Research Paper

MICROBIAL AND CHEMICAL ANALYSIS OF POTABLE WATER IN PUBLIC – WATER SUPPLY WITHIN LAGOS UNIVERSITY, OJO

O. A. Ojo*, S. B. Bakare and A. O. Babatunde

Department of Microbiology, Lagos University,
Badagry Expressway, P. M. B. 1087 APAPA, Lagos – Nigeria.
E-mail: solayom@yahoo.com

Abstract

Water samples were collected especially into sterile containers at four designated pints within the Lagos State University, Ojo Campus. The water samples were immediately subjected to both chemical and microbiological analysis in order to evaluate the quality of potable water in circulation within the university and identify its sources of contamination. Levels of iron, calcium and magnesium detectable in the circulating drinking water were far below the WHO recommended limits. However, more potentially dangerous discovery was the level of Coliform contamination which far exceeds the WHO standards. This explains the high incidence of water-borne diseases such as Dysentry, Diarrhea and Typhoid fever within the university population. Meanwhile, other micro-organisms detected were *E. coli, Pseudomonas aeruginosa, Staphylococcus aureus*, yeasts and moulds. The pH of potable water in circulation falls within recommended limits (6.0-8.0) but for faculty of arts and social sciences that had pH of 5.5 which suggested a high degree of public health concern. There is the need for adequate changes to be made at points where water distribution systems integrity appeared compromised. The university community is advised to boil water before drinking in order to avoid consumption of unwholesome biological agents in the water distribution networks.

Introduction

Water is one of the most important of all natural resources known on earth. It is important to all living organisms, most ecological systems, human health, food production and economic development (Postel et al., 1996). The safety of drinking water is an on going concern within the global village. Traditionally, the safety of potable water supplies has been controlled by disinfection, usually by chlorination and coliform population estimates. However, it has been reported that coliform-free potable water may not necessarily be free of pathogens (Sim et al., 1987).

Many congenital diseases such as goiter and cancer have been associated with presence of high concentration of a chemical or its inadequate supply in water. Opinya et al, (1987) reported that low or high level of fluoride ions concentration in water as the major cause of dental flurosis. Low concentration of iodine in *Homo sapiens* results in goiter. Infants have been considered as a potential high risk group to the toxic effects of sodium from drinking water (smith, 1974). Currently, about 20% of the world's population lacks access to safe drinking water, and more than 5 million people die annually from illness associated with safe drinking water or inadequate sanitation. If everyone had safe drinking water and adequate sanitation services, there would be 200milion fewer cases of diarrhea and 2.1 million fewer deaths caused by diarrhoeal illness each year (Hunter et al., 2001).

Biofilms in drinking water distribution system has generated health concerns. Biofilms are coating of organic and inorganic materials in pipes that can harbor, protect and allow the proliferation of several bacterial pathogens, including *Legionella* and *Mycobacterium avium* complex (MAC). Factors that affect bacterial growth on biofilms include water temperature, type of disinfectant and residual concentration, biodegradable organic carbon level, degree of pipe corrosion and

treatment/distribution system characteristics. Chloramines are considerably more effective than chlorine for controlling legionella in biofilms distribution system deficiencies linked to a number of water born disease outbreaks. (Hunter et al., 2001).

Amazingly, current drinking water standards don't even require testing for any of the more than 7,000 pharmaceutical compounds being prescribed; pharmaceutically active compounds such as analgesics, antibiotics, antileptics, anti-rheumatics, beta blockers, chemotherapeutics, steroid hormones and X-ray contrast media have been detected in tap water in Europe and Americas (Bob Masters, 2001).

The aim of this study was to evaluate the sanctity of potable water in circulation within Lagos State University, Ojo Campus and suggest safety measures to reduce the incidence of water – borne diseases.

Materials and Methods

The experiments were carried out at the laboratories of Lagos State Water Corporation (Iju Water Works) Lagos. The source of water was the four tap water sources in four Strategic Location within Lagos State University, Ojo Campus. Aseptically, tap water was collected in the morning into sterile 4-litre plastic container in the morning after the tap was allowed to run for 5 minutes. The 4-litre container were immediately covered tightly after collection of water samples and transported to the laboratory for chemical and microbiological analysis. This process was done separately on each occasion for the four selected sampling points in the four faculties. Nutrient agar, Baired – Parker agar, McConkey agar, Plate count agar, Potato dextrose agar (PDA), Pseudomonas agar base were used fro the isolation of micro-organisms.

Isolation of micro-organisms

Membrane filtration technique was used to isolate the microorganisms present in the water samples. The funnel of the membrane filtration unit has a capacity of 50ml and the funnel was mounted one receptacle fixed to the vacuum pump which allows the water to flow over the porous sterile membrane filter (0.45µm). Aseptically, the membrane filters were placed on each microbial growth medium using sterile forceps after passage of 100ml of water sample. The following media (Baired Parker agar, McConkey agar, Plate count agar, potato dextrose agar Pseudomonas agar base) were prepared and autoclaved at 121^0C for 15 minutes at 15Ib before being inoculated with membrane filters. (APHA, 1992; Anonymous, 1982).

Isolation of *Escherichia coli*

Water sample (100ml) was drawn and filtered with sterile membrane filter 0.45um. The filter membrane was then placed on McConkey agar aseptically. Then the plate was incubated at 45^0C for 22hrs (APHA 1992; Balogun, 2000).

Isolation of general coliforms

Water sample (500ml) was filtered with a separate sterile membrane filter (0.45µm). The membrane filter was then placed aseptically on McConkey agar and incubated at 37^0C for 24hrs. (APHA, 1992; Balogun, 2000).

Isolation of total bacteria

Water sample (100ml) was filtered with a sterile membrane filter (0.45/µm). It was then placed aseptically in an empty sterile Petri-dish by pour-plate method using plate count agar incubated at 37^0C for 24hrs (APHA, 1992: Balogun, 2000).

Isolation of pseudomonas aeruginosa

Water sample (100ml) was filtered with a sterile membrane filter (0.45/µm). It was then

placed aseptically on *Pseudomonas* agar base and incubated at 42^0C for 48hr (APHA, 1992: Balogun 2000).

Isolation of yeast and moulds

Water sample (100ml) was filtered with a sterile membrance filter (0.2/µm). The membrane filter was then placed aseptically on potato dextrose agar and incubated at 22^0C for 48hrs (APHA, 1992: Balogun, 2000).

Isolation of *Staphylococcus aureus*

Water sample (100ml) was filtered with a sterile membrane filter (0.45/µm). It was then placed aseptically on the Baired-parker agar and then incubated at 37^0c for 24hrs (APHA,1992: Balogun, 2000).

Chemical analysis
Alkalinity

Water sample (100ml) was placed in a conical flask and a drop of methylorange on it, This served as an indicator. The magnetic stirrer was then put in the conical flask with its content.   This was stirred magnetically while a burette was filled with N/50 HCL, and this was titrated against the water sample (100ml) in the conical flask (Balogun, 2000).

Acidity

Water Sample (100ml) was placed in a conical flask and a drop of phenolphthalein on it, This served as an indicator. The magnetic stirrer was then put in the conical flask with its content. This was stirred magnetically while a burette filled with N/50 NaOH was titrated against the water sample (100ml) in the conical flask. (Balogun, 2000).

Hardness
Total hardness

Water sample (100ml) was placed in a conical flask, two drops of erichrome-T which is an indicator was dropped into the water sample and a drop of buffer-9 (i.e amino chloride and amino sulphate) on the contents of the conical flask. A burette was also filled with N/50 Ethylditetra amine (EDTA.) and titrated against the water sample (100ml) in the conical flask.

Calcium hardeness

Water sample (100ml) was placed in a conical flask and two drops of murexide which is an indicator was dropped on the contents of the conical flask. Buffer–12 (NaOH) was added to the contents of the conical flask. A burette filled with N/50 EDTA was titrated against the water (100ml) in the conical flask (Balogun, 2000).

Magnesium hardness

Deduced by obtaining the difference between the values of total hardness and calcium hardness of each water sample (Balogun, 2000).

Spectrometric analysis of water samples

The concentration of chloride, iron, sulplate, copper, fluoride ions were detected using spectro-meteric analytic system. The TDS meter detected total dissolved solids. Turbidity was determined using the turbidimeter (Balogun, 2000).

Results and Discussion

High microbial counts in water are undesirable because of the increased likelihood that pathogens may be present, the possibility that these organisms will find access to foods and drink thereby causing spoilage and the adverse effects such organisms may have on pipelines and processing equipment. Biofilms may clog pipes and tubes and they are resistant to biocides and antibiotics which may cause food poisoning. Generally, the chemical quality of the water samples under study falls within the standards stipulated by World Health Organisation and Federal Environmental Protection Agency.

Table 1:   Mean number of microbial species detected in the water (per 100ml) distribution system

Micro-organisms	Science	Arts and Social Scheme	Amala Joint	Staff School	WHO (max. standard 1989)	Expression of Result
Escherichia coli	9	7	15	10	0	Number/100ml
General coliform	30	39	40	28	0	Number/100ml
Pseudomonas aeruginosa	15	14	35	38	1	Number/100ml
General bacteria	7	31	16	10	1	Nmber/20ml
Yeasts and moulds	13	11	24	11	No significant increase	Number/100ml
Staph. aereus	2	2	5	1	No significant increase	Number/100ml

Table 2: Mean value of selected chemical properties of water in the distribution

Parameter	Faculty of Science	Arts and Social Science	Amala Joint	Staff School	WHO (max. Standard 1989)	Expression of Result
Alkalinity	3.92	3.32	3.26	2.01	30	HC03 mg/l
pH	6.96	5.50	6.7	6.86	6.8-8.0	-
Total hardness	3.98	1.13	1.38	0.78	60.0	Ca mg/l
Acidity	1.23	0.87	0.61	0.84	-	-
Calcium	1.10	0.65	1.10	0.49	25	Ca mg/l
Magnesium	0.35	1.06	0.62	0.60	50	Mg mg/l
Conductivity	223	234	226	218	1500at20^{0}C	Us/cm
T.Ds	146	150	140	132	200	Mg/l
Chloride	12.5	13.7	11.4	12.4	0.4	Cl2mg/l
Sulplate	57	39	51	64	250	SO4 mg/l
Copper	0.04	0.1	0.1	0.1	5.0	Mg/l
Fluoride	0.1	0.1	0.1	0.1	1.5	Mg/l
Iron	0.34	0.55	0.14	0.26	0.2	Mg/l
Turbidity	1.5	2.5	2.5	2.5	<2.0	

(FEPA) standards (WHO 1984; 1989; APHA, 1992). High level of microbial contamination of water supply within LASU campus could be due to faculty distribution network as well as much body contact with the water. This suggests the reason for high prevalence of water-borne diseases such as

Typhoid fever, diarrhea, dysentery and few incidences of cholera on Ojo Campus (Table 1). Also, inadequate protection for the water source which leads to seepage from sewage lines and other waste disposal facilities into bore holes might be responsible. High coliform counts were the most common reason for the failure of potable water to meet acceptable standards (Le Chevallier et al 1996). Although, it may sometimes be necessary to seek specific pathogens in water in response to epidemiological investigation following outbreaks of water-borne diseases of biofilms formation.

Chemical analysis of water supplies was necessary to guarantee the quality, compliance with established quality criteria and efficiency of operation of water treatment plants and distribution systems. The pH of the water in circulation falls within WHO limits (Table 2) but for the water distribution in Arts and Social Science area which tends to be more acidic (5.5). it won't be a surprise to experience burning sensation while such water is tasted and this may affect the colour of textile materials washed with this water especially when it is done with detergents. The concentration of chloride ions detected in the water distributed was similar in all the four sampling points. Chlorine is an effective antimicrobial agent with the capacity to react destructively with the protein components of all types of organisms and even protecting the water from contamination during distribution. However, with LASU water distribution system the chlorination was ineffective and this was responsible for high coliform counts, high counts of *Escherichia coli* and high population of general bacteria detected in the water samples.

Excessive concentration of Fe^{3+} in circulation is objectionable for a number of reasons which includes; its precipitation as insoluble ferric hydroxide, which stains laundry and plumbing fixtures, Fe^{3+} also promotes growth of "Iron Bacteria" which deposits slimy coating in the pipes (Balogun, 2000).

Presently, public health standards consider water to be safe for human consumption when it contains a maximum of 500 colony forming units per milliliter (cfu/ml), when it is free of *E. coli* (less than 5cfu/100ml) and when its nephelomertic turbidity is less than 2 (WHO 1984; 1989 and APHA, 1992). However, the water in circulation in LASU campus fails to meet any of this internationally acceptable standards (Table 1 and 2). The water supply can be improved if faculty water distribution networks are properly replaced and maintained in order to reduce health hazards to University community.

Acknowledgement

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