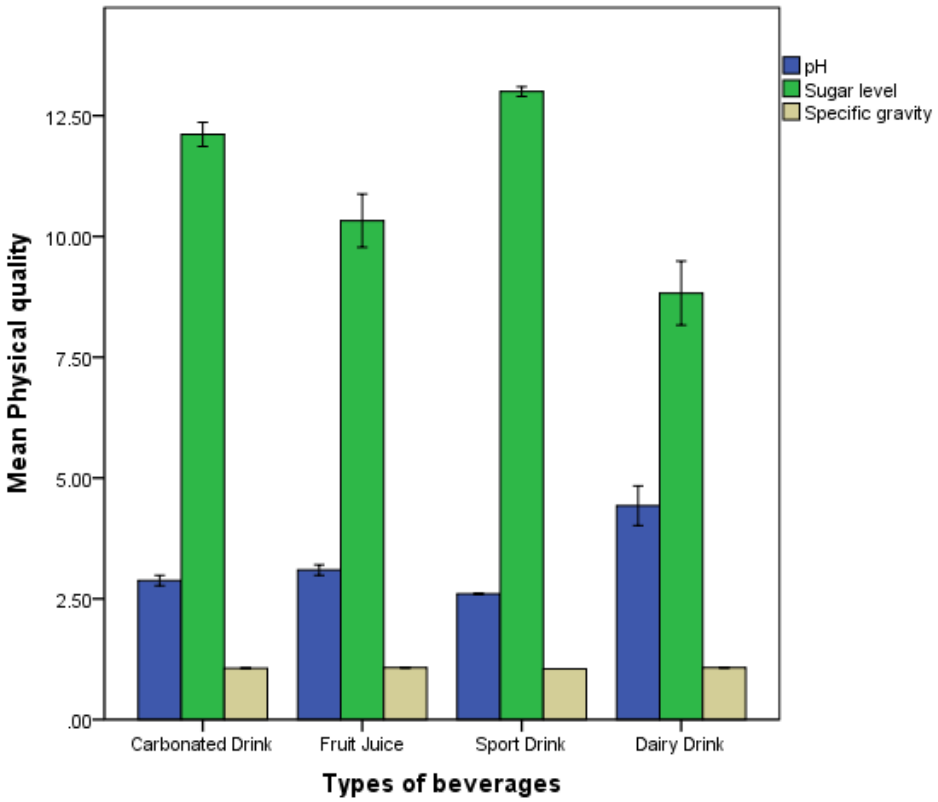

Figure 1. pH, sugar and specific gravity contents of types of beverages

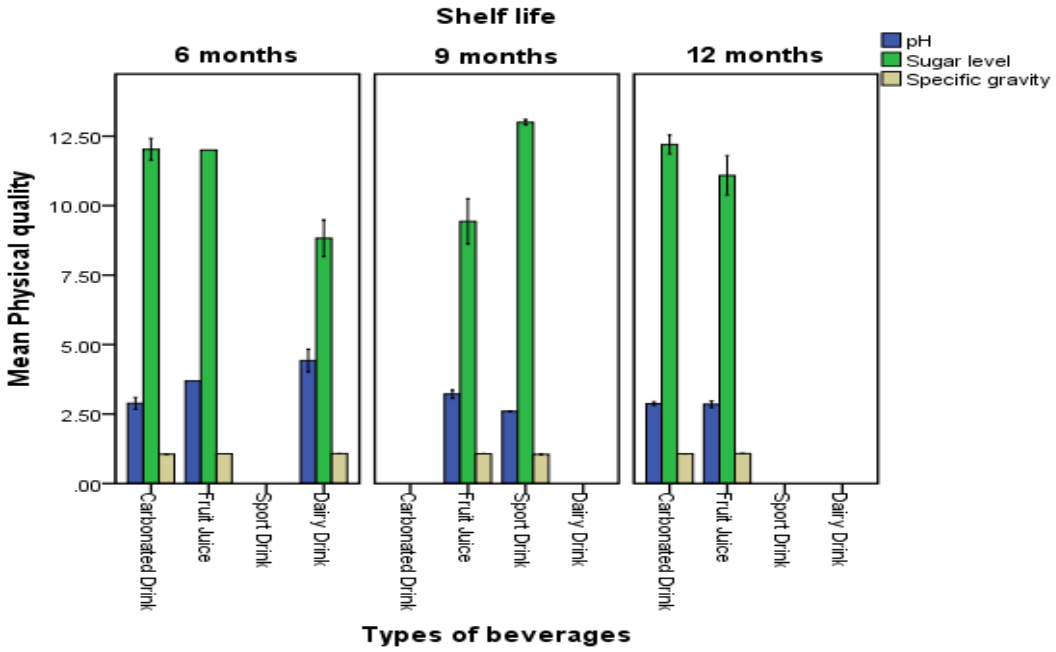

Figure 2. pH, sugar and specific gravity contents in shelf life of types of beverages

The results of the benzoic acid and ascorbic acid were displayed in Figure 3. The benzoic acid content of the various types of drinks is in the order of sport drink > carbonated drink >fruit juice > dairy drink. The result is in consonant to the level of sugar content. Ascorbic acid contributes to the product appearance and palatability. The ascorbic acid is highest in sport drink and lowest in carbonated drinks. Level of the ascorbic acid of the various types of beverages analysed were within the regulatory limits of 350 mg/kg, [25,26].

Fruits drink shelf life of 6 months had the highest level of benzoic acid followed by carbonated drink while dairy drink had the least (Figure 4). The 9 months shelf life product had sport drink higher than fruit drink while 12 months shelf life product had carbonated drink higher than the fruit drink. The ascorbic acid level is similar in trend to the result obtained in benzoic acid for the various shelf lives of the types of beverages.

The CD samples had level of benzoic acid of about 71.4% not within the regulatory limits of 250 mg/L for drinks that contained ascorbic acid. The sport drink and fruit juice analysed had 100% non compliance to the regulatory limit of benzoic acid level of 250 and 150 mg/L respectively. The mean concentration of benzoic acid for all the samples of FJ 336±190 was greater than the mean concentration recorded by [27] in Brazil, 259.2 mg/L and [28] in Iran, 163.8 mg/L) while the result obtained by [29], 70.20 mg/L is lower than the level recorded in this study.

It was observed that 28.6% of CD samples had citric acid not within the regulatory limit of 0.5% m/v. The % of non compliance of citric acid level in the samples of SD and FJ are 100 and 23.1 respectively. The regulatory limits of benzoic acid level in the DD types of beverages were not specified.

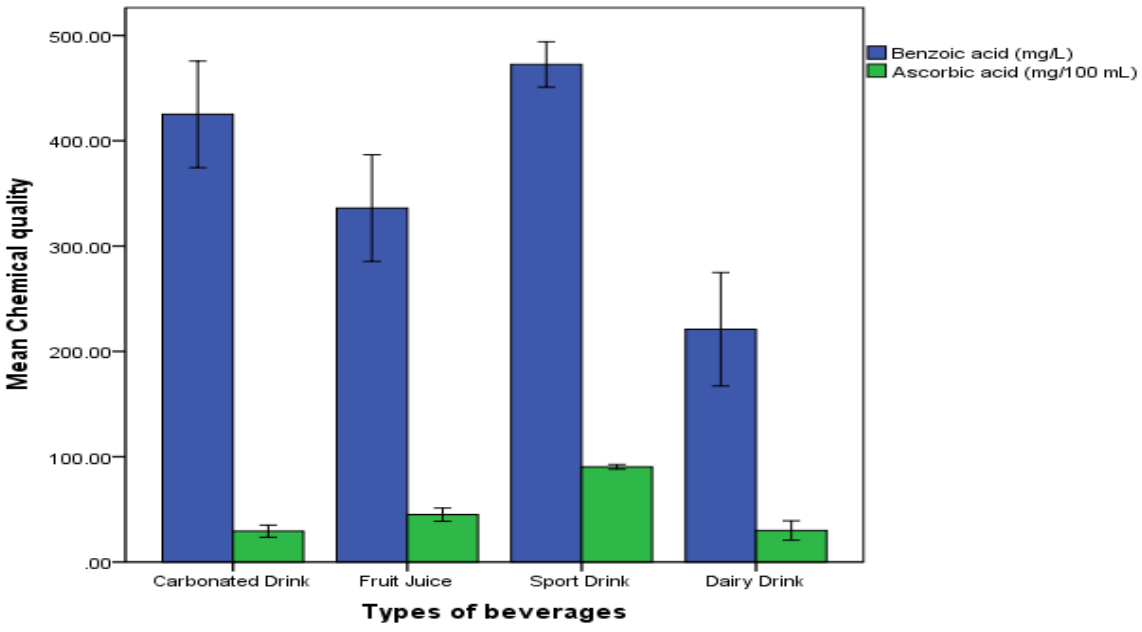

Figure 3. Benzoic acid (mg/L) and ascorbic acid (mg/100mL) contents of types of beverages

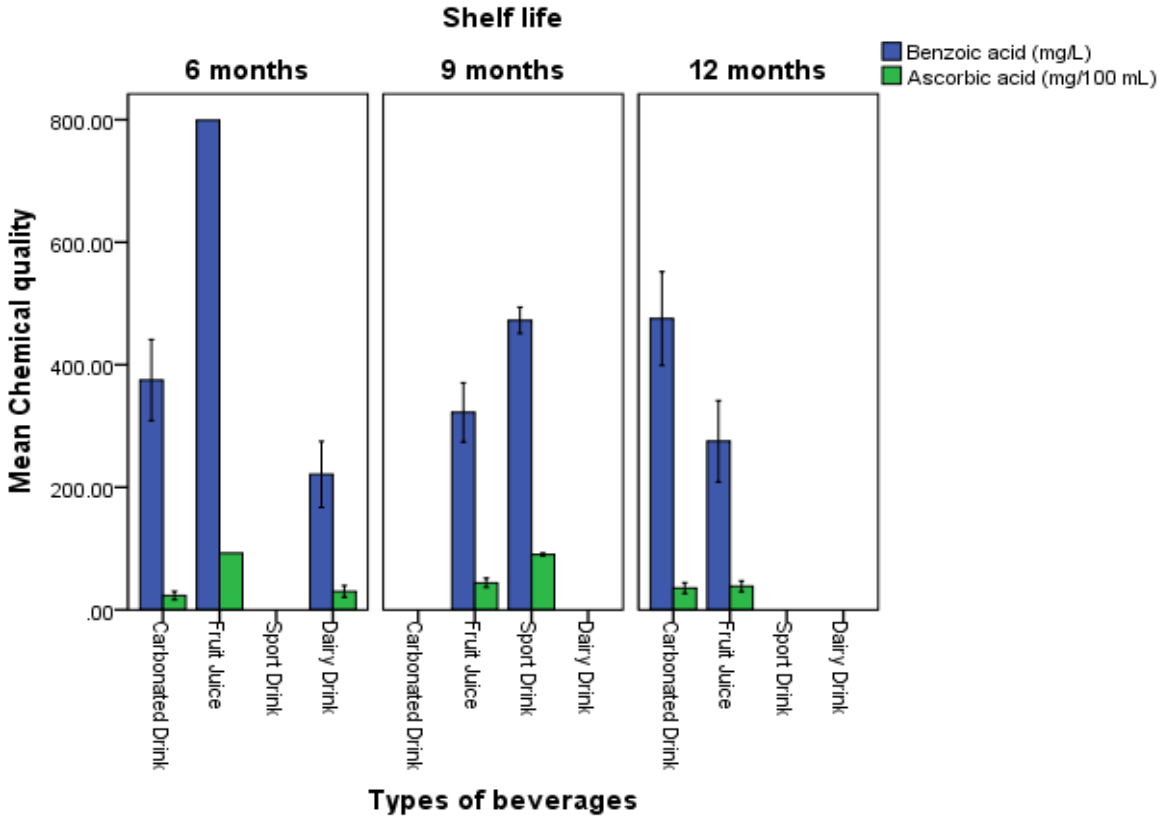

Figure 4. Benzoic acid (mg/L) and ascorbic acid (mg/100mL) contents in shelf life of types of beverages

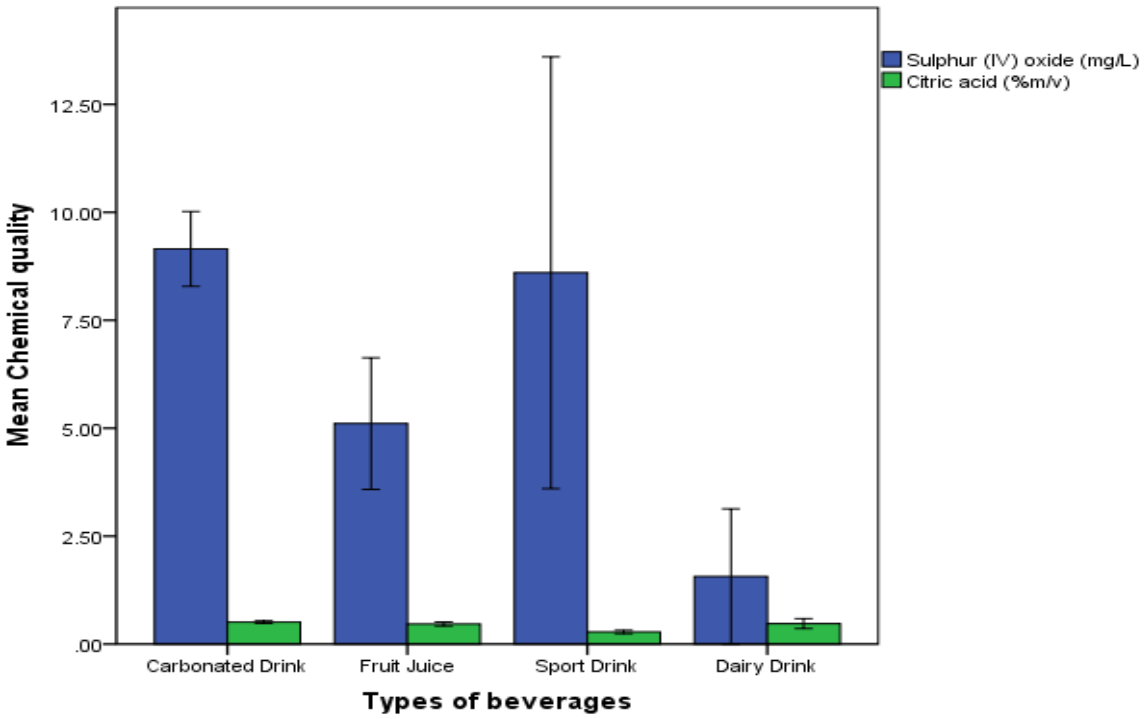

Figure 5. Sulphur (IV) oxide (mg/L) and citric acid (% m/v) contents of types of beverages

Sulphur (IV) oxide (mg/L) level is higher in carbonated drink followed by fruit drink and dairy drink in 6 months shelf life product (Figure 6). Sport drink content of SO_2 is higher than fruit drinks in 9 months shelf life product. The carbonated drink is higher in SO_2 than fruits drink for 12 months shelf life product. Citric acid (% m/v) level for 6 months shelf life product is in the order of carbonated > dairy > fruit while shelf life product is in order fruit drink > sport drink. The 12 month shelf life products had carbonated drink >fruit drink while levels of citric acid (% m/v) are same in both CD and FD.

Sorbic acid ranged between 74.5-109 for fruit juice and 105-129 mg/L for dairy drink (Table 2). The level is within the regulatory limit of 350 mg/L. It is observed that the level of sorbic in other similar studies by [21,30,31] were within the regulatory limit.

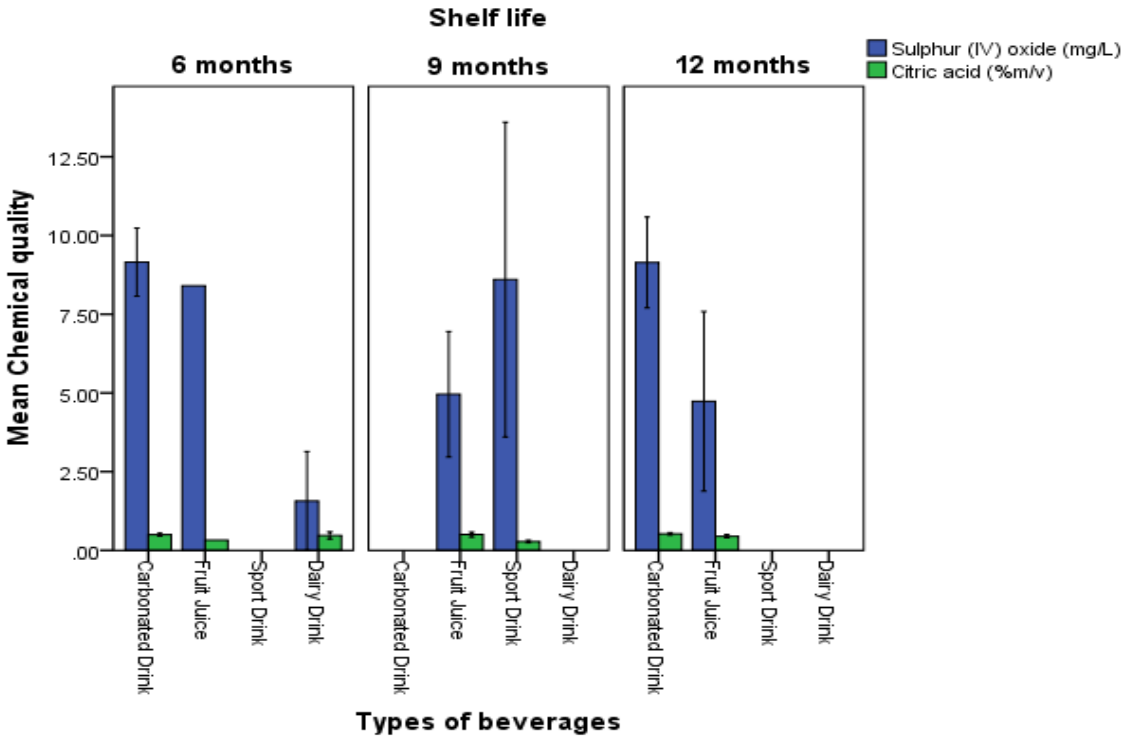

Figure 6. Sulphur (IV) oxide (mg/L) and citric acid (% m/v) contents in different types of beverages during shelf life

Table 2. Level of Sorbic Acid in the Fruit and Dairy Drinks

Types of beverages	Mea±SD
FJ 3	109±4
FJ 5	104±1
FJ 12	74.5±0.0
FJ 13	85.1±3.0
DD2	128±1
DD3	105±5

Analysis of variance (p=0.05) showed statistically significant difference between the types of beverages studied for pH, sugar level, ascorbic acid, and sulphur(IV) oxide indicating constituents concentrations variation. The pH showed significant difference between CD and other types of beverages analysed while FJ and DD showed significant in pH value. There are significant differences in Sugar level between CD and FJ; CD and DD; FJ and SD and SD and DD. Ascorbic acid level is significantly difference at p=0.05 between CD and SD; FJ and SD and SD and DD. CD is significantly difference between FJ and DD in sulphur (IV) oxide content. These could be attributed to the various constituents that were used to make up the different beverages. Citric acid content is significantly difference between the CD and SD.

4. Conclusion

It is noteworthy from the results that 71.4% of carbonated drinks samples analysed had benzoic acid level above the limits. Application of good manufacturing practices by beverages producers; better control of environmental conditions during storage and retail and closer monitoring of preservatives levels by regulatory agencies are needed to reduce levels of usage of the various preservatives (benzoate, sorbates, sulphur (iv) oxide, sorbic acid and ascorbic acid) studied in during the production of the beverages

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