Original Research Article

Comparative Analysis of the Microbial Content of Some Drinking Water Sources in Port Harcourt Metropolis, Rivers State

ABSTRACT

Introduction: The short falls in the distribution of treated pipe borne water leads to resort to alternative sources of drinking water. Comparative analysis of sachet, bottle and tap water supply sources in Port Harcourt Metropolis Rivers State, Nigeria, was conducted by applying culture dependent methods in order to examine their qualities.

Methodology: Ten(10) samples comprising 4 bottle water samples from Rumuodara (zone B), Elekahia (zone C), Orogbum (zone G), and Mgbuoba (zone I), 4 sachet water samples from Rumukurushi (zone A), Borokiri (zone M), Rumuepirikom (zone J), Mgbuoshimiri (zone K), and 2 tap water samples from Rivers State University hostels NDDC and C were analyzed using standard analytical techniques.

Results: Twenty-seven (27) bacterial isolates identified in 5 of the 10 water samples were 12 (45%) *Escherichia coli*, 8 (30%) *Streptococcus species*, 4 (15%) *Klebsiella species* and 3 (10%) *Staphylococcus aureus* respectively. Total Plate Count on sachet water samples ranged from 0.1 to 1.2cfu/ml while that of the tap water was 2.0 to 2.9cfu/ml. In sachet water, *Staphylococcus aureus* ranged from 0.1 to 0.2cfu/ml, where as 1.2cfu/ml colonies was recorded for *Streptococcus species*. In tap water *Escherichia coli* ranged from 0.3cfu/ml to 1.8cfu/ml, whereas 0.4 to 0.8cfu/ml was recorded for *Streptococcus species* and *Klebsiella species* respectively.

Conclusion: The findings show that the drinking water sources did not meet the approved acceptable limits of the World Health Organization (WHO) for drinking water though there was no growth of indicator organisms in the samples and no difference in the physicochemical variables. It is recommended that sachet and tap water supply in Port Harcourt Metropolis be properly treated before human consumption and other domestic purposes.

Key words: Microbial content, physicochemical parameters, water, indicator organisms

1. INTRODUCTION

Following the theory of creation, it is clear that water is as old as man.

Most of our water supplies are from surface water which include: rivers, streams, lakes, oceans and seas and their water bodies are likely to be polluted with domestic and Industrial as well as agriculture waste, As populations increase, the problem become more serious and as such, water can endanger the health and life of human beings because when polluted by faecal materials it becomes potential carrier of pathogenic organism [1].

Water is one of the most important as well as one of the most abundant compound on earth, and is vital to the survival of any organism [2]. Most of the biochemical reaction that occur in metabolism and growth of living cells involved water, and all take places in water [3].

Man uses water not only for drinking purposes but also for bathing, washing, laundering, heating, air conditioning, agriculture, stock raising, gardens, Industrial processes, cooling water power, steam power, fire protection, fishing, swimming and wild life propagation and navigation.

Natural water contain not only then natural flora but also microorganisms from soil and possible from animals or sewage. Surface waters in streams or pools and stored waters in lakes and large ponds vary considerably in microbial content [4].

Tap water, as one of the water sources that is mostly used domestically. It is found that the tap water changes sometimes and clear, which calls for microbial load, in order to be sure of its purity [5].

However, water that moves below the ground surface undergoes natural filtration that removes most organisms. For this reason, water from springs and deep wells are generally of better quality than flowing water. Water related diseases continue to be one of the major health issues globally. The high prevalence of diarrhoea among children and infants can be traced to the use of unsafe water and unhygienic practices [6]. The most dangerous form of water pollution occur when faecal contaminants like *Escherichia coli* enter the water supply and also through the faecal-oral routes of transmission. Microbial contaminants in water supply are the sources of many diseases such as typhoid fever, cholera, bacillary dysentery

and so on. Examples of such microbial contaminants are *Salmonella spp., Shigella spp., Vibrio cholerae, Escherichia coli* [2].

The National Agency for Food and Drugs Administration Control (NAFDAC) in association with the World Health Organization [7] has the responsibility of regulating the standard of drinking water. The agency has published guidelines for the production of drinking water such as sachet water and bottle water. Unfortunately most producers do not adhere to these guidelines [8].

The increase in drinking water from different sources especially in Rivers State University has made to investigate the microbial load or content of this water. If the microbial content is not within acceptable limit, such water sources should be condemned immediately [9]. The aim of this study is to compare the microbial content of some sachet, bottle and tap water in Port Harcourt Metropolis.

2. MATERIALS AND METHODS

2.1 Description of Study Area

The study areas were eight zones in Port Harcourt metropolis; zone A, B, C, G, I, J, K, M and two different Rivers State University Hostels which are located in two different local Government Area of Rivers State in Nigeria. The water samples used were bottle, sachet, and tap water samples.

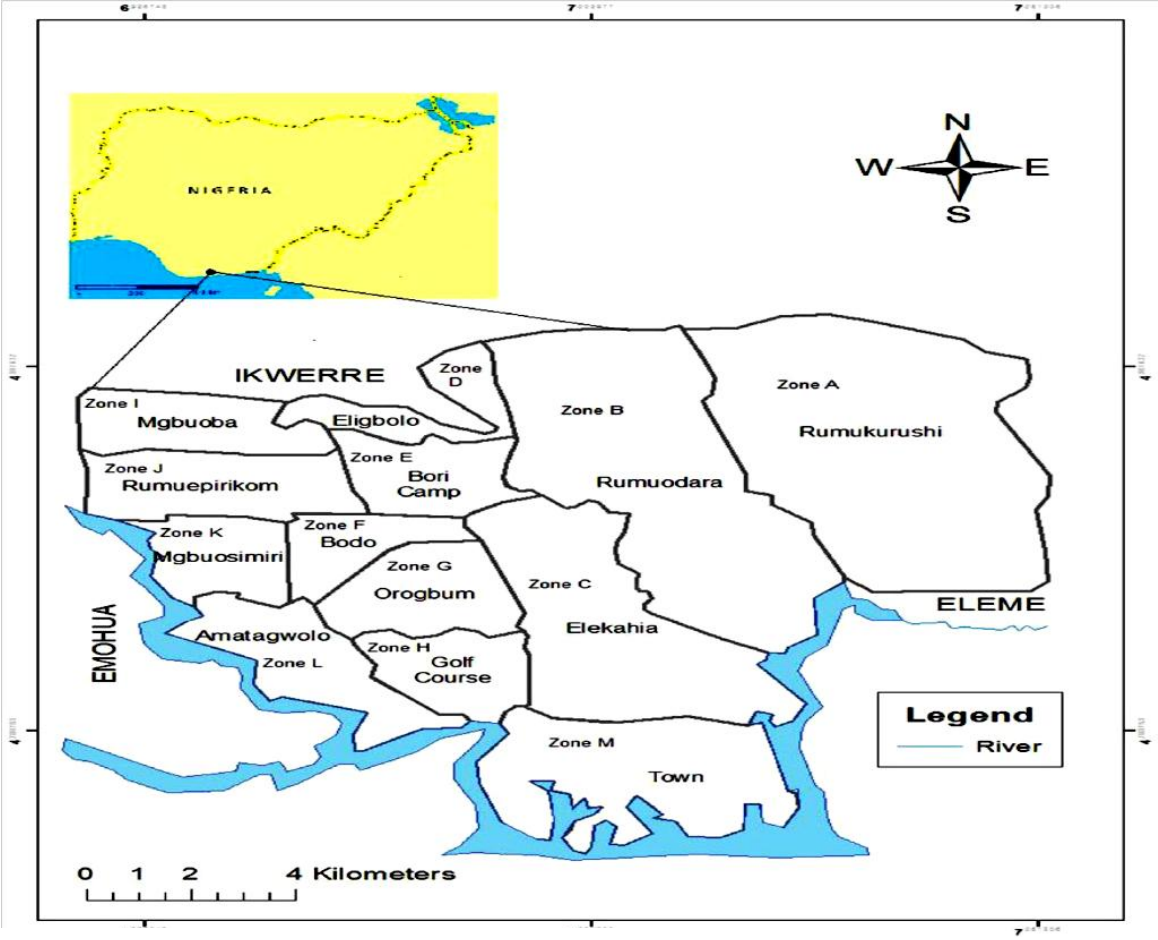

Figure 1: Map of Port Harcourt Metropolis (Akukwe&Ogbodo, 2015)

3.2 Sample Collection

The water sample were collected from January 2021 during rainy season in ten different sources comprising; four bottle water samples from Rumuodara zone B, Elekahia zone C, Orogbum zone G, and Mgbuoba zone I, four sachet water samples from Rumukurushi zone A, Borokiri zone M, Rumuepirikom zone J,Mgbuoshimiri zone K, and two tap water samples from Rivers State University NDDC and C hostels. Sterile sample bottles were used to collect the tap water samples, by cleaning the outside nozzle of the tap carefully, turned the tap on full, and allowed the water to run to wastefor 1 minute. Sterilized the tap by igniting a piece of cotton-wool soaked in methylated spirit and holding it with a pair of tongs closeto the nozzle until the whole tap is unbearably hot to thetouch.Allowed the tap to

cool by running the water to waste for afew seconds. Then, filled the sample bottle from a gentle flow of water, andreplaced the cap of the bottle and labelled [10].

The samples were brought within two hours of collection to the laboratory for microbiological analysis and 1500ml capacity for each samples was labelled and transported for physiochemical parameters of the water.

2.2 Sample Analysis

2.2.1 Physiochemical Analysis

The standard analytical methods used for the physicochemical parameters determination in the water was the American Public Health Association Series of Standard Methods of Examination of Water and Effluent. The parameters are; Temperature, pH, Conductivity, Salinity, Turbidity, Total Dissolved Solid (TDS), Chloride, Alkalinity, Total Hardness, Nitrate, Phosphate, Manganese, Iron, Magnesium and Calcium.

2.2.2 Microbiological Analysis

All media used for this research were prepared according to manufacturer's specification as presented in Appendix III.

The media was sterilized in an autoclave at 121^{o}C for 15minutes. All glassware are sterilized in a hot air oven at 160^{o}C for 2hours.

The bacteria analyses were carried out by using the Direct Streak, Pour Plate, Centrifugation Methods and Most Probable Number (MPN) of the isolated bacteria was also determined. The water samples were cultured on Nutrient, MacConkey agar for Coliforms, Salmonella-Shigella Agar for *Salmonellae* and Thioglycholate citrate bile salt sucrose agar for *VibroCholeae*. These were incubated at 37^{o}C for 24 hours after which bacterial counts were

made and sub-cultured for viable count. Gram staining, and other biochemical tests such as catalase, coagulase, oxidase, citrate, and indole were carried out.

2.2.2.1 Viable count

Petri plates of nutrient agar medium were used to determine viable bacterial count. 0.5ml of each sample was transferred to the individual plates for determination of total viable counts (TVC) followed by incubation at 37ºC for 24-48 hrs. Total number of colonies on each plate were counted [10].

2.2.2.2 TotalColiform Counts and Total Faecal Coliform Counts

The coliform counts were determined by the most probable number (MPN) techniques.

Principle

To estimate the concentration of viable microorganisms in a sample by means of replicate liquid broth growth in ten-fold dilutions and the results are compared with the standard statistical tables.

The presumptive test was done in a tests tubes that was arranged in a rack and labelled, 50 ml of double strength MacConkey broth in one test tube, 10 ml of double strength MacConkey broth in each 5 test tubes and 5ml of single strength of MacConkey brothin another 5 test tubes. The double and single strength MacConkey broth were sterilized containing inverted Durham tube to indicate the gas production. The tubes were incubated at 37°C for 24 hours. Allowed to cool and the water samples was added accordingly. It was mixed thoroughly and was incubated at 37°C for 24 hours. Positive tubes producing acid and gas with colour change from purple to yellow.

The confirmatory test is after which positive tube evidenced by acid (change of colour of broth from purple to yellow)and gas production while the negative ones are left for another 24 hours. Using an inoculating loop, an aliquot from each of the first set up is transfer red to a new set up with the same number of tubes and left for 24hours.

Completed test for total coliform and faecal coliform was carried out by plating a loopful of broth from a positive confirmatory tubes unto an Eosine methylene blue agar plate. The plates were incubated at 37°C for 48 hours and observed for a dark red colour with metallic green sheen. The colonies of the total and faecal coliforms were prepared on nutrient agar and colonies were used for Gram staining and biochemical test. Final faecal coliform of *Escherichia coli* count as MPN/ml was calculated based on the completed test [10].

2.2.3 Biochemical Identification Test

2.2.3.1 Gram Reaction Test

Principles

The iodine and crystal violet form a complex within the peptidoglycan. When decolorizer is applied to the cells, the CV-I complex remains within the cell, making it appear dark purple to blue. The gram-negative organisms do not contain a thick cross-linked layer of peptidoglycan.

Smears of the isolates were prepared with a sterile wire loop and heat fixed by passing over flame on clean grease free slides. The smears were stained for one minute with crystal violet. This was washed out with distilled water. The slides were flooded with dilute Grams iodine solution for one minute. This was washed off with distilled water and the smears were decolorized with 95% alcohol for 30 seconds and rinsed off with distilled water. The smears were then counter stained with safranin solution for one minute. Finally, the slides were

washed off with distilled water, air dried and observed under oil immersion objective (100x) [10].

2.2.3.2 Catalase test

Principle

This is a test to detect the presence or absence of catalase enzyme. The catalase enzyme catalyses the breakdown of hydrogen peroxide to release free oxygen gas and the formation of water.

A few drops of freshly prepared 3% hydrogen peroxide were added onto the bacteria isolates smeared on a slide. The production of gas bubble indicate indicates presence of catalase enzyme. It is essential for differentiating catalase-positive *Micrococcaceae* from catalase negative *Streptococcaceae.*

2.2.3.3 Coagulase test

Principle

Coagulases are enzymes that clot blood plasma and they produced by *Staphylococcus aureus.* The enzyme protease converts fibrinogen to fibrin resulting to blood clotting.

The Slide method was used. Here, clean slide was divided into two sections, to one section the test organism was smeared on it using a sterile wire loop while a drop of distilled water was added to the other section serving as control. Then human plasma was added to both sections and the slide was rocked gently for some minutes. A clumping/agglutination of the plasma indicates the presence of coagulase.

2.2.3.4 Indole test

Principles

This test was used to determine which of the isolates has the ability to split indole from tryptophan present in buffered peptone water. The test is used to differentiate Gram-negative *Bacilli* especially those of the *Enterobacteriaceae.*

Peptone water was prepared and about 3 ml of it was dispensed in test tubes using a sterile pipette. Then, fresh sterile loops were used to pick a well-isolated colony of bacteria and inoculated into test tubes, thereafter, the tubes were incubated at 37°C for 24 hours. After incubation period, 0.5 ml of Kovac'sIndole Reagent was added to the inoculated test tubes and gentle shaken. A red ring was examined in the surface layer within 10 minutes which indicated indole positive reaction.

2.2.3.5 Citrate Utilization Test

Principle

This test is based on the ability of some organisms to utilize citrate as a sole source of carbon.

It was carried out by inoculating the test organism in a slant test tube containing Simon's citrate medium and incubated at 37°C for 24hours. A deep blue colour indicates a positive result.

3. RESULTS

The Primary aim is to evaluate the microbial safety of drinking water in Port Harcourt Metropolis.

3.1 Physiochemical parameters: The Physiochemical Parameters obtained for the Water Samples; pH range from 4.63-7.09. The Temperature range was within 29^{o}C. Results for other Parameters such as Conductivity, Iron, Nitrate, Manganese, Phosphate, Chloride,

Calcium, Magnesium, Alkalinity, TDS, Total Hardness, Salinity and the corresponding WHO Guidelines is represented in Table 1.

Table 1: Shows the Physiochemical Parameters of the Water Samples

Parameters	**Samples Zones**										**WHO STD**
	A	**B**	**C**	**G**	**I**	**J**	**K**	**M**	**HC**	**HNDDC**	
pH	*4.86	6.94	6.93	*6.27	7.09	*4.96	*5.44	7.02	*4.63	*6.08	6.5-8.3
Color	colorless	colorless	colorless	colorless	colorless	colorless	colorless	colorless	colorless	colorless	colorless
Tempt (^{o}C)	29.2	29.8	29.7	29.5	29.5	29.2	29.1	29.4	29.6	29.7	25-40
Conductivity (µS/cm)	87	539	582	519	610	94	69	38	**1001**	661	651
TDS (mg/l)	61	377	406	365	427	66	48	27	**697**	463	500
Salinity (%)	0.04	0.26	0.28	0.25	0.29	0.04	0.03	0.02	0.48	0.32	5
Total Hardness (mg/l)	4.4	0.1	32.2	0.5	3.8	3.6	4.3	11.1	17.5	0.6	41
Calcium (mg/l)	0.70	0.03	11.88	0.21	1.14	0.70	0.96	4.19	4.63	0.20	7.5
Magnesium (mg/l)	0.64	0.02	0.62	Nd	0.23	0.57	0.45	0.16	1.44	0.02	30
Alkalinity (mg/l)	4.0	20.0	34.0	8.0	**60.0**	8.0	4.0	16.0	2.0	28.0	50
Chloride (mg/l)	**4.9**	**1.0**	**1.5**	**1.0**	**1.2**	**6.4**	**4.0**	<1.0	**20.7**	**9.9**	0.05

Phosphate (mg/l)	**0.78**	**0.46**	**1.08**	**0.54**	**0.25**	**0.98**	**0.42**	**0.40**	**0.87**	**0.78**	0.1
Nitrate (mg/l)	**1.88**	<0.05	0.13	0.09	0.16	**2.14**	**1.31**	**0.19**	**2.71**	**1.83**	0.17
Iron (mg/l)	<0.005	<0.005	<0.005	<0.005	0.035	<0.005	<0.005	<0.005	<0.005	0.024	0.45
Manganese (mg/l)	0.142	0.016	0.027	0.026	0.016	0.085	0.067	0.011	**0.302**	0.015	0.18

Keys: * = low, Bold = high, < = less than, Nd = Not detected.

3.2 Microbiological Analysis: Table 2, Table 3, and Table 4 Shows Isolation and Identification of Microorganisms using Direct Streak, Pour Plate, and Centrifugation and Spread Plate Method. According to Table 3 and Table 4; *Staphylococci spp*., *Streptococci spp*., *Escherichia coli* and *Kebsiella sp* were isolated in the different water samples. Bacteria Counts is represented in Table 5. Morphological and Biochemical test used to identify the Bacteria are represented in Table 6.

Table 2: Shows the Isolation and Identification Microorganisms using Direct Streak Plate Method

Sample Zones (0.1 ml volume)	Sample Sources	Growth on TCBS	Growth on SS agar	Growth on Mac-Conkey agar	Growth on Nutrient agar	Interpretation
A	Sachet	No growth	No growth	No growth	No growth	-
B	Bottle	No growth	No growth	No growth	No growth	-
C	Bottle	No growth	No growth	No growth	No growth	-
G	Bottle	No growth	No growth	No growth	No growth	-
I	Bottle	No growth	No growth	No growth	No growth	-
J	Sachet	No growth	No growth	No growth	No growth	-
K	Sachet	No growth	No growth	No growth	No growth	-
M	Sachet	No growth	No growth	No growth	No growth	-
HC	Tap	No growth	No growth	No growth	No growth	-
HNDDC	Tap	No growth	No growth	No growth	No growth	-

Table 3: Shows the Isolation and Identification Microorganisms Using Pour Plate Method

Sample Zones (0.1 ml volume)	Sample Sources	Growth on TCBS	Growth on SS agar	Growth on Mac-Conkey agar	Growth on Nutrient agar	Interpretation	Morpology
A	Sachet	No growth	No growth	No growth	Growth	*Streptococcus specie*	Dry & white-greyish
B	Bottle	No growth	No growth	No growth	Contaminant	Contaminant	
C	Bottle	No growth	No growth	No growth	Contaminant	Contaminant	
G	Bottle	No growth	No growth	No growth	Contaminant	Contaminant	
I	Bottle	No growth	No growth	No growth	No growth	-	
J	Sachet	No growth	No growth	No growth	Contaminant	Contaminant	
K	Sachet	No growth	No growth	No growth	No growth	-	
M	Sachet	No growth	No growth	No growth	No growth	-	
HC	Tap	No growth	No growth	No growth	Contaminant	Contaminant	
HNDDC	Tap	No growth	No growth	No growth	Growth & contaminant	*Streptococcus specie*& contaminant	Dry & white-greyish

Table 4: Shows the Isolation and Identification Microorganisms Using Centrifugation and Spread Method

Sample Zones ml (0.1 volume)	Sample Sources	Growth on TCBS	Growth on SS agar	Growth on Mac-Conkey agar	Growth on Nutrient agar	Interpretation
A	Sachet	No growth	No growth	No growth	No growth	No growth
B	Bottle	No growth	No growth	No growth	No growth	No growth
C	Bottle	No growth	No growth	No growth	No growth	No growth
G	Bottle	No growth	No growth	No growth	No growth	No growth
I	Bottle	No growth	No growth	No growth	No growth	No growth
J	Sachet	No growth	No growth	No growth	No growth	No growth
K	Sachet	No growth	No growth	No growth	Growth	*Staphylococcus specie*
M	Sachet	No growth	No growth	No growth	Growth	*Staphylococcus specie*
HC	Tap	No growth	No growth	Growth	Growth	*Klebsiella specie*
HNDDC	Tap	No growth	No growth	No growth	Contaminant	Contaminant

Table 5: Shows the Bacterial Count of the Water Samples

Sample Zones (10 ml volume)	Sample Sources	TCC (MPN/10ml)	TEC (MPN)	TPC (cfu/ml)	TPC (%)
A	Sachet	12	3	1.2	45
B	Bottle	0	-	0	0
C	Bottle	0	-	0	0
G	Bottle	0	-	0	0
I	Bottle	0	-	0	0
J	Sachet	0	-	0	0
K	Sachet	1	-	0.1	3
M	Sachet	2	1	0.2	7
HC	Tap	4	5	0.4	15
HNDDC	Tap	8	3	0.8	30

Key: TCC = Total Coliform Count, TEC = Total *Escherichia coli* Count, TPC = Total Plate Count

Table 6: Shows the Morphological and Biochemical Tests Used to Identify the Bacteria.

Sample 0.1 ml Volume	Sample Source	Catalase	Coagulase	Indole	Citrate	Gas	Gram	Cocci/Rod	Bacteria Isolated
A	Sachet	-	-	-	-	-	+	Cocci in chain	*Steptococci specie*
K	Sachet	+	+	-	+	-	+	Cocci in cluster	*Staphylococci specie*
M	Sachet	+	+	-	+	-	+	Cocci in cluster	*Staphylococci specie*
HC	Tap	+	-	+	-	+	-	Rod	*Escherichia coli*
		+	-	-	+	+	-	Rod	*Klebsiella species*
HNDDC	Tap	+	-	+	-	+	-	Rod	*Escherichia coli*
		-	-	-	-	-	+	Cocci in chain	*Steptococci species*

Keys: - = No Reaction, + = Reaction

4. DISCUSSION

The analysis examination carried out on the water sources that serves for public water supply were intended to assist in the determination of the quality of drinking water in Port Harcourt Metropolis in Rivers State. World Health Organization, [11] have stipulated standards for water meant for human consumption and the result of sample A, K, M, HC and HNDDC investigation did not meet the standards except the B, C, G, I and J samples. In this study, the values of the physicochemical parameters shows pH 4.63 – 7.09. The pH values are below the permissible limit of pH6.5 – 8.3 at sample A, G. J, HC, and HNDDC which were not fully in agreement with the WHO standards for drinking water [12]. The temperature range was 29.1 – 29.7^{o}C which is within range with studies conducted by Aleru *et al*., [13] which is of good quality for human consumption. Results for other parameters such as conductivity, salinity, total hardness, alkalinity, sulphate, nitrate phosphate, manganese, magnesium, TDS, calcium, iron and the corresponding WHO guidelines is represented in Table 1. In order for water to be fit for drinking, it must meet internationally acceptable standard and must be in agreement with the guidelines clearly stated by the World Health Organization [14].

The samples collected from the eight different zones and 10 sampling points were analyzed for pathogenic organisms, total coliform counts, total *Escherichia coli* count and total plate count. The bacteria isolated in the study were *Escherichia coli, Staphylococcus, Streptococcus, and Klebsiella* is represented in Table 3 and Table 4. Out of the 10 water samples, 5 (Zone A, Zone K, Zone M, Hostel C and NDDC Hostel) had bacterial isolates of 27 (100%). The water samples Zone A, Zone K, i Zone M, Hostel C and NDDC Hostel had the bacterial isolates of 12 (45%), 1 (3%), 2 (7%), 4 (15%) and 8 (30%), respectively. Of the Twenty-seven (27) bacterial isolates identified, which represented 100 percent, 12 (45%) were identified as *Escherichia coli,* 8 (30%)

Streptococcus species, 4 (15%) *Klebsiella species*, 3 (10%) *Staphylococcus aureus* respectively in agreement with the studies conducted by Dalha *et al*., [15] the present of coliform or faecal coliform, such as *Escherichia coli* shows that some of the drinking waters in Port Harcourt Metropolis did not meet internationally acceptable standard. The values for Total Coliform Count, Total *Escherichia coli* Count and Total Plate Count ranged from 1 -12mpn/10ml, 1-5mpn/100ml and 0.1 2.9cfu/ml is represented in Table 5, which were not fully in agreement with the WHO standards for drinking water [16], so it indicates that the water is polluted either before or during preparation or distribution. And since they are coliforms, it's most likely faecal contamination. The samples A, HC & NDDC showed the highest pathogenic organisms and fecal coliform counts compared with the other sample sites with the studies conducted by Agbo *et al.* [17] which is not good quality for human consumption. The samples M, and K also showed very less counts of pathogenic organisms in agreement with Ollor *et al.,* [18] they are still above the WHO standard for potable water as it states that no coliform should be present in any drinking water and this makes the water samples unacceptable. Majority of the microorganisms isolated were *Streptococci species* and *Escherichia coli* in agreement with Ngele*et al.*,[19] in his study of Quality assessment of selected water samples and also with Bukar *et al*., [20] in Maiduguri Metropolis, Nigeria, who reported that drinking sachet water is contaminated with *Escherichia coli, Klebsiella species* and *Streptococci species*.

Most of the taps were sited close to septic tanks, and the points of collection of the water were not kept clean and which have a lot of coliforms. Similar results have been reported for microbial analysis in tap water at Nnewi [21], Oyigbo [22], Lagos [23] and Ogbomosho [24] in Nigeria. The presence of coliforms in these zones were attributed to poor water treatment and handling methods of the producers such as poor sanitary conditions of the packaging environment, inadequate sterilization of the packaging material and contamination by the sealing machine

used. In line with the assertions of Khaniki *et al*., [25] implementation of hazard analysis critical control points (HACCP) for the microbial quality of packaged water in all processing from raw water to final production, to control contamination during packaging and prohibit microbial growth during storage and distribution can be terminated to receive safe water.

Lack of information on pathogenic bacteria in sachet water on our market creates some uncertainties in our understanding of the overall quality of drinking water on our markets. Ajayi *et al*., [26] had in sachet water suggests the potential presence of pathogenic enteric microorganisms and it requires an improved surveillance system for the sachet packaged water industry. In drinking water from sachet, the coliform test can be used as quality index, an indicator of treatment efficiency and the integrity of the production system [25]. This is in line with the findings of some other authors in Nigeria and outside [27].

This result expected as the water source, is most likely to have been treated by the process of chlorination to public out lets. The isolation of coliform from the water sources is indication of feacal contamination of the water such as the tap water. Their presence also indicates poor sanitary condition of the water sources. Access to good quality water is very important. For this reason, every sachet or tap providing drinking water should be checked at least a year for bacteria and other contaminants.

5. CONCLUSION

This study has revealed the unsanitary state of some drinking water consumed in this part of Port Harcourt Metropolis. As most samples contain bacterial indicators of faecal pollution. However, the presences of bacteria in some brand of sachet and tap water sampled were not expected. Also it revealed the presence of *coliforms, E. coli, Klebsiella spp., Streptococci spp., and*

Staphylococci spp. Out of the water samples examined, sachet and tap water samples have the bacterial contaminants. However, the bacteriological values from total coliform count did not meet international standard as they were higher than WHO standard of zero per 100ml. This is pointer to the poor quality standard of some waters that are being consumed by the inhabitant of Port Harcourt Metropolis. Tap water regulation makes it mandatory that the public water supply is tested daily and that findings are freely. Contamination of the water supplies in Port Harcourt Metropolis should be better prevented than remediated. Fortunately, many waterborne diseases are preventable with observance of optimal hygiene practices. The current study demonstrated the contamination degree of studied water samples collected from water points.

It can be concluded that some sachet water and the tap water are not fit for human consumption and are hazardous to health. This could be as a result of inadequate sanitation and under hygienic practices. It can also be as a result of ineffectiveness or malfunctioning of the water treatment process employed. Therefore, appropriate treatment process should be utilized for production of quality and safe packaged drinking waters.

Following the result of the study, it is recommended that Sachet and Tap water within Port Harcourt Metropolis should be adequately treated before use and Water Board should enforce and ensure strict compliance to the standards as regard the production and sales of packaged water. Water purification method that provides safe drinking water should be made available by government in order to avoid out break cause by pathogenic organism found in water. The government should make more sacrifices to provide adequate treatment facilities that purify sewage prior to discharge or disposal, so as to save our drinking water form continuous pollution.

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