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Original Research Article

Bacteriological Analysis of Drinking Water from Kumba, South West Region Cameroon

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Abstract: A total of 33 water samples, randomly and aseptically collected from four water sources (stream catchment, pipe borne, urban springs and main municipal reservoir) in Kumba, were assessed for bacteriological contamination. All were found positive for the presence of coliforms. 39.4% of the samples were categorized as grossly polluted, 21.2% as acceptable and 39.4% grossly polluted according to WHO standards. Specifically, the water samples were contaminated mainly with gram negative bacteria like *E. coli*, *Shigella* spp., *Enterobacter* spp., *Streptococcus spp*., and *Salmonella* spp., which are potential pathogens. However the bacterial loads were least in water samples graded as “Acceptable with low health risk”. The presence of Escherichia coli was an indication of recent faecal pollution.

Keywords: Water analysis, bacteriological, human health, Kumba Cameroon.

INTRODUCTION

Water is essential to life, but many people do not have access to clean and safe drinking. Increased human population, industrialization, use of fertilizers in the agriculture and man-made activity has polluted water with different harmful contaminants. Contaminants in the water can affect the water quality and consequently the human health [1]. Contaminated water can be the source of large outbreaks of disease, including cholera, dysentery and cryptosporidiosis [2], These contaminants are further categorized as microorganisms, inorganics, organics, radionuclides, and disinfectants [3].

The microbiological quality of drinking water is a very important aspect because of its association with water borne diseases [4]. Some bacteria, although naturally occurring, are known to cause diseases in humans, especially those with compromised immunity [4]. Several types of disease-causing viruses, protozoa, and bacteria are known to occur in sewage, human feces, and fecally contaminated waters [5, 6]. Many of these pathogens (e.g., Vibrio cholerae, Salmonella spp., Campylobacter jejuni) originate directly from human and other warm-blooded animal sources, and are the causative agents of some of the most important waterborne diseases in the world , especially in developing countries where sanitation is generally poor and access to portable water is limited [4]. Pathogenic microorganisms found in the guts of infected humans are excreted with fecal matter and are thus found in sewage and reclaimed water. Fecal coliforms and pathogenic microorganisms enter surface waters from many sources. Raw or inadequately treated sewage discharged into surface waters; excrement from wildlife; runoff from farm-animal feedlots and farmlands that have been fertilized with manure; and overflow of, and leaks from septic tanks can introduce pathogenic bacteria into surface- and ground waters [7]. Humans become infected by drinking water or consuming food, including shellfish, contaminated with pathogens, or through recreational contact with water in form of bathing, boating, swimming, fishing, or washing of clothes [6].

The detection and enumeration of disease-causing organisms in surface waters is difficult, time consuming, and expensive [8]. The high cost of isolation and enumeration makes it impossible and impractical to identify all the enteric pathogenic organisms present in the water at any particular time.

Total coliforms, fecal coliforms, Escherichia coli, fecal streptococci, and enterococci (bacteria found in the gastrointestinal tracts of humans and other warm blooded animals), are traditionally been used as indicators, of the occurrence of some pathogenic organisms in water analysis since they are easily isolated and identify than the enteric pathogens [4]. Coliforms are a group of gram-negative, rod-shaped bacteria that are nonpathogenic and nonspore forming. The most common coliform genera are Escherichia, Enterobacter, Citrobacter,

Serratia, and Klebsiella, with E. coli being the most abundant in the gut of humans and other warm-blooded animals. Coliform bacteria are identifiable by their ability to ferment lactose to produce acid and gas within 48 h, when incubated at 358C. Because they are found in the intestines of humans, domestic animals, and wild animals, coliforms are shed in feces along with pathogenic organisms present in the gut of infected animals, and can be detected in water with relative ease. Total coliforms have been recommended as the standard for sanitary quality of water [4].

Fecal coliforms (FC) are a subgroup of total coliforms consisting mainly of E. coli, Enterobacter, and some Klebsiella. They inhabit the intestines of warm-blooded animals. Because they can grow and ferment lactose at a relatively high temperature (_45.08C), a characteristic that has earned them the name ‘‘thermotolerant coliforms,’’ they can be differentiated from the other members of total coliform [9]. A high number of fecal coliforms in water suggests fecal contamination, which might have resulted in the introduction of pathogenic microorganisms in the water that present potential health risks to individuals using the water. Fecal coliforms are better indicators of the presence of pathogenic bacteria in water than total coliforms. Levels higher than established standards present the water as unsafe for human consumption [4].

Escherichia coli is found in the intestines of humans and other warm-blooded animals where it performs important physiological functions [10]. They are not normally found living in other environments, but have been reported to multiply in surface waters, especially in tropical environments. Several strains of E. coli are usually non disease causing, although illnesses such as septicemia and urinary tract infections have been reported, especially in immunocompromised individuals. Some E. coli strains (e.g., E. coli O157:H7) produce toxins that may cause diarrhea or even death in humans, particularly in elderly people and children [11]. Waterborne transmission of pathogenic *E. coli* has been well documented for recreational waters and contaminated drinking-water [12, 13]. E. coli is a more reliable indicator of fecal pollution and the occurrence of pathogens in water than fecal coliforms and conventional testing for *E. coli* (or, alternatively, thermotolerant coliform bacteria) provides an appropriate indicator for the enteropathogenic serotypes in drinking-water [13].

Fecal streptococci have been used as indicators of fecal contamination in water. The group includes many species of bacteria in the genus Streptococcus such as, S. faecalis, S. bovis, S. equines, S. avium, S. faceium, and S. gallinarum that are normally found in feces and gut of warm-blooded animals. Unlike the coliform bacteria, they are gram positive and also tend to live longer in water than fecal coliforms [4].

Enterococci are a subgroup of the fecal streptococci that includes S. avium, S. faecium, S. gallinarum, and S. faecalis. The group is found primarily in the gut of warm-blooded animals and generally do not grow in the environment [14], hence, they are used as a bacterial indicator of fecal contamination of recreational surface waters. They generally live longer in water than fecal coliforms [15], and are preferred to fecal coliforms and fecal streptococci as indicators of illnesses associated with swimming and other recreational uses of freshwater and marine waters [16]. A combined monitoring of E. coli and enterococci in water is believed to provide a higher degree of confidence in the estimated risk of fecal contamination as well as the presence of pathogens in water [17].

Salmonella spp. belong to the family Enterobacteriaceae. They are motile, Gram negative bacilli that do not ferment lactose, but most produce hydrogen sulfide or gas from carbohydrate fermentation [18]. *Salmonella* infections typically cause four clinical manifestations: gastroenteritis (ranging from mild to fulminate diarrhoea, nausea and vomiting), bacteraemia or septicaemia (high spiking fever with positive blood cultures), typhoid fever/enteric fever (sustained fever with or without diarrhoea) and a carrier state in persons with previous infections [13]. *Salmonella* spp. are widely distributed in the environment and infection by typhoid species is associated with the consumption of contaminated water or food [19, 20]. Waterborne typhoid fever outbreaks have devastating public health implications. Within a water safety plan, control measures that can be applied to manage risk include protection of raw water supplies from human and animal waste, adequate treatment and protection of water during distribution. *Escherichia coli* (or, alternatively, thermotolerant coliforms) is a generally reliable indicator for *Salmonella* spp. in drinking-water supplies.

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Ideally, drinking water should not contain any microorganisms known to be pathogenic or bacteria indicative of pollution with excreta [12]. The majority of the population in Cameroon is not adequately supplied with potable water, and thus obliged to use unsafe water for domestic and drinking purposes. Fonteh [21] reported that in Cameroon, water-related diseases account for about two-third of all recorded diseases and is responsible for about 50% of reported cases of death. Studies from various parts of Cameroon, showed that many water sources used for various domestic needs have alarming levels of microbiological pollution [22-24]. The microbial quality of drinking water in Kumba has not received much attention from researchers. This study was initiated to determine bacterial loads in drinking water in Kumba which could serve as water quality guide for judgment of the acceptability of public drinking water supplies.

MATERIAL AND METHODS

Kumba is located in the South West region of Cameroon and has a population of about 400.000 inhabitants with about ¾ of this population falling within the youthful age group.

Thirty three water samples were randomly and aseptically collected following standard procedures of WHO [13] in sterilized glass bottles from four water sources (stream catchment, pipe borne, urban springs and main municipal reservoir) which are used by the population for domestic and drinking purposes. Sampling was done in the month of April, 2017 and water samples transported in ice chest to the laboratory for analyses.

Bacteriological analyses were done in accordance with WHO standards [25, 26]. The Multiple Tube/Most Probable Number was to investigate the presence of coliform bacteria and the water samples graded as acceptable (low risk), unacceptable (high risk) or grossly polluted. The Standard Plate Count Method was used to estimate the quantity/ types of faecal coliforms present in the water samples and the results expressed as number of coliform forming units per milliliter (CFU/ml) of sample.

RESULTS

The water samples investigated in this study were mainly analyzed for the bacteriological contamination. The pH of the water samples (33) fall between pH 4-6.9. Table-1 shows the MPN of coliforms in 100ml and the bacteriological category of the water samples.

Table-1: MPN of coliforms in 100ml and the bacteriological category of the water sample

Sample code	MPN of coliform/100ml	WHO category
1	180+	D- Grossly polluted
2	30	C- Unacceptable (High risk)
3	30	C- Unacceptable (High risk)
4	7	B- Acceptable (Low risk)
5	11	C- Unacceptable (High risk)
6	5	B- Acceptable (Low risk)
7	8	B- Acceptable (Low risk)
8	5	B- Acceptable (Low risk)
9	14	C- Unacceptable (High risk)
10	30	C- Unacceptable (High risk)
11	20	C- Unacceptable (High risk)
12	35	C- Unacceptable (High risk)
13	180+	D- Grossly polluted
14	160	D- Grossly polluted
15	30	B- Acceptable (Low risk)
16	90	D- Grossly polluted
17	90	D- Grossly polluted
18	180+	D- Grossly polluted
19	12	C- Unacceptable (High risk)
20	180+	D- Grossly polluted
21	14	C- Unacceptable (High risk)
22	4	B- Acceptable (Low risk)
23	180+	D- Grossly polluted
24	20	C- Unacceptable (High risk)
25	14	C- Unacceptable (High risk)
26	180+	D- Grossly polluted
27	40	C- Unacceptable (High risk)
28	180+	D- Grossly polluted
29	180+	D- Grossly polluted
30	180+	D- Grossly polluted
31	25	C- Unacceptable (High risk)
32	180+	D- Grossly polluted
33	3	B- Acceptable (Low risk)

Out of 33 water samples, all were found positive for the presence of coliforms. 39.4% of the samples were categorized as grossly polluted, 21.2% as acceptable and 39.4% grossly polluted according to WHO standards. However, the water samples contained varying loads of faecal coliforms (Table-2).

Table-2: Total faecal bacterial isolates recovered from water samples (Colony Forming Unit/ml of sample)

Sample code	Enterobacteria	E. Coli	Streptococcus	Salmonella/shigella
1	400	250	100	200
2	300	200	200	150
3	400	200	300	300
4	20	10	10	5
5	100	50	10	50
6	60	50	60	50
7	70	60	50	70
8	30	20	10	15
9	400	200	300	200
10	300	250	200	200
11	300	200	100	50
12	200	100	200	30
13	400	200	200	100
14	500	200	300	300
15	70	60	50	40
16	150	100	200	5
17	300	200	200	50
18	400	300	150	100
19	50	30	150	10
20	300	200	100	30
21	100	50	100	0
22	30	20	100	0
23	200	150	200	200
24	250	200	100	30
25	100	50	60	0
26	300	200	100	40
27	300	200	300	200
28	300	100	200	150
29	400	300	200	150
30	300	200	150	27
31	100	75	100	25
32	200	50	250	150
33	70	21	50	45

All the water samples investigated revealed contamination mainly with gram negative bacteria like *E. coli*, *Shigella* spp., *Enterobacter* spp., *Streptococcus spp*., and *Salmonella* spp., which are potential pathogens. However the bacterial loads were least in water samples graded as “Acceptable with low health risk”.

DISCUSSION

An acceptable pH for drinking water is between pH 6.5 to pH 8.5, a guideline value recommended by WHO. 88% of the water samples examined in this study had pH< 6.5, values which are below the acceptable pH range. In this study 78.8% (high risk and grossly polluted) of the water samples showed presence of high number of faecal coliform bacteria as revealed by standard plate count, which is far beyond the limit set by World Health Organization for drinking water considered to be safe to public health. This indicates high contamination and risk to public health. If large numbers of coliforms are found in water, there is a high probability that other pathogenic bacteria or organisms, such as Giardia and Cryptosporidium, may be present [13]. It is recommended that public drinking water supplies should demonstrate the absence of total coliform per 100 mls of drinking water [4].

The result revealed the isolation of bacterial strains like *E. coli*, *Shigella* spp., *Enterobacter* spp. and *Salmonella* spp., which are pathogenic for human health. According to WHO [27], the bacteria that pose a serious disease risk whenever present in drinking water include *Salmonella* spp., *Shigella* spp., pathogenic *E. coli*, *Vibrio cholerae*, *Yersinia enterocolitica*, *Campylobacter jejuni* and *Campylobacter coli*. Also, the presence of *E. coli* in water is nearly always associated with recent fecal pollution, which may pose an immediate health risk to anyone consuming the water [28, 4].

CONCLUSION

From this study, it was clear that seriously polluted water was used by the population of Kumba. None of the water samples collected was suitable for human consumption following the WHO standards. Safe drinking water for all is one of the major challenges faced in Cameroon. We recommend that microbiological control of drinking water should be done in every part of the country frequently since safe water is essential for good health. All efforts must be taken to safeguard drinking water quality in accordance with the WHO guidelines for bacteriological quality of drinking water. Safe water and sanitation improve the health status of the population and reduce the morbidity from water borne diseases.

We strongly recommend that public health authorities should undertake the initiative to encourage and spread the culture of sanitation among residents in the study area.

REFERENCE

1. Rahmanian, N., Ali, S. H. B., Homayoonfard, M., Ali, N. J., Rehan, M., Sadef, Y., & Nizami, A. S. (2015). Analysis of physiochemical parameters to evaluate the drinking water quality in the State of Perak, Malaysia. *Journal of Chemistry*, *2015*.
2. Kim, Y. H., Sachse, C., Machala, M. L., May, C., Müller-Meskamp, L., & Leo, K. (2011). Highly conductive PEDOT: PSS electrode with optimized solvent and thermal post-treatment for ITO-free organic solar cells. *Advanced Functional Materials*, *21*(6), 1076-1081.
3. Nollet, L. M. L. (2000). Handbook of Water Analysis, Marcel Dekker, New York, NY, USA.
4. WHO. (2007). World Health Organization Guidelines for drinking-water quality, 3rd Ed. Volume 1 Recommendations. WHO. Geneva, Switzerland. 121-143.
5. Bruhn, R., & McLachlan, M. S. (2002). Seasonal variation of polychlorinated biphenyl concentrations in the southern part of the Baltic Sea. *Marine pollution bulletin*, *44*(2), 156-163.
6. Schellin, M., & Popp, P. (2003). Membrane-assisted solvent extraction of polychlorinated biphenyls in river water and other matrices combined with large volume injection–gas chromatography–mass spectrometric detection. *Journal of Chromatography A*, *1020*(2), 153-160.
7. WHO. (1984). World Health Organization Guidelines for drinking-water quality. vol. 2. Health criteria and other supporting information. Geneva, WHO. 3.
8. Maldonado, C., & Bayona, J. M. (2002). Organochlorine compounds in the north-western Black Sea water: Distribution and water column process. *Estuarine, Coastal and Shelf Science*, *54*(3), 527-540.
9. Basher, R., & Briceño, S. (2005). Climate and disaster risk reduction in Africa. *Climate change and Africa*, 271-284.
10. EPA. (1998). Update: Listing of fish and wildlife advisories. Fact Sheet. US Environmental Protection Agency, Office of Water. EPA-823-F-98–009.
11. Telli-Karakoç, F., Tolun, L., Henkelmann, B., Klimm, C., Okay, O., & Schramm, K. W. (2002). Polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) distributions in the Bay of Marmara sea: Izmit Bay. *Environmental Pollution*, *119*(3), 383-397.
12. Nataro, J. P., & Kaper, J. B. (1998). Diarrheagenic escherichia coli. *Clinical microbiology reviews*, *11*(1), 142-201.
13. WHO. (2011). World Health Organization Guidelines for drinking-water quality, 4th Ed. WHO. Geneva, Switzerland. 231-257.
14. Yang Y., Hawthorne B. S,, Miller D. J., Liu Y,, and Lee L.M, (1998) Adsorption versus absorption of polychlorinated biphenyls onto solid-phase microextraction coatings, Anal. Chem. 70, 1866–1869.
15. Petty, J. D., Jones, S. B., Huckins, J. N., Cranor, W. L., Parris, J. T., McTague, T. B., & Boyle, T. P. (2000). An approach for assessment of water quality using semipermeable membrane devices (SPMDs) and bioindicator tests. *Chemosphere*, *41*(3), 311-321.
16. Fitzgerald, E. F., Weinstein, A. L., Youngblood, L. G., Standfast, S. J., & Melius, J. M. (1989). Health effects three years after potential exposure to the toxic contaminants of an electrical transformer fire. *Archives of Environmental Health: An International Journal*, *44*(4), 214-221.
17. Sun C., Dong Y., Xu S., Yao S., Dai J., Han S., and Wang L, (2002). ''Trace analysis of dissolved polychlorinated organic compounds in the water of the Yangtse River (Nanjing, China), Environ. Pollut. 117(1), 9–14.
18. Tindall, B. J., Grimont, P. A. D., Garrity, G. M., & Euzeby, J. P. (2005). Nomenclature and taxonomy of the genus Salmonella. *International journal of systematic and evolutionary microbiology*, *55*(1), 521-524.
19. Angulo, F. J., Tippen, S., Sharp, D. J., Payne, B. J., Collier, C., Hill, J. E., ... & Swerdlow, D. L. (1997). A community waterborne outbreak of salmonellosis and the effectiveness of a boil water order. *American Journal of Public Health*, *87*(4), 580-584.
20. Escartin EF et al. (2002) Potential *Salmonella* transmission from ornamental fountains. *Journal of Environmental Health*, 65:9–12.
21. Fonteh, M. F. (2003). Water for all and the environment. The United Nations-Cameroon Water Development Report. United Nations Economics Commission for Africa. Addis Ababa, Ethiopia. 199.

22. Sorlini, S., Palazzini, D., Sieliechi, J., & Ngassoum, M. (2013). Assessment of physical-chemical drinking water quality in the Logone Valley (Chad-Cameroon). *Sustainability*, *5*(7), 3060-3076.
23. Magha, A., Awah, M. T., Kouankap, G. D., Wotchoko, P., Tabot, M. A., & Kabeyene, V. K. (2015). Physico-chemical and bacteriological characterization of spring and well water in Bamenda III (NW Region, Cameroon). *Am. J. Environ. Protec*, *4*(3), 163-173.
24. Ketchemen-Tandia, B., Boum-Nkot, S. N., Ebondji, S. R., Nlend, B. Y., Emvoutou, H., & Nzegue, O. (2017). Factors Influencing the Shallow Groundwater Quality in Four Districts with Different Characteristics in Urban Area (Douala, Cameroon). *Journal of Geoscience and Environment Protection*, *5*(8), 99-120
25. WHO. (1984). World Health Organization Guidelines for drinking-water quality. vol. 1. Recommendations. Geneva, WHO. 17, 83.
26. APHA. (1998). Standard methods for the examination of water and wastewater. 20th Ed., American Public Health Association. Washington D.C, USA, 1134.
27. Anonymous. (2006). Guidelines for Drinking Water Quality. World Health Organization, Rome.
28. Eaton, A. D., Clesceri, L. S., Rice E. W., Greenberg A. E., & Franson M. A. H.(2005). Standard Methods for the Examination of Water and Wastewater. 21st Edn., American Public Health Association, USA. 1200.