

Effect of Storage time on Physico-Chemical properties of sachet water produced and consumed in Afikpo Metropolis of Ebonyi State, Nigeria

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Abstract

Sachet water consumption and the resultant effect on human health have prompted several studies across Nigeria. Effect of storage time on physico-chemical properties of sachet water produced and consumed in Afikpo metropolis was carried out in this study. Five sachet water brands (SWB) were selected and evaluated for a period of six (6) weeks to investigate the physico-chemical. The concentration of NH_4 , NO_3 , NO_2 , Fe , PO_4 , O_2 , Ca/Mg , $CaCO_3$ and pH level were determined using Aquanal Fishwater Lab. Turbidity was determined using HI88703 turbidimeter. The result obtained indicates that the concentrations of the analyzed properties were within the permissible limit by WHO and NSDWQ. The statistical analysis of $p < 0.05$ significant showed that the selected sachet brands met the standards within six weeks of storage at ambient temperature. Therefore, the result obtained shows that the sachet water sold in Afikpo Metropolis meets with WHO and NSDWQ standard and suitable for drinking purposes within six (6) weeks of storage.

Abstract: Storage time, Physico-chemical, sachet water and turbidity

1. INTRODUCTION

Water is of essential significance to human physiology and man's proceeded with presence relies especially upon its accessibility (Akuagbazie and Onweluzo, 2010). Water is perhaps the main normal resource known on the planet (Ojo et al., 2005). It has consistently been a subject of incredible interest to man since it is fundamental for man to endure. Water of good drinking quality is of fundamental significance to human physiology and man's proceeded with presence relies particularly upon its accessibility. A normal man (of 53 kg – 63 kg body weight), requires around 3 liters of water in fluid and food every day to keep healthy (Wordlaw et. al., 2004). According to Pidwirny (2001), the total volume of water on earth is estimated to be 1.409x10¹⁰ cubic kilometres with 97.25% forming the ocean, 2.05% as glaciers, 0.68% as groundwater 0.01% in lakes, 0.005% as soil moisture, 0.0001% in the atmosphere, 0.0001% in rivers and 0.0004% in the biosphere.

Great quality water is scentless, tasteless, colourless, and liberated from any type of contamination (Ezeugwuenne et al., 2009).

Okonkwo et al., (2008) affirmed that the inventory of safe drinking water is thought of to have a significant impact on the prevention of transmissible water-borne diseases. Water quality is determined by its physical, chemical, and microbiological properties. Each living being need water to endure. A great many people living in the significant urban communities of Nigeria don't approach pipe borne water, most likely due to its unavailability and/or inadequacy where

obtainable, this has led to increased water related diseases that has continued to be one of the major health problems globally (Omalu et al. 2010, Onifade and Ilori, 2008).

Onifade and Ilori (2008) also noted that the high prevalence of diarrhoea among children and infants could be traced to the use of unsafe water and unhygienic practices. Anuonye et al., (2012) observed that unsanitary water has particularly serious negative effects on young children in the developing world. They further reported that each year, more than 2 million persons, mostly children less than five years of age, die of diarrhoea which accounts for 17% of all deaths between the year 2000 and 2003. Diarrhoea is ranked third among the major causes of death in children, after neonatal causes and acute respiratory infections. To curb this health problem, bottled water was introduced, but that could only be afforded by individuals who earned good incomes. Low income earners could only afford the cheaper sachet packed water which surfaced in the late 1990s.

According to the World Health Organization (2004), it is estimated that 80% of all sickness and diseases in developing countries can be attributed to water-borne infectious agents. The World Bank further estimated that if everyone had access to pure drinking water, less than 200 million episodes of diarrhoea would occur each year and 2 million childhood death will be avoided. There is challenge need for satisfactory compact water to satisfy essential human self – adequate demand.

Safe drinking water is an essential requirement for human turn of events, health and prosperity and it is a worldwide acknowledged human right (WHO, 2003).

Sachet water, a type of packaged water has, therefore, gradually become the most widely consumed fluid for both the rich and the poor in Nigeria. Sachet water is a sort of water which is preoccupied from typical pipeline water supply (regular water) or borehole and is bundled into a straightforward 50cl nylon sack yet more likely than not went through a few or full traditional water treatment cycles of deliberation, air circulation, screening, flocculation, coagulation, sedimentation, filtration, and chlorination. It is the brand of decision to everybody since it is a cheaper option in contrast to the packaged brand, viewed as the best beverage of the wealthy. Seen cleanliness, virtue, taste, and, in particular, wellbeing are the purposes behind sachet water utilization. Tragically, the issue of its virtue and health concerns has started to manifest (Oladipo et. al., 2009).

Sachet water is managed as a food item in Nigeria by National Agency for Foods Drugs Administration and Control (NAFDAC). Sachet water isn't totally sterile; it may not be altogether liberated from every single irresistible microorganism. The potential risk related with sachet water is defilement, which is a factor of the wellspring of the actual water, treatment, bundling materials, administering into bundling materials and conclusion (Omalu et al., 2010). The success and market performance of the sachet water industry is critical to the health and economic well-being of the nation. Unfortunately, most of the companies in the industry are under-performing due to their inability to leverage quality and quality management strategies (Dodoo et al., 2006). The industry continues to be challenged by numerous quality problems that are of much concern for the health of people who patronize packaged water products. There is therefore the need for the immediate adoption of a quality system that is sufficient to combat the quality problems of such an important industry.

Many studies have been done to assess the physicochemical as well as microbiological quality of sachet water in different parts of Nigeria (Addo et al., 2009).

This present study will provide information on aspect of the palatability in terms of physico-chemical properties of vended sachet water within Afikpo Metropolis of Ebonyi of as well as clarify concerns about its safety to consumers.

1.2 Literature Review

The drinking water that is protected and tastefully satisfactory involves high need to National Agency of Food and Drugs Administration and Control (NAFDAC) and other regulatory Agencies like WHO, FEPA, and SON. Drinking portable sachet water that is fit for human consumption is expected to meet WHO standard and be free from chemical and physical substances and micro – organism in an amount that cannot be hazardous to health (Denloye, 2004). Access to safe drinking water is key to sustainable development and essential to food production, quality health and poverty reduction (Adekunle et al., 2004). Safe drinking water is crucial forever and an acceptable safe stockpile should be made accessible to buyers (Kalwale et al., 2012). Mustapha (2008) asserted that the changes in physical characteristics like temperature, suspended solid and chemical characteristics of water such as dissolved oxygen provides valuable information on the quality of water. Ntengwe (2003) stated that the existence of elevated levels of elements and organisms in drinking water constitutes poor water quality, which is a recipe for disease outbreaks.

To safe aide the health of individuals and to diminish to the barest least of terrible encounters of drinking or utilizing bad quality water, it is fundamental that the nature of water ought to be observed with the view of finding solution to



health problems associate with use of low-quality water, in producing sachet portable water, (Ukpong, 2004). The drinking water that is protected and tastefully OK involves high need to National Agency for Food and Drugs Administration and Control (NAFDAC) and other regulatory Agencies like WHO, FEPA, and SON. Drinking portable sachet water that is appropriate for human ingestion is expected to meet WHO standard and be free from chemical and physical substances and micro – organism in an amount that cannot be hazardous to health (Denloye, 2004).

To accomplish the arrangement of safe sachet drinking water for human utilization in Nigeria, NAFDAC recommended that potable water should not contain any pathogen and the physicochemical properties of the water should also not exceed the NAFDAC recommended limits (NAFDAC, 2001). Production outfits should of such drinking waters should also adhere strictly to the NAFDAC guidelines (NAFDAC, 2004).

Again, WHO (2011) explained that in the effort to protect citizens in urban areas, governments all over the world must augment the quality of urban drinking water that is to be provided to their citizens. However, in the bid to maintain the quality of urban drinking water, the manufacturers have had to spend huge sums of money to pump, treat package and distribute the water to the consumers.

Truth be told, water of good drinking quality many emerging nations, accessibility of consumable water has turned into a basic and critical issue, and it involves extraordinary worry to families and networks relying upon Non-public water supply framework. Expansion in human populace has applied a huge pressure on the arrangement of safe savouring water non-industrial nations (Ibemesim, 2014).

Okechukwu et al., (2015) additionally examined six unique brands of sachet water to be specific: Wilnelly, prephil, peak, lephzzy aljonlife and mayln gathered from various parts inside the Federal University of Technology, Owerri grounds were inspected utilizing standard techniques. Physiological and microbiological investigation were done by Nigeria standard of drinking water quality (NSDWQ) and World Health Organization (WHO), the five brands of sachet drinking water had their Ph esteems beneath the lower reasonable cutoff, going from 5.21 to 5.93. Just lephzzy sachet water brand had Ph esteemed inside as far as possible. Turbidity result went from 0.24 to 0.43, which could be supposed to be adequate. The all out dissolved solids result of the brands of sachet water went from 21.00 to 156.00. The various brands of sachet water had short proximity results in the vast majority of the boundaries examined and agreeably satisfied the set guidelines. Anyway a few boundaries like discovery of different components, Barium were found over its passable breaking point in five out of the six examples going from 1.00 to 2.00, while lephzzy sachet water had its worth beneath identification level. From the ANOVA test, pH, all out dissolved solids and Barium had huge contrast ($P < 0.05$), while other physicochemical boundaries tried were irrelevant ($P > 0.05$) among the different sachet water tested. In light of these results, there is need to notice great quality control examination to guarantee similarity with the set guidelines. Additionally arbitrary testing of market tests will be a decent method of recognizing whether the quality is fulfilling the necessary guidelines.

2. MATERIAL AND METHODS

The research is employing the use Aquanal Fishwater and HI88703 turbidity meter to analysis the physico-chemical properties of the sachet water produced and consumed with Afikpo metropolis. Five brands of sachet water with NAFDAC certification were randomly collected in different parts of Afikpo metropolis in bags within 24hours of production. These were denoted as SWB1 – SWB5. The samples were taken to Akanu Ibiam Federal Polytechnic water laboratory where they were stored at ambient temperature, since it is the most common method of storage for all brands of sachet water consumed within Afikpo Metropolis. Subsamples were drawn from the stock samples in duplicates for physico – chemical analysis. Physico – chemical properties of the sachet water were analysed immediately after collection and subsequently thereafter on two weekly basis for six weeks

The following physico – chemical tests were conducted for the determination of the concentration of the properties:

- Ammonium concentration in water samples (NH₄).
- Nitrate concentration in water samples (NO₃).
- Nitrite concentration in water samples (NO₂).
- Iron concentration in water samples (Fe).
- Phosphate concentration in water samples (PO₄).
- Oxygen concentration in water samples (O₂).
- Total hardness in water samples.



3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Analysis of sachet water sample before and after storage

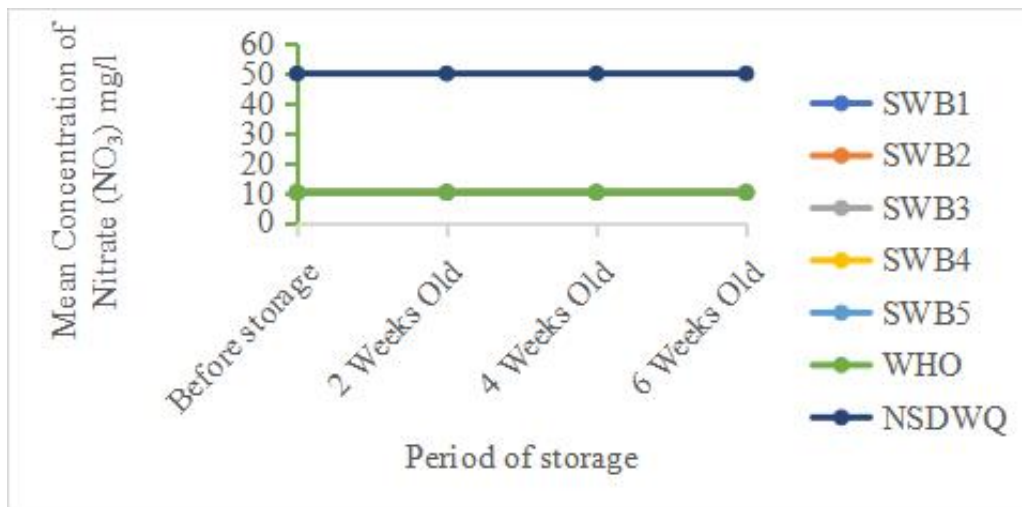


Figure 1: Mean concentration of Nitrate (NO₃) mg/l in the Sachet Water Brands.

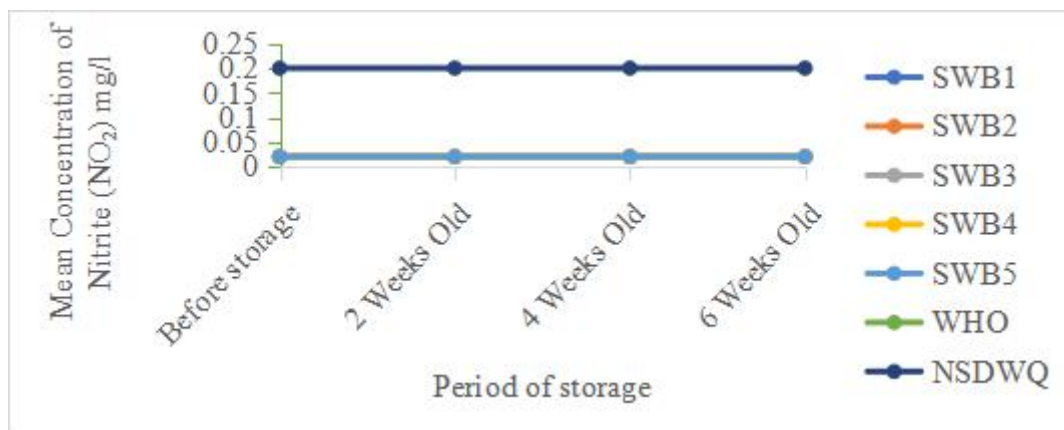


Figure 2: Mean concentration of Nitrite (NO₂) mg/l in the Sachet Water Brands.

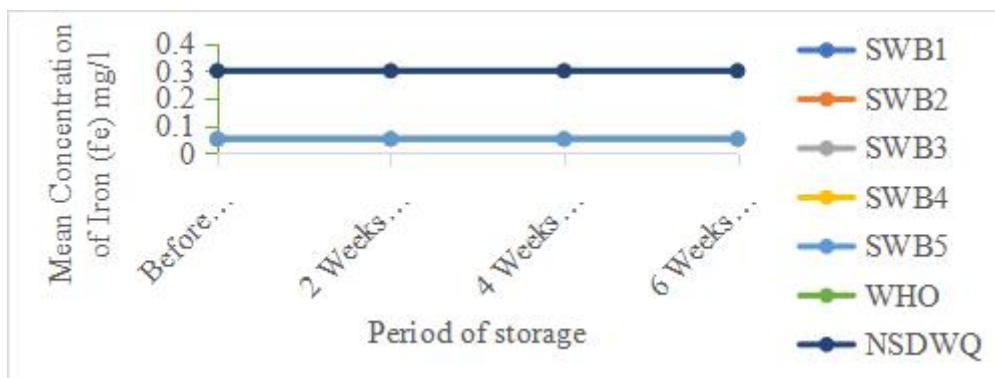


Figure 3: Mean concentration of Iron (Fe) mg/l in the Sachet Water Brands.

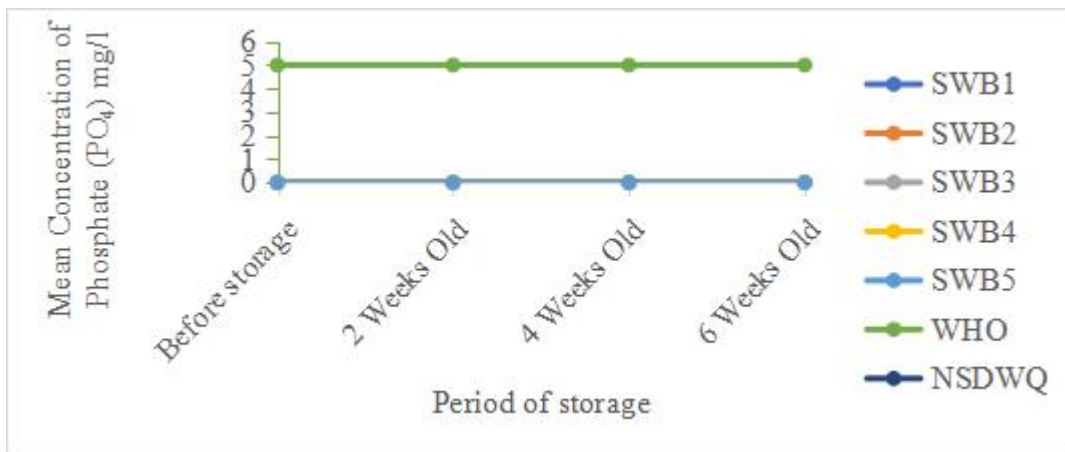


Figure 4: Mean concentration of Phosphate (PO₄) mg/l in the Sachet Water

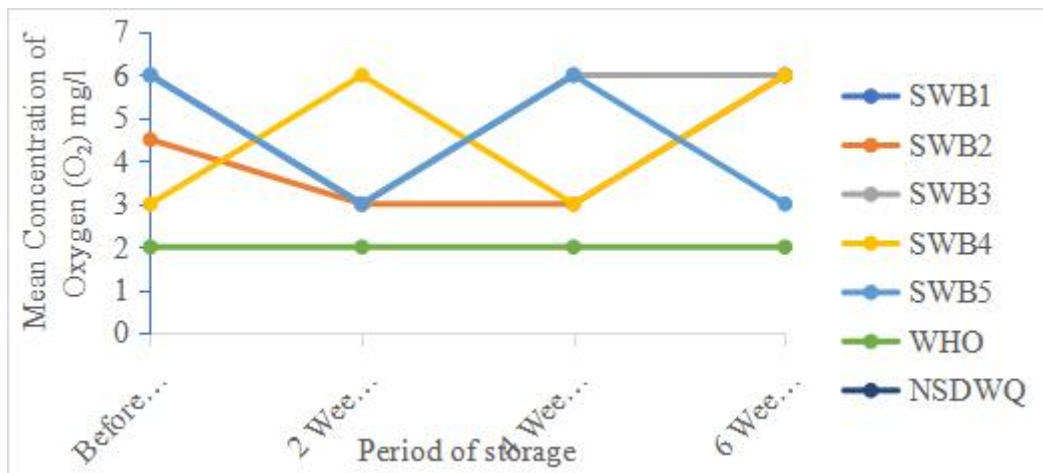


Figure 5: Mean concentration of Oxygen (O₂) mg/l in the Sachet Water Brands.

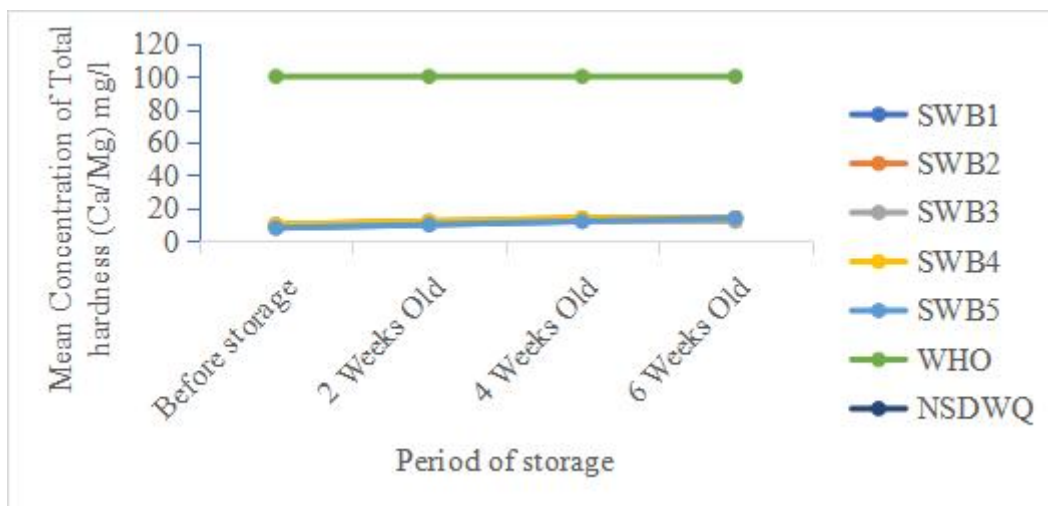


Figure 6: Mean concentration of Total hardness (Ca/Mg) mg/l in the Sachet Water Brands.

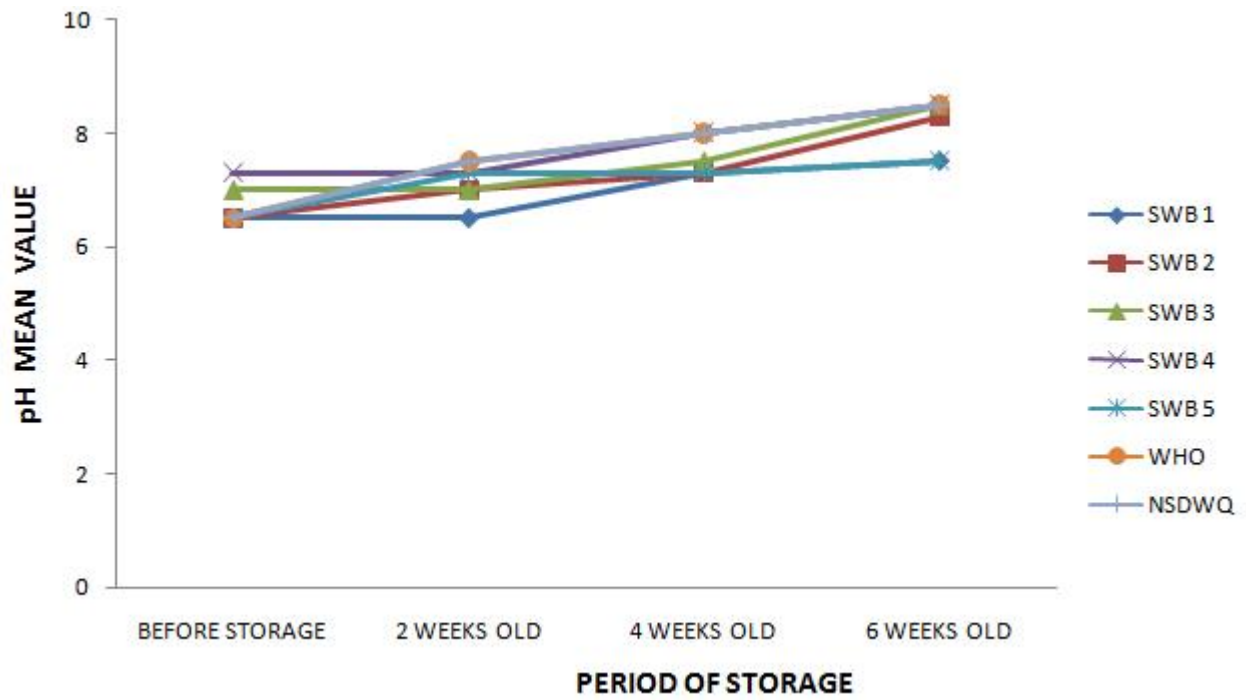


Figure 7: Mean concentration of pH in the Sachet Water Brands.

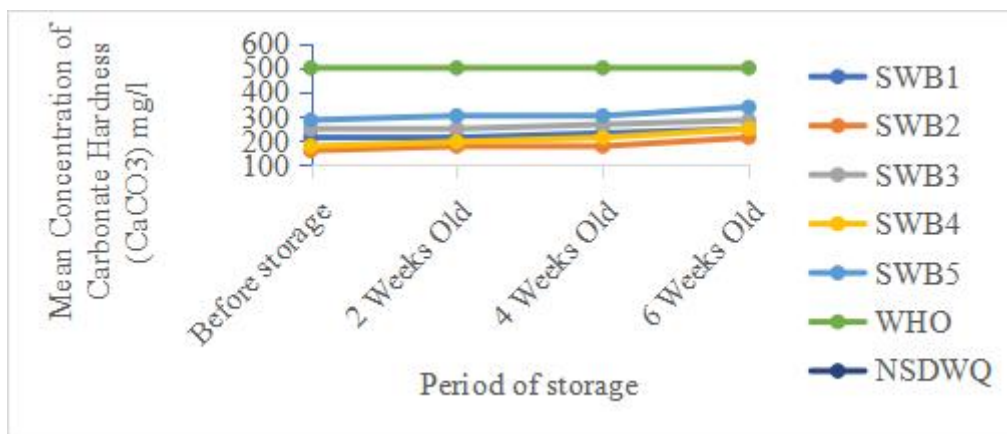


Figure 8: Mean concentration of Carbonate Hardness (CaCO₃) mg/l in the Sachet Water Brands.

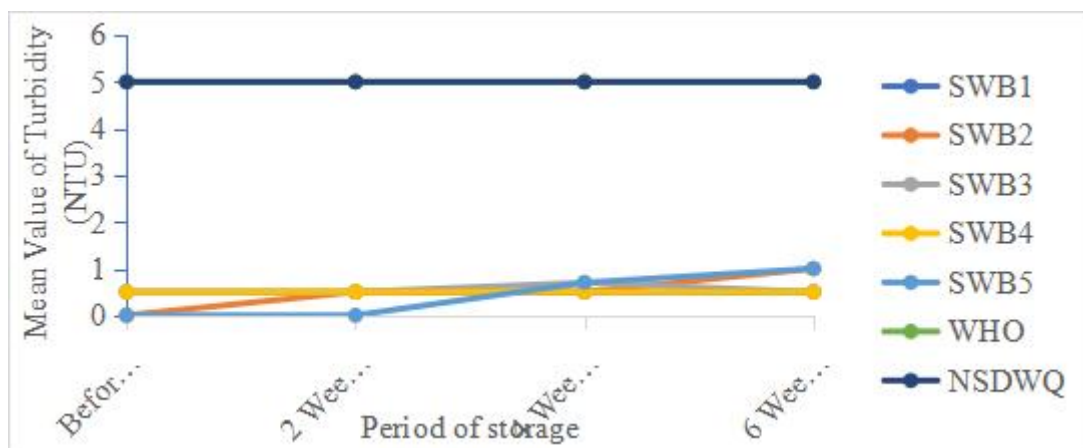


Figure 9: Mean concentration of turbidity (NTU) in the Sachet Water Brands.



3.2 Discussion

The laboratory analysis reveals that the mean concentration of Ammonium (NH_4) mg/l in the Sachet Water Brands was ≤ 0.05 and statistically significant different at 5% level of significance shows that the ammonium concentration is within the permissible limit of drinking water by the establish standards. Figure 1 reveals that all the selected sachet water brands had 10mg/l concentration throughout the period of storage. There was no significant difference in the Nitrate values ($p < 0.05$) of the sachet water brands. The nitrate values are within the acceptable limits of WHO and NSDWQ and will not be harmful to the consumers. Figure 2 also show that the concentration Nitrite (NO_2) in the sachet water brands was ≤ 0.02 mg/l throughout the test period, statistically no significant differences in the values of nitrite ($p < 0.05$) was noticed throughout the test period. The nitrite values were also within the permissible limits of WHO and NSDWQ standards and is not dangerous to human health. Figure 3 shows Iron (Fe) concentration in the selected sachet water brands, the study reveals an average value of < 0.05 mg/l were gotten from test chart throughout the test period and significant differences in the Iron values ($p < 0.05$) was noticed statistically. The Iron concentration was okay for consumption as it didn't exceed the permissible drinking water limits as established by WHO and NSDWQ. The mean concentration of phosphate (PO_4) in Figure 4 shows that the phosphate was not present in the selected sachet water brands and is still allowable by WHO and NSDWQ limits. Therefore, the selected sachet water brands are fit for consumption. Figure 5 disclose Oxygen concentration test was carried out on the water samples. The following result were obtained; SWB1 recorded a mean range value of 3mg/l - 6mg/l, SWB2 had a mean range value of 4.5mg/l - 6mg/l, SWB3 recorded a mean value of 3mg/l - 6mg/l, SWB4 had a mean range value of 3mg/l - 6mg/l and SWB5 recorded a mean range value of 3mg/l - 6mg/l. significant differences in oxygen values ($p < 0.05$) were observed statistically. However, the oxygen concentrations were above the permissible limit of WHO but NSDWQ limit was not found.

In Figure 6 Mean total hardness (Ca/Mg) reveals that SWB1 had a range values of 8mg/l - 14mg/l, SWB2 recorded a range values of 10mg/l - 14mg/l, SWB3 had a range values of 10mg/l - 12mg/l, SWB4 recorded a range values of 10mg/l - 14mg/l and SWB5 had a range values of 8mg/l - 14mg/l. statistically no significant differences in the total hardness values ($p < 0.05$) were obtained. Since the mean values were within the WHO and NSDWQ permissible drinking water limit the water is certified okay for human consumption. Again, in Figure 7 The mean pH value also disclose the following results: SWB1 had a mean value of 6.5 - 7.5, SWB2 recorded a range value of 6.5 - 8.3, SWB3 had a range value of 7.0 - 8.5, SWB4 recorded a range value of 7.3 - 8.5, SWB5 recorded the range values of 6.5 - 7.5. The result shows that the sachet water brands had a pH mean values within the reference standards. However, statistically there was not a significant difference in the pH values ($p < 0.05$) within the testing period making water fit for consumption.

Figure 8 The samples were analysis in terms Carbonate Hardness (CaCO_3) concentration. The mean range values manifest that SWB1 had 214.2mg/l - 249.9mg/l, SWB2 recorded 160.7mg/l - 214.2mg/l, SWB3 had 249.9mg/l - 285.6mg/l, SWB4 recorded 178.5mg/l - 249.9mg/l and SWB5 had 285.6mg/l - 339.2mg/l. No significant differences were observed. The range of values recorded are still within the permissible drinking water standard. Therefore, the water is certified safe for human consumption and poses no threat to human health. Lastly in Figure 9 Turbidity mean range values were as follows; SWB1 recorded 0.5ntu throughout the test period, SWB2 had 0.0ntu - 1.0ntu, SWB3 had 0.5ntu - 0.7ntu, SWB4 had 0.5 throughout the test period and SWB5 recorded 0.0ntu - 1.0ntu. There was a significant difference in the turbidity values ($p < 0.05$). the findings of the study indicates that the turbidity of the selected sachet water tested were within the approved range and therefore the samples were good for drinking as far as turbidity is related.

4. CONCLUSION

Sachet water is a very essential component of the water distribution system of the Afikpo metropolis. The patronage of factory-produced sachet water is very high in Afikpo metropolis since it is the commercial hub of Ebonyi State and is also difficult to access pipe borne water in the area. The physico-chemical properties accessed in this study were with the NSDWQ and WHO permissible limit and show that selected sachet waters are of good qualities for the storage period of six (6) weeks at ambient temperature. So therefor, it is also very important that the regulatory authorities should and must continue with their regular inspection activities of sachet water supplies to Afikpo metropolis. In order to safe guide the health of consumers. Regulatory bodies should also intensify effort at monitoring of packaged water manufacturers, periodic sanitary inspection of factories should be carried out. Emphasis should be placed on good management practices by producers of sachet water especially in terms of location of the factories and maintaining high level of hygiene within the premises of production.



REFERENCES

- Addo, K.K, Mensah, G.I. Donkor B, Bonsu, C, Akyeh. M., (2009). *African Journal of Food, Agriculture, Nutrition and Development*, 9 (6).
- Aguagbazie, C. A. and Onweluzo, J. C. (2010). The quality of bottled and sachet water sold in Nsukka Town.
- Ahima, J and Ofosu S.A (2014). Assessment of the quality of sachet water vended in Ghana: experiences from the new Juaben municipality *Health, Safety and Environment*, 2(1): 1-11.
- Anuonye J. C, Maxwell O. M. and Caleb, M. Y. (2012). Quality of sachet water produced and marketed in Minna metropolis, North Central Nigeria, *African Journal of Food Science* 6(24): 583-588.
- Denloye, S. A, (2004). Quality parameters for packaging water NAFDAC laboratory experience, IPAN
- Ibemesim, A.O. (2014). Comparative study of qualities of sachet and bottle water sold on the streets of Abuja, Nigeria. *South American Journal of Public Health*, 2(3):308-328.
- Isikwue, M.O and Chikezie, A (2014). Quality assessment of various sachet water brands Marketed in Bauchi metropolis of Nigeria. *International journal of advances in Engineering and Technology*, 6: 2489 – 2495.
- Kalwale M. Ajit and Savale A. P. (2012). *Advances in applied science research* 3(1): 273-279.
- Mustapha, K. M (2008). Assessment of the water quality of Oyun Reservoir, Offa, Nigeria using Selected physico-chemical parameters. *Turkish Journal of Fisheries and Aquatic science* 8: 309 -319.
- NAFDAC, (National Agency for Food Drugs Adimistration and Control) (2001). Consumer Bulletin October – December.pp.1-9.
- NAFDAC, (2004), Guidelines for production and regulation of packaged water, new guidelines NAFDAC, Abuja, Nigeria.NIS, (NIS_544: 2007). Nigeria Standard for Drinking Water Quality,(NSDQW),http://www.unicef.org/nigeria/ng_publication_Nigeria_Standard_for_Drinking_Water_Quality.pdf.
- Ntengwe, F.W, (2005). Designing a Domestic Water Supply System-The Engineer's Perspective and Considerations as a Challenge to Consumers. *Physics Chem. Earth*, 30(11-16): 850-858. <http://ewb-uiuc.org/system/files/sdarticle.pdf>.
- Ojo, O. A, Bakare, S. B. and Babatunde, A. O. (2005). Microbial and chemical analysis of potable water in public-water supply within Lagos University, Ojo. *African Journal of Infectious Diseases*, 1(1): 30-35.
- Okechukwu, R.I. Ogukwe, C.E. and Igboasoiki O.O. (2015). Physico-Chemical Quality of different Brands of Sachet Water Sold in Federal University of Technology Campus Imo State, *Nigeria Research Journal of Chemical Sciences*, 5(1): 83-87.
- Okonkwo, I.O. Adejoye, O.D. Ogunusi, T.A. Fajobi, E.A. and Shittu, O.B. (2008). Microbiological and Physiochemical analysis of Different Water Samples used for Domestic Purposes in Abeokuta and Ojota, Lagos State, Nigeria. *African. Journal. Biotechnol*, 7 (3): 617-621.
- Oladipo, I. C, Onyenike, I.C and Adebisi, A. O. (2009). Microbiological analysis of some vended sachet water in Ogbomoso, Nigeria. *African Journal of Food Science*, 3(12): 406 – 412.
- Omalu, I.C.J. Eze, G.C. Olayemi, I.K. Gbesi, S. Adeniran, L.A. Ayanwale, A.V. Mohammed, A.Z. and Chukwuemeka, V. (2011). Contamination of sachet water in Nigeria: Assessment and health impact: online, *Journal of Health Allied Sciences*, 9(4): 15.
- Onifade, A. K. and Ilori, R. M. (2008). Microbiological analysis of sachet water vended in Ondo State, Nigeria. *Environmental Research Journal*, 2(3):107-110.
- Ukpong O. H (2004). *International Journal of water Resources and Environmental Engineering*, vol. 4, issue 5, pp. 134-138.
- WHO (2003). Guideline for drinking water quality vol 1 recommendations. World Health Organization 3rd ed who Geneva.
- WHO (2004). Report of the WHO workshop: Nutrient minerals in drinking water and the potential health consequences of long-term consumption of demineralized and re-mineralized and altered mineral content drinking waters. Rome, 11–13 November2003 (SDE/WSH/04.01).
- WHO (2011). Guideline for drinking water quality vol. 1 recommendations. World Health Organization 3rd ed who Geneva.
- Wordlaw, .M. Hampl, J. S. and Disilvestro, R. A. (2004). *Perspectives in Nutrition*. 6th ed. McGraw-Hill Publishers, New York, pp.372 – 412.

