PRINT ISSN 1119-8362
ELECTRONIC ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 22 (11) 1769–1775 November 2018

Evaluation of Mineral Element and Sugar Contents of Soft Drinks in Nigeria

[1*]HASSAN, A; [2]EMIFONIYE, EU

[1]*Department of Petroleum and Natural Gas Processing, Petroleum Training Institute (PTI), Effurun, Nigeria*
[2]*Department of Mechanical Engineering, Igbinedion University, Okada, Nigeria*
**Corresponding Author* Email: patrickpaul.delpol@gmail.com

ABSTRACT: This research work analyzed and evaluated the sugar and mineral elements contents of soft drinks consumed daily in Nigeria using standard methods. The sugar content and mineral element were determined. The sugar content varies from 22.8.4mg/L to 274.4mg/l and means sugar level varies from 30.4mg/l to 271.07mg/l. The mineral elements analyzed were Na, K, Ca, Mg, Ni, Fe, Cu, Zn, Cr, Pb and Cd. From the results it can be seen that the macro element (Na and Ca) which are essential mineral reduces rapidly in all the samples of soft drink after 4 weeks. Results of one way ANOVA above indicates that there was a significant difference in the sugar test between sample 1 to sample 7 at $p<0.05$. ($F= 1104.637$, $p= 0.000$).

DOI: https://dx.doi.org/10.4314/jasem.v22i11.10

Dates: Received: 07 October 2018; Revised: 06 November 2018; Accepted 09 November 2018

Keywords: Soft drinks, mineral elements, sugar content, ANOVA

Soft drinks are complex mixtures containing different variety of substances such as colouring compounds, flavoring agents, acidifiers, sweeteners, preservatives and caffeine (Galadima, and Garba, 2012). Soft drinks are generally synthesized with water plus 1 – 3% liquid carbon dioxide, 3 – 5% liquid sugar, acidified to a pH of about 2.4 - 4.0, emulsifiers, colors, flavors and/or spices, herbs and extracts of roots, leaves, seed and flower or bark (Agbazue *et al.,* 2014). Soft drink is any of a class of non-alcoholic beverages, usually but not necessarily carbonated, normally containing a natural or artificial sweetening agent, edible acids, natural or artificial flavours, and sometimes juice (Ashurst et al., 1998). Soft drinks are mixed with other ingredients in several contexts. In Western countries, in bars and other places where alcohol is served (e.g., airplanes, restaurants and nightclubs) several mixed drinks are made by blending a soft drink with hard liquor and serving the drink over ice. A good example is the rum and coke, which may also contain lime juice (Hollman *et al.,* 1996). Also, some homemade fruit punch recipes, which may or may not contain alcohol, contain a mixture of various fruit juice and soda pop (e.g., ginger ale).

Non-alcoholic beverages play a very important role in the dietary pattern of people in most developing countries. They are regarded as after meal drinks or refreshing drinks during the dry season in rural and urban centers (Huelin *et al.,* 1971). Soda or soft drinks contain several types of acid, which may include citric, phosphoric, malic, carbonic, and tartaric acids (Chandraker *et al.,* 2014). These produce an extremely damaging effect and can soften and demineralize enamel (Davenport, 2005). 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 (Nagy, and Smoot, 1971). 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 (Ristovska *et al.*, 2012). 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 (Dharmasena, 2010). 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 (Phillip, et al., 2013). When the body pH level rises above 7.45, it implies alkalosis. Alkalosis makes the nervous system hypersensitive, resulting in muscle spasms and convulsions (Galadima, and Garba, 2012). Glucose is an important energy source that is needed by all the

**Corresponding Author* Email: patrickpaul.delpol@gmail.com

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 (Khurdiya and Anand, 1981). Since elevated concentrations of sugar and mineral elements in carbonated soft drinks may be responsible for negative health effects, it became necessary to evaluate soft drinks in our locality to ascertain their sugar and mineral element contents.

MATERIALS AND METHODS

The materials used in this research work include; beakers, weighing balance, conical flask, measuring cylinder, spatula,filter paper (Whatman No. 1), stirrer, pipette, volumetric flask, UV-visible Spectrophotometer (Jenwey model), atomic Absorption Spectrophotometer (Buck scientific 210 VGP), flame photometer (Sherwood 410), sample containers, test-tube, fume Cupboard, refrigerator (Thermocool), and digestion flask.

Chemicals and Reagents: The following reagents were of analytical quality; Di-ionized water, concentrated, Hydrochloric acid (HCl), Nitric acid, Concentrated Sulphuric acid (H_2SO_4), Phosphate Buffer, and Anthrone reagent

Sampling Collection/Preservation: The seven soft drinks sample of locally produced commercial brand were purchase from a local shop in Nigeria. The Soft drinks were properly package in a PET bottle. The soft drinks were opened, degassed and poured into empty distilled-water washed sample containers for storage. The sugar content and mineral element were determined and remaining samples was stored in a refrigerator for further sampling. The analyses of the samples were carried out in six weeks.

Preparation of Samples for Anthrone Test: 1000mg of glucose was dissolved in 100ml of distilled water (Charles and Wilcox, 1984).

Preparation of Anthrone Test Reagent: 200mg of anthrone reagent was dissolved in 1000mg of ice cold 95% concentrated Sulphuric acid (H_2SO_4) prepared fresh before use (Charles and Wilcox, 1984).

Determination of Sugar Content by Anthrone: 5ml of used samples soft drinks was weigh into a boiling tube. It was hydrolyzed by keeping it in a boiling water bath for three (3) hours with 5ml of 2.5 M HCl and allowed to cool at room temperature. This was followed by centrifuge. The supernatant was collected and 0.5 and 1ml of aliquots was taken for analysis. The standards were prepared by taking 0, 0.1, 0.2, 0.3 and 0.4 and 0.5ml of the working standard '0' that serves as blank. The volume was make up to 1ml in all the tubes including the sample tubes by adding distilled water and 4ml of anthrone reagent was added to the prepared sample. The sample was heated for eight minutes inside a boiling water bath. The sample changes colour from green to dark green color and reading was taken at 630nm using a UV-visible spectrophotometer (Charles and Wilcox, 1984). A standard graph was plotted using the concentration of the standard on the X-axis versus absorbance on the Y-axis. From the graph, the amount of glucose present in the sample tube was deducted.

A standard curve of glucose was prepared by taking 0.0, 0.1, 0.2, 0.2, 0.3, and 0.5 ml of standard glucose solution in different test tubes containing 0, 200, 400, 600, 800, and 1000 ml of glucose, respectively, and the volume was made up to 1 ml with distilled water. Then 4 ml of anthrone reagent was added to each test tube and mixed well. All these solutions were treated similarly as described above. The absorbance was measured at 680 nm using the blank containing 1 mL of water and 4 mL of another reagent. From the graph, calculate the amount of glucose (sugar content) present in the sample tube.

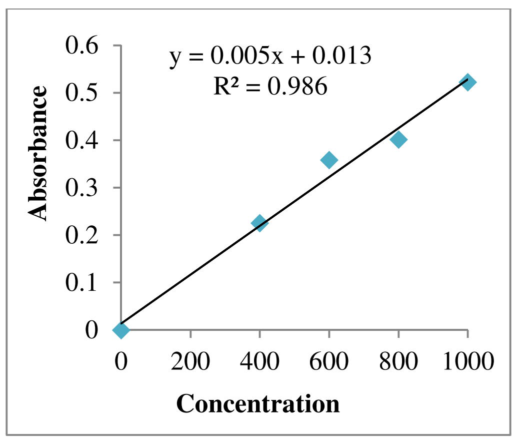

Fig 1: Standard Curve for Sugar Determination

Determination of Mineral Element: The samples drinks were digested according to the method of Wallace. 5ml of sample was measured into a clean 250ml dry Pyrex digestion flask. 10ml of concentrated nitric acid and perchloric acid from a prepared solution containing the two acids in a ratio of 3:1 was added. The digestion flask was heated gently and a brown gas is evolved out, heating continue until a clear solution was obtained in a fume cupboard. The clear solution was filtered with Whatman filter paper into a 100ml volumetric flask and mark up with de-ionised water. Mineral element analysis for Fe, Mg, Cu, Zn, Pb, Cd, Ni, Cr, K, Na and Ca were determined after acid digestion and using the samples concentrations of various elements were recorded accordingly using an Absorption Spectrophotometer (Buck 210) while K and Na were determined using Flame Photometer. The samples were acid digested again after one month of storage of the samples in a refrigerator and the mineral elements determined.

RESULTS AND DISCUSSION

Table 1 shows the quantitative analysis of sugar content in samples 1-7 for week 0, 1, and week 2. Table 2 and Table 3 show the Anova tests of significance difference in samples 1-7 in the sugar test for week 0, 1 and week 2. Results of one way ANOVA above indicates that there was a significant difference in the sugar test between sample 1 to sample 7 at $p<0.05$. ($F = 1104.637$, $p = 0.000$). Results of one way ANOVA above indicates that there was no significant difference in the sugar test between samples from day 1 to day 20 at $p<0.05$ ($F = 0.014$, $p = 0.986$). Table 4 shows the results of Post Hoc Tests. Post Hoc tests using Duncan Multiple range test indicates that only sample 1 and 5 were homogenous subsets having a relative close mean while the other samples were of diverse means thus causing the significant difference. Table 5-Table 15 shows the mineral elements analysis for samples 1-7. The summary of ANOVA results for elements is shown in Table 16.

Table 1: Quantitative Analysis of Sugar Content in Samples 1-7 for Week 0, 1 and Week 2

Samples	Week 0	Week 1	Week 2	Mean	SD	CV
M_1	76.4	74.4	72.4	74.40	2.00	0.03
M_2	32.4	30.4	28.4	30.40	2.00	0.07
M_3	108.4	98.4	92.4	99.73	8.08	0.08
M_4	120.4	114.4	112.4	115.73	4.16	0.04
M_5	70.4	68.4	66.4	68.40	2.00	0.03
M_6	74.4	70.4	268.4	71.07	3.06	0.01
M_7	60.4	56.4	52.4	56.40	4.00	0.07

Table 2: Anova Tests of Significance difference in Samples 1-7 in the Sugar Test for Week 0, 1 and Week 2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	113619.810	6	18936.635	1104.637	.000
Within Groups	240.000	14	17.143		
Total	113859.810	20			

Table 3: Anova Tests of significance difference within the Samples 1-7 in the Sugar test for Week 0, 1 and Week 2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	180.952	2	90.476	.014	.986
Within Groups	113678.857	18	6315.492		
Total	113859.810	20			

Table 4: Duncan[a] Tests of Samples 1-7 in the Sugar Test for Week 0, 1 and Week 2

Samples	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
M_2	3	30.4000					
M_7	3		56.4000				
M_5	3			68.4000			
M_1	3			74.4000			
M_3	3				99.7333		
M_4	3					115.7333	
M_6	3						71.0667
Sig.		1.000	1.000	.098	1.000	1.000	1.000

**Means for groups in homogeneous subsets are displayed; *Uses Harmonic Mean Sample Size = 3.000*

From the ANOVA result, there was no significant difference in the values of all the elements at $p < 0.05$. The physicochemical characteristics of the sample drinks immediately after production and storage for six weeks are shown above in Table 16. The sugar content of the sample drinks measured slight changes after 20 days of storage inside refrigerator (Table 16). Samples drink show decrease during storage for all samples.

The type of sugar confirmed in these samples drink after analysis was simple sugar (glucose). The glucose in soft drinks adds to sweetness taste that is common in most soft drinks. The sugar content varies from 22.8.4mg/l to 274.4mg/l and mean sugar level variation of 30.4mg/l to 271.07mg/l. M_6 however, contained the highest mean of 271.07mg/l while M_2 contains the least mean of 30.4mg/l. The samples dink concentration conforms to the range of sugar concentration level within the regulatory limit of 350 mg/l.

Table 5: Sodium (Na) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	14.82	1.10	.96	9.70	1.22
M_2	9.21	2.96	6.09	4.42	0.73
M_3	6.18	1.61	3.90	3.23	0.83
M_4	13.42	.29	6.86	9.28	1.35
M_5	5.73	2.18	3.96	2.51	0.63
M_6	9.16	1.68	5.42	5.29	0.98
M_7	6.19	.30	3.25	4.16	1.28

Table 6: Potassium (K) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.71	.36	0.54	0.25	0.46
M_2	.57	.30	0.44	0.19	0.44
M_3	3.77	.32	2.05	2.44	1.19
M_4	6.31	.81	3.56	3.89	1.09
M_5	2.31	1.39	1.85	0.65	0.35
M_6	1.31	.71	1.01	0.42	0.42
M_7	1.98	1.23	1.61	0.53	0.33

Table 7: Calcium (Ca) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	3.40	.71	22.06	30.19	1.37
M_2	39.43	.40	19.92	27.60	1.39
M_3	39.47	.34	19.91	27.67	1.39
M_4	62.34	.61	31.48	43.65	1.39
M_5	54.17	.34	27.26	38.06	1.40
M_6	41.42	1.16	21.29	28.47	1.34
M_7	29.00	.21	14.61	20.36	1.39

Table 8: Magnesium (Mg) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.91	36	0.64	0.39	0.61
M_2	.91	.14	0.53	0.54	1.04
M_3	.91	.14	0.53	0.54	1.04
M_4	.93	.20	0.57	0.52	0.91
M_5	.93	.23	0.58	0.49	0.85
M_6	.92	.46	0.69	0.33	0.47
M_7	.70	.11	0.41	0.42	1.03

Table 9: Nickel (Ni) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.11	.21	0.16	0.07	0.44
M_2	.10	.17	0.14	0.05	0.37
M_3	.01	.19	0.10	0.13	1.27
M_4	.04	.18	0.11	0.10	0.90
M_5	.12	.17	0.15	0.04	0.24
M_6	.10	.26	0.18	0.11	0.63
M_7	.10	.14	0.12	0.03	0.24

Table 10: Iron (Fe) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.41	1.15	0.78	0.52	0.67
M_2	.60	.94	0.77	0.24	0.31
M_3	.31	.99	0.65	0.48	0.74
M_4	.41	1.32	0.87	0.64	0.74
M_5	.31	.96	0.64	0.46	0.72
M_6	.52	.93	0.73	0.29	0.40
M_7	.21	.76	0.49	0.39	0.80

The results of glucose concentrations as sugar content in the soft drinks under study varied among samples drink, this could be because of the different composition and preservative used in their production. The concentrations of glucose in the various brands of samples soft drink showed the following trend: $M_6 > M_4 > M_3 > M_1 > M_5 > M_7 > M_2$. Analysis of Variance, ANOVA (Table 15), between sample 1-7 for storage from 0 – 2 weeks showed that the storage period do not significantly influence sugar content of samples this implies that samples sugar content is retain after storage. In general, the sample drinks contained high quantity of sugar which contributes to the flavour associated with these soft drinks. The concentration of the glucose content as sugar in samples drink was deducted from Figure 1 using Beer Lambert law after the sugar analysis was carried out. 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/l. The Standard Organization of Nigeria 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 etc.

The high level of sugar in samples drink may be because it is required to supply energy and quench thirst. The high concentration level of glucose in soft drink can result of poor industrial process. Industrial processes require good sterilization procedures and quality control to ensure the safety of soft drinks. Poor sterilization during production may lead to contamination which may ferment sugar. Results from this study showed the presence of sugar in soft drinks. This study have shown sugar content level in soft drinks to be present in very high amounts of about 8% which is very in significant to cause related health issues such as diabetes, insulin resistance, promoting fat in the body, etc. Glucose is produce in human body, hence the human body does not require much glucose intake regularly, and consumption of soft drink often can be dangerous to human health because of the present of glucose in it which is about 5%. Furthermore, low significant variation was manifested between samples drink means in terms of total sugar present in each samples drink at different week after storage.

Table 11: Copper (Cu) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.01	.11	0.06	0.07	1.18
M_2	.02	.12	0.07	0.07	1.01
M_3	.01	.14	0.08	0.09	1.23
M_4	.01	.13	0.07	0.08	1.21
M_5	.01	.13	0.07	0.08	1.21
M_6	.01	.10	0.06	0.06	1.16
M_7	.01	.11	0.06	0.07	1.18

Table 12: Zinc (Zn) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.03	.14	0.09	0.08	0.92
M_2	.02	.14	0.08	0.08	1.06
M_3	.01	.15	0.08	0.10	1.24
M_4	.02	.17	0.10	0.11	1.12
M_5	.01	.15	0.08	0.10	1.24
M_6	.03	.14	0.09	0.08	0.92
M_7	.02	.12	0.07	0.07	1.01

Table 13: Chromium (Cr) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.32	.43	0.38	0.08	0.21
M_2	.31	.41	0.36	0.07	0.20
M_3	.31	.57	0.44	0.18	0.42
M_4	.22	.33	0.28	0.08	0.28
M_5	.27	.30	0.29	0.02	0.07
M_6	.30	.41	0.36	0.08	0.22
M_7	.17	.32	0.25	0.11	0.43

Table 14: Lead (Pb) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD	CV
M_1	.00	.00	0.00	0.00	#DIV/0
M_2	.00	.03	0.02	0.02	1.41
M_3	.00	.14	0.07	0.10	1.41
M_4	.00	.12	0.06	0.08	1.41
M_5	.00	.01	0.01	0.01	1.41
M_6	.00	.01	0.01	0.01	1.41
M_7	.00	.00	0.00	0.00	#DIV/0

Table 15: Cadmium (Cd) for Week 0 and Week 4

Samples	Week 0	Week 4	Mean	SD
M_1	.00	.00	0.00	0.00
M_2	.00	.00	0.00	0.00
M_3	.00	.00	0.00	0.00
M_4	.00	.00	0.00	0.00
M_5	.00	.00	0.00	0.00
M_6	.00	.00	0.00	0.00
M_7	.00	.00	0.00	0.00

Table 16: ANOVA Summary Table for all Elements

Elements	F value	Significance
Sodium	0.161	0.980
Potassium	0.734	0.639
Calcium	0.060	0.998
Magnesium	0.075	0.997
Nickel	0.233	0.952
Iron	0.151	0.983
Copper	0.018	1.000
Zinc	0.015	1.000
Chromium	0.946	0.519
Lead	0.710	0.654

Sugar content decreases during storage period. The reducing trend was of minimal decrease in the sugar content in all the samples drink. The highest sugar value was obtained from M_6 during storage period and the lowest sugar value was observed in M_2.

The results of the present investigation show that storage after opening a soft drink and the preservative has left (CO_2) the glucose concentration is minimally affected. This implies that both carbonized and non-carbonized drinks still retain almost same level of sugar content even after opening. The trend of sugar content decrease might be perhaps due to breaking down or conversion of complex carbohydrate into simple compound and fermentation of carbohydrate in drink. According to WHO (2003), a food is deemed to be adultered if its content is composed in whole or in part of any poisonous or deleterious substance, which renders its contents injuries to health.

The mineral elements analyzed were Na, K, Ca, Mg, Ni, Fe, Cu, Zn, Cr, Pb and Cd. From the results it can be seen that the macro element (Na and Ca) which are essential mineral reduces rapidly in all the samples after 4 weeks of storage with about 15% when compared to all samples decrease was about 10%, micro element (K, Mg, Fe, Cu, Zn and Cr) increases minimally while ultra-elements (Ni, Pb and Cd) also increases slightly. Although increase in both micro and ultra-element were less than 12% in all samples drink with absent of Cd was not found in all the samples, Pb in all samples drink was about 7% when compare within the safe limit recommended WHO was found higher than the maximum contaminant level of 0.01 mg/l. This Pb found may originate from corrosion during manufacturing of samples. Nevertheless, samples drinks mineral elements for all elements concentrations are in the order Cu = Zn > Ca > Mg > Fe > Na >K > Pb > Cr respectively as shown in Table 4.2 show no significant different. Zinc is an essential element found in all food and portable water in form of salts or organic complexes. It has a mean concentration level of 0.09 – 0.10 mg/l with percentage difference from 9-13% in the analysis conducted for samples drink. The level of zinc conforms to the provisional regulatory limits. The reports on zinc concentration in samples drink were comparable to reported zinc analysis in Nigeria. The WHO limit for concentration for Zn is 0.1mg/l.

Sodium is an essential mineral for the human body and very vital to health. The mean sodium concentrations of samples drink in this study ranges from 3.25-7.96 mg/L with percentage difference from 7 – 13%. The concentration of sodium was not compared to other study. Iron is one of the most abundant elements in the earth crust. It analysis in the selected samples drink showed percentage different between samples of 6 – 14% and mean concentration of 0.049 – 0.087 mg/l range and is in compliance to the acceptable regulatory limit at concentration range of 0.01mg/L. In this study Fe is within acceptable limit when compare to regulatory limit and study work by EU, U.S.A FDA Inorganic Chemical for Commercial Beverage and WHO which is 0.01mg/L. Copper is an essential element for growth as well as drinking water contaminant. The copper level of sample drink in this study has percentage difference of less than 13% and mean concentration ranges from 0.06 – 0.08mg/L, in this study and is not within acceptable limit when compare to regulatory limit and study work by 0.01mg/L. Calcium is one of the most abundant elements in the earth crust. It analysis in the selected samples drink showed mean concentration range of 14.61 to 31.48 mg/L with percentage difference of not more than 15%. The concentration of calcium was not compared to other study.

Magnesium is an abundant mineral in the body, is naturally present in many foods, added to other food products, available as a dietary supplement. Its analysis in the selected samples drink has a mean concentration range of 0.41 to 0.64mg/L with percentage difference of 4 – 11% range. The concentration of magnesium was not compared to other study. Nickel is a strong, lustrous, silvery-white metal that is a staple of our daily lives and can be found in everything. It has a mean concentration level of 0.10 to 0.18 mg/L. The level of nickel by WHO regulatory limits is 0.05mg/L. The reports on nickel concentration in samples drink were comparable to reported nickel analysis in Nigeria. Potassium has a mean concentration range from 0.44 to 3.56mg/L. The concentration of potassium in samples drink was comparable to reported zinc analysis in Nigeria. Potassium is an essential nutrient used to maintain fluid and electrolyte balance in the body. It's also the third most abundant mineral in the body and a required mineral for the function in the human body. Chromium in this study has a mean concentration ranges from 0.025 – 0.44mg/L. Chromium is a mineral that humans require in trace amounts, although its mechanisms of action in the body and the amounts needed for optimal health are not well defined. Its analysis in the selected samples drink did not show compliance to the acceptable regulatory limit at concentration range of 0.05mg/L. The concentration of chromium was not compared to other study.

Cadmium has an acceptable mean concentration level in all samples drink in this study. Cadmium has a 0mg/L mean concentration in samples drink and was found to conform to WHO regulatory limit. Cadmium exerts toxic effects on the kidney, the skeletal and the respiratory systems, and is classified as a human carcinogen. Lower concentrations are found in vegetables, cereals and starchy roots. Humans are exposed to cadmium through food contamination or inhalation from metal industry. The level of lead was above regulatory limit of 0.001mg/L, lead concentration mean ranges from 0.01 – 0.07mg/L in samples drink. Lead present in soft drink can accumulate thereby progressing from acute to chronic intoxication with serious health issues. Hence, the result of the present study calls for serious public health concern on the part of the consumers and the Nigerian regulatory agencies. The habitual intake of beverages drinks especially in dry season by aged, children and pregnant women can lead to over accumulation of toxic heavy metal in the body and hence toxicity.

At the beginning of storage the minerals content samples drink were, sodium (Na), potassium (K),calcium (Ca), magnesium (Mg), nickel (Ni), iron (Fe), copper (Cu), zinc (Zn), chromium (Cr), lead (Pb) and cadmium (Cd) with respective mean shown in table 4.0- 4.10, after 4 weeks of storage period the changes in mineral content differed from one mineral to the other. On the 4th week of storage the mineral element which are Na, K, Ca, Mg, Ni, Fe, Cu, Zn, Cr, Pb and Cd has no significant different in the values of all the element at $p < 0.05$ from the experiment between week 0 and week 4 the percentage difference for all elements in samples drink as follow; sodium (Na) is 9.8%, potassium (K) is 6.3%, calcium (Ca) is 9.9%, magnesium (Mg) is 9.9%, nickel (Ni) is 9.5%, iron (Fe) is 9.8%, copper (Cu) is 10% , zinc (Zn) is 10%, chromium (Cr) is 5.1% and lead (Pb) is 6.5%. In this study, cadmium was not present in all samples drink during the storage period, lead and nickel element were present in samples drink and these element values when compared in all samples drink quantities varied significantly ($p \leq 0.05$) among the various soft drinks. The percentage of lead and nickel in samples drink were above 1%, which is the WHO tolerable limit. Chromium as detectable in samples drinks and has concentration of no more than 0.57mg/L present in all samples drink. Although, presents of chromium contamination in soft drinks may not only be a Nigerian issue as it has also been shown to be present abroad. A study in Spain also showed the presence of chromium in soft drinks thus may be a global problem. Another heavy metal that was investigated in this study was lead. Lead concentration for all the samples drink was 5.1%.Lead was shown to be detectable in all the soft drinks and the concentrations were also found to be beyond the accepted Maximum Contamination Level Goal (MCLG - 0.00) and the Maximum Contamination Level (MCL - 0.015) limits.

Conclusion: The outcome of this research work showed that Na, K, Ca, Mg, Ni, Fe, Cu, Zn, Cr, Pb and Cd are all present in soft drinks. However, macro element (Na and Ca) reduces after 4 weeks of storage unlike micro element (K, Mg, Fe, Cu, Zn and Cr) that increased. Also, ultra-elements (Ni, Pb and Cd) increases slightly. Therefore, quality control should be ensured during production and the quality of sugar and water used for soft drink production be evaluated for the presence of heavy metals at the level of purification and sterilization to reduce or prevent subsequent health effects of intoxication.

REFERENCES

Agbazue, VE; Ibezim, A; Ekere NR (2014). Assessment of Sugar levels in Different Soft Drinks. Int. J. Chem. Sci. 12(2): 327 – 334

Ashurst, PR.; Beal, C; Davenport, RP; Giles, GA; Hammond, DA; Lea, RAW; Palmer, Q; Taylor, RB; Tompsett, A (1998). The chemistry and Technology of Soft Drinks and Fruit Juices. Sheffield Academic Press

Chandraker, SK; Singh, P; Pandey B (2014). Clastogenic effect of soft drink on root tip of Allium cepa, Int.J.Curr.Microbiol. App. Sci. 3(5): 200-206

Davenport, DD (2005). Microbiology of soft drinks, In Chemistry and Technology of Soft Drinks and Fruit Juices, Academic Press, CRC, Sheffield, UK. 197–216

Dharmasena, KA (2010). The Non-Alcoholic Beverage Market in the United States: Demand Interrelationships, Dynamics, Nutrition Issues and Probability Forecast Evaluation (PhD thesis), Texas A&M University

Galadima, A; Garba, ZN (2012). Heavy metals pollution in Nigeria: causes and Consequences. Elixir Pollute. 7917–7922

Hollman, PC; Hertog, MGL; Katan, MB (1996). Analysis and health effects of flavonoids. J. of Food Chemistry. 57: 43–46

Huelin, FE; Coggiola, IM; Sidhu, GS; Kenneth, BH (1971). The anaerobic Decomposition of Ascorbic Acid in the pH range of Foods and in more Acid solutions. J. Sci. Food Agric. 22: 540-542

Nagy, S; Smoot, JM (1977). Temperature and storage effects on percent retention and percent U.S. recommended dietary allowance of vitamin C in canned singletrength orange juice. J. of Agric. and Food Chem. 25 (1): 135-138

Phillip, BB; Shittu, AM; Ashaolu, OF (2013). Demand for non-alcoholic beverages among urban households in South West, Nigeria, *Afr. J. Food Agric. Nutr. Dev*. 13 (3): 7853–7869

Ristovska, G; Dmitrovska M; Najdenkoska, A (2012). Safety issues associated with nonalcoholic beverages," Food Safety Magazine. 6: 58–80