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Bacteriological Quality of Water Produced at the Kwanyaku Water Treatment Plant in the Agona District of the Central Region.

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ABSTRACT

The presence of pathogens in drinking water may result from source water contamination by human and animal activities, followed by improper or insufficient treatment. The study was conducted to assess the bacteriological quality of water produced at the Kwanyako Water Treatment Plant in the Central the Region of Ghana. Triplicate water samples of Raw and Final water were collected in sterile 500ml polypropylene bottles, and analysed for thermotolerant coliform (TTC) using the Most Probable Number (MPN) method to determine the bacteriological quality of water before and after treatment. The study was carried out for a period of 6 months (September, 2013 to February 2014). TTC was positive for all Raw water samples but negative for all Final water samples. This implied that, the water produced at the Treatment plant is efficiently treated and poses no health threat.

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1.0 Introduction

In the production of potable water, all water-borne organisms, especially water-borne pathogens are of concern. Pathogens are microorganisms that can cause disease in other organisms (Supply, & UNICEF, 2000; Hunter, Toro & Minnigh, 2010). Majority of these pathogens affect the gastro-intestinal tract and can be bacteria, viruses, protozoa and sometimes fungi. Viruses, bacteria and protozoa are the three principal groups of microorganisms that can be transmitted via drinking water (Engdaw, 2014). They are all transmitted by the faecal-oral route, and so largely arise either directly or indirectly by contamination of water resources (LeChevallier et al., 1996). Introduction of pathogens into the distribution system can rapidly lead to an infection of thousands of people since they may depend on the same source of water and become infected with an infected person.

Pathogens in drinking water may result from source water contamination by human and animal activities. Contamination by sewage or human excrement from septic tanks, open dumps, improper constriction latrines and surface impoundments are the most common sources and present the greatest danger to public health (Breach, 2011; Dufour & Bartram, 2012; Aidoo, 2013; Mansour-Rezaei, & Naser, 2013). Thus, regular examination of water for the presence of pathogenic organisms must be conducted to provide information on the level of contamination to ensure appropriate treatment.

The United States Environmental Protection Agency and WHO regulations (USEPA, 1999; WHO, 2011) require three main groups of indicator organisms to be used to monitor water quality. These comprise, *total coliform* (TC), *faecal* coliform (FC) or thermotolerant coliform (TTC), and *Enterococci.* Many of these pathogens are proficient in causing infections even when ingested in extremely small numbers (Skraber1 *et al*., 2005; WHO, 2011). The World Health Organization estimates that 80% of all illnesses in the world were attributable to insufficient water supplies or sanitation. Over 250 million new cases of waterborne diarrhoea are reported worldwide each year, which results in more than 10 million deaths. Hence, the presence of any of the above listed indicators in water makes it unsafe for drinking.

The major prevalent water quality problems in Ghana are those related to physical, chemical, as well as microbiological parameters, the possible causes of which are natural, anthropogenic or both. These problems are related to diseases such as cholera, typhoid, schistosomiasis, malaria, skin infection among others. However, modern microbiological techniques such as the MPN method have made possible the detection of these pathogenic bacteria in water for effective treatment in order to minimize if not totally prevent drinking water related illnesses (WHO, 2011; Abhineet, & Dohare, 2014).

1.1 Problem Statement

Microbial contamination is considered to be the most serious risk factor in drinking water quality because of the possible consequences of waterborne disease. Therefore, it is important to determine the microbiological safety of water before consumption. The ideal manner for doing this would be to analyse the water for the presence of specific pathogens of concern by the use of indicators (OECD/WHO, 2003). Frequent occurrences of high coliform counts signify the need for an alternative water source, or sanitary protection of the current sour.

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About 2.2 million people in developing countries including Ghana, most of them children, die every year from diseases associated with lack of safe drinking water, inadequate sanitation and poor hygiene. Diarrhoeal illness remains a major killer in children and it is estimated that 80% of all illnesses in developing countries are related to water and sanitation (Supply, & UNICEF, 2000). For this reason, more stringent method of analysis must be conducted on water to determine the presence of any disease causing organism.

Over the years the Ghanaian populace has raised a lot of concern about the quality of water produced and supplied by the Ghana Water Company Limited (GWCL). This study was to determine the bacteriological quality of water produced at the Kwanyaku Water Treatment Plant.

2.0 Methodology

The study used the experimental research design to determine the Bacteriological quality the water sampled. Pre-analytical activities included collection of all glassware and other materials, Media Preparation, Sterilisation and Storage.

Triplicate water samples were collected from Raw and Final water. The water samples were examined for the presence of TTC using the Most Probable Number (MPN) method. The method of sample collection at each source was according to the WHO Guidelines (WHO, 2011) for drinking water quality assessment. The One Way Analysis of Variance (ANOVA) was adopted for the analysis. Results were presented in a table and the means calculated. The methods are detailed below.

2.1 Bacteriological Analyses of Raw Water

Different test portions to provide tenfold serial dilution steps were used to analyse the raw water. The dilutions were based on the anticipated number of coliform bacteria in the water sample being tested. The following inoculations were made: 10ml sample each of five tubes containing 10 ml of double strength medium, 1.0 ml sample each of five tubes containing 10 ml of single strength medium and 0.1 ml sample each of five tubes containing 10 ml of single strength medium. The reliability of the result obtained depends on the number of tubes inoculated with each test portion. The process was as follows:

i. Three rows of five tubes each were arranged in a test-tube rack. The tubes in
the first row (F1) held 10 ml of double-strength presumptive medium while
the tubes in the second and third rows (F2, F3) contained 10 ml of single strength presumptive medium.

ii. With a sterile pipette, 10 ml of sample was added to each of the five tubes in row F1

iii. With a sterile 1ml pipette, 1 ml of sample was added to each of the five tubes in row F2.

iv. A 1:10 dilution of the sample was prepared by adding 1 ml of sample to 9 ml of dilution water (tryptone water), using a sterile 1 ml pipette. The diluted sample was shaken vigorously to ensure a thorough mixture.

v. With another sterile pipette 1ml of the 1:10 dilution was added to each of the five tubes in row F3.

vi. The tubes were shaken to mix the contents and to remove any gas collected in the inverted Durham tubes.

vii. The racks with the 15 tubes were incubated at 350C for 24 hours.

viii. Confirmatory test was conducted for all presumptive positive tubes as described for treated water below (Last three steps).

2.2 Bacteriological Analysis of Final Water

i. The capped bottle containing the sample was shaken vigorously to achieve a homogeneous dispersion of bacteria.

ii. With a sterile 10 ml pipette, the sample was inoculated into five tubes each containing 10 ml of MacConkey Broth of double strength

50 ml of sample was also added to 50 ml double strength MacConkey broth The tubes were shaken gently to distribute the sample uniformly throughout the medium and also to ensure that no gas was collected in the Durham tubes before incubation. The tubes were then incubated at a temperature of 35^{o}C for 24 hours.

iii. At the end of the 24- hour incubation period, each tube was examined for the presence of gas. Any tube with gas in the Durham tube was labeled presumptive positive. Tubes with no gas were shaken gently. Effervescence produced as a result of this also indicates a presumptive positive tube.

iv. All negative tubes were re-incubated for a further 24-hour period and the tubes checked again as above. The number of positive tubes at the end of both 24 and 48 hour periods were recorded.

v. A confirmatory test was conducted for all presumptive positive tubes by using a sterile loop to transfer one to two drops of sample from each presumptive positive tube into tubes containing Brilliant Green Lactose Bile (BGLB) Broth.

vi. The tubes were then incubated for 24 to 48 hours at 440C to confirm the presence of thermotolerant coliforms.

vii. At the end of the incubation period, the broth tubes were examined for the presence of gas in the Durham tube. Growth and gas in the tubes confirmed the presence of thermotolerant coliforms.

3.0 Results and Discussions

The Bacteriological analyses of the Raw water revealed a high MPN value for TTC with the highest values recorded in September, 2013 and January, 2014 (Table 1). The resulting mean gave coded results of 5, 4, 2 which implies that, the mean concentration of Thermotolerant Coliform (TTC) or Faecal Coliform (FC) per 100 ml is 220 (Table 1). This is above the WHO Guideline value of nil, an indication that the Raw water is polluted and unsafe for drinking.

Coded results of resulting means: 1ml = 5; 0.1ml = 4; 10ml =2

The coded results of the resulting means (5, 4, 2) meant that an average of 5 tubes, 4 tubes and 2 tubes recorded positive for all samples when a sample volume of 10ml, 1ml and 0.1ml respectively was inoculated into the test media. This resulting mean recorded, corresponded to a Thermotolerant Coliforms (TTC) value of 220 per 100ml of water. The high TTC values recorded (Table 1) for the whole sampling period for the Raw water, was an indication that the water before treatment was polluted with faecal coliform. The possible sources of the pollution could be drainage from farms, streets, rooftops, driveways, feedlots, compost piles. Water percolating from domestic wastewater, livestock manure and septic tanks (Breach, 2011; Ring, 2003) may contain viruses, bacteria and parasites and may contaminate water supplies. However, the result of all the bacteriological analyses conducted on the Final water was negative. This implied that the bacteriological treatment was effective in destroying all disease causing organisms in the water. Hence the water produced at the Kwanyako Water Treatment Plant was safe for consumption.

Table 1. Results of Bacteriological Analysis of Raw Water

SAMPLING PERIOD/ MONTH	SAMPLE VOLUME INNOCULATED (ml)	NO. OF POSITIVE TUBES IN CONFIRMATORY TEST AT 44^{O}C				MPN
		S1	S2	S3	MEAN	TTC
SEPTEMBER, 2013	10	5.00	5.00	5.00	5.00	540.00
	1	5.00	4.00	5.00	5.00	
	0.1	2.00	2.00	3.00	2.00	
OCTOBER, 2013	10	5.00	5.00	5.00	5.00	220.00
	1	4.00	5.00	4.00	4.00	
	0.1	2.00	2.00	1.00	2.00	
NOVEMBER, 2013	10	5.00	5.00	5.00	5.00	220.00
	1	4.00	5.00	3.00	4.00	
	0.1	2.00	2.00	1.00	2.00	
DECEMBER, 2013	10	5.00	5.00	5.00	5.00	170.00
	1	5.00	4.00	4.00	4.00	
	0.1	2.00	1.00	1.00	1.00	
JANUARY, 2014	10	5.00	5.00	5.00	5.00	920.00
	1	5.00	5.00	5.00	5.00	
	0.1	3.00	3.00	2.00	3.00	
FEBRUARY, 2014	10	5.00	5.00	5.00	5.00	220.00
	1	4.00	4.00	5.00	4.00	
	0.1	2.00	1.00	2.00	2.00	

Source: Filed data. Keys: S1- Sample1, S2- Sample2, S3- Sample3

4.0 Conclusion

The Results obtained from the bacteriological analyses of the water produced at the Kwanyaku Water Treatment Plant revealed that the water was efficiently treated since no faecal contamination was recorded in the Final water. The quality of water produced by the GWCL at the Kwanyaku Water Treatment Plant is within the acceptable limit of WHO with regards to bacteriological parameters and poses no health threat to consumers. However, the study should be replicated at all other treatment plants in the country and extended to determine the quality of treated water at consumer point.

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