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Assessment of Coliform Bacteria as Indicator of Water Quality in Jigawa State Nigeria

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ABSTRACT

Groundwater is sometimes considered as the cleanest form of water available to Nigerians. A total of two hundred water samples (10 from each of the 20 cities) were analyzed for the presence of coliform bacteria as an indicator of water quality. The mean coliform viable counts, aerobic mesophilic bacterial count as well as a biochemical test were conducted. Based on the result obtained, seven cities were found to contain coliform count above the acceptable limit of the World Health Organization (WHO) for drinking water. *Escherichia coli* was also found in water samples of four cities. Presence of faecal coliform is an indication of faecal contamination of any drinking water which can be due to leakage of pipes from the main source. Efforts need to be intensified in the monitoring of activities in this rapidly expanding industry with a view to raising standards.

INTRODUCTION

Good quality water is said to be colorless, odorless, tasteless and free from any faecal contamination, water is fundamental to life for both plant and animal for the performing of their routine activities like metabolism, food absorption by plant roots, photosynthesis and other uses like pharmaceutical companies, textile industries and other many industries. Water also serves as a medium for the transmission of diseases, organisms such as bacteria that cause diseases like *typhoid* and *cholera* etc. A large amount of money, time and energy is spent in the provision of good drinking water. The need forsake portable water necessities is the bacteriological assessment of water in urban areas [1].

Water received microbial content from the air, sewage, organic waste, dead of plants and animals. The world health organization (WHO) in 1980 established that up to 80% of sickness and diseases in the world are caused by inadequate sanitation, pullulated water or availability of water. In safeguarding public water supplies, health authorities and water engineers rely on information obtained from the result of frequent bacteriological quality standard for most during water in Nigeria; this drinking water must be free from faecal indicator organisms such as *Escherichia coli, Salmonella species* and pathogenic microorganisms. However, the quality of drinking water is assessed based almost entirely on faecal coliform count. In Nigeria, the legally recognized standard for drinking water quality is The Nigerian Standard for Water Quality (NSDWQ). This stipulates the acceptable values of the different water parameters (which must not be exceeded) before it can be considered to be safe for drinking [2]. However, indigenous researchers do not base their assessment on it alone but also compare with World Health Organization [3] standards. In some studies, they also do a comparison with the standards by the United States Environmental Protection Agency (USEPA). This is because there are slight differences in these guidelines and some agencies impose stricter regulations for some parameters than other agencies.

In this research, drinking water of twenty (20) cities in Jigawa state Nigeria were selected and analyzed for the presence of faecal coliform as an indicator of faecal contamination in water.

MATERIALS AND METHODS

Study area

Jigawa state is situated in North Western Nigeria between latitudes 11.00^{O}N to 13.00^{O}N and longitudes 8.00^{O}E to 10.15^{O}E with total land area of approximately 22,410 square kilometers **(Fig. 1)**. Basic indicators for water supply sector show that access to potable water is over 90%, which is among the highest in the country. The 2002 CWIQ Survey, however indicated that while access to high quality safe drinking water (pipe born, hand pump boreholes and protected wells) is low at about 63%, nearly two-thirds of households have good means of sanitation (www.jigawastate.gov.ng).

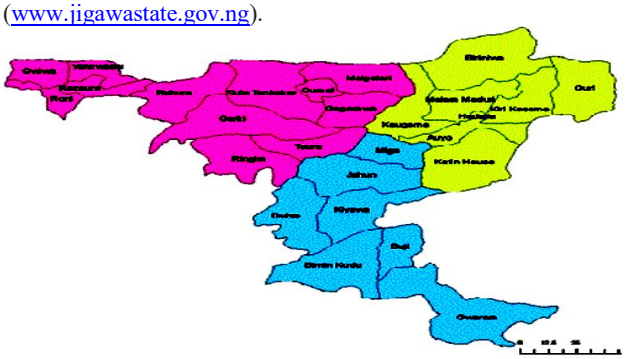

Fig. 1. A map of Jigawa state showing all the 27 local government areas.

Sample Size/Sample Collection

Domestic water samples were collected from twenty selected Local Government areas of Jigawa state. These samples were aseptically transported immediately to the laboratory for microbiological analysis.

Sample Preparation and Serial Dilution

In the presumptive test, a series of nine (9) tubes of lactose broth are inoculated with a measured amount of water to observe any lactose fermenting bacteria. Serial dilution was conducted according to standard procedure [4].

Detection of Coliform

Serially diluted samples in a test tube containing lactose broth with inverted Durham tubes were incubated at 37 °C for 24 to 48hrs. Following incubation, tubes that produced gas were counted and the number were compared with the most probable number (MPN) table [4].

Estimation of Aerobic Mesophilic Bacterial Count

One millilitre (1mL) from each dilution of the samples were pipetted into each of the appropriately marked duplicate Petri plates. This was followed by pouring aseptically onto molten nutrient agar. The prepared Petri plates were incubated at 37 °C for 24 h. After incubation, plates with colonies were counted and the numbers obtained were multiplied by the inverse of the dilution factor to get the number of colony-forming unit (CFU/mL) [3].

Detection of *Escherichia coli*

A loopful of inoculum from gas positive tubes were streaked on to plates of Levine's Eosine Methylene Blue (L-EMB) and the plates were incubated at 37°C for 24hrs. Following incubation, bluish-black colonies with green metallic sheen are suspected to be *Escherichia coli* [4].

Gram Staining

A smear of the suspected microorganisms was taken on a glass slide from the positive Petri dish and the gram staining produce were followed as per standard protocol. The slides were examined under oil immersion microscope [4].

Biochemical Characterization

Indole test, Methyl red, Voges-proskauer and citrate utilization test (IMViC) were conducted to confirm the presence of pathogenic microorganism capable of causing water-borne disease based on the presence of color change.

RESULTS AND DISCUSSION

Groundwater is sometimes considered as the cleanest form of water available to Nigerians. Its source is either digging boreholes or by hand-dug wells with vertical depth as their main difference. The situation of fit latrines near groundwater sources can lead to the pollution of those specific wells. This usually leads to a high microbial load in the hand-dug wells or boreholes. The total viable count is the sum of the coliform count, faecal coliform count, faecal streptococci count and other pollutants in the water [4]. Although high viable counts are usually indicative of the contamination of the water and the presence of bacteria other than aquatic bacteria, they do not necessarily indicate pollution by faeces and or sewage. Furthermore, the bacteria may be mostly soil saprophytes. Thus, a high viable count alone is not evidence that a source of water is potentially dangerous due to the possible presence of intestinal pathogens. Nevertheless, water supplies with high viable counts are undesirable since they still carry the associated risk of possible pollution.

In this research, high microbial counts were observed in water samples of some cities which were beyond the maximum limit of $1.0x10^5$ CFU/mL set by the World Health Organization (WHO). These cities includes Auyo ($1.5x10^6$ CFU/mL), Ringim ($1.6x10^5$ CFU/mL), Maigatari ($1.6x10^6$ CFU/mL), Kaugama ($1.7x10^6$ CFU/mL), Kirikasamma ($1.6x10^7$ CFU/mL), Guri ($1.8x10^6$ CFU/mL) and Yankwashi ($2.6x10^6$ CFU/mL) **(Table 1)**.

Table 1. Colony count, mesophilic bacterial count and plate appearance of selected Local Governments groundwater samples.

Site	Mean CFU/mL	MPN/100mL	Appearance on EMB agar
Hadejia	$1.2x10^3$	12	NG
Kafin Hausa	$1.2x10^4$	10	NG
Birniwa	$1.2x10^5$	132	NG
Malam Madori	$1.4x10^5$	20	NG
Gumel	$1.3x10^5$	25	NG
Auyo	$1.5x10^6$	142	Green metallic sheen
Ringim	$1.6x10^5$	36	NG
Taura	$1.6x10^3$	23	NG
Maigatari	$1.6x10^6$	56	NG
Kaugama	$1.7x10^6$	53	NG
Garki	$1.6x10^3$	12	NG
Gagarawa	$1.9x10^4$	20	NG
Kirikasamma	$1.6x10^7$	86	Green metallic sheen
Suletankarkar	$1.1x10^5$	29	NG
Guri	$1.8x10^6$	120	Green metallic sheen
Kazaure	$1.4x10^3$	22	NG
Roni	$1.5x10^4$	26	NG
Yankwashi	$2.6x10^6$	102	Green metallic sheen
Gwiwa	$1.0x10^3$	18	NG
Babura	$1.1x10^4$	12	NG

Note: NG no growth

As reported by [5], coliform count less than 10, between 100 - 300 and greater than 300 is considered as satisfactory, unsatisfactory and dubious respectively. As per this research, water samples in some cities were found to have a coliform count within the unsatisfactory range. These include Birniwa, Auyo, Maigatari, Kaugama, Kirikasamma, Guri and Yankwashi. A considerable number of *E. coli, Psuedomonas, Staphylococcus* spp and *Enterobacter* spp were observed in Uli town Anambra state Nigeria when a water pipe was found leaked close to pit latrine [6].

Based on the water samples of twenty (20) cities examined for coliform bacteria, *E. coli* was detected in water samples of four cities when a gas positive samples on lactose broth were inoculated on Eosine methylene blue (EMB) agar (20%) sample were found to contain *Escherichia coli* following biochemical test. The biochemical tests conducted are indole test, methyl red, Voges Proskauer and citrate utilization (IMViC) **(Table 2)**. Based on the result, water samples of Auyo, Kirikasamma, Guri and Yankwashi were found to contain coliform bacteria called *E. coli* which is an indication of faecal contamination. The detection of *E. coli* in this water sample also correlated with a finding of American Published Health Association that *E. coli* species are isolated organisms in water samples that make it as an indicator of faecal contamination. Knowing that, water fit for consumption should have *E. coli* count per 100mL not exceed five for chlorinated water, we can then say that, all the water tested are fit for human consumption because it is within the limit of WHO [3] standard. A research shows that closeness of hand-dug well with a fit latrine in Foko slums of Ibadan Nigeria leads to the presence of high microbial load [7] while Bashir *et al*., [8] reported same from water samples of Sokoto metropolis Nigeria.

Table 2. Biochemical test confirming the presence of E. coli in some water samples.

Sample area	Gram staining	Indole	Methyl Red	Voges Proskauer	Citrate
Auyo	-	+	+	-	-
Kirikasamma	-	+	+	-	-
Guri	-	+	+	-	-
Yankwashi	-	+	+	-	-

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CONCLUSION

Water is no doubt one of the most important factors in the development of modern society. The availability of potable water (water free of pathogens and deterioration chemicals) is directly related to the control or elimination of diseases. The presence of coliform bacteria in drinking water especially *E. coli* is an indication of faecal contamination which may lead to the spread of water borne diseases. Drinking water is expected to be free from coliform bacteria and other deleterious chemicals capable of causing serious health hazards. Many water samples tested were found to be using within the acceptable limit of the World Health Organization (WHO).

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CONFLICT OF INTEREST

Authors declared none

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