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Prevalence of Coliform Bacteria and Physico-Chemical Parameters of Water Tanks in Rumuokwuta Community, Rivers State

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ABSTRACT

This study investigated the prevalence of coliform bacteria and physico-chemical parameters in some water tanks from bore-holes in Rumuokwuta community, Obio/Akpor Local Government Area, Rivers State. Water samples were collected with consent of the bore-hole owners from five locations in the community. The samples were collected from a running tap below the water tank. The tap was allowed to flow for two minutes before collection of the water. The total heterotrophic bacteria count was evaluated and results shows that water from Barata Pharmacy had the highest bacteria count of ($6.3 \times 10^4 cfuml^{-1}$), followed Owaoma close which had bacteria count of ($5.5 \times 10^4 cfuml^{-1}$), while water from Shell Location Road had the lowest count of ($1.5 \times 10^4 cfuml^{-1}$). The total coliform and the feacal coliform results showed that Okania new Layout, Shell Location Road and ADC close had total coliform counts of 1, 2 and 2 respectively with undetectable faecal coliform all through 5ml, 10ml and 50ml respectively and are interpreted using the MPN index chart at 100ml to be less than 2 faecal coliform. Barata Pharmacy had the highest coliform count (6) and was seen to have 1, 2 and 4 faecal coliform at 50ml, 10ml and 5ml respectively with 26 MPN index/100ml. The biochemical characterization and identification of the isolates showed that, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Klebsiella variicolaii*, *Escherichia coli* and *Staphylococcus aureus* were contained in the water samples. This study shows remarkable variations in the physicochemical parameters and significant difference in the sampling sites at ($p < 0.05$) which can influence living organism especially humans. It can be concluded that the water tanks from Rumuokwuta town contains high count of different bacteria species, some pathogenic, which might be dangerous to the health of residence, hence the need adopt established water purification and proper treatment methods.

Keywords: Water Tank, Water Quality, Coliform Bacteria, Waterborne Diseases,

1.0 INTRODUCTION

Water is a necessary obligation for life and makes up about 70% of the human body and 95% of all plants and animals (Obioma *et al*., 2017). In many countries, there is little or no supply of potable water, so most residents resort to either drill boreholes or buy from water vendors in tanks or plastic containers (Yusuf, 2007).At first, properly drilled boreholes supplies pure water, but subsequently if the water is not treated and the water tank washed, the growth of microorganisms in the water is encouraged, thereby making the water unsafe for drinking. This can also lead to altered physic chemistry of the water. Tanks come in all shapes and sizes, but nearly all of them, from the backyard personal tank to the water park wave tank, work in the same basic way. They use a combination of filtration and chemical treatment to continually clean a large volume of water. Nevertheless, it takes a great deal of effort and cost to make and keep the tank water clean and free of germs. A

properly maintained and operated tank becomes very beneficial to the owners and other users. However, many home tanks are poorly maintained and frequently referred to as attractive nuisances or hazards as they soon become contaminated. A good number of these water supplies are unprotected and exposed to contamination from external sources such as surface runoff, windblown debris, human and animal faecal pollution and poor sanitary collection methods (WHO, 2008). Among the surface water and groundwater sources, only 3% is safe in terms of its quality and freshness (Kegley and Andrew, 1998).

Mbgerekpe, (2014) noted that many infectious diseases are associated with faecally contaminated water and are the major cause of morbidity and mortality worldwide. Enteric pathogens such as bacteria, viruses and parasites that are transmitted through the faecal oral route are responsible for the development of water borne diseases (Thliza, 2015). The coliform bacteria are members of the intestinal microflora of both humans and warm blooded animals. They are commensals or opportunistic pathogens that can cause acute urinary tract infections (UTI) and gastrointestinal tract infections (GTI) in humans. The regular presence of coliforms in the intestine and faeces of warm blooded animals makes the bacterium a good indicator of faecal pollution (Yang *et al*., 2004). The detection of faecal coliforms in water indicates that the water is unsuitable for consumption, (Szakal *et al*., 2001). Ahmed *et al*., (2005) stated that the use of faecal coliforms and *Escherichia coli* as indicator bacteria for the assessment of faecal pollution and water quality deterioration in various water sources is a scientifically accepted procedure world-wide.

Total coliforms include bacteria of known faecal origin such as *E. coli* as well as bacteria that may not be of faecal origin such as *Klebsiella spp*., *Citrobacter spp*., *Serratia spp*. and *Enterobacter spp*, which are found in nutrient rich water, soil decaying vegetation and drinking water with relatively high levels of nutrients (WHO, 2004). The presence of total coliform in water samples are therefore, an indication that opportunistic pathogenic bacteria such as *Klebsiella* and *Enterobacter* which can multiply in water environments and pathogenic pathogens such as *Salmonella spp*., *Shigella spp*, *V. cholera, Campylobacter jejuni, Campylobacter coli, Yersinia enterocolitica* and pathogenic *E. coli* may be present (Thliza, 2010). These pathogens and opportunistic microorganisms could cause diseases such as gastroenteritis, dysentery, *cholera*, typhoid fever and salmonellosis to consumers (Fisher, 2015).

The faecal coliform group includes other organisms, such as *Klebsiella spp*., *Enterobacter spp* and *Citrobacter spp*., which are not exclusively of faecal origin (Standard Methods, 1995). *Escherichia coli* are specifically of faecal origin from birds, humans and other warm blooded animals (WHO, 2010). Faecal coliform bacteria are therefore considered to be a more specific indicator of the presence of faeces (Mbgerekpe, 2014).

2.0 METHODOLOGY

2.1 Study Area

The investigation was conducted in five different water tanks located at Rumuokwuta Town, Obio/Akpor Local Government Area, Port Harcourt as shown in figure 1. Rumuokwuta is located at Latitude 4.8406^{o} N and Longitude 6.9921^{o}E. It is bounded in the East by Rumuola, South; Rumuoprikom, West; Mgbuoba and North; Rumuigbo. It houses several banks, eateries, filing stations, hospitals, small firms and open markets. The popular Rumuokwuta roundabout is home to cell phone retail outlets and also, several mini residential estates.

Figure 1: Map showing the water tanks locations.
Keys: The yellow markings depict each tank location.

2.2 Sample Collection

Five different water samples were collected from selected water tanks with the consent of the owners in Rumuokwuta community. The samples were collected from the tap below the water tank. The tap was allowed to flow for two minutes before collection as described by Cheesbrough, (2000). The samples were taken to laboratory for bacteriological analysis.

2.3. Cultivation, Isolation and Identification of Bacteria.

The aerobic heterotrophic bacteria count of all water samples were determined using the dilution plate technique and nutrient agar medium, while MacConkey Agar was used for enumeration of total coliforms/faecal coliforms, Eosin-Methylene Blue Agar for enumeration of *E. coli* and MacConkey Broth for the enumeration of faecal coliform (*E. coli*).Total coliforms were estimated using the most probable number (MPN) method as described by (Cheesbrough, 2006). All the culture media were reconstituted and prepared according to the manufactures instruction.

2.4. Determination of Physico-Chemical Parameters

A number of physicochemical parameters of the water tanks samples were determined. They included the temperature, pH, total dissolved solids (TDS), total suspended solids (TSS), turbidity and conductivity. The pH was measured in-situ using Hach pH meter (Model EC1O). Temperature, conductivity and total dissolved solids were measured in-situ using Hach conductivity meter (Model CO1 50). The nephelometer was used for the measurement of turbidity. All the measurements were carried out according to APHA, (1998) methods.

3.0 RESULTS

4.1 Determination of the total heterotrophic bacteria

The total heterotrophic bacteria count of drinking water tanks in Rumuokwuta town is as shown on Figure 1. Samples from Barata Pharmacy had the highest bacteria count of (6.3 x 10^4cfuml^{-1}) and was followed by Owaoma close which had bacteria count of (5.5 x 10^4cfuml^{-1}) while water from Shell Location Road had the lowest count in bacterial(1.5 x 10^4cfuml^{-1}). There was significant difference at $P<0.05$ between water tanks from Barata Pharmacy, Owaoma close and Shell location road. Water tanks from Okania new Layout and ADC close had bacteria counts of 6.3 x 10^4cfuml $^{-1}$ and 6.3 x 10^4cfuml^{-1} respectively, which are not different from each other but statistically different from the other locations.

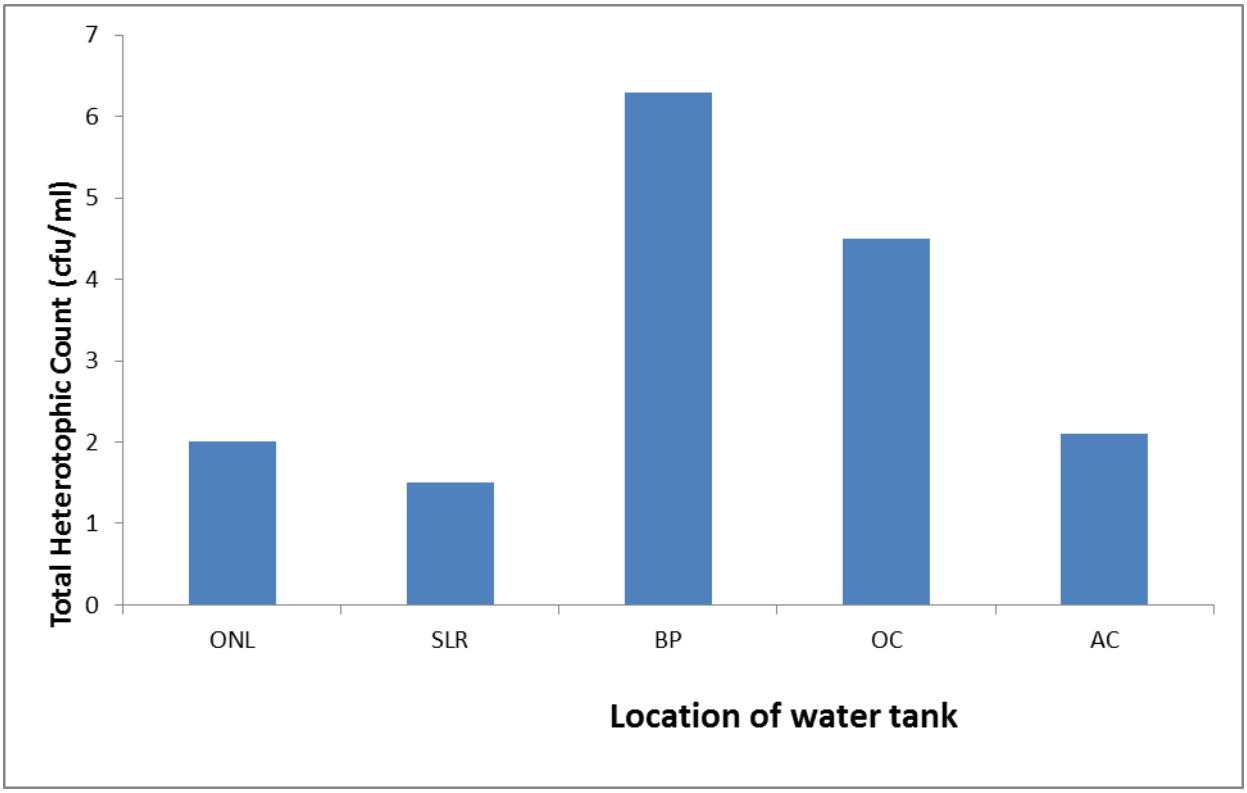

Figure 2: Total heterotrophic bacteria count of drinking water tank in Rumuokwuta town

Keys: ONL: Okania new Layout; **SLR**: Shell Location Road; **BP:** Barata Pharmacy; **OC**: Owaoma close; **AC:** ADC close.

4.2 Total and feacal coliform bacteria in drinking water tanks

The total coliform and the feacal coliform bacteria count in the water tanks are shown on Table 1. Okania New Layout, Shell Location Road and ADC close had total coliform count of 1, 2 and 2 respectively with no detectable faecal coliform. Barata Pharmacy had the highest coliform count of 6 and was seen to have 1, 2 and 4 faecal coliform with 26 MPN index/100ml. Owaoma close was next to Barata pharmacy in faecal coliform count with values of 1, 4 and 1 at and 21 MPN index/ 100ml.

Table 1: Total and Faecal Coliform counts of drinking water tanks in Rumuokwuta town

S/N	Location	Total coliform counts (cfu/10ml)	Faecal Coliform			MPN index/100ml
			50ml	10ml	5ml	
1	ONL	1 ± 0.10^{bcde}	0 ± 0.00^{cd}	0 ± 0.00^{cd}	0 ± 0.00^{cd}	<2
2	SLR	2 ± 0.56^{acd}	0 ± 0.00^{cd}	0 ± 0.00^{cd}	0 ± 0.00^{cd}	<2
3	BP	6 ± 0.23^{abde}	1 ± 0.17^{abe}	2 ± 0.22^{abde}	4 ± 0.43^{abde}	26
4	OC	4 ± 1.09^{abce}	1 ± 0.12^{abe}	4 ± 0.71^{abce}	1 ± 0.32^{abce}	21
5	AC	2 ± 0.32^{acd}	0 ± 0.00^{cd}	0 ± 0.00^{cd}	0 ± 0.00^{cd}	<2

Keys: **ONL:** Okania new Layout; **SLR:** Shell Location Road; **BP**: Barata Pharmacy; **OC**: Owaoma close; **AC:** ADC close. Values with superscript a, b, c, d and e in the same column are statistically significant at $p<0.05$ with the groups ONL, SLR, BP, OC and AC respectively

4.3 The biochemical characterization and identification

The isolates identified in the drinking water tanks include, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Klebsiella variicolaii*, *Escherichia coli* and *Staphylococcus aureus*. Table 3 below gives the summary of the biochemical characterization and probable identificaties of the isolates.

Table 3: The biochemical characterization and identification of isolates from drinking water tanks in Rumuokwuta town

S/N	Location	Grams Stain	Indole test	Urease test	Methyl red test	Oxidase Test	Inference
1	ONL	-	+	-	-	-	*E. coli*
2	SLR	-	-	-	-	-	*P. aeroginosa*
3		-	+	-	-	-	*E. coli*
4	BP	-	+	+	+	-	*Proteus vulgaris*
5		-	-	-	-	-	*P. aeroginosa*
6		-	+	-	-	-	*E. coli*
7		-	-	-	+	-	*Salmonella typhi*
8		-	-	+	-	-	*Klebsiellavariicola*
9		+	-	-	-	-	*Staphylococcus aureus*
10	OC	-	-	-	-	-	*P. aeroginosa*
11		-	+	-	-	-	*E. coli*
12		-	+	+	+	-	*Proteus vulgaris*
13		-	-	-	+	-	*Salmonella typhi*
14	AC	-	+	-	-	-	*E. coli*
15		-	+	+	+	-	*Proteus vulgaris*

Key: + = Positive test - = Negative test; ONL- Okania new Layout; SLR- Shell Location Road; BP- Barata Pharmacy; OC- Owaoma close; AC- ADC close

Results of physicochemical parameters showed that the pH values of all the drinking water samples are shown on table 4.4

Table 3: Determination of the physicochemical parameters of drinking water tanksin Rumuokwutatown

S/N	DESCRIPTION	ONL	SLR	BP	OC	AC	DISTILLED WATER	WHO STANDARD
2	Temperature (^{o}C)	26.32±0.72	26.52±0.12	28.11±0.36	27.41±1.08	27.02±2.43	27.05±0.09	0±0.00
3	Turbidity	1.06±0.43	1.55±0.24	3.16±0.14	2.71±0.30	1.96±0.33	0.57±0.55	5.0
	Ph	6.76.13±0.15	6.53±0.07	6.04±0.13	6.38±0.45	7.33±0.25	7.03±0.05	6.5±9.50
	Conductivity (us/cm)	102.68±3.57	142.23±5.26	588.09±7.30	320.68±12.06	124.18±4.21	12.68±1.17	0±0.00
	Total dissolved solids (TDS) (mg/L)	45.67±1.55	65.14±5.01	205.11±8.65	145.64±5.58	85.77±3.86	5.67±2.08	1000
	Total suspended solids (TSS) (mg/L)	1.23±0.06	2.21±0.30	4.00±0.14	3.09±0.15	1.83±0.27	0.03±0.01	0±0.00

Key: + = Positive test - = Negative test; ONL- Okania new Layout; SLR- Shell Location Road; BP- Barata Pharmacy; OC- Owaoma close; AC- ADC close

4.1 DISCUSSION

Microbiological contamination of water tanks can result in pathogenic microorganisms if present, causing infections to the numerous users of the water (Moore *et al*., 2002). This study was conducted to determine the prevalence of coliform bacteria and physico-chemical parameters from selected water tanks in Rumuokwuta town, Port Harcourt. The total heterotrophic bacteria count of the drinking water tanks in Rumuokwuta town shows that Barata Pharmacy tank had the highest bacteria count of 6.3±1.72 x 10^4cfuml -1, followed by Owaoma close, with bacteria count of 5.5±0.38 x 10^4cfuml -1, while Shell Location Road had the lowest count of 1.5±1.55 x 10^4cfuml -1. ANONA results showed that there was significant differences at $P<0.05$ between water tanks from Barata Pharmacy, Owaoma close and Shell location road. Water tanks from Okania new Layout and ADC close had bacteria counts of 2.0±1.32 x 10^4cfuml -1 and 2.1±1.02 x 10^4cfuml -1 respectively, which are not very different from each other but are statistically different from the other locations. The biochemical characterization of the isolates identified the following coliform bacteria, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Klebsiellavariicolaii*, *Escherichia coli* and *Staphylococcus aureus*, a non-coliform. This research is similar to those obtained by Idowu *et al.,* (2013) and Zakariya *et al*., (2013). The bacteria identification results showed that Okania new Layout, Shell Location Road and ADC close had total coliform count of 1, 2 and 2 respectively with no detectable faecal coliform all through 5ml, 10ml and 50ml respectively and are interpreted using the MPN index chart at 100ml to be less than 2 faecal form. Barata Pharmacy had the highest coliform count (6) and was seen to have 1, 2 and 4 faecal coliform at 50ml, 10ml and 5ml respectively with 26 MPN index/100ml. Owaoma close is next to Barata pharmacy in faecal coliform with values of 1, 4 and 1 at 50ml, 10ml and 5ml respectively and 21 MPN index/ 100ml.

Pseudomonas aeruginosa is an opportunistic pathogen commonly found in water, soil and vegetation. It also can be found in human and animal faeces. It rarely causes infection in healthy people but can colonize damaged systems, such as burn wounds and damaged eyes. Immuno-compromised individuals are particularly at risk. *P. aeruginosa* can grow at the selective temperature of 41–42 °C, where most environmental microorganisms would not survive, allowing it to proliferate to high numbers and cause diseases like ear and eye infections and folliculitis. Although relatively resistant to a range of disinfectants, chlorination of tank should be sufficient to kill the bacterium. The bacterium produces biofilms and colonizes drains and filter media (Moore *et al.,* 2002). *Pseudomonas aeruginosa* can grow within untreated waters and in biofilms. It can cause skin, ear and eye infections when present in large numbers and outbreaks of skin infections. *Staphylococcus aureus* on the other hand is the major cause of staphylococcal food poisoning. The poisoning is characterized by diarrhea and vomiting (Eze *et al.,* 2008).

For the physico-chemical parameters, the maximum temperature recorded was 28.11^{o}C in Barata pharmacy and minimum 26.32^{o}C in water tank from Okania New Layout, which may probably be attributed to relative humidity. This result agrees with previous reports of Idowu *et al.* (2013); Ayoade *et al.*,(2006) and Kamran *et al*., (2003) that temperatures in the tropics vary between 21^{o}C and 32^{o}C.The presence of considerable concentrations of different nutrients in the water tanks along with a relatively high temperature favors the growth of various microorganisms. Water temperature plays an important role in governing the growth of organisms, ultimately affecting the water quality (Pandey *et al.*, 2012).The pH of the water ranged between 6.03- 7.35, indicating that the water was near neutral and slightly alkaline range. This pH ranges is similar that reported by Antoine and Al-saadi (1982). Boyd and Lichtkoppler (1979) also reported that the pH range of 6.09 – 8.45 as being ideal for supporting aquatic life including fish. This result corroborates with the findings of Idowu *et al.*,(2013) and Kamran *et al*., (2003).The changes and significant differences in physicochemical values of the water tanks indicate different environmental conditions due to variations related to temperature, rainfall, etc. (Ayoade *et al.*, 2006, Oso and Fagbauro, 2008).

4. CONCLUSION

The results of the study have shown that the quality of water tanks from Rumuokwuta town varied significantly, and are o poors in terms of the physicochemical parameters and bacteriological content due to high total coliform and faecal coliform counts. There is therefore a greater risk of the occurrence of water-borne diseases such as cholera, gastroenteritis, salmonellosis and shigellosis among others. It is therefore proper that high level of treatment of these water tanks be carried out regularly in other to maintain a clean tank environment.

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