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The Physico-Chemical and Bacteriological Studies of Polythene Packaged Water [Pure Water] Sold in Ilaro Metropolis, South West, Nigeria

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ABSTRACT
Samples of polythene packaged water [pure water] sold in Ilaro metropolis, southwest, Nigeria were subjected to physico-chemical and bacteriological analyses to determine their wholesomeness and conformity to standards as stipulated by relevant regulatory bodies such as World Health Organization and National Agency For Food And Drug Administration Control[WHO, NAFDAC]. The results of the analyses revealed that most of the water samples were colorless, odorless, tasteless and clear in appearance. The chemical analyses showed that samples from a single source [GG] exceeded the permissible levels in terms of calcium and copper contents while other samples conformed to standards when compared to maximum allowable concentration. The total plate counts for all the polythene packaged water samples [pure water], which ranged from 10.0-97.0 cfu/l conformed to standards as stipulated by WHO and NAFDAC while the presence of Escherichia coli and streptococcus faecelis in one of the samples is a direct contamination by sewage and human excretal which is dangerous to human health.
Keyword: *Escherichia coli, S. faecelis, WHO*

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INTRODUCTION

Water is the most common of all liquids which contain two atoms of hydrogen covalently linked to an atom of oxygen [1]. It is a colorless, odorless and tasteless liquid. Water is the most abundant substance on earth making up to — of the entire earth surface [2]. It is one of the most important needs of all forms of life and it is unavoidable in man's daily life. It's role in life sustenance cannot be overemphasized [3]. Water according to World Health Organization [4] is declared portable when it is free from contaminants [chemical or biological] and aesthetically appealing.

Polythene packaged water [pure water] has been widely consumed in the rural areas across Nigeria. Majority of the infectious diseases in developing countries are those carried by water, or those who provides the vital link in their transmission. Water transmitted diseases often leads to the incidence of gastro enteritis in young children, diarrhea, dysenteries and enteric fever. Pathogenic micro-organism contaminates our water sources [bore holes, springs, public mains, etc] and even if this packaged water is treated, most are not properly done [5]. Drinking water should not contain pathogenic micro-organism and should be free of bacteria that indicate excremental pollution.

Water quality is the physical, chemical and micro- biological characteristic of water in relation to set standards [6,3]. Because of the magnitude of health hazards associated with water, it is very vital that water for public use must be wholesome and meet accepted standards [7,3]. Drinking water must be tested regularly for possible indicators or faecal pollution [5] . Therefore, this present work aims at determining the quality of sachet water produced, hawked and sold in Ilaro metropolis, south west, Nigeria, there by ascertaining their conformity with standards as stipulated by regularly bodies such as; National Agency for Food and Drug Administration Control [NAFDAC][8] and World Health Organization [WHO].

MATERIALS AND METHODS

Source of materials; Ten [10] polythene packaged water samples [pure water] were bought from different market and location spread across Ilaro metropolis for the purpose of the research. The samples were

transported to the Food Technology Laboratories of Federal Polytechnic, Ilaro, stored at room temperature [27^0] and coded appropriately for easy identification before analyses.

Analytical Procedure

The physical and chemical analyses of the samples were carried out using standard methods. The color, odor, taste, general appearance and general acceptability were carried out by physical observation using sensory evaluation panel according to the method of APHA [9]. Turbidity was measured by placing 25ml of water sample in a curette and read at 425nm using spectrophotometer and expressed as Normal Turbidity Unit [NTU] [10]. PH was determined by dipping the probe of the digital meter into the sample of water and read off the value on the display board as described by APHA [10]. Free carbon dioxide [free co_2] was determined by titrating 100ml of water sample with 0.023M NA_2CO_3 using drops of phenolphthalein indicator to permanent pink color according to APHA [10]. Total chloride was determined by titrating 100ml of water sample in which 3 drops of $K_2Cr_20_4$ indicator has been added with $AgNO_3$ to pink color. [10]. Total alkalinity was carried out by titrating 100ml of water sample to which 3 drops of phenolphthalein indicator has been added with 0.01M H_2SO_4 until the color disappeared [10]. Total hardness was determined by titrating 50ml of water sample buffered with 1ml of ammonic buffer solution and 4 drops of Erichrome Black T indicator with Ethylene diamine tetra acetic acid [EDTA] for color change from wine-red to blue [APHA,1958]. Dissolved oxygen was determined using the modified Winkler's method. The Winkler's bottle was filled with water sample and 2ml of $MnSo_4$ was added beneath the surface using a pipette, shaken, and allowed to precipitate. 2ml of 1:1 H_2So_4 and water added, shaken to dissolve the precipitate. The solution was then titrated with 0.02M thiosulphate solution and 3 drops of starch solution added when the yellow color was reached, to give blue coloration which was further titrated to colorless solution. Conductivity was determined by inserting the electrode of a conductivity meter into the water sample and the value read off according to APHA [10]. Phosphate was determined by adding 10ml of mixed reagents [50ml ammonium molybdate, 25ml Sulphuric acid, 50ml Ascorbic acid and 25ml Potassium antionyl-tartarate solution] and mixed at once. The optical density was measured in a spectrophotometer at 885nm after 15 minute [10]. The mineral elements [Ca, Na, Fe, Mg, Mn, Zn and Cu] were determined by Atomic Absorption Spectrophotometry methods.

Microbiological analyses [Bacteriological examination] were carried out to detect total place counts for viable micro- organism, *Coliform*, *Streptococcus Faecelis* and *Clostridium Perfringes* using methods described by Pelezer and chan [11], and Fawole and Oso [12] respectively.

RESULTS

The results of physical analysis of polythene packaged water [pure water] sold in s Ilaro metropolis, south west, Nigeria are shown in table 1. Table 2 shows the results of chemical analyses of polythene packaged while the bacteriological analyses of polythene packaged pure water are as shown in Table 3.

Table1. Physical Analysis of polythene packaged samples [pure water]from ten[10] different location in Ilaro metro polis

Parameter	Colour	Odour	Taste	General Appearance	Turbidity	General Acceptability
Sample						
AA	Colourless	Odourless	Insipid	Clear	10units	Not objectionable
BB	Colourless	Odourless	Insipid	Clear	23units	Not objectionable
CC	Colourless	Odourless	Insipid	Clear	20units	Not objectionable
DD	Colourless	Odourless	Has taste	Clear	11units	Objectionable
EE	Colourless	Odourless	Has taste	Clear	12units	Objectionable
FF	Colourless	Odourless	Insipid	Clear	10.5units	Not objectionable
GG	Colourless	Odourless	Has taste	Clear	24units	Objectionable
HH	Colourless	Odourless	Insipid	Clear	20units	Not objectionable
II	Colourless	Odourless	Insipid	Clear	15units	Not objectionable
JJ	Colourless	Odourless	Insipid	Clear	15units	Not objectionable

AA represents location 1, BB location 2, CC location 3, DD location 4, EE location 5, FF location 6, GG location 7, HH location 8, II location 9, JJ location 10.

TABLE 2: Chemical properties of polythene packaged water samples (purewater) obtain from 10 different locations in Ilaro metropolis,South-West Nigeria.

Parameter	Sample	AA	BB	CC	DD	EE	FF	GG	HH	II	JJ
pH		6.6	5.9	6.5	6.7	7.2	7.1	6.2	7.3	6.5	6.5
Free CO^2		4.5±0.1	2.1±0.1	1.9±0.1	1.8±0.1	4.2±0.1	3.5±0.1	3.1±0.1	2.8±0.1	1.8±0.1	1.9±0.1
C12		20±0.4	15±0.4	21±0.4	32±0.4	28±0.4	36±0.4	14±0.4	39±0.4	36±0.4	36±0.4
T.A		24±0.1	1.4±0.1	1.7±0.1	1.6±0.1	2.2±0.1	1.6±0.1	1.9±0.1	1.8±0.1	1.9±0.1	1.9±0.1
T.H		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
D.O		7.6±0.1	6.4±0.1	8.5±0.1	9.±0.1	6.2±0.1	6.3±0.1	8.7±0.1	7.2±0.1	7.4±0.1	9.8±0.1
C		50±0.+	60±0.+	70±0.+	75±0.+	55±0.+	50±0.+	80±0.+	70±0.+	75±0.+	50±0.+
PO_4		0.08±0.01	0.07±0.01	0.05±0.01	0.09±0.01	0.08±0.01	0.07±0.01	0.1±0.01	0.09±0.01	0.05±0.01	0.1±0.01
Ca		40±0.+	50±0.+	60±0.+	55±0.+	65±0.+	70±0.+	45±0.+	60±0.+	55±0.+	50±0.+
Na		2.15±0.1	4.05±0.1	6.06±0.1	7.00±0.1	1.7±0.1	4.8±0.1	2.15±0.1	3.05±0.1	7.05±0.1	8.06±0.1
Fe		0.1±0.1	0.1±0.1	0.15±0.1	0.12±0.1	0.2±0.1	0.3±0.1	0.1±0.1	0.2±0.1	0.15±0.1	0.2±0.1
K		2.7±0.1	4.8±0.1	2.13±0.1	3.20±0.1	2.67±0.1	1.60±0.1	9.06±0.1	2.60±0.1	4.80±0.1	3.06±0.1
Mg		0.01	0.02	0.03	0.01	0.04	0.02	0.03	0.01	0.04	0.05
Mn		0.2±0.1	0.3±0.1	0.4±0.1	0.2±0.1	0.5±0.1	0.5±0.1	0.2±0.1	0.3±0.1	.04±0.1	0.3±0.1
Zn		7±0.1	7±0.1	7.5±0.1	6±0.1	8±0.1	9±0.1	10±0.1	11±0.1	12±0.1	14±0.1
Cu		0.03	0.02	0.04	0.04	0.05	0.04	0.06	0.07	0.02	0.03

Value represents means of three determinations with standard deviation.

AA represents location 1, BB location 2, CC location 3, DD location 4, EE location 5, FF location 6, GG location 7, HH location 8, II location 9, JJ location 10.

Table 3: Bacteriological Analysis of Polythene Packaged Water Samples [Pure Water] sold in Ilaro Metropolis, South west, Nigeria.

SAMPLE	Parameter	Total plate count for viable m/o/(cfu per ml)	Coliform test	*Streptococcus faecilis*	Clostridum perfringes
AA		74	Nil	Nil	Nil
BB		66	Nil	Nil	Nil
CC		54	Nil	Nil	Nil
DD		42	Nil	Nil	Nil
EE		15	Nil	Nil	Nil
FF		90	Nil	Nil	Nil
GG		97	*E.coli present*	Present	Nil
HH		10	Nil	Nil	Nil
II		45	Nil	Nil	Nil
JJ		52	Nil	Nil	Nil

AA represents location 1, BB location 2, CC location 3, DD location 4, EE location 5, FF location 6, GG location 7, HH location 8, II location 9, JJ location 10.

DISCUSSION

The results of physical properties of the water samples carried out showed that all the samples were colorless. Relevant regulation bodies such as National Agency for Food and Drug Administration Control]NAFDAC],World Health Organization [WHO] had stipulated that drinking water must be colorless. However, as reported in a previous work, color and particles in water are due to the presence of organic matter associated with humus fraction of the soil [13,3]. Only water samples obtained from location 6 [FF] had odor while other polythene packaged water samples were odorless. WHO [4] guidelines for the examination of drinking water quality had recommend that water must be odorless. NAFDAC [8] recommended that boreholes used for drinking water must not be below the sea level, while equipping the boreholes with submersible pump to pump out water. The water, to prevent odor must also be running freely in the factory and lifting of water with tankers from one location in the factory is not acceptable to avoid cross contamination of the water [8]. About 33.3% of polythene packaged water samples [pure water] had taste in contrarily to WHO standard. According to literature, poor odor and taste may results from contamination with dusty particles and dissolved solids [14]. All the water samples had clear appearance, and this is in agreement with the standard stipulated by WHO and NAFDAC [15,8]. There was variation for all the water samples examined physically in terms of turbidity. Turbidity according to American Public Health Association [10] is an expression of the optical property that causes light to be scattered and absorbed rather than being transmitted in a straight line through the sample. Therefore, clarity of water is important for human consumption. Suspended matter such as clay, causes turbidity in water in addition of organic and inorganic matter, soluble organic compounds, plankton and other microscopic organisms. NAFDAC had recommended maximum level of 25 units, and values obtained from this work ranged from 10 units to 24 units. The general acceptability showed that one-third of the samples examined physically were not accepted [objectionable] and it has bearing with the taste as earlier stated in this discussion.

The results of chemical analyses of the polythene packaged water [pure water] sold in Ilaro metropolis, south west, Nigeria are shown in Table 2. The results revealed that the pH for all the polythene packaged water ranged from 5.9 to 7.3. According to literature [16], pure water is said to be neutral, meaning that ionization of water produced equal number of hydrogen ions and hydroxyl ions. A solution is described as being acidic if its hydrogen ion concentration is greater than 10^{-7} and basic if its hydrogen ion concentration is less than 10^{-7} [16]. National Agency For Food And Drug Administration Control [8] and World Health Organization [4] had recommended pH of 6.5-8.5 for portable water. Only two samples obtained from locations BB and GG have pH lower than the stipulated levels. However, chlorination tends to lower the pH, whereas, water softening using excess lime or soda as process raises the pH level [17]. In a previous work [13], pH values lower than 6.5 can lead to corrosion of pipes causing release of toxic metals like zinc, lead and copper in water. High pH on the other hand can damage the mucous lining of tissues, increase scale formation in heating vessels, reduces germicidal effect of chlorine and induces the formation of trihalomethane. As observed in a previous work, a direct relationship between human health and pH of drinking water is closely associated with other aspect of water quality. The free carbon dioxide obtained from the samples varied between 1.8mg/l – 4.5mg/l. This amount is low when compared with 50mg/l stipulated by regulatory standard bodies [4,8,15]. The chloride contents ranged from 14 – 39mg/l for all the samples under investigation. The values are extremely low when compared to standard of WHO and NAFDAC [30 – 250mg/l]. Four of the samples analyzed have chloride contents of 36,39,36and36mg/l and could be agreed to be between the range recommended by WHO and NAFDAC[30 -250mg/l]. Chloride of high concentration occurs from chloride containing geological formation, pollution by sewage industrial water, intrusion of sea water and other saline water[17]. Chlorine is used in water treatment as a bactericide but at the end of the process, the excess chlorine needs to be removed as it may affect the consumption of the water [3]. WHO[4] states that high chlorine concentration gives an undesirable salty taste to water and beverages and may also lead to corrosion by extracting calcium from calcide [3]. Furthermore, the limitation of treatment by chlorination alone should be borne in mind to avoid undue reliance on this process alone when other types of treatment are also required [16].

The total alkalinity for all the water samples varied between 1.4-2.4 mg/l. The alkalinity of water is a measure of its capacity to neutralize acids [3] and according to literature [13], alkalinity in water makes the taste unpalatable. The results obtained in this research work met WHO and NAFDAC standards [100 mg/liter]. The total hardness as revealed by the results of analyses carried out on the ten samples indicated that they are all soft. Temporary or carbonate hardness is caused by carbonate or hydrogen

carbonate salts of calcium and magnesium while permanent or non-carbonate hardness is due to calcium or magnesium sulphates or chloride[16]. Principal techniques for mineral reduction include lime-soda softening, ion-exchange softening, demineralization, electro dialysis, distillation, membrane filtration and freezing [16]. According to literature [16], of considerable interest is the investigation of possibility of links between the consumption of soft or softened waters and the incidence of certain cardiovascular disease. WHO and NAFDAC [4,8] had recommended total hardness of 1.00mg/liter. The dissolved oxygen [D.O] for the water samples ranged between 6.2-9.8 mg/l. This is within the limits of 5-10 mg/l recommended [15]. Serious corrosion is indicated by the decrease in dissolved 0xygen content and increase in pH value and Iron content of water flowing through the mains, hence removal of dissolved oxygen is a practical way of controlling corrosion in water. All the polythene packaged water [pure water] had conductivities ranging from 50.0-80.0 Us/cm. All the values obtained are in conformity with standard recommended by NAFDAC/WHO [50.0-9 Us/cm]. Substance affecting water portability such as calcium, sodium, iron, potassium, magnesium, manganese, zinc and copper were also found to be within standards. Those substances may be found in drinking water and normally do not constitute a danger to the health of the people drinking the water, but may never-the-less give rise to trouble if they are present in excessive amounts [16]. Iron, for example is essential for the formation of red blood cells and it's deficiency can cause anemia; calcium gives rigidity to the bones and teeth, magnesium function in nerve metabolism, sodium maintain fluid balance, potassium regulates heart rhythm and impulse conduction while copper are components of enzymes and essential in the formation of hemoglobin of red blood cells.
The results of bacteriological analyses of polythene packaged water [pure water] sold in ilaro metropolis are as shown in table 3. The total plate counts for all the samples ranged from 10.0-97.0 cfu/ml, indicating values well below 100 cfu/ml stipulated by WHO [15]. Samples GG obtained from location seven showed the presence of *E. coli* and *streptococcus faecelis*. Contamination by sewage or human excrement and by animal pollution poses the greatest danger associated with drinking water in most developing countries of the topics [16]. Such contamination, when exist is caused partly by cases or carrier of such infectious disease as enteric fever, dysentery or cholera [16]. Generally, the organisms commonly used as indicators of pollution are *Escherichia coli* and the coli form group as a whole. However, as reported in a previous work [18], water not meeting the recommended micro-biological standards for water stipulated by WHO is an indication that the water sources were not given enough sterilization treatment.

CONCLUSION

The results obtained from this work revealed that most of the polythene packaged water samples [pure water] sold in Ilaro metropolis met standards stipulated by WHO/NAFDAC for drinking water. However, the presence of *Escherichia coli* and *streptococcus faecelis* in one of the water samples is an indication of contamination by sewage/human excretal which can lead to infectious diseases such as enteric fever, dysentery or cholera, thereby posing health risks to the consumers of such water.

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