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Safety evaluation of some packaged potable water in Ondo State, Nigeria

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ABSTRACT: Twenty samples of potable water, known as 'pure water' in Nigeria, were collected fresh from the production sites in Ondo State, Nigeria. They were analysed for their physical, chemical and microbiological qualities. Observations on the physical analysis showed that the colour, odour, taste, turbidity, conductivity and pH, except in one sample, agreed with WHO standards for drinking water. The turbidity ranged between 0.010 and 0.090, conductivity ranged between 120 and 780 while the pH ranged between 6.68 and 8.86. No detection of cadmium, cobalt, arsenic and carbonate ions in all the water samples tested. However, nickel, calcium, bicarbonate were within acceptable range, as recommended by WHO, although two of the samples had lead content higher than the acceptable level.

The bacterial loads of the water samples ranged between 0.40×10^5 and 0.04×10^5 which were higher than the acceptable range (30 – 300 cfu/ml). Some pathogenic bacteria (*Escherichia coli*, *Staphylococcus aureus*, *proteus* sp. and *Enterobacter*) were detected in some of the water samples. Ten of the tested water samples were not safe for drinking and strict quality control by Food and Drug Administration is recommended.

Key Words: Potable water; 'Pure water'; Safety evaluation; Water microbiological quality..

Introduction

Water is important to life (Sen, 1981). It is also the symbol of the advancement of human civilization (Sen, 1981). Unlike many other raw materials, there is no substitute for water in many of its uses (Tebbutt, 1993). Every individual in the world requires between 1 and 2 litres of clean water per day to survive. Today, life, healthcare, research and industry rely on the availability of purified water (Kemmer, 1988), hence society cannot function without water. Therefore, routine monitoring of the physical, chemical and microbiological parameters of drinking water is essential to ensure the supplies of good drinking water (Kemmer, 1988).

In Nigeria, water is easily taken for granted. It has been observed that people use water from sources that are readily available or relatively cheap without minding the quality. Several people, including companies, have cultivated the habit of selling water in the open markets, supermarkets and other outlets. The water is usually packed in bottles or sealed in transparent polythene bags without meeting with WHO standards for drinking water. In view of this, this study is aimed at evaluating the physicochemical and microbiological parameters of potable water in Ondo State, with a view to ascertaining their conformity with WHO standards.

Materials and Methods

Packaged potable water samples were collected from twenty production sites in Ondo State and were labelled serially from PW1 to PW20. The chemicals used for analysis were Analar grade and the water used was sterile and glass-distilled.

Physical Analysis

The physical analysis of the packaged water was carried out with respect to WHO (1994) standard. The following physical parameters: odour, colour and taste were observed. The pH was also determined with the aid of a pH meter. The turbidity and conductivity were determined using an automated method as described by Udo and Ogunwale (1978).

Chemical Analysis

The presence of some anions and cations were determined in the water using the standard AOAC (1990) methods. Chloride, magnesium, carbonate, bicarbonate and calcium were determined using titration techniques. The level of toxic metals (lead, manganese, cobalt, arsenic, nickel and cadmium) present in the water were determined using atomic absorption spectrophotometer. The samples were aspirated into the flame and atomised standard solutions which were prepared for each metal using suitable metal salts of each element to be determined. The instrument was switched on to warm up for stability and the required lamp for each metal aspirated simultaneously, as well as the sample serially. the absorbance readings were recorded under the same condition.

Bacteriological Analysis

The bacterial isolation and counts were carried out on each water sample using the por plate technique. One millilitre of water sample was added aseptically to sterilised Nutrient Agar plates and after 24 hours of incubation at 37°C, the total bacterial load was determined and expressed as colony forming units (cfu/ml). A selective or differential medium (Eosin Methylene Blue Agar) was also employed to isolate and differentiate the enteric organisms.

Results and Discussion

The physical properties of the twenty samples of potable water analysed in triplicate are shown in Table 1. the colour, taste and odour were acceptable, as all the samples were colourless, tasteless and odourless. the turbidity range between 0.010 and 0.090 and agrees with the WHO standard for drinking water. However, the conductivity of the water ranged between 140 and 780. This was higher than the WHO permissible standard of 50 but lower than the WHO recommended excessive level. Although one of the samples had a high pH value of 8.86, the pH of virtually all the water samples analysed ranged between 6.68 and 8.04 which were within the WHO recommended level of between 6.00 and 8.50 (WHO, 1994).

Table 2 shows the results of the chemical analysis of the potable water. The results revealed that cadmium, cobalt, arsenic (toxic metals) and carbonate were not detected in the water. However, magnesium ranged between 0.020 and 17.71, calcium ranged between 0.318 and 25.57, bicarbonate ranged between 4.00 and 96.00. They were found to be within the WHO recommended level (WHO, 1994), Lead (a toxic metal) was detected in some of the water samples (< 0.1) and they are within the WHO recommended level in drinking water. However, two of the samples (PW4 and PW19) had high lead content. In addition, manganese (a toxic metal) was detected in all the water analysed, their content were higher than the acceptable level of 0.1 but lower than the dangerous level of 0.5 (Udo and Ogunwale, 1978). The presence of these toxic metals (lead and manganese) must be seen as a potential threat to human health (Pillai, 1991).

The results of the microbiological evaluation of these potable water samples are shown in Tables 3 and 4. This revealed that the total bacterial counts ranged between 0.04×10^5 and 0.4×10^5 in all the pure water analysed. These values were higher than the WHO recommended standard of 300 cfu/ml and below (WHO,

1994). On further analysis, *Escherichia coli* was detected in some of the water samples, indicating possible faecal contamination. *Escherichia coli* belongs to the group Enterobacteriaceae which inhabit the intestine of man and animals. It causes gastroenteritis and biliary infections (Hughes, 1959). *Staphylococcus aureus* was detected in some of the water samples. Man is the main reservoir of this organism and it is common in the nose, skin, eye, throat and intestinal tract (Elek, 1959). From these sources, the organism can find its way to the dust, air or water during sneezing, coughing or yawning. The organism can also be found on clothing, hands as well as in skin infections such as boils. *Proteus* sp., an opportunistic bacterium, as well as Enterobacter and *Aerobacter aerogenes* (Enterobacteriaceae) were detected in these water samples.

Table 1: The physical analysis of some packaged potable water samples in Ondo State.

Sample No.	Turbidity	Conductivity	pH
PW1	0.050	270	6.68
PW2	0.030	250	7.37
PW3	0.045	200	7.64
PW4	0.060	300	7.31
PW5	0.035	280	6.69
PW6	0.090	250	7.44
PW7	0.065	250	7.65
PW8	0.035	120	7.26
PW9	0.015	120	6.85
PW10	0.030	220	8.86
PW11	0.015	130	8.09
PW12	0.030	280	8.00
PW13	0.030	780	7.64
PW14	0.030	320	7.88
PW15	0.015	280	8.08
PW16	0.015	180	7.35
PW17	0.010	260	7.50
PW18	0.025	280	7.59
PW19	0.020	160	7.29
PW20	0.030	140	7.72

The taste, colour and odour were acceptable.

From the results presented here, it is obvious that some of the so-called 'pure water' usually hawked in Ondo State are actually impure. Ten of the 'pure water' samples are not safe to drink due to defects in one or a combination of physical, chemical or microbiological quality of the water samples. In view of these, strict quality control and good hygiene should be enforced by the Food and Drug Administration in order to reverse this unpleasant situation.

Table 2: **CHEMICAL COMPOSITION (TOXIC METALS) OF SOME PACKAGED PORTABLE WATER IN ONDO STATE**

Sample No	Mg	Ca	Cl ⁻	CO ₃ ⁻	HCO ₃ ⁻	Mn	Pb	Ni	As	Cd
PW1	0.98	0.40	49.65	ND	96.00	0.17	0.05	0.10	ND	ND
PW2	0.64	0.40	56.72	ND	42.00	0.03	ND	ND	ND	ND
PW3	0.72	0.32	54.21	ND	40.10	0.03	0.05	0.03	ND	ND
PW4	0.60	0.32	62.10	ND	62.25	0.09	0.14	0.16	ND	ND
PW5	0.66	0.18	63.81	ND	36.00	0.02	ND	0.13	ND	ND
PW6	0.02	0.40	49.63	ND	48.00	0.24	0.03	0.17	ND	ND
PW7	1.00	0.64	21.27	ND	61.00	ND	0.02	ND	ND	ND
PW8	7.30	0.57	67.35	ND	60.00	ND	ND	ND	ND	ND
PW9	7.13	2.32	46.03	ND	66.00	0.03	ND	0.06	ND	ND
PW10	11.71	25.57	31.98	ND	58.00	ND	0.03	ND	ND	ND
PW11	5.34	4.72	38.99	ND	60.00	0.05	0.01	0.01	ND	ND
PW12	17.59	14.30	60.25	ND	90.00	ND	0.10	ND	ND	ND
PW13	23.96	21.56	187.88	ND	50.40	0.20	0.02	0.07	ND	ND
PW14	17.10	13.54	60.10	ND	40.40	ND	0.66	ND	ND	ND
PW15	4.85	6.33	60.26	ND	60.21	ND	ND	ND	ND	ND
PW16	9.75	7.13	60.26	ND	51.60	0.10	0.04	0.04	ND	ND
PW17	9.26	11.49	38.99	ND	62.80	0.07	0.07	0.11	ND	ND
PW18	8.23	13.54	74.44	ND	42.00	0.19	ND	0.16	ND	ND
PW19	6.25	8.24	50.21	ND	45.00	0.18	0.12	0.07	ND	ND
PW20	4.85	2.32	60.26	ND	4.00	0.02	ND	0.06	ND	ND

ND: Not detected.

Table 3: Total bacterial counts of some packaged potable water in Ondo State (cfu/ml)

Sample No.	Bacterial count ($\times 10^5$ cfu/ml)
PW1	0.04
PW2	0.07
PW3	0.08
PW4	0.04
PW5	0.04
PW6	0.04
PW7	0.20
PW8	0.27
PW9	0.16
PW10	0.10
PW11	0.20
PW12	0.10
PW13	0.04
PW14	0.17
PW15	0.11
PW16	0.10
PW17	0.30
PW18	0.15
PW19	0.15
PW20	0.30

Table 4: Microbiological analysis of some packaged potable water in Ondo State.

Organisms	Water samples affected
<i>Bacillus</i> sp.	PW20
<i>Escherichia coli</i>	PW4, PW9, PW18, PW19
<i>Enterobacter aerogenes</i>	PW2, PW11, PW13, PW15
<i>Proteus</i> sp.	PW2, PW10, PW19
<i>Staphylococcus aureus</i>	PW15, PW20

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