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QUALITY ASSESSMENT OF VINTAGE PREMIUM TABLE WATER ELELE RIVERS STATE OF NIGERIA FOR SOME YEARS

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ABSTRACT

The analysis of the physical, chemical and microbial properties of vintage premium table water in Elele Rivers State of Nigeria were studied for its level of compliance with Standard Organization of Nigeria (SON) specifications for drinking water quality for over some years and seasons. The comprehensive water analysis were done over the years by certified public analytical companies and establishments. Experimental results showed that the physicochemical parameters; odour, colour, taste, pH, conductivity, total dissolved solids, copper, iron, zinc, chlorides, sulphates, nitrates, nitrite, fluoride magnesium, manganese, mercury, barium, cadmium, chromium, aluminium, arsenic, lead, hydrogen sulphide, phenol, mineral oil and chlorine residue were found to comply with specifications for drinking water. The microbial screenings also comply with SON specification. The statistical analysis showed that though the samples were fit for drinking, there were variation in some measured parameters which suggested inconsistency in their concentrations for the studied years.

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INTRODUCTION

Water of good drinking quality is of basic importance to human physiology, and man's continued existence depends very much on its availability (Onweluzo, 2010). Good drinking water has remained a challenge, particularly in under-developed and developing countries (Isikwue, 2014). According to statistics from the Federal Ministry of Health, only about 30% of Nigerians have access to portable water while the United Nations estimated that about 1.2 billion people all over the world lack access to potable water (Onweluzo, 2010; Oyeku, 2001 and Ajewole, 2005). The presences of pesticides and insecticides in water have impacted on health and have also become an issue (Isikwue, 2014 and Kegley, 1998). There is need to define and ascertain the quality of water due to the increasing demand of this resource. Water quality is high and can be said to be potable if its physical, chemical and microbiological qualities conform to specified standards by regulatory authorities (WHO, 2008). Water quality guidelines form the basis for judgment of acceptability of public water supplies and the most preferred is the World Health Organization (WHO) regulations and NIS Regulations by Standard organization of Nigeria used in Nigeria. Unavailability and scarcity in the supply of drinking water has given rise to the involvement of private companies in the production of packaged drinking water (Dada, 2009). Sachet water which is commonly accepted to be safe due to its affordability to the local populace and instant means of quenching public thirst. Bottled water is also widely consumed by the middle class and high class individuals due to its tasteless form, absence of odour, colour and the presumption that it is mostly free from germs (Ibrahim, 2015 and Chiarenzelli, 2008). However, the hygiene of the environment, source of the water, treatment processes and conditions under which majority of brands of bottled water are produced and stored are faced with a number of risk and uncertainties (Ekwujuru, 2011). Many Researchers have carried out a number of studies on the quality assessment of bottled drinking water in different cities in Nigerian and other parts of the world. Most of these studies reported that approximately 50% drinking water available to the populace seems to be unfit for consumption. In the assessment of the quality of bottled and sachet water sold in Bauchi metropolis (Ibrahim, 2015), results showed that 73.30% and 25.00% of sachet and bottled water considered in the study were not fit for human consumption at the time of the studies. The study of the quality of packaged drinking water brands marketed in Ibadan metropolis and Ile-Ife city in South Western Nigeria (Oyedeji, 2009), showed that most of the sachet water brands fell below WHO drinking water standards and therefore are of doubtful quality. The quality assessment of packaged water in Uyo Metropolis South Southern Nigeria (Odiongenyi, 2015) revealed that the conductivities of some of the samples were above the WHO standard for drinking water. In the study of the physicochemical characteristics of bottled water in Bolgatanga Municipality of Ghana (Oyelude, 2012), it was reported that two percent of the bottled water samples had pH levels below the minimum level of 6.5 recommended by WHO. The concentration of ions in selected bottled water brands sold in Malaysia (Aris, 2013), showed that the quality of the supplied bottled water samples was in accordance with standards set by WHO.

The study entitled, "Bottled Water: Pouring Resources Down the Drain", reveal that the United Nations Millennium Development Goal for environmental sustainability calls for halving the proportion of people lacking sustainable access to safe drinking water by 2015. Meeting this goal would require doubling the $15 billion a year that the world currently spends on water supply and sanitation. While this amount may seem large, it pales in comparison to the estimated $100 billion spent each year on bottled water. Thus, between the money spent by companies on promotion of bottled water and that spent by consumers on the product itself, adequate public water systems could be put in place for a large portion of the world reducing dependence on bottled water and lifting a massive amount of pressure off the environment (Arnold, 2006). The study on, "Bottled Water: Why Is It so Big? Causes for the Rapid Growth of Bottled Water Industries", in 2005, Nestle Waters of North America reported that the average person in the United States consumes twenty times more bottled water than they did 20 years ago. The reasons for this vary from person to person, but the outcome is the same: bottled water has become the most popular beverage in the U.S. Nestle suggested that consumers feel a sense of safety in consuming bottled water rather than tap water. Over half of the population surveyed in 2001, water quality survey had concerns about the quality of their drinking water (Miller, 2006). There are limited or no documented literature on the physicochemical quality of bottled drinking water in Elele in recent time. The aim of this study, therefore, is to evaluate the physical, chemical and microbial characteristics of Vintage premium bottled water brand produced in Elele to ascertain their level of conformance with WHO and Standard Organization of Nigeria (SON) specifications.

MATERIALS AND METHODS

Sample Collection: Bottled water samples used for this study were collected randomly from the production line of Vintage farms and products (Vintage water factory) at Km 2 Ahoada Road Elele River State over the years of analysis to cover both the rainy, dry and harmattan seasons experienced in Nigeria. The label information, batch number, production date and best before dates for the products were noted.

Analysis of Bottled Water Samples: Bottled water packs for each year were collected and analyzed immediately by some independent public analyst companies or establishments which include; YEMAC Consulting and analytical Services no 3 Constitution Crescent Aba Town Hall Abia State for November 2010 and 11th August 2011. Niger Delta Basin Development Authority Port Harcourt, River State (Pollution monitoring Laboratory for 10-02-2011), Niger Delta Basin and Rural development Authority Port Harcourt River State for 8th October 2014. Vintage Quality control Lab for January 2014. HOA Limited 5 Elebor Street, St. Johns, Port Harcourt River State for June 2019. The samples were analyzed immediately after collection. Bottled water was selected randomly in threes from a pack for the years analyzed for.

RESULT AND DISCUSSION

Labels and Nutritional Information: The labeling requirements specified in the Nigerian Industrial Standard, NIS 345:2008 for packaged water by the SON includes the production batch number, nutritional information, production date and best use before/expiry date. The National Agency for Food and Drug Administration and Control (NAFDAC) also requires that the NAFDAC registration number, name and address of producers are to be displayed on all bottles of the samples. All the bottled water samples fulfilled the NAFDAC requirements. All the bottles had the production batch number, production date and best use before/expiry date. This information is essential as it tells the consumer whether the water sample is still within shelf life. The batch number is essential for any product especially when there is need to recall a product from the market in the event of discovery of any abnormality with the product.

Analysis of Samples: Various studies carried out by Baba et al. (Baba, 2008), Semerjian (2011), and Miranzadeh et al. (2011) have shown that the qualities of bottled water in different countries were within acceptable range. However, the influx of a large number of local brands and administrative ignorance, the physical chemical and microbial quality parameters of packaged water sources have not been found to be in the acceptable limits (Oyelude, 2012 and Ackah, 2012). In the present study, results of the physical, chemical and microbial analysis of the vintage table water samples for the years are shown in Table 1. The study of the quality of bottled drinking water of vintage premium table water for five (5) different years revealed the range of the water pH for the years as 6.7-7.4, the pH for all the years and seasons were in conformity with the standard range of drinking water pH by SON which is 6.5-8.5. Water with pH < 6.5 is acidic, soft and corrosive. Acidic water may contain high metal ions such as iron, manganese, copper, lead and zinc which can give a metallic taste to water. Therefore, acidic water contains elevated levels of toxic metals. Water with pH > 8.5 is highly alkaline which is not good for consumption. The TDS and Conductivity of the samples ranged from 1.0 -121mg/L and 1.6–241 µs/cm respectively which were within SON specification of 500 mg/L and 1000 µs/cm for TDS and conductivity respectively. Conductivity provides a measure of common salts (usually salts of calcium, sodium, magnesium, chlorides and fluorides) dissolved in water. A higher conductivity value indicates that there are more chemicals dissolved in the water, because dissolved salts and other inorganic chemicals conduct electrical current, conductivity increases as salinity increases. Elevated dissolved solids can cause "mineral tastes" in drinking water. The conductivity and TDS of the sample from February 2011 was high maybe due to some additives added during treatment or from malfunctioning of the reverse osmosis machine and treatment line or due to the dry season

Table 1. Result of the water analysis for the years

Parameter	Nov 2010	Feb 2011	Aug 2012	Jan 2014	Oct 2014	June 2019	SON Max permitted Limit
Colour TCU	3	10.0	3.0	Colourless	Colourless	Colourless	15
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Unobjectionable
Taste	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Unobjectionabe	Unobjectionabe
pH	6.7	7.1	6.7	6.8	7.4	7.22	6.5-8.5
Conductivity µs/cm	1.6	241	3	20.1	65.4	40	1000
TDS mg/L	1.0	121	1.0	10.01	43.6	25	500
Turbidity NTU	5.0	0.05	3.0	0.01	0	1.0	5.0
Aluminium (mg/L)	0	0	0	0	0	0	0.2
Arsenic (mg/L)	0	0	0	0	0	0	0.1
Barium (mg/L)	0	0	0	0	0	0	0.7
Cadmium (mg/L)	0	0	0	0	0	0	0.003
Calcium hardness (mg/L)	8.1	10	12	16.1	17.6	14.3	150
Chloride (mg/L)	4.0	14.0	1.7	12	11.6	1.2	250
Chlorine Residue (mg/L)	0	0	0	0	0	0	0.25
Chromium (mg/L)	0	0	0	0	0	0	0.05
Copper (mg/L)	0	0.5	0	0	0.006	0.01	1
Cyanide (mg/L)	0	0	0	0	0	0	0.1
Fluoride (mg/L)	0	0	0	0	0	0.001	1.5
Hydrogen sulphide (mg/L)	0	0	0	0	0	0	0.05
Iron (mg/L)	0.02	0	0.03	0.006	0.002	0.001	0.3
Lead (mg/L)	0	0	0	0	0	0	0.01
Magnesium (mg/L)	0.12	0	0.11	0	0	0.79	20
Manganese (mg/L)	0	0	0	0	0	0.001	0.2
Mercury (mg/L)	0	0	0	0	0	0	0.001
Mineral oil (mg/L)	0	0	0	0	0	0	0.003
Nickel (mg/L)	0	0	0	0	0	0	0.02
Nitrate	2.35	0	1.34	0.011	0.016	0.19	50
Nitrite	0	0.011	0	0	0	0.001	0.2
Phenol (mg/L)	0	0	0	0	0	0	0.001
Sodium (mg/L)	13	5	11	4.3	4.8	9.1	200
Sulphate (mg/L)	0	86.4	0	0.48	0	0	0.001
Total hardness (mg/L)	10.0	12.0	1.5	13.2	14.8	16.6	250
Zinc (mg/L)	0.29	0	0.23	0	0	0.001	3.0
Total Coliform count	0	0	0	0	0	0	10
Clostridium perfringens	0	0	0	0	0	0	0
Cryptosporidium oocyst	0	0	0	0	0	0	0
E.coli	0	0	0	0	0	0	0
Salmonella	0	0	0	0	0	0	0
streptococcus enterococcus	0	0	0	0	0	0	0

weather, TDS above the SON maximum limit of 500 mg/L affect the taste of drinking water negatively and not considered fit for drinking purpose. Turbidity of the samples for the years in view ranged from 0.01-5 NTU which is within the SON maximum limit of 5 NTU this explain why the water samples were clear and colourless. The water samples were also odourless and tasteless throughout the years of analysis making it fit for drinking. The range of the concentration of all the heavy metals and toxic minerals (aluminum, chromium, cadmium, nickel, barium, arsenic, mercury and cyanide) are very low and within the SON specifications and most of them were not dictated at all. The essential mineral (calcium, magnesium, zinc and sodium) concentrations in the samples were within SON specification. Consumption of water low in mineral content may lead to excretion of huge amount of calcium, magnesium and other trace minerals in urine. The more the mineral loss, the greater the risk of high blood pressure, coronary artery disease, hypothyroidism, osteoporosis, etc. (Consumer Research, 1991)

Copper is an essential element for living organisms, including humans, and in small amounts necessary in our diet to ensure good health. However, too much copper can cause adverse health effects, including vomiting, diarrhea, stomach cramps and nausea. It has also been associated with liver damage and kidney disease. The human body has a natural mechanism for maintaining the proper level of copper in it. People with Wilson's disease also have a problem with maintaining proper copper balance and should exercise particular care in limiting exposure to copper (Isikwue, 2014). Iron is not hazardous to health but is considered a secondary or aesthetic contaminant. Zinc is an essential element and has a dietary value as a trace element. It is generally considered non-toxic. Zinc concentrations in water above 5.0mg/L tend to be opalescent and develop a greasy film when boiled, and has an undesirable astringent taste (Dada, 2009). In all the analyzed bottled water samples, the concentrations of these heavy metals were well below the stipulated maximum concentration. Chloride ions concentration in the samples was determined to vary from 1.2 to 14 mg/L for all bottled water samples with the higher values occurring in the February 2011, these results are well below the maximum permissible concentration of 250 mg/L desirable for drinking water. This limit was been laid down primarily based on taste considerations. High nitrate concentration in drinking water usually indicates possible microbial contamination. Results from the analysis of nine bottled water brands collected from retail and food shops around University of Dhaka showed high nitrate concentrations of 72.93 mg/L and 110.66 mg/L in two of the studied brands (Rahman, 2012). This indicated high levels of microbial contamination in the two bottled water brands. Nitrate ion concentration in all the samples in this study ranged between 0.00 to 2.35 mg/L which are below SON maximum permissible concentration of 50 mg/L for drinking water. The lowest nitrate concentration was found in February 2011 while November 2010 had the highest concentration.

Table 2. Statistical table of Vintage water for 5 years

Parameter	Min	Max	Range	Mean	SD	CV%	SON
Colour TCU	0	10	9	2.7	3.9	100	15
Odour	0	0	0	0	0	0	Unobjectionable
Taste	0	0	0	0	0	0	Unobjectionabe
pH	6.7	7.4	0.71	7.0	0.3	4.3	6.5-8.5
Conductivity µs/cm	1.6	241	239.4	61.9	91	147	1000
TDS mg/L	1.0	121	120	33.6	45.8	136	500
Turbidity NTU	0.01	5	5	1.5	2.1	140	5
Aluminium (mg/L)	0	0	0	0	0	0	0.2
Arsenic (mg/L)	0	0	0	0	0	0	0.1
Barium (mg/L)	0	0	0	0	0	0	0.7
Cadmium (mg/L)	0	0	0	0	0	0	0.003
Calcium hardness (mg/L)	8.1	14.3	6.2	13.0	3.6	27.7	150
Chloride (mg/L)	1.2	14	12.8	7.4	5.7	77	250
Chlorine Residue (mg/L)	0	0	0	0	0	0	0.25
Chromium (mg/L)	0	0	0	0	0	0	0.05
Copper (mg/L)	0	0.5	0.5	0.1	0.2	200	1
Cyanide (mg/L)	0	0	0	0	0	0	0.1
Fluoride (mg/L)	0	0.001	0.001	0.0002	0.013	6300	1.5
Hydrogen sulphide (mg/L)	0	0	0	0	0	0	0.05
Iron (mg/L)	0	0.03	0.03	0.01	0.3	3000	0.3
Lead (mg/L)	0	0	0	0	0	0	0.01
Magnesium (mg/L)	0	0.79	0.79	0.2	0.31	155	20
Manganese (mg/L)	0	0.001	0.001	0.0002	0.0004	205	0.2
Mercury (mg/L)	0	0	0	0	0	0	0.001
Mineral oil (mg/L)	0	0	0	0	0	0	0.003
Nickel (mg/L)	0	0	0	0	0	0	0.02
Nitrate	0	2.35	2.35	0.65	0.97	149	50
Nitrite	0	0.011	0.011	0.002	0.004	220	0.2
Phenol (mg/L)	0	0	0	0	0	0	0.001
Sodium (mg/L)	4.3	13.0	8.7	7.9	3.7	47	200
Sulphate (mg/L)	0	86.4	86.4	14.5	35.2	243	0.001
Total hardness (mg/L)	1.5	16.6	15.1	11.4	5.3	46	250
Zinc (mg/L)	0	0.29	0.29	0.1	0.14	140	3
Total Coliform count	0	0	0	0	0	0	10
Clostridium perfringens	0	0	0	0	0	0	0
Cryptosporidium oocyst	0	0	0	0	0	0	0
E.coli	0	0	0	0	0	0	0
Salmonella	0	0	0	0	0	0	0
streptococcus enterococcus	0	0	0	0	0	0	0

This is an indication of a general good level of hygiene in the production areas. The microbial analysis of the samples showed that all the water samples for the analyzed years are free from microbes as the count showed zero for all the years. The physicochemical and microbial data on the quality of the bottle water brands in Table1 were statistically analyzed to evaluate the consistency in quality of the water over the (5) years analyzed. The results obtained are shown in Tables 2. The water samples for the years have low coefficient of variation for pH less than 5% indicating consistency of value of pH over the years. The values of the coefficient of variation for conductivity and TDS were high 147% and 136% showing that their values were not consistent as there was high increase for the year 2011.The samples have high coefficient of variation for nitrate, nitrite, sulphate and copper concentrations. The high coefficient of variation indicates obvious changes in their concentrations during the years of study. Calcium, chloride, sodium and total hardness concentration had a coefficient of variation of 28, 77, 47 and 46% indicating a fair consistency in the concentration. The coefficient of variation for turbidity, iron, magnesium, manganese, and zinc were 140, 3000, 155, 205 and 140 which were high, showing inconsistence in their concentrations for the years studied. The high variation in chloride concentration indicated that the chloride used in the water purification or mineral additive needs to be properly regulated. Copper was detected for samples of 2011, October 2014 and 2019 but was not detected for the other years suggesting that it may be introduced from a point source during production or packaging. Iron was detected for all of the years except for sample from year 2011. Magnesium was present in water sample of 2010, 2012 and 2019 but was absent in other samples. Nitrate was detected for all the samples except for year 2010. Nitrite was detected in very low concentration in 2011 and 2019 samples but was absent in other years. Zinc and sulphate were detected in 2011, 2012, 2019 and 2011, January 2014 respectively. The concentrations of all the parameters studied across the years were well below the specified SON maximum permissible limits.

Conclusion

The study showed that the analyzed bottled water of Vintage water brands collected from production line of Vintage farms and products at Km 2 Ahoada road Elele Rivers State of Nigeria were of good quality and met the SON's drinking water quality specifications for the tested parameters.

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