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ANALYSIS OF PURE WATER PRODUCTION: A CASE STUDY OF TEN (10) RANDOMLY SELLECTED PURE WATER FIRMS IN MINNA, NIGER STATE

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Abstract : Research has shown that two third of human body weight is made up water. The human brain contains eighty five percent (85%) of water, Muscles contains .seventy five percent (75%) and Bones, thirty three percent (33%) (Akpan, 1998). It is difficult to survive long without water. The realization of this fact necessitated for this research in other to identify if the pure water consummated within Minna conform to the quality standard. Thirty (30) samples were collected and tested; the result shows that there is statistical significant difference between conformity to the standard led down for quality drinking water by the Standard organization of Nigeria at 5% level of significance. This could pose high health risk to the consumers.

1. Introduction

Water apart from being absolutely essential for life, is the most common, most widely distributed and most useful liquid on earth. It is the most precious natural resource that exist on our planet (Musa, et al; 2008). Two third of the human body weight is made up of water attaining forty-five percent in the average adult. The brain is eighty five percent water, muscles contain seventy five percent water, and bones thirty three percent (Akpan, 1998). As a result of the significance of water in physiological systems, it is difficult to survive long without water (Longdet, et al; 2004).

Accessibility and availability of fresh clean water is a key to sustainable development and an essential element in health, food production and poverty reduction (Adekunle, 2004). However an estimated 1.2 billion people around the world lack access to safe water and close to 2.5 billion are not provided with adequate sanitation (Third World Water Forum on Water, 2003).

Keywords : Body weight, Consummated, Conformity, Tasteless, Variability, Inspection, Chemicals.

The standard industrialized world model for delivery of safe drinking water and It sanitation technology is however, not affordable in much of the developing world. Thus, given the renewed global commitments towards the Millennium Development Goals (MDG) marked for 2015, the importance and contribution of locally sourced low cost alternative drinking water schemes to sustainable access in rural and semi-urban settings of developing nations cannot be over emphasized (UNDESA, 2004).

Statutorily, portable water supply in Nigeria had been by the government owned public water utilities (GPWU) in the past. The GPWUs provided their supply from conventional water treatments plants that uses water from impounded reservoirs, flowing perennial streams, lakes and deep boreholes. As the country population grows and industries increase, the supply of water by the GPWUs becomes inadequate in quality and quantity. This led to the emergence of some privately owned water enterprises (POWE). That operated side by side with the GPWUs within the water sector (Onemano and Otun, 2003).

One of the most popular POWE in Nigeria is the sachet water sold in polythene sachet otherwise called 'Pure Water'. The POWEs mainly collect their water as the end product of initially treated water supplied by the GPWUs and do little treatment such as the removal of the suspended solids to make the GPWUs water more potable. They also do some minor treatment on water from natural springs, open wells and deep boreholes. Some also collect water directly from the GPWUs kiosks and later resells them at a higher price (Onemano and Otun, 2003).

The production, marketing and consumption of sachet water have increased tremendously. There are now several brands of these type of packaged water marketed in Nigeria and other developing nations (Ogan, 1992 and Kassenga, 2007). This so called 'Pure Water' in sachets is readily available, easy to serve and the price is affordable, and finds patronage from the middle class and members of low socio-economic classes, but there are concerns about its purity. The integrity of the hygienic environment and the conditions where majority of the water in sachets are produced has also been questioned (CAMON, 2007).

2. Objectives of the study

The importance of water to the human existence cannot be over emphasized, this research tend to investigate the concentration of some chemicals in the randomly selected pure water production firms and the conformity of the products to the standard organization of Nigeria (SON) standard for drinking water.

3. Hypothesis

The hypothesis below is stated for this research work.

H_0 : There is no significant difference in the standard led down by the standard organization of Nigeria (SON) on drinking water and the mean of the pure water produce by the randomly selected pure water firms in Minna.

H_1 : There is significant difference in the standard led down by the standard organization of Nigeria (SON) on drinking and the mean of the pure water produce by If the randomly selected pure water firms in Minna

4. Materials and Methods

4.1 The study area:

The study area was in the Minna municipal area of Niger state, it serves as the state headquarters. It proximity to the Federal capital has made it provide cheap accommodation to those who cannot afford the high rent of Abuja, thus, its population is fast increasing and stretching the facilities available especially drinking water

4.2 Sample selection:

Ten (10) different brands of the 'Pure Water' were randomly selected from the study area. Ten samples of each were collected direct from hawkers and wholesalers at different locations of the town which includes; motor parks, markets and other busy areas of the town, a total of thirty samples were collected. These were then transferred to the laboratory for analysis. For Physical and laboratory analysis, the physical visual examination of the water samples; odour, and appearance such as colour; turbidity and presence of floating particles were all noted. While in the Laboratory, each sample was subjected to both physical and chemical tests in accordance with standard methods as obtained from the American Public. Health Association (APHA), (2005). The chemical tests conducted include chemical analysis of lead (Pb), chloride (Cl), iron (Fe), and Aluminum (Al). The physical tests carried out were those of pH and conductivity.

5. Data analysis and Interpretation:

Data obtained were analyzed using means, standard deviation, standard error of mean and Analysis of variance (ANOVA) with the use of Instat and SPSS Statistical software.

All the tests were conducted at three different times of the year; August 2009, January, 2010 and April, 2010. The analysis is as follows:

Table-1 : Mean, Standard deviation, Standard error of mean of the Chemicals tested in August, 2009

Group	Mean	Standard deviation	Standard error of mean	95% Confident interval
PH	7.090	0.7923	0.25050	6.523 to7.657
conductivity(μS/cm)	0.3680	0.1586	0.05015	0.2546 to 0.4814
Iron (Fe^{+2})	0.0800	0.1189	0.03759	–0.005038 to 0.1650
Lead(Pb)	0.03900	0.09219	0.02915	–0.02694 to 0.1 049
Aluminum (Al)	0.01200	0.01687	0.005333	–6.400E-05 to 0.02406
Chloride (Cl)	8.815	4.741	1.49900	5.424 to 12.206

From table 1, Mean of lead (Pb) is 0.03900 with – 0.02694 to 0.104 (95% confident interval). This is greater than the maximum permitted from the standard organization of Nigerian standard which is 0.01, as in appendix-l (Table-10). This could lead to Health impact like cancer, interference with vitamin D metabolism, and affect mental development in infants.

Table-2 : Analysis of variance (ANOVA) for the Chemicals test conducted in August, 2009

Source of variation	Degree of freedom	Sum of squares	Mean of squares	$F_{calculated}$	F_{table}
Treatments (between columns)	5	832.67	166,53	43.153	2.56
Residuals (within columns)	54	208.40	3.859		
Total	59	104.07			

$\propto = 0.05$

Since the value of $F_{calcultated} = 43.153$ is greater than $F_{table} = 2.56$. We shall reject the null hypothesis and conclude that there is statistical significant difference in the conformity with the Nigerian standard organization standard for drinking water. This is evidence in the mean of Lead (Pb) which is greater than the maximum permitted.

Table-3 : Mean, Standard deviation, Standard error of mean of the Chemicals tested in January, 2010.

Group	Mean	Standard deviation	Standard error of mean	95% Confident interval
PH	7.200	0.7846	0.2481	6.639 to 7.761
conducti vity (µS/cm)	0.3810	0.2364	0.07477	0.2119 to 0.5501
Iron (Fe^{+2})	0.1040	0.1333	0.04214	0.008673 to 0.1 993
Lead(Pb)	0.01600	0.03098	0.009798	–0.006163 to 0.03816
Aluminum (Al)	0.05400	0.05420	0.01714	0.01523 to 0.09277
Chloride (Cl)	8.48100	5.3700	1.69800	4.639 to 12.323

From table 3, above the Iron (Fe^{+2}) mean is 0.1040 with 0.008673 to 0.1993 (95% confident interval) which is less than the standard maximum permitted as in appendix-1 (Table 10) of 0.3000; mean lead (Pb) is 0.01600 with - 0.006163 to 0.03816, 95% confident interval which is greater than the maximum permitted of 0.01. This is evidence that could led to heath impact.

Table-4 : Analysis of variance (ANOVA) for the Chemicals test conducted in January, 2010

Source of variation	Degree of freedom	Sum of squares	Mean of squares	$F_{calculated}$	F_{table}
Treatments (between columns)	5	799.92	159.98	32.501	2.56
Residuals (within columns)	54	265.81	4.922		
Total	59	1065.73			

$\propto = 0.05$

Since the value of $F_{calcultated} = 32.501$ is greater than $F_{table} = 2.56$. We shall reject the null hypothesis and conclude that there is statistical significant difference in the conformity with the mean of chemicals tested and the Standard led down by the standard organization of Nigerian for portable drinking water as in appendix-1–(Table-10).

Table-5 : Mean, Standard deviation, Standard error of mean of the Chemicals tested in April, 2010

Group	Mean	Standard deviation	Standard error of mean	95% Confident interval
PH	7.170	0.7103	0.2246	6.662 to 7.678
conductivity (µS/cm)	0.3540	0.1760	0.05564	0.2281 to 0.4799
Iron (Fe^{+2})	0.07900	0.09574	0.03027	0.01052 to 0.1475
Lead (Pb)	0.04900	0.1240	0.03920	–0.03967 to 0.1377
Aluminum (Al)	0.02600	0.03836	0.01213	–0.001436 to 0.05344
Chloride (Cl)	7.82300	5.37800	1.70100	3.976 to 11.670

From table-5, the means of all the chemicals tested are within the standard of the standard organization of Nigerian as shown in Table-10 appendix-1. This shows an improvement in the conformity to the standard by the pure water production firms.

Table-6 : Analysis of variance (ANOVA) for the Chemicals test conducted in April, 2010

Source of variation	Degree of freedom	Sum of squares	Mean of squares	$F_{calculated}$	F_{table}
Treatments (between columns)	5	726.96	145.39	29.585	2.56
Residuals (within columns)	54	265.38	4.914		
Total	59	992.34			

$\propto = 0.05$

Since the value of $F_{calcultated} = 29.585$ is greater than $F_{table} = 2.56$. We shall reject the null hypothesis and conclude that there is statistical significant difference in the conformity with the

mean of chemicals tested and the Standard led down by the standard organization of Nigerian for portable drinking water as in appendix-1 (Table-10).

6. Discussion

The results were compared with Nigerian Standard for Drinking Water Quality as outlined by Standard Organization of Nigeria (SON), (2007). As can be seen from the tables the mean pH ranges from 6.2 – 8.8, which indicates that some of the samples falls out of range of the normal pH of drinking water (6.5 – 8.5). Though, this might not have any direct effect but could lead to increase of dissolution of certain metals whose concentration above normal could have detrimental health effect. The conductivity has a mean range of 0.13 – 0.62 mS/cm, while iron has a mean range of 0.00 – 0.32 mg/L indicating a deviation of the accepted level of 0.3 mg/L, this could lead to the water having a metallic taste and could cause stains to laundry. Lead has a mean range of 0.00 – 0.03 mg/L with the upper limit well above the accepted limit of 0.01 mg/L this could have deleterious health effect as lead is associated with cancer, interference with mental development and vitamin D metabolism, and is also implicated in central and peripheral nervous system toxicity. Aluminum has a mean range of 0.00 – 0.08 mg/L which is within the accepted limit of 0.2 mg/L. Chloride concentration in the samples has a mean range of 4.33 – 15.74 which also within the accepted limit of 250 mg/L.

7. Conclusion and Recommendation

As evidence from the results some of the packaged water at times do not conform to standards led out for quality drinking water, as such this could pose health risk to the Consumers. The result also confirms other reports on the health risk of pure water.

We therefore recommend that a periodic inspection of the chemicals application in the treatment of the waters production should be check for updating and correct application of the required chemicals; there should also be regular monitoring in other to reduce process variability.

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APPENDIX-1

Table-7 : Raw Mean score of parameters analyzed for the month of August, 2009

SAMPLE	pH	Conductivity (µS/cm)	Fe (mg/L)	Pb (mg/L)	Al (mg/L)	Cl (mg/L)
1	7.10	0.41	0.01	0.30	0.02	11.34
2	6.40	0.21	0.00	0.00	0.01	4.78
3	7.20	0.59	0.14	0.03	0.00	3.95
4	6.80	0.14	0.01	0.01	0.01	10.78
5	8.80	0.36	0.00	0.01	0.00	14.79
6	6.30	0.42	0.26	0.01	0.00	7.88
7	6.10	0.61	0.01	0.00	0.03	3.45
8	7.10	0.25	0.02	0.00	0.05	15.80
9	7.30	0.45	0.03	0.02	0.00	11.90
10	7.80	0.24	0.32	0.01	0.00	3.48

Table-8 : Raw Mean score of parameters analyzed for the month of January, 2010

SAMPLE	pH	Conductivity (µS/cm)	Fe (mg/L)	Pb (mg/L)	Al (mg/L)	Cl (mg/L)
1	6.60	0.51	0.06	0.10	0.05	10.12
2	6.30	0.21	0.02	0.00	0.10	6.34
3	6.70	0.71	0.11	0.01	0.06	2.41
4	7.20	0.12	0.01	0.00	0.07	1.78
5	8.60	0.11	0.00	0.00	0.11	18.12
6	8.10	0.31	0.34	0.00	0.00	11.24
7	6.20	0.48	0.04	0.01	0.00	7.96
8	7.10	0.62	0.05	0.00	0.15	2.90
9	7.50	0.63	0.05	0.03	0.00	14.64
10	7.70	0.11	0.36	0.01	0.00	9.30

Table-9 : Raw Mean score of parameters analyzed for the month of April, 2010

SAMPLE	pH	Conductivity (µS/cm)	Fe(mg/L)	Pb (mg/L)	Al (mg/L)	Cl (mg/L)
1	6.70	0.32	0.00	0.40	0.00	12.15
2	6.50	0.25	0.01	0.01	0.06	1.86
3	7.10	0.62	0.20	0.02	0.03	7.88
4	7.50	0.13	0.07	0.00	0.01	11.33
5	8.90	0.21	0.00	0.01	0.00	14.30
6	7.20	0.41	0.13	0.00	0.12	2.90
7	6.30	0.52	0.06	0.00	0.01	14.71
8	7.20	0.61	0.03	0.01	0.03	1.70
9	7.10	0.22	0.01	0.04	0.00	1.60
10	7.20	0.25	0.28	0.00	0.00	9.80

Table-10 : Chemical Parameters- inorganic constituents

Parameter	Unit	Maximum permitted	Health impact
Aluminum (Al)	Mg/L	0.2	Potential Neuro-degenerative disorders
Arsenic (As)	Mg/L	0.01	Cancer
Barium	Mg/L	0.7	Hypertension
Cadmium (Cd)	Mg/L	0.003	Toxic to the kidney
Chloride (Cl)	Mg/L	250	None
Chromium (Cr^{6+})	Mg/L	0.05	Cancer
conductivity	µS/cm	1000	None
Copper (Cu^{+2})	Mg/L	1	Gastrointestinal disorder
Cyanide (CN^{-})	Mg/L	0.01	Very toxic to the thyroid and the nervous system
Fluoride (F)	Mg/L	1.5	Fluorosis, skeletal tissue (bones and teeth) morbidity
Hardness (as $CaCO_3$)	Mg/L	150	None
Hydrogen sulphide (H_2S)	Mg/L	0.05	None
Iron (Fe^{+2})	Mg/L	0.3	None
Lead (Pb)	Mg/L	0.01	Cancer, interference with vitamin D metabolism, affects mental development in infants, toxic to the central and peripheral nervous systems.
Magnesium (Mg^{+2})	Mg/L	0.20	Consumer acceptability
Manganese (Mn^{+2})	Mg/L	0.2	Neurological disorder

Source : Nigerian Industrial Standard NIS 554: 2007
Nigerian standard for drinking water quality