

# Incidence Of Bacteria Of Public Health Importance In Drinking Water From Water Dispenser Systems In Homes And Offices In Lagos And Ibadan, Nigeria

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## Abstract

The isolation and characterization of bacteria in drinking water samples from 11 water dispenser machines was carried out. The water samples were obtained from five homes in Ibadan, Oyo state and eight offices in Victoria Island, Lagos state. Twenty-five bacteria were isolated. They include *Pseudomonas aeruginosa* (16%), *Pseudomonas fluorescens* (4%), *Chryseomonas luteola* (8%),

*Citrobacter freundii* (4%), *Enterobacter sp.* (8%), *Cedecea sp.* (4%), *Citrobacter sp.* (12%), *Salmonella sp.* (12%), *Chromobacter violaceum* (4%), *Providencia rettgeri* (8%), and *Escherichia coli* (16%). However, the water samples collected from the bottled water before being fixed on the dispenser machines showed no growth of any bacteria on the culture media. The mean values of the heterotrophic counts range between  $63 \times 10^{-2}$  cfu/ml and  $272 \times 10^{-2}$  cfu/ml. The mean values of the coliform counts range between  $26 \times 10^{-2}$  cfu/ml and  $162 \times 10^{-2}$  cfu/ml. The result of this work of has confirmed the presence of bacteria of public health importance in drinking water from water dispenser machines. Also, the result of the analysis of the water from the bottle before being fixed on the dispenser shows that the contamination of the water is from the dispenser machines.

## INTRODUCTION

Water of good quality is of basic importance to human physiology and man's continued existence depends very much on its availability (Lamikanra, 1999; FAO, 1997a and b). Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is palatable and safe for drinking (Tebutt, 1983). Potable water is defined as water that is free from diseases producing organisms and chemical substances deleterious to health (Ihekoronye and Ngody, 1985). The effects of drinking contaminated water results in thousands of deaths every day, mostly in children under five years in developing countries (WHO, 2004). In addition, diseases caused through consumption of contaminated water, and poor hygiene practices are the leading cause of death among children worldwide, after respiratory diseases (WHO, 2003). Thus lack of safe drinking water supply, basic sanitation and hygienic practices is associated with high morbidity and mortality from excreta related diseases. Diarrhea illness remains a major killer in children and it is estimated that 80% of all illness in developing countries is related to water

and sanitation; and that 15% of all child deaths under the age of 5 years in developing countries result from diarrhea diseases (WHO, 2000, 2004; Thompson and Khan, 2003).

There are many types of pollutants that can contaminate drinking water and cause illness and disease. Regardless of where drinking water comes from - a lake, a river, an underground aquifer, a well, a public water utility, and even bottled water - all can be contaminated by a number of impurities.

The pathogens most frequently transferred through water are those which cause infections of the intestinal tract (Pelczar et al., 2000). Most bacterial pathogens potentially transmitted by water infect the gastrointestinal tract and are excreted in the faeces of infected humans and other animals. However, there are also some waterborne bacterial pathogens, such as *Legionella*, *Burkholderia pseudomallei* and atypical *Mycobacteria* that can grow in water and soil.

## THE SAFETY OF BOTTLED DRINKING WATER

While the term bottled water is widely used, the term packaged water is perhaps more accurate. Water sold in

countries for consumption can come in cans, laminated boxes and even plastic bags. However, bottled water is most commonly sold in glass or disposable plastic bottles. Bottled water also comes in various sizes from single servings to large carboys holding up to 80 litres.

There has been a substantial increase, in recent years, in the use of water coolers and water dispensing machines in the workplace and even in some homes. Whilst these machines have a place, under certain circumstances, in providing suitable refreshment to people, their use is not without hazard and in many cases the perception of need for these machines is misguided. One of the main hazards associated with the use of bottled dispensers relates to the manual handling of the bottles themselves. The Health and Safety Executive and some Trades Unions have highlighted the number of over three-day absence injuries contributed to by the activity of bottle changing, this task often being left to the slightly built female secretary who has had no training in safe lifting techniques. The aims and objectives of this work are to ascertain the presence of bacteria of public health significance (enteric) from drinking water from water dispensers, to isolate and characterize the isolates and to recommend ways of improving the microbiological safety of the water dispenser systems.

## **MATERIALS AND METHODS**

### **COLLECTION OF SAMPLES**

The water samples were collected from five dispenser machines from homes in Ibadan, Oyo State and six dispenser machines from offices in Victoria Island, Lagos using sterile bottles. The samples were brought into the laboratory for analysis.

### **STERILIZATION OF APPARATUS AND CULTURE MEDIA.**

All glass wares used were thoroughly washed with detergent and rinsed with water. They were air dried, wrapped in aluminium foil and sterilized in hot air oven at 170°C for 2 hours.

All culture media used were prepared according to manufacturer's specification, homogenized and sterilized by autoclaving at 121 C for 15 minutes.

### **CULTURE MEDIA USED**

The culture media used for this research include Eosin Methylene Blue Agar, Plate Count Agar, MacConkey Agar, Salmonella Shigella Agar and Nutrient Agar.

### **TOTAL HETEROTROPHIC BACTERIAL COUNT**

Plate Count Agar (PCA) was prepared, homogenized and sterilized according to the manufacturer's specification. 1ml each serial dilution of the samples were placed in a sterile Petri dish. 15mls of the molten PCA was poured into the plate and swirled to mix with the sample. The mixtures were allowed to set and then incubated at 35°C for 48hours. Counting was done with Gallenkamp Colony Counter.

### **TOTAL COLIFORM COUNT**

MacConkey Agar (MCA) was prepared, homogenized and sterilized according to the manufacturer's specification. 1ml each serial dilution of the samples were placed in a sterile Petri dish. 15mls of the molten MCA was poured into the plate and swirled to mix with the sample. The mixtures were allowed to set and then incubated at 35°C for 48hours. Counting was done with Gallenkamp Colony Counter.

### **CHARACTERIZATION OF ISOLATES**

Characterization of isolates was carried out by

employing macroscopic, microscopic, physiological, and biochemical tests using API 20E Identification kit.

The API 20E kit is a standardized miniaturized version of conventional procedures for the identification of Enterobacteriaceae and other Gram negative rods. It is a microtube system designed for carrying out 21 standard biochemical tests on bacterial colonies isolated on plating media.

### **PRINCIPLE OF API 20E SYSTEM**

The API 20E strip consists of 20 microtubes containing dehydrated substrates. These tests are inoculated with a bacterial suspension that reconstitutes the media. During incubation, metabolism produces colour changes that are either spontaneous or revealed by the addition of reagents. The reactions are read according to the reading table and the identification is obtained by referring to the Analytical Profile Index or using the identification software.

The table below shows the 20 tests and the reactions involved in each test.

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**Figure 1**

Table 1: Various tests and Reaction involved in API-20E Kit.

Tests	Active ingredients	Reactions/enzymes
1 ONPG	2-nitrophenyl-bD-galactopyranoside	b-galactosidase
2 ADH	L-arginine	Arginine DiHydrolase
3 LDC	L-lysine	Lysine Decarboxylase
4 ODC	L-ornithine	Ornithine Decarboxylase
5 CIT	Trisodium citrate	Citrate utilization
6 H2S	Sodium thiosulphate	H2S production
7 URE	Urea	Urease
8 TDA	L-tryptophane	Tryptophane deaminase
9 IND	L-tryptophane	Indole production
10 VP	Sodium pyruvate	Acetoin production (Voges Proskauer)
11 GEL	Gelatine	Gelatinase
12 GLU	D-glucose	Fermentation/oxidation (Glucose)
13 MAN	D-mannitol	Fermentation/oxidation (Mannitol)
14 INO	Inositol	Fermentation/oxidation (Inositol)
15 SOR	D-sorbitol	Fermentation/oxidation (sorbitol)
16 RHA	L-rhamnose	Fermentation/oxidation (rhamnose)
17 SAC	D-sucrose	Fermentation/oxidation (saccharose)
18 MEL	D-melibiose	Fermentation/oxidation (melibiose)
19 AMY	Amygladin	Fermentation/oxidation (Amygladin)
20 ARA	L-arabinose	Fermentation/oxidation (arabinose)

## INTERPRETATION OF RESULTS

Identification was carried out with the use of numerical profile. The numerical profile for each test isolate was looked up in the Analytical Profile Index supplied by the Kit manufacturer.

## RESULTS

The water samples collected from the bottled water before being fixed on the dispenser machines showed no growth of any bacteria on the culture media. The results of the analysis of the water samples collected from the dispenser outlets are discussed below.

The total heterotrophic bacterial count on Plate Count Agar and the coliform bacterial count on MacConkey Agar is shown in Table 2. The mean values of the heterotrophic counts range between  $63 \times 10^{-2}$  cfu/ml and  $272 \times 10^{-2}$  cfu/ml. The mean values of the coliform counts range between  $26 \times 10^{-2}$  cfu/ml and  $162 \times 10^{-2}$  cfu/ml.

A total of 25 bacteria were isolated from the water samples collected from a total of 11 dispenser machines in Lagos and Ibadan. These include the following; *Pseudomonas aeruginosa*, *Pseudomonas fluorescens*, *Chryseomonas luteola*, *Citrobacter freundii*, *Enterobacter sp.*, *Cedecea sp.*, *Citrobacter sp.*, *Salmonella sp.*, *Chromobacter violaceum*, *Providencia rettgeri*, and *Escherichia coli*. Table 3 shows the frequency of occurrence of the isolates. *Pseudomonas aeruginosa* and *Escherichia coli* had the highest frequency of occurrence of 16 %

**Figure 2**

TABLE 2: TOTAL HETEROTROPHIC COUNT ON PLATE COUNT AGAR

SAMPLES	COUNT ON PCA (cfu/ml)		COLIFORM COUNT ON MCA (cfu/ml)	
	$10^0$	$10^2$	$10^0$	$10^2$
3E1	120	20	56	11
6E2	201	34	42	8
2E2	163	27	45	9
3E2	270	45	126	25
2M2	140	23	58	12
1E4	134	22	92	18
5M1	230	38	83	17
5E1	96	16	34	7
1M2	74	12	43	9
2E3	68	11	37	7
4M2	146	24	38	8
6E4	264	44	56	11
5P1	273	46	106	21
4E4	70	12	32	6
6P2	128	21	28	6
11E	96	16	32	6
4M3	84	14	28	6
6P4	106	18	29	6
8E	207	35	34	7
7P1	214	36	46	9
9P	226	38	33	7
10E	138	23	56	11
1E3	246	41	87	17
7E2	248	41	86	17
4P1	63	11	40	8

**Figure 3**

TABLE 3: FREQUENCY OF OCCURRENCE OF ISOLATES

ISOLATE	NO OF ISOLATES	FREQUENCY OF OCCURRENCE (%)
<i>Pseudomonas aeruginosa</i>	4	16
<i>Pseudomonas fluorescens</i>	1	4
<i>ryseomonas luteola</i>	2	8
<i>Citrobacter freundii</i>	1	4
<i>Enterobacter sp.</i>	3	12
<i>Cedecea sp.</i>	1	4
<i>Citrobacter sp.</i>	3	12
<i>Salmonella sp.</i>	3	12
<i>Chromo. Violaceum</i>	1	4
<i>Providencia rettgeri</i>	2	8
<i>Escherichia coli</i>	4	16

### DISCUSSION AND CONCLUSION

Determining the bacterial quality of drinking water is the single most important water quality test, because one glass of water containing just a few disease initiating organisms can cause illness. When minimal exposure creates an immediate health risk, that factor is known as an acute health risk. In contrast, a meaningful health risk from chemical contaminants such as arsenic, radon, or benzene, to name only a few, requires a long period of exposure, typically over many years.

The total coliform test is the basic yardstick for determining a water supply's biological quality. This test is performed

frequently because of the risk that disease causing organisms pose to health.

The public health effects of some of the coliforms isolated from the drinking water in this work are discussed as follows.

The result of this work showed that contamination of the drinking water is from the dispenser machine and not from the source of the water, therefore it is suggested that a maintenance agreement is entered into with the supplier of the equipment that will includes regular thorough cleaning of the internal and external components of the dispensers. Also, proper personal hygiene should be maintained by people using water dispenser machines like washing of hands after toilet breaks before handling and refilling of the dispenser water.

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