Microbial Quality of Water supplies in Maiduguri Metropolis, North Eastern Nigeria

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Abstract: The bacteriological quality of water supplies from different sites and sources in some parts of Maiduguri Metropolis was carried out. To examine the sanitary indicator bacteria for the different sites of water sources and water storage reservoirs, eight water samples were collected from different sources during the period September, 2012 – September, 2013 in a sequence of two samples per month for each source. Samples were transported to Microbiology Laboratory within six hours of collection and then processed accordingly. Most probable number of coliform technique was used to determine the total coliform. The results showed that extremely high levels of total coliform were detected at each sample location. Consequently, the total bacterial counts for all samples gave positive results in the eight examined sources. The results suggest faecal pollution of the water sources, and imply that these water sources pose a serious health risk to consumers. The physico-chemical properties of drinking water from eight different sources revealed that all the water was colourless, odourless, tasteless and free of particles. The pH values from 6.6-6.9 were slightly acidic and 7.0-7.1 was neutral to slightly alkaline. The lowest value was obtained from Mosque Tap (pH = 6.6), while the highest was linked to NEW GRA and Ramat Polytechnic (pH = 7.1). The deterioration of water may be due either to regrowth of bacteria in the water supply systems or during storage in reservoirs, where water is often handled hygienically.
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1.0 Introduction

Water makes life possible on earth for all living organisms. It is next to air in importance for human existence. The provision of an adequate supply of safe drinking water was one of the eight components of primary health care identified by the international conference on primary health care in 1978 Dufour, *et al*.,(2002). The importance of water to life on earth particularly human becomes clearer when its role or usefulness is considered in various aspects of human endeavour. Even though a lot of resources are being spent for the supply of clean and potable drinking water all over the world, achievement of this aim is still facing serious plight in Nigeria.

The rural population, which constitutes 80% of the country's population most of the year used untreated water directly from sources such as traditional surface wells, rivers, intermittent rainy season stream, natural rain bonds and artificial rainwater catchments reservoirs (Abdelmagid *et a*l., 1984). Many common diseases and widespread health risks of biological origin has been found to be associated with drinking water in developing countries.

The contamination of drinking water with biological substances constitute a huge problem to public health particularly in developing contries. About 1.1 billion people globally drink unsafe water and most diarrhoeal disease in the world (88%) is attributable to unsafe water, sanitation and hygiene (Ashbolt, 2004).

The problem of supplying adequate quantity and quality of drinking water remains a major public health need in many African countries, where diarrhea disease continues to cause extensive morbidity and mortality. It has been reported that the death of most African children under the age of five years is caused by inadequate and insecure water supply (Loucks, 1994)). Risky water, poor sanitation and hygiene have been reported to rank third among the 20 leading risk factors for health burden in developing countries, including Sudan (WHO, 2003).

Wide variety of microorganisms pathogenic to human beings are transmitted through contaminated water (Idakwo and Abu 2004). According to (WHO, 1982) some 300,000 people die every day from water related diseases like typhoid and paratyphoid fevers, cholera, bacillary dysentery and gastroenteritis. The objective of this study was to assess the bacteriological quality of drinking water sources, in order to substantiate the nation's effort to ensure the provision of safe drinking water to Maiduguri metropolis and to recommend some possible measures of ensuring its portability.

2.0 Materials And Methods

2.1 Sampling Sites

A survey was conducted on water supply source to Maiduguri metropolis main public reservoir (Public Dam) and Maiduguri Water Treatment Plant (Tap Water). Emphases were made to places that served as commercial and/or public water sources, and these places were identified. Site where hawkers collected water in jerry cans before selling to the public, were chosen for the sampling. The sites were; Ngomari wards, Custom area, Ramat Polytechnic, Mairi village and New GRA.

2.2 Sample Collection

Sample collections were carried out in two forms. One from the main source (reservoir) and the other directly from the jerry cans of the hawkers at the point of delivery to households. This was repeated four times a month on weekly basis. For each sampling sites, samples were collected in a sterile 500 mL bottle (Cheesebrough, 2000) in each case. All samples were transported to the Microbiology laboratory, University of Maiduguri and then stored at 4^0C until required.

2.3 Test for odour and colour

A 20 mL volume of each water sample was poured into a clean beaker. The beaker was then shaken vigorously to check for any frothing and allowed to settle. The beaker was then observed under bright light for the presence of any particulate matter and then brought close to the nose to test for any odour present (Yakassai, 2009).

2.4 Test for taste

Small volumes of each sample was tasted with the tongue and then immediately rinsed with taste free distilled water after each sample. The results were recorded accordingly.

2.5 Test for pH

A 40 mL volume of each sample was poured into a beaker; the beaker was placed on the stage of the pH m. The pH m rod was inserted into the beaker containing the sample, the machine was switched on and the reading was taken and then recorded.

2.6 Detection and Enumeration of Coliforms

This was carried out according to the method described by (Harold and (Benson 1998). Each sample was inoculated into 3 sets of tubes as follows: First, l0 ml into a tube containing 40 m1 of lactose broth, usually designated as double strength lactose broth (DSLB) with Durham tubes, then 1.0 ml of the 20 m1 of lactose broth, usually designated as single strength lactose broth (SSLB) with durham tubes, and then 0.l ml inoculated into three tubes each containing 20 m1 of lactose broth, usually designated as single strength lactose broth (SSLB) with durham tubes. The tubes were incubated at 35^0C for 24-48 hrs. Following incubation, tubes showing gas production were counted and compared with MPN table adapted from APHA (APHA,1998) for the determination of most probable number (MPN) of coliforms per 100 ml of water. A loopful of broth from gas positive tubes was seeded on to eosin methylene blue (EMB, Antec UK) agar plate and incubated at 35^0C for 24 hours. The plates were observed after 24 hours for the presence of bluish black colonies with greenish metallic sheen which confirmed the presence of *Escherichia coli* (*E. coli*).

2.7 Standard plate count

This was carried out according to (FAO, 1979). In this method; 1 ml of sample was transferred into a test tube containing 9.0 ml of sterile distilled water and the tube labeled 1: 10. From this tube 1.0ml was transferred after agitation into another tube containing 9.0 ml of sterile distilled water and labeled 1: 100. This was also agitated and the procedure was repeated up to 1: 1000. Using sterile pipette 1.0 ml of inoculum was transferred from dilution tubes into appropriately labeled duplicate Petri dishes. This was followed by pouring a cooled molten nutrient agar (Oxoid). The dishes were gently rocked, allowed to solidify and incubated at 37^0C for 24 hours. After 24 hours incubation, plates containing 30-300 colonies were counted and the number obtained multiplied by the reciprocal of the dilution factor to get the actual number of organisms. The results were finally expressed in colony forming unit per ml (cfu/ml) of the sample.

2.8 Biochemical characterization of *E. coli*

2.8.1 ndole test

Three loopfuls of the material from colonies formed were inoculated into a bijou bottle containing 3 ml of sterile peptone water and incubated at 37^0C for 48 hours. This was followed by the addition of 0.5 ml of Kovac's reagent (Cheesebrough, (2000)).

2.8.2 Methyl red test

Tube of methyl red - Voges Proskauer (MRVP) broth was inoculated with three loopfuls from the suspected colony of *E. coli*_and incubated at 37^0C for 3 days. This was followed by the addition of few drops of methyl red indicator (Cheesebrough, 2000).

3. Result

The physico-chemical properties of drinking water obtained from eight different sources revealed that all the water sampled was colourless, odourless, tasteless and free of particles. (Table I). The pH values recorded for those from 6.6-6.9 were slightly acidic and from 7.0-7.1 were neutral to slightly alkaline. The lowest value was obtained from Mosque Tap (pH = 6.6), while the highest was associated with sources of water in NEW GRA and Ramat Polytechnic (pH = 7.1).

The mean counts of the bacterial load from different water sources; Custom area, Ramat Polytechnic, Mairi Village, New GRA, Ngomari and School of Nursing were presented. The highest mean mesophilic count cfu/ml for water source from Custom area was 3.00 x 10^5 and the lowest was from Mairi village (2.00 x 10^2). Higher values for water in Jerry cans (3.30 x 10^4), treated (2.00 x 10^4) and untreated (3.2 x 10^5), were all found in association with sample sources obtained in Custom area. Lowest mesophilic count cfu/ml of 3.10 x 10^2 for Jerry cans was linked to Ngomari, while 2.81 x 10^2 and 2.90 x 10^2 for treated and untreated were connected to water sources from School of Nursing (Table II).

Ngomari wards, Custom area, Ramat Polytechnic, Mairi village and New GRA obtain their drinking water from treated sources. Seventy percent (70 %) of these supplies had bacterial count of 1.0 cfu/ml and about 30 % had bacterial count of = 10^3 cfu/ml. The MPN values range from 21-121 per 100 ml with the lowest value at Custom area water source (Table III). This corresponds to the lowest mesophilic count where *E. coli* was detected in 80 % of the samples.

Table I: The physico-chemical properties of drinking water obtained at different sources

Source	Colour	Odour	Taste	Presence of particles	pH
MT	Colourless	Odourless	Tasteless	None	6.6
CA	Colourless	Odourless	Tasteless	None	6.8
NEW GRA	Colourless	Odourless	Tasteless	None	7.1
CAA	Colourless	Odourless	Tasteless	None	7.0
MMC	Colourless	Odourless	Tasteless	None	6.7
MV	Colourless	Odourless	Tasteless	None	6.7
VTH	Colourless	Odourless	Tasteless	None	6.9
RP	Colourless	Odourless	Tasteless	None	7.1

Key:
MT = Mosque Tap CA = College of Agriculture CAA = Custom Area MMC = Maiduguri Metropolitan Council MV = Mairi Village VTH =Veterinary Teaching Hospital RP = Ramat Polytechnic

Table 2: Mean count of the bacterial load obtained from different water sources

Sample Source	Mean Mesophilic count Cfu/ml			
	Water source	Jerry cans	Treated	Untreated
Custom area	3.00 x 10^5	3.30 x 10^4	2.00 x 10^4	3.2 x 10^5
Ramat Polytechnic	2.92 x 10^3	3.23 x 10^3	2.10 x 10^3	3.1 x 10^4
Mairi Village	2.00 x 10^2	3.25 x 10^4	2.0 x 10^2	3.1 x 10^3
New GRA	2.22 x 10^3	3.12 x 10^2	2.1 x 10^3	3.2 x 10^3
Ngomari	3.11 x 10^2	3.10 x 10^2	2.91 x 10^2	3.20 x 10^2
School of Nursing	2.90 x 10^2	2.99 x 10^3	2.81 x 10^2	2.90 x 10^2

Table 3: Most probable number of coliforms present in water samples

Sample Source	Number of gas positive tubes			MPN Index Per 100 ml
	2 0f 10 ml each	3 of 1 ml each	3 of 0.1 ml each	
MT	3	1	1	43
CA	3	1	0	120
NEW GRA	2	2	1	43
CAA	3	1	1	75
MMC	2	2	1	28
MV	2	2	1	39
VTH	2	2	0	21
RP	3	0	1	39

Key:
MT = Mosque Tap CA = College of Agriculture CAA = Custom Area MMC = Maiduguri Metropolitan Council MV = Mairi Village VTH =Veterinary Teaching Hospital RP = Ramat Polytechnic

4. Discussion

The physico-chemical properties of the various sources of water as shown in Table I indicates that all sample werter were colourless, odourless, tasteless and are devoid of presence of any particles in them with pH range of 6.5-7.2, which is within the standard limit of 6.5-8.5 as stipulated by (WHO, 1997) as criteria for drinking water. This also conforms to the pH range reported by other authors (Okonko, *et al* 2008). According to (Mead *et al* 1999), the PH of most natural waters range from 6.5-8.5 while deviation from the neutral 7.0 is as a result of the carbon dioxide/bicarbonate/carbonate equilibrium. The pH of water is extremely important; fluctuation in optimum pH ranges may lead to an increase or decrease in the toxicity of poisons in water (Olayemi, (1999)). The result of coliform count using the Most Probably Number (MPN) is shown in Table III which defined the degree of contamination and the microbiological quality of the selected water sources. Going by the zero tolerance levels stipulated by regulatory agency for coliforms in drinking water, a cumulative figure of 5% meets the standards of quality water and a cumulative figure of 95% (n = 100) of all the identified water did not meet the existing standards as shown in Table III. Previous studies in other parts of the country reported similar bacterial load indicative of poor water quality (Itah, and Akpan, 2005, Geldriech, (1996). Relatively high aerobic colony counts are indicative of poor, unhygienic handling and processing, bacteria growth in water may be unnoticed even in transparent packaged water and the presence of some of these microorganisms may pose a potential risk to consumer (Okonko, *et al* 2008). Table II shows the results of various biochemical test carried out to determine the type of bacteria present. It can be seen that 6 source of water samples were found to contain isolates of coliform species. Which is about 55% of the total number of the sachet water brands used. Therefore, the presence of *coliform* species as well as *E.coli* which is also a member of the *coliform* group found in 10% of the sample water brands, suggests that these sample of water brands have been contaminated with feces either of human or animal origin (Mukta *et al* ., 2007). The presence of *Pseudomonas* sp. in (2%) of the sample water source suggest contamination of the water either through decay or improper sanitization or sterilization of the factory equipment or instrument used in the production processes. It can also result from the use of unsterile jerricans which is used for conveying the water product. The presence of *Salmonella* sp. in (2%) of the sample sorce suggest a serious pathogenic water borne threat, liable of causing serious disease to the consumer of those sample water brand. This could be as a result of serious microbial pollution of the factory equipment or from an infected worker, working under unhygienic practices. The result for bacteriological assessment of water supply from public reservoir (Public Dam) and Maiduguri Water Treatment Plant (Tap Water) indicated contamination at both the source (reservoir) and the point of delivery to the consumers. The counts at the sampling sites are however higher at the point of delivery to the consumers than at the source. This suggests that the increase in microbial load might be as a result of poor handling of the water or the use of unclean containers (Jerry cans). This result agrees with the work of (Muktar, *et al*., 2007) who reported that 90 % of water hawked in some selected areas in Kano had bacterial count of 10^4 cfu/ml and MPN values ranged between 9 and > 180 per 100ml. This result is also in conformity with the work of (Muktar, and Oyeyi, 2005), who reported that some of the raw water sources from some open wells in Kano had Coliforms of up to 15 MPN/l00ml.

Furthermore, the result obtained from the standard plate count shows conspicuously that people living around these areas of study namely: Ngomari wards, Ccustom area, Ramat Polytechnique, Mairi village and New GRA are exposed to risk of contracting infection by the organisms isolated, which might lead to an outbreak of gastroenteritis and other enteric diseases.

The distribution of such important commodity (water) in the hands of illiterate members of the society who are habitually dirty and always unhygienic may be responsible for the introduction of microbes into the water, because most of the hawkers don't wash their jerry can thoroughly and regularly. The entire study area has been known with long history of prominent water scarcity. The inability of the government to provide potable drinking water had contributed immensely to the water scarcity, creating more public health problems. People depend heavily on truck pushers who sell water some of which were obtained from doubtful sources.

Conclusion

The microbiological quality of water from various sources in Maiduguri metropolis revealed the presence of *coliforms*, *E. coli*, . and Ssalmonella sp. Out of the total number of water sample examined, it can be concluded that 95% are not fit for human consumption and are hazardous to health. This could be as a result of inadequate sanitation and under hygienic practices. It can also be as a result of ineffectiveness or malfunctioning of the water treatment process employed. Therefore, appropriate treatment process should be utilized for production of quality and safe delivery in the metropolis. Therefore there is need for regulatory agencies to intensity effort

in the routine monitoring of quality of water from the various sources to unsuspecting consumers. They should also ensure that all water source supply to to the metropolis is safe and devoid of contamination.

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