Food Science and Quality Management
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.34, 2014

Quality Parameters of Some Selected Potable Packaged Water in Minna, Nigeria

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Abstract
This study was conducted on sachet water samples mostly consumed in Minna Nigeria. Six types of sachet water samples were collected (A, B, C, D, E and F) and the six were randomly selected from the numerous sachet water factory in Minna. The purpose of this study was to determine the quality of sachet water used as drinking water and domestic purpose by looking into the microbiological aspect and several physicochemical analyses such as turbidity, pH and total suspended solid (TSS). The microbiological analyses were performed to trace the presence of indicator organisms and pathogens such as *Escherichia coli* and total coliform count. However, the total coliforms and *E. coli* were detected to range between 0 and 43 cfu/100mL while the E. coli ranged between 0.00 and 7.00 cfu/100mL. The pH value was slightly alkaline (pH >6.5) but below 9.5 which within the recommended standards. The TSS for the samples ranged between 45 and 190 mg/L which were very low compared with the recommended values and the turbidity for all the samples were recorded below 2 Nephelometric Turbidity Units (NTU) thus, complying with the regulations. All the water samples were fit to be consumed except those with high values of E. coli and total coliform count.
Keywords: Drinking water, filters, microbiology, physicochemical, quality, sachet water

1. Introduction

Water is essential for the majority of the body functions, to maintain a healthy lifestyle and also to regulate body temperature (EFSA, 2010). The provision of an adequate supply of a safe drinking water was one of the eight components of primary health care identified by the international conference on primary health care in 1978. A clean and treated water supply to each house may be the norm in developed countries, but in developing countries, access to both clean water and sanitation are not the rule, and waterborne infections are common. Two and a half billion people have no access to improved sanitation, and more than 1.5 million children die each year from diarrheal diseases (Gangil, *et. al*., 2012). Water plays a key role in prevention of diseases; drinking eight glasses of water daily can decrease the risk of colon cancer by 45% and bladder cancer by 50% as well as reducing the risk of other cancers (Allan, 1998). In addition to being in abundant supply, the available water

must have specific characteristics, signifying its quality (Oparaocha, *et. al*., 2010).

However, in Nigeria, though much have been achieved after 52 years of independence but the quality and quantity of safe drinking water is still grossly inadequate in some areas. This inadequacy compelled people to purchase and use water from hawkers who obtain the water from polluted environment and it is a well-known fact that the intake of unclean water could cause devastating microbial diseases with serious effects on human health (Maimuna**,** 2012). It is recorded that more than 47 million people do not have access to potable water supply and nearly 42 million (about 54% of the population) lack basic sanitation. This highlights the potential of infection due to water - borne pathogens (Ajayi, 1996).

The most important uses for water are at our homes. Water generally gets to our homes in one of two ways, by a city/county water department or maybe by a private company or people supply their own water, normally from boreholes and wells. Water delivered to homes from public water boards is called public supplied while that supplied by the people themselves is called self-supplied. People who supply their own water almost always use ground. Quite a few of the residents of Minna gets their water delivered from a public-supply system.

The evaluation of potable water supplies for coliform bacteria is important in determining the sanitary quality of drinking water. High levels of coliform counts indicate a contaminated source, inadequate treatment or post-treatment deficiencies (WHO, 2004). Many developing regions suffer from either chronic shortages of freshwater or the readily accessible water resources are heavily polluted. Microbiological health risks remain associated with many aspects of water use, including drinking water in developing countries (Gleick, 1996). It has been reported that drinking water supplies have a long history of association with a wide spectrum of microbial infections.

Hence, it could be summarized that potable water must meet the physical, chemical and bacteriological parameters when supplied by an approved source, delivered to a treatment and disinfection facility of proper design, construction and operation and in turn delivered to the consumer through a protected distribution system in sufficient quantity and pressure.

The objectives of this study was to ascertain the quality of water being sold as potable packaged (sachet) water to the people of Minna and its environs. The results of which will be compared with the Nigerian Standard for Drinking Water Quality (NSDWQ) and World Health Organisation standards.

2. Materials and Methods

2.1 Description of the area

Niger State is one of the 36 states created in Nigeria with her capital in Minna located between latitude $9^{o}34'$ - $9^{o}37'$N and longitude $6^{o}36'$ - $6^{o}39'$E, (Musa *et. al*, 2011) with an average annual rainfall of 578mm and an average mean temperature of 34^{o} (Minna metrological centre, 2008).

2.2 Sample collection techniques

Six different packaged water samples were collected from various package water factories in Minna at intervals of three weeks. The water samples were collected between 0800 hours and 1000 hours and stored in an iced box before taking them to the laboratory for analysis. This was carried out according to Musa and Ahanonu (2013) and Musa *et. al*., (2011). The samples collected were analysed for physical, chemical and bacteriological parameters.

To identify and locate samples easily, all samples carried self-adhesive labels. These were affixed on the sample packages. The information carried on the sample label includes; location, date and time.

3. Results

The major population of Minna and her environs are highly dependent on packaged for their water supply for domestic purposes. Thus, raising the concern about the quality of this water. Such concerns can be raised by what appears to be water pollution, or by disease symptoms perceived to be water related. In these case, chemical, physical and biological water quality measurements were taken to ascertain the suitability of the sachet (pure) water for consumption. Table 1 presents the physical, chemical and bacteriological analysis of some sachet water samples in Minna.

4. Discussion of results

The electrical conductivity of the various samples considered range between 90 and 370 µs/cm. This result when compared with NSDWQ (2007) and WHO (2003) standards, the values were observed to below the permissible limit. The total dissolved solids present in some of the sampled sachet water ranged between 45 and 190 mg/L. Though, when these values were compared with the recommended values of WHO (2003) and that of NSWDQ (2007), they were observed to lower but this can also be eliminated if proper attention is given to the treatment process before packaging. It was discovered from Table 1 that only Sample A had some suspended solids inside it but still below the maximum permissible limit of 25.0 recommended by WHO (2003). The pH of the water for

all the samples fluctuated greatly. Sample E had relatively the lowest pH of 6.9 with samples A and F having value of 7.2. It is important to note that samples were collected directly from the production factories and stored in an iced box. The overall pH pattern showed that the pH values were relatively within the WHO (2003) and NSDWQ (2007) range of 6.5-9.5 and 6.5 – 8.5 respectively. The temperature of most of sachet water (pure water) going into the open market is usually not fixed as they are usually transported directly under the influence of the sun thus giving it an atmospheric temperature. The temperature of the samples in the iced box were maintained at 28 ^{0}C. This is slightly higher when compared with WHO standard but within the recommended range of NSWDQ. The highest value of turbidity was observed from sample A had the highest turbidity value of 2 mg/L while sample B and E had values of 1 mg/L and others had zero values. When compared with the recommended values of WHO and NSDWQ, they were all within the maximum permissible limit of 5.0 mg/L. The colour of the sampled sachet water varied considerably as they had values ranging between 0 and 15 TCU with the highest recommended value by both NSDWQ and WHO to 15 TCU. The total iron content in the sampled sachet water ranged between 0.00 mg/L and 0.01 mg/L. It was observed that the samples were within the maximum permissible limits of 0.3 mg/L as recommended by WHO and NSDWQ. sIt was observed that for calcium hardness the values obtained ranged between 14 and 54 mg/L with sample D more than the permissible limit 50 mg/L recommended by WHO and less than that of NSDWQ while samples D of magnesium hardness was discover to be out of range of the recommended values of WHO and NSDWQ. The Nitrate values of the samples ranged between 0.4 and 5.3 mg/L which is within the permissible limits of WHO and NSDWQ while for Nitrite values, samples A, B, C and D had values ranging between 1.76 and 4.4 mg/L which were also found to be within the recommended range of WHO and NSDWQ. The sulphate values for the samples considered ranged between 13 and 72 mg/L which were all found to also be within the range of the recommended permissible limit of WHO and NSDWQ. It was observed that the value of phosphate for the samples ranged between 0.07 and 1.16 mg/L, it was observed that only sample D was above the recommended permissible limit by WHO and NSDWQ. The total alkalinity values for the samples ranged between 15 and 140 mg/L with sample D higher than the recommended value by both WHO and NAFDAC of 100.

4.1 Bacteriological Analysis of Water Samples

The total coliform count for samples A to F were 23, 4, 4, 0, 43, 0, 9 respectively. It is observed that only samples A and D had their values higher than the recommended values by WHO and NSDWQ. The E. coli content for the samples tested showed that samples A and D had 7 and 5 E. Coli counts while others had 0 counts. The recommended value of the E. Coli count by WHO AND NSDWQ is 0 cfu/100ml for which samples A and D were found to be higher than the recommended value.

5. Conclusion

It can be concluded generally that the sampled sachet water are fit for domestic purposes on checking with the recommended values of WHO and NSDWQ that is in terms of the physical, chemical and bacteriological parameters. Though samples that contained high values of total coliform count and E. coli should not be used for domestic purposes. Most of the sachet water factories in Minna should at the start of daily production send samples for analysis to determine how to further treat their water for public consumption.

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Table 1. Physicochemical and bacteriological analysis of sampled sachet water in Minna

S/No	Parameters	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F	W.H.O. limit (2003)	NSDWQ Limit (2007)
1	Electrical conductivity (us/cm)	100	90	110	370	170	140	1000	1000
2	Total dissolved solids (mg/L)	50	45	55	190	80	70	1000	500
3	Temperature (^{0}C)	35	35	35	35	35	35	25	27.0 –28.0
4	Suspended solids (mg/L)	1	0	0	0	0	0	25	-
5	pH	7.2	7.4	7.3	8.1	6.9	7.2	6.5–9.5	6.5-8.5
6	Turbidity (NTU)	2	1	0	0	1	0	5.0	5.0
7	Colour (TCU^2)	15	10	0	0	4	0	15	15
8	Iron content (mg/L)	0	0.007	0	0.02	0.02	0.01	0.3	0.3
9	Total hardness (mg/L)	47	50	52	135	16	19	150	200
10	Hardness (ca) as $caco_3$ (mg/L)	18.8	20	20.8	54	16.0	14	50	75
11	Hardness (mg) as $caco_3$ (mg/L)	28.2	30	31.2	81	17.0	9.0	50	30
12	Nitrate as Nitrogen (mg/L)	1.4	0.9	0.4	1.0	5.3	4.8	50	10
13	Nitrite (mg/L)	4.4	3.96	1.76	4.4	-	-	0.2	3.0
14	Sulphate (mg/L)	57.0	72	19	15	18	13	100	100
15	Phosphate	0.07	0.023	0.13	1.16	0.03	0.01	0.5	0.5
16	Total alkalinity (mg/L)	46.0	75.0	43.0	140.0	18.0	15.0	100	100
Bacteriological analysis									
15	Total Coliform (cfu/100ml)	23	4	0	43	0	9	10	<10
16	E. Coli (cfu/100ml)	7	0	0	5	0	0	0.00	0.00

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