

Chemical and microbial evaluation of water samples obtained from itinerant water vendors in Idi – Araba, Lagos State, Nigeria

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Abstract

This study was carried out to investigate the potability of vendor waters mostly used by the urban dwellers in Idi-Araba, Lagos State, Nigeria. Sixteen water samples were analyzed, eleven from water vendors and four from source (Pumped Wells). One water sample from Nigerian bottling company was used as a control standard. Chemical analysis of the various water samples showed that they contained little and insignificant amount of toxic metals such as cadmium, nickel, lead and silver. Microbiological studies showed that vendor water was more contaminated than the source water and the contamination involved indicator and pathogenic organisms. All the organisms found in source water and more were found in vendor water. Susceptibility studies showed that of all the antibiotics used, the quinolones (Ofloxacin and Ciprofloxacin) and also aminoglycoside (Gentamycin) were the most effective antibiotics against the isolated microorganisms while Cloxacillin was the least active. The results of this investigation therefore suggests that the use of vendor and source waters in Idi-Araba appear unsafe for human consumption and domestic use. There is therefore the need for government and relevant authorities/organizations to provide potable water, stage awareness campaign and mass education on hygienic principles amongst the inhabitants of Surulere and the water vendors in particular.

Keywords: Microorganisms; Bacteria; Fungi; Itinerant; Contamination; *E. coli*

1. Introduction

Access to water is a basic human right [1] and water for human consumption must be free from all objectionable odor, turbidity, taste, enteric pathogenic bacteria or their indicators and must not fluctuate in its quality [2]. These days in the cities, water is circulated through piped systems [3]. The most convenient water supply, which is standard for all urban dwellers in wealthy countries, is water piped into the homes from a reliable piped-water network. A piped connection to the yard, however, can also constitute a fairly convenient service and may, as long as the water is forthcoming, support good hygiene practices and, given adequate drainage, safe water environments, In-house or yard connections are estimated to reach some 43 per cent of the urban population in Africa [4]. Water vending, an informal alternative access to urban water is therefore a symptom of failure in the piped system [5]. Poor governance is an increasingly popular explanation for bad water management and rapid urban growth exacerbates the problem [6]. Indeed, many piped systems in developing countries have not only had problems in matching population growth and urban sprawl, but are also having problems with the maintenance and operations of existing distribution networks,

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hence, vendors often perform a parallel service [7]. In response to the limitations of water supply, 44% of households have their own private Wells, and many rely on water vendors whose high prices amount to more than 30 percent of household income for the poor. As a result, a large proportion of poor households resort to drawing water from unhygienic source [8]. The general shortage of water supply that is a result of this low capacity utilization is then met by privately operated tankers, porters and privately owned boreholes and wells. This in turn has its own issues with regards to water purity standards, higher delivery costs and the ultimate impact on the state's water levels from the improper tapping of ground water reserves and wastage in its collection and delivery [9]. The safety of a privately-owned, individual water supply, such as a back-yard well, rests in the hands of its owner [10]. It is estimated that water, sanitation and hygiene are responsible for 4.0% of all deaths and 5.7% of the total disease burden occurring worldwide. [10, 11]. Women bear a disproportionate share of the inconvenience, while infants and small children bear a greater burden of disease [11, 12].

Lagos is a state surrounded by water and it can be assumed that the problem of water should not be faced. In practice however, reliable supply of potable water to many parts of the city is a big problem. This is because the lagoon is large and of course the ocean is salty [13]. It is infact difficult to find a reliable supply of river water in Lagos to purify which is why water from Ogun River (Iju) is the major source of water for purification for consumption in Lagos [14]. After purification, there is still the major problem of distribution and this explains why the supply of treated pipe-borne water in Lagos, is erratic with acute shortage experienced mostly in the dry months [15]. Ageing supply lines, water works and poor public electricity hamper the services of the water corporation, hence the corporation is operating at only 48% capacity, or only 36% of water demand. Only about 4million of the 15million population have access to piped water [8, 16]. A study in 2002 estimated that water, sanitation and hygiene were responsible for 4.0% of all deaths and 5.7% of the total disease burden occurring worldwide [17, 18]. Diarrheal disease alone causes 2.2 million of the 3.4 million water-related deaths per year [19], ranking third among all causes of infectious disease deaths worldwide. Idi-Araba is a community in Lagos Mainland situated within Mushin and Surulere. In rainy seasons, there is so much water everywhere with little or none potable. In dry season, there is little or no water at all, thus water is a very good private commercial business in this area. Vendors sell water in buckets, Jerry-cans, Sachets "pure" etc.

2. Material and methods

2.1. Collection of water samples

A total of sixteen water samples were collected aseptically between January and March 2019 from Idi-Araba in Mushin Local Government Area, Lagos State. Out of the sixteen water samples, eleven were collected directly from the itinerant water vendors (from their water Jerricans) while four of the samples were collected directly from the source (Pumped wells). One sample used as a control standard was collected from representative of the Nigerian Bottling Company (NBC), using a sterile 500cm³ sampling bottle. Separate similar containers were used for samples meant for physicochemical analysis. The collected water samples were stored at 4°C in the Department of Pharmaceutical Microbiology and Biotechnology Laboratory, Faculty of Pharmacy, College of Medicine Campus, Idi-Araba, University of Lagos for analysis.

2.2. Sterilization of materials

The materials (Sampling bottles, Agar and Broth media) used in this study were sterilized by autoclaving at 121°C for 15 minutes. The mouth of the Jerrican were flamed with automatic lighter for 30 seconds and water quickly poured from the Jerrican into the sterile bottle without allowing the Jerrican to touch the bottle before, during and after the water transfer. During collection of water from pumped wells, the taps were flamed for 30 seconds, water allowed to run for five minutes and sterile bottles were opened, the mouth flamed and water quickly collected from the already running tap. The mouth of the bottle and cover were flamed and closed immediately for analysis.

2.3. Chemical evaluation of the water samples

This was carried out in the Department of Chemistry Laboratory, Faculty of Science, University of Lagos, Akoka, Lagos. The water samples were digested to remove the organic materials and convert the metals present in the water into soluble forms [20]. To achieve this, 10mls of each of the water samples were measured into a 250ml conical flask and 1ml of nitric acid added into each of the flasks. This was then evaporated on a hot plate in a fume cupboard until the brown fumes disappeared. Each solution was made up to 20mls and filtered into a plastic bottle ready for Atomic Absorption Spectrophotometer (AAS) analysis using the Perkin Elmer Analyst 200.

2.4. Isolation and characterization of micro-organisms

A 10⁻² dilution of each water sample was cultured into nutrient agar and Sabouraud dextrose agar plates. The nutrient agar plates were incubated at 37°C for 24 hours while the Sabouraud dextrose agar plates were incubated at 25°C for 72 hours. The organisms obtained from Nutrient agar plates were subcultured into various diagnostic media -Tryptone Soy Agar (TSA), Salmonella-Shigella Agar (SSA), Eosin Methylene Blue Agar (EMBA), MacConkey Agar (MAC), and Manitol Salt Agar (MSA) for further characterization and identification of pure isolates using the NCCLS, 2003 method. The fungal organisms isolated from Sabouraud Dextrose Agar were further identified using their morphological characteristics.

2.5. Antibiotic susceptibility of the organisms isolated from water samples

The antibiotic sensitivity pattern of the microorganisms isolated from the water samples was determined using the NCCLS (2003) disk diffusion method [21]. Each of the test organisms, 10³cfu was plated in TSA and incubated at 37°C for 24 hrs. Colonies from each organism was emulsified in normal saline to match the turbidity of 0.5% Mcfalan standard solution. Each suspension was then incubated at 37°C for 4hrs and 1 ml of 1X10⁶ cfu of each of the organisms was seeded into Mueller Hinton Agar prepared according to manufacturer's instruction. Antibiotic multi discs from Oxoid Biological Ltd were placed on the solidified Mueller Hinton Agar culture. The plates were incubated at 37°C for 24hrs after which they were examined and zones of inhibition recorded.

2.6. Statistical analysis

The Student's t-test was used to determine the statistical significant difference which was regarded as significant when P < 0.05. Every data was expressed as mean ± standard deviation of the mean.

3. Results and discussion

Out of the 16 water samples examined (vendor and source), 13 were contaminated with different micro-organisms as shown in table 1.

Table 1 Organisms isolated from water samples (1-16)

Samples	Organisms
1	<i>E. coli</i>
2	<i>E. faecalis, Chromobacter</i>
3	<i>E. faecalis P. aeruginosa,</i>
4	<i>E. faecalis</i>
5	<i>Salmonella</i>
6	<i>Shigella</i>
7	<i>Shigella</i>
8	<i>B. subtilis</i>
9	<i>B.subtilis</i>
10	<i>E.coli</i>
11	<i>E. faecalis</i>
12	-
13	-
14	<i>E. faecalis</i>
15	<i>Bacillus, E.coli</i>
16	-

1-11=water samples from vendors; 13-16=water samples from source
12=control standard from Nigerian bottling company; - = No organism found

The heavy metals were found in traces as shown in table 2 and Nickel was found present in all the water samples. The analysis showed that vendor waters were more contaminated than the source waters since all the organisms found in source waters were replicated in vendor waters and more even in higher microbial load concentrations as is observed

in the microbial limit test in table 3. This could be an indication of unhygienic practices of collecting, storing and distributing water from the vendors. This suggests that continuous use of such waters (vendor and source) untreated exposes people to the risk of diseases such as bacillary dysentery typhoid fever, urinary tract infections bronchial pneumonia etc. The antibiotic sensitivity pattern of bacterial isolates is shown in table 4. The organisms were found to be most sensitive to fluoroquinolones (Ofloxacin and Ciprofloxacin) and Gentamycin. aminoglycoside. Cloxacillin was the least effective as it showed mild sensitivity only to Salmonella. The high microbial load recorded from the waters is an indication of the presence of high organic matters and the dissolved salts in the waters which are usually a common feature for naturally untreated water [22]. The presence of E. coli also indicates fresh fecal contamination [23, 24] which renders the water unacceptable for human consumption and domestic use [25, 26].

Table 2 Concentration of heavy metals in the water samples

Water Sample	Cadmium (ppm)	Lead (ppm)	Nickel (ppm)	Silver (ppm)
1	0.017	-	0.046	-
2	0.02	-	0.048	0.081
3	-	-	0.048	0.051
4	-	-	0.041	0.163
5	-	-	0.035	0.006
6	-	-	0.04	-
7	-	-	0.005	0.006
8	0.052	-	0.035	0.034
9	-	-	0.056	0.045
10	-	-	0.057	0.034
11	-	0.045	0.045	0.045
12	-	-	0.067	0.002
13	-	-	0.038	0.027
14	-	-	0.076	0.014
15	-	0.005	0.045	0.012
16	-	-	0.076	0.032

-- None

Table 3 Microbial limit test

Samples	Dilution	No of Colonies	Actual No of Colonies (Cfu/ml)
1	1:100	-	-
	1:10	2	2×10^2
2	1:100	3	3×10^2
	1:10	168	1.68×10^2
3	1:100	2	2×10^2
	1:10	TNTC	
4	1:100	1	1×10^2
	1:10	TNTC	
5	1:100	No growth	-
	1:10	1	1×10^2

6	1:100	1	1×10^2
	1:10	1	1×10^2
7	1:100	39	3.9×10^2
	1:10	26	2.6×10^2
8	1:100	19	1.9×10^2
	1:10	60	6.0×10^2
9	1:100	4	4×10^2
	1:10	41	4.1×10^2
10	1:100	No growth	No growth
	1:10	120	1.2×10^2
11	1:100	10	1.0×10^2
	1:10	126	1.26×10^2
13	1:100	No growth	No growth
	1:10	No growth	No growth
14	1:100	5	5×10^2
	1:10	12	1.2×10^2
15	1:100	20	2.0×10^2
	1:10	35	3.5×10^2
16	1:100	No growth	No growth

= None, TNTC = too numerous to count

Table 4 Antibiotic susceptibility result of organisms isolated from water samples

Water sample	Organism	Ery	Amx	Cot	Gen	Aug	Tet	Cip	Lev	Cxc	Chl	Nit	Nal	Ofl
1	<i>E.coli</i>	-	-	-	-	-	-	18	-	-	-	15	-	10
2	<i>E. faecalis</i>	10	-	-	14	-	-	21	-	-	-	-	-	15
	<i>Chromobacter</i>	-	-	20	15	-	-	20	-	-	-	-	20	-
3	<i>E. faecalis</i>	-	-	-	10	-	-	-	15	-	28	-	-	-
	<i>P. aeruginosa</i>	-	-	15	-	-	-	25	-	-	-	-	-	25
4	<i>E. faecalis</i>	10	-	-	22	-	-	20	-	-	-	7	10	13
5	<i>Salmonella</i>	-	17	-	-	25	-	30	18	15	-	-	-	24
6	<i>Shigella</i>	-	15	-	18	22	-	25	20	-	18	-	-	24
7	<i>Shigella</i>	-	13	-	-	22	-	24	18	-	-	-	-	20
8	<i>B. subtilis</i>	-	-	-	20	-	17	19	-	-	-	17	-	12
9	<i>B.subtilis</i>	-	-	-	-	20	-	22	-	-	-	18	-	12
10	<i>E.coli</i>	-	-	20	15	-	-	20	-	-	15	-	20	-
11	<i>E. faecalis</i>	8	-	-	10	-	-	18	15	-	-	-	-	-

	<i>E.coli</i>	-	-	-	-	19	-	18	-	-	-	15	10	10
12	None													
13	None													
14	<i>E. faecalis</i>		-	-	22	-	-	20	-	-	17	7	10	13
15	<i>Salmonella</i>	-	18	-	-	23		25	14		-	-	-	27
	<i>E.coli</i>													
16	None													

Keys: Amoxicillin=Amx, Cotrimoxazole = Cot, Nitrofurantoin = Nit, Gentamicin = Gen, Nalidixicacid = Nal, Ofloxacin = Of, Augmentin = Aug
Tetracycline = Tet, Erythromycin = Ery, Amoxicillin = Amx, Cotrimoxazole = Cot, Gentamicin = Gen, Augmentin = Aug, Ciprofloxacin = Cip,
Levofloxacin = Lev) Cloxacillin = Cxc, Chloramphenicol = Chl.

4. Conclusion

From the result obtained, it therefore appears unsafe using water obtained from itinerant vendors or water obtained from such wells as stated above without treatment because of microbial and chemical contamination. The people that have no choice but rely on such means of water supply should be educated on the need to employ various disinfection techniques which include boiling, Filtration, chlorination, using disinfectants/antiseptics etc. There is also the need for relevant authorities to provide potable water, stage awareness campaign and mass education on hygienic principles amongst the inhabitants of Surulere and the water vendors in particular.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest

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