BACTERIOLOGICAL QUALITY OF POTABLE WATER FROM DIFFERENT SOURCES IN KEFFI, NASARAWA STATE, NIGERIA

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Abstract: An investigation was carried out to determine the bacteriological quality of potable water from different locations and sources within Keffi metropolis. Water samples from Tap, Borehole and Well were collected in duplicates from ten (10) different locations within Keffi metropolis. Samples obtained were analyzed bacteriologically using standard methods. The spread plate method following serial dilution and the Most Probable Number techniques were used for the isolation of microorganisms and determination of the total viable counts from samples. For water samples from tap, borehole and well, the total viable counts were 5.5 x 10^6cfu/ml, 6.3xl0^6cfu/ml and 8.3xl0^6 cfu/ml respectively, while the Most Probable Number counts of coliform bacteria were 22.0 (MPN/100 ml), 24.5 (MPN/100 ml) and 40.5 (MPN/100 ml), respectively. Of the eight bacteria species isolated from the studied samples, all eight *(Staphylococcus aureus, Proteus mirabilis, Klebsiella pneumoniae, Pseudomonas aeruginosa, Salmonella typhi, Shigella dysentriae, E. coli* and *Enter ococcus faecalis)* were found in well water samples. All the species except *K. pneumonia, Pseudomonas aeruginosa* and *Enter ococcus faecalis* were found in borehole water samples, while *Staphylococcus aureus, Klebsiella pneumoniae, Salmonella typhi* and £. *coli* were isolated from tap water samples. The results of this investigation indicated that most potable water within Keffi Metropolis are not microbiologically safe for human consumption, therefore there is need for stringent treatment of water before consumption so as to avoid potential health hazard.

Key words: Bacteriology, potable water, Keffi, Nigeria.

INTRODUCTION

Water of good drinking quality is of basic importance to the physiology of human and man's existence depends very much on its availability (Lamikanra, 1999; FAO, 1977). The provision of potable water to the rural and urban population is necessary to prevent health hazards (Nikoladze and Akastal, 1989). Tebutt (1983) reported that 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. Ihekoronye and Ngoddy (1985) pointed out that potable water is that which is free from disease - causing microorganisms and chemical substances deleterious to health. Water can be obtained from a number of sources, among which streams, lakes, rivers, ponds, and rain water are natural sources Willey *et al.*, 2008).

Unfortunately, clean and safe water only exist briefly in nature and is immediately polluted by prevailing environmental factors and human activities (Baxter-Potter and Gilliland, 1998). Atmospheric waters such as rain water which are precipitated from clouds usually

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ıtain microbial flora contributed by the In effect, the air is "washed" by ıospheric water, which carries with it the :ticles of dust to which microorganisms : attached. Surface water such as lakes, eams, rivers and ponds, to a greater or ser degree are exposed to contamination microorganisms from atmospheric water ring precipitation (Evans *et al.,* 2006). oundwater, which are found in aquifers ater-containing layers of rock, sand and avel), such as springs and wells are not rectly exposed to rain, animals and the mosphere. They are somewhat protected ɔm contamination. However, poorly cated or maintained septic tanks and wer lines, as well as sludge or other rtilizers can lead to ground water ıntamination, as reported by Nester *et al.* 004). Water from most sources is therefore ıfit for immediate consumption without ɔme sort of treatment (Raymond, 1992). he principal objectives of potable water :cording to Lamikanra (1999) are the roduction and the distribution of safe ater, which is fit for human consumption. Vater can be classified based on certain ualities as potable water (clean, safe water leasing in appearance and taste), polluted vater (water with added substances which mpair color, odour or taste), contaminated vater (water which is rendered unsafe, hrough the addition of discharges from ıuman or animal intestines or rendered langerous by addition of poisonous :hemicals) (Nester *et al.,* 2004). Water for lrinking and domestic uses may be ɔbtained from natural sources like surface water, ground water and rainwater. However, streams, rivers and lakes are the major sources of surface waters, which originate partly from groundwater outflows and partly from rain water which flows over the terrestrial areas into the surface water bodies. Outflows from groundwater bring in the dissolved solids, and the surface run-off contributes turbidity, organic matter and pathogenic organisms (Prescott *et al.*, 2008).

The World Health Organization (WHO, 1998) estimates that up to 80% of ill health in developing countries are water and sanitation related. Since the International Drinking Water and Sanitation Decade (1981 – 1990) significant progress was made in water supply and sanitation coverage, the proportion of people with access to adequate water and sanitation has increased. Only 61% of people in developing countries are estimated to have access to adequate water supply. Most of the mortality and morbidity associated with water-related diseases in developing countries are directly or indirectly due to infectious agents. Water-related diseases can be transmitted through water-borne route in which humans may become infected by ingesting water containing pathogenic bacteria, viruses or protozoa parasites in water that has been polluted by human or animal faeces or urine. Common water-borne diseases include cholera, bacillary dysentery (shigellosis), Typhoid fever, Paratyphoid fever, Salmonellosis, *Campylobacter* enteritis, *Escherichia coli* diarrhea and Leptospirosis, all of which are of bacterial origin. Those of protozoa origin are Amoebic dysentery, Cryptosporidiosis, Giardiasis, Balantidiasis, while those of viral origin include Rotavirus, Hepatitis A, and poliomyelitis (Nester *et al.*, 2004). Water-borne diseases can also be transmitted by faecal-oral routes, which involves the ingestion of feacal contaminated food or water. Coliforms which typically reside in the intestine of both human and animals are used by regulatory agencies as indicator organisms of faecal pollution and their presence indicates a potential health risk because faecal-borne pathogens might also be present (Nester *et al.*, 2004).

The World Health Organization (WHO) is an international agency devoted to achieving the highest possible level of health for all people, and it recognizes that very stringent standards cannot be used universally as this may severely limit the availability of water in some localities but instead, a range of standard values for more than 60 parameters have been elaborated (WHO, 1998). A general review of the standards employed by WHO, European Economic Community, Canada and USA are given by Premazzi *et al.* (1989). The WHO standards recommend that the total viable counts for potable water should not exceed 1.0×10^2 cfu/ml, while the MPN value should be <1 MPN/100ml (WHO, 2008). It is in this light that this investigation was carried out with the aim of determining the bacteriological quality of potable water in Keffi Metropolis, Nasarawa State, Nigeria.

MATERIALS AND METHOD STUDY AREA

The study was carried out in Nasarawa State University, Keffi, Nasarawa State Nigeria. Nasarawa State shares boundaries with Kaduna, Plateau, and Kogi and the Federal Capital Territory, Abuja. Keffi is approximately 68 km from Abuja (the Federal Capital Territory) and 128 km from Lafia (the capital of Nasarawa State). The town lies between latitude 8°5`N of the equator and longitude 7°5`E of the Greenwich meridian on the altitude of 850 meters above sea level (Akwa *et al.*, 2007).

SAMPLE COLLECTION

Water samples from tap, borehole and well were collected from ten (10) different locations respectively using random sampling technique (Aneja, 2003). The water samples were conveyed to the microbiology laboratory in an ice packed cooler and stored in the refrigerator at 4°C until analysed.

DETERMINATION OF TOTAL VIABLE MICROBIAL COUNT

Standard plate count method as recommended by Sanders (2012) was used to determine the total viable counts of colonies from the different sources of water samples. A seven-fold aerial dilution of samples from each of the locations were performed and plated out on nutrient agar sing the pour plate technique as described by Aneja (2003). The plates were incubated at 35°C for 24 hours. The average microbial count from triplicate plates of the water samples from each of the different sources and locations were obtained and expressed as colony forming units per milliliter (CFU/ml) (Harrigan and McCance, 1976).

DETERMINATION OF MOST PROBABLE NUMBER (MPN) OF COLIFORM BACTERIA IN WATER SAMPLES

Standard methods as recommended by Aneja (2003) were used for the determination of the presence of coliforms in water samples obtained from the three different sources (Tap, Borehole and Well). Coliforms counts were expressed as the Most Probable Number (MPN) of coliform bacteria present in 100 ml of water sample.

ISOLATION AND IDENTIFICATION OF BACTERIA ISOLATES FROM SAMPLES

Standard bacteriological methods recommended by Cheesbrough (2006) were used for the isolation of bacteria. Serial dilutions of samples were prepared and aliquots of dilution 10^{-6} were plated out using the spread plate method. The media used for the isolation of the bacteria were Nutrient agar, Salmonella-Shigella agar, Manitol salt agar, MacConkey agar, Eosin Methylene Blue agar and Cystein Lactose Electrolyte Deficient agar. Plates were incubated at 35°C for 24 hours. The isolates were identified using cultural, morphological and biochemical methods as recommended by Holt (1994).

RESULTS

The total bacterial count observed as given in Table 1 shows that well water have the highest total bacterial count of 8.3×10^6 (cfu/ml) while tap water had the least total bacterial count of 5.5×10^6 (cfu/ml). The results further revealed that the Most Probable Number was highest for well water with an average value of 40.5 ± 1.33 (MPN/100 ml) while tap water had the

Table 1: Total viable bacterial counts (cfu/ml) and the most probable number (MPN) of coliform bacteria in potable water from different sources of in Keffi metropolis

Water Sources	Viable Counts (cfu/ml)	Most Probable Number (MPN/100ml)
Tap	$5.5x10^6 \pm 1.19$	22.0 ± 0.90
Borehole	$6.3x10^6 \pm 2.05$	24.5 ± 1.02
Well	$8.3x10^6 \pm 2.62$	40.5 ± 1.33

Table 2: Bacterial isolates in potable water from different sources in Keffi metropolis

Bacterial Isolates	Tap	Borehole	Well
Staphylococcus aureus	+	+	+
Proteus mirabilis	-	+	+
Klebsiella pneumonia	+	-	+
Pseudomonas aeruginosa	-	-	+
Salmonella typhi	+	+	+
Shigella dysenteriae	-	+	+
Escherichia coli	+	+	+
Enterococcus faecalis	-	-	+

Table 3: Biochemical characteristics of bacterial isolates

Test	W1	W2	W3	W4	W5	W6	W7	W8
Gram's	+	-	-	-	-	-	-	+
Motility	-	+	+	+	+	-	-	-
Methyl red	-	+	+	-	+	+	+	-
Voges-Proskauer	-	-	-	-	-	+	-	-
Catalase	+	+	+	-	+	+	-	-
Indole	-	-	+	-	+	-	-	-
Citrate	-	+	-	+	-	+	-	+
Coagulase	+	-	-	-	-	-	-	-

Key: W_1 = *Staphylococcus aureus* W_2= *Salmonella typhi* W_3= *Escherichia coli*
W_4= *Pseudomonas aeruginosa* W_5= *Proteus mirabilis* W_6 = *Klebsiella pnenmoniae*
W_7= *Shigella dysenteriae* W_8= *Enterococcus faecalis*

DISCUSSION

This study corroborates with earlier studies in Lagos and Ibadan where it was reported that well and borehole water used as sources of water for drinking and domestic purposes were grossly contaminated with pathogenic organisms (Akinyemi *et al.*, 2006). This was also depicted in this study where water from both well and borehole were found to be highly contaminated with faecal-oral pathogenic microorganisms. A situation where enteric pathogens are grossly isolated from sources of water consumed by humans is a serious problem which calls for vigilance on the part of the authorities as it signal possible future outbreak of water borne-disease (Baxter-Potter and Gilliland, 1998). The presence of pathogenic microorganisms, most especially *E. coli, S. aureus and P. mirabilis* in water from tap, borehole and well can be attributed to poor hygiene and sanitary practices around these sources of water and the unavailability of facilities as well as financial constraints in the provision of water of good quality in rural areas (Akinyemi *et al.*, 2006). In keffi metropolis treated pipe-borne water (tap water) is limited, as the quantity provided is inadequate and the frequency of supply is epileptic, this may be due to the unavailability of chemicals needed for water treatment. Therefore this poorly or partly treated water tends to portents potential health hazard to the public when consumed (Adeyemo *et al.*, 2002).

The results of this study are similar to results of a previous study carried out at Sagamu, which highlighted the fact that most well water are not microbiologically safe for drinking without additional treatment such as boiling or disinfection (WHO, 1998).

The role of water as a medium of water borne diseases which constitute a significant percentage of the diseases that affect both human and animals cannot be underestimated. The standards for quality of water as guidelines for bacteriology of water differs from country to country, but all conform to WHO recommendation, though the standards for drinking water are more stringent than those for recreational water (WHO, 2008). This study showed that there is a high incidence of contamination of various potable water sources in Keffi metropolis by pathogenic microorganisms.

CONCLUSION

The pathogenic, and indicator organisms present in the water samples obtained from various potable water sources in Keffi metropolis, render them microbiologically unfit for human consumption, however, they can be used for other domestic purposes. The results of this investigation signify that well water may be exposed to underground contamination. The presence of *S. aureus, E. coli* and *Proteus mirabilis* in these water bodies is an indication of poor hygienic conditions and sanitary practices, and also inadequacy in the treatment of the various water sources. This investigation would also be useful in establishing health implications that may be associated with the different sources of water within Keffi metropolis. Therefore, there is need for stringent treatment of water before consumption in order to avoid potential health hazard as a result of water borne disease.

ACKNOWLEDGEMENT

The authors are grateful to the Microbiology Unit, Department of Biological Sciences, Nasarawa State University, Keffi, Nigeria, for providing the laboratory materials and facilities used in this investigation.

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