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Full Length Research Article

# SEASONAL INFLUENCE ON MICROBIAL QUALITY OF WATER SOURCES IN SOME RURAL COMMUNITIES OF ZARIA, NIGERIA.

HASSAN, A. S.

Department of Biological Sciences, Kaduna State University, Kaduna, Nigeria
danmasaniashres@yahoo.com

**ABSTRACT**
**This work examined fifteen (15) different water sources in some rural communities of Zaria, Nigeria for microbial index of water quality in relation to seasonal influence from June, 2005 to May, 2006. The microbiological quality indices indicated widespread fecal contamination with the on-set of rainy season *Escherichia coli* MPN-index indicated highly significant difference between seasons, stations, season by stations and year by stations (P<0.01). The microbial quality of the water sources located near point sources of fecal contamination (pit latrine, sanitary drainage) raised some points of concern particularly during the rainy season when the water sources become extensively contaminated. Such contamination, coupled with the corresponding high temperature associated with tropical waters, and poor hygiene stand as potential indicators for pathogenic transmission.**

***Keywords*:** Microbial indicators, seasonal influence, water quality.

**INTRODUCTION:**
Water is regarded as one of the nutrients, although it yields no calories. It forms part of the structural composition of cells and is an essential component of diet (Baloch *et al*., 2000). Many developing regions of the world suffer from either shortage of water or the readily accessible water sources are heavily polluted (Kazmi, 2004). Human health in tropical countries is generally rated by many indices as poor. A comparison of likely fate of a thousand babies born alive in poor developing countries and advanced ones reveals that a quota (250 out of a 1000) given birth to fail to reach theirs fifth birthday. One hundred and fifty (150) die in the first year of life, seventy (70) in the second year; and relatively few survive into old age, with large number, probably 5 – 10 % overall deaths in many of such places, particularly among very young children, due to water borne and water related diseases (Bradley, 1972).

The situation is different in developed countries, where it is estimated that twenty four (24) out of a thousand (1000) die shortly after birth. Majority survives through childhood and early adult life and most people survive into their fifties. Reason for this was attributable to excellent water supplies and sewers systems, hence water-related diseases consequently are rare.

Figures advanced by Richardson (1989), indicated that 32% of the population in developing countries lack adequate water supply. These factors, together with the inadequate waste treatment facilities and general low level of personal hygiene have been attributed to have resulted in high level of enteric diseases associated with the developing nations (Bradley, 1972).

Nigeria is one of the nations in developing countries. By characteristics, one of the prominent quality indices of concern in its rural water sources is the microbial quality. According to WHO (1968), in developing countries, the incidence of typhoid fever, bacillary dysentery, amoebiasis, infectious hepatitis and other enteric infections that may be transmitted by water is often 10 to more than 100 times compared with the advanced countries.

United Nations International Children's Education Fund, UNICEF (1985) revealed that in Nigeria only 18% of the population living in rural areas had access to potable water, and infant mortality rate (IMR) was 115 per 1000 live births with leading cause being diarrhea in 1983.

Routinely it is impossible to test water supply for all pathogens related to water borne diseases because of the complexity, time and cost (Toze, 1999; Lee & Kim, 2002). It is therefore practicable to use indicator systems, which are able to index the presence of pathogens and related health risks in water intended for human consumption. According to Kazmi (2004), the presence of pathogen is usually accompanied by the presence of classic indicators such as *Escherichia coli,* which could be used as a way of assessing indirectly, the quality of such water. Several bio-assessment techniques have been developed on evaluation of water quality. In this work, the Multiple-Tube Fermentation Technique (MTFT) of American Public Health Authority, APHA (1992) was adopted.

**MATERIALS AND METHODS**
**Study area:** Zaria lies between latitudes 11.13$^0$ N' and 11.00$^0$ N' and longitudes 7.30$^0$ E' and 7.47$^0$E'. There are a number of rural communities surrounding the ancient city, which have poor access roads, and most importantly lack potable water supply. The inhabitants of these villages are predominantly subsistent farmers whose major source of water is from hand dug wells, with all year round availability of water. The water table rises significantly inside the wells during the rainy season up to a few meters to the surface,

but drops as dry season progresses to over 10 meters. The rainy season corresponds with the months of May to October, while the dry season is from November to April (Kowal & Omolokun, 1970).

**Samples collection MPN-Index Determination and data analysis:** Fifteen sampling stations were selected from three rural communities in Zaria: They were hand-dug wells (restricted water sources, RWSs), located at Bomo (3), Kurmin Bomo (4), Shika village (4) and Tudun Sarki (4).

**Collection of samples and inoculation:** Samples were collected once a month from each of the 15 stations for 24 months.

Multiple-Tube Fermentation Technique for Members of the Coliform group adopted from American Public Health Authority (APHA, 1992) was used.

100 ml collection bottles were washed, cleaned and sterilized using autoclave. Water samples were collected by using clean rope and fetching bucket, then immersing the collection bottles into the water and away from the collector's hand. The bottles were caped placed in dark, insulated ice-packed cooler and transported to the laboratory, where 5-tube, 3 dilution series of A-1 media, using Durham tubes were prepared for each sample collected. The first dilution contained double strength broth, while the others contained single strength. Each series of dilution was inoculated with 10, 1.0, and 0.1ml of water from each sample and incubated for 3 hrs at 35$^{o}$C, transferred to water bath, and continued incubating at 44 $^{o}$C for additional 21 hrs.

**Determination of *Escherichia coli* MPN-Indices:** The results of examinations were reported in terms of the Most Probable Number (MPN) of indicator organisms/100 ml of water sample, based on the number of positive tubes (tubes that showed gas formation) out of five (5) multiple tubes sets. All tubes that showed gas formation in the Durham tube at the end of the 21 hours were regarded as positive, using MPN-Index table (WHO, 1963., APHA, 1992).

Statistical analysis was by Ducan's Multiple Range Test and Analysis of variance ANOVA using SPSS Package (Hassan, 2001; 2003).

## RESULTS

The MPN-Index values per 100 ml of water samples were are presented in Table 1. The Most Probable Number (MPN)-index exhibited low dry season mean (DSM) of 9.62/100 ml of water sample. The rainy season mean (RSM) was mush higher being 13.00/100 ml of the sampled water sources. Analysis of variance for MPN-index (Table 2) indicated highly significant difference between seasons, stations, season by stations and year by stations ($P<0.01$).

Ducan's Multiple Range test (Table 3) revealed that stations 7, 8, 9, 10, 11, and 15 had the highest *E. coli* MPN indices of infinity. Station 3 recorded the lowest.

Major peaks in MPN-Indices were observed during the period of heavy rainfall (June to October) with stations 15, 11and 7 showing major elevations.

## DISCUSSION

Stations 8, 9 and 10 were located close to pit latrines, major drains and extended gutter that remains wet throughout the season recorded high MPN-Indices. The location of these stations near point sources of fecal contamination could be responsible for the recorded high indicator counts. Work on water samples from open wells in Conakry was carried out by Gelinas *et al.,* (1996) and reported widespread well water contamination for nitrate and fecal bacteria. Reason for this was linked to insufficient well maintenance, high permeability of the soil and shallow water table of the area sampled. Lewis *et al.,* (1981) reported the pit latrine sanitation and shallow underground water exploitation for drinking purposes conflict one another because of the facilitated migration of contaminants, both bacteriological and chemicals, through the soil. The nature of soil in the sampled areas was noted to be highly permeable to water, the aquifer of particularly S7, S11 ad S15 were low and the wells were unprotected.

The high counts recorded during the rainy season in this case may be attributed to wet weather events. Ferguson *et al.,* (1996) studied the relationship between indicators and water quality in an estuarine system and associated rainfall and sewage overflows with significant increases in MPN index count. A possibility for the recorded high indicators MPN-Index count could be due to the unprotected nature of the water sources from direct contamination by fetching materials and spilt water. Human and animal excrement deposited close to the water source could be introduced directly into he water sources, particularly during the rainy season. The sanitation practices of the dwellers, involving the use of water for cleansing feces, provided the possibility of used water to be in contact with soles of foot wears (shoes and slippers or even bare feet) and be transported from toilets to the vicinity of water sources (wells) to become source of contamination of fetching ropes, containers and ultimately the water.

Being base-line work it indicates higher *E. coli* MPN-Indices, suggesting high contamination, during the rainy season as compared to dry season. Regardless of such, it is early to be totally conclusive on the microbial quality definition of the water sources. It will be necessary to apply different microbial quality measuring techniques so as to create concurrency. The results obtained also indicate that there were high microbial population values in water sources with close proximity to waste disposal point sources and in water sources with high soil porosity and low aquifers.

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**TABLE 1. MONTHLY MPN-INDEX VALUES FOR ALL THE STATIONS FOR THE PERIOD OF SAMPLING.**

| Period | SAMPLING STATIONS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** | **S9** | **S10** | **S11** | **S12** | **S13** | **S14** | **S15** |
| **Jun** | 9.2 | 16.2 | 2.2 | 20 | 9.2 | 9.2 | 20 | 20 | 20 | 20 | 20 | 5.1 | 2.2 | 9.2 | 20 |
| **Jul** | 16.2 | 16.2 | 5.1 | 20 | 9.2 | 5.2 | 20 | 20 | 20 | 20 | 20 | 2.2 | 2.2 | 5.1 | 20 |
| **Aug** | 5.1 | 2 | 5.1 | 20 | 16.2 | 5.1 | 20 | 20 | 20 | 20 | 20 | 5.1 | 5.1 | 5.1 | 20 |
| **Sep** | 2.2 | 2 | 2.2 | 20 | 16.2 | 2.2 | 20 | 20 | 20 | 20 | 20 | 2.2 | 2.2 | 0 | 20 |
| **Oct** | 0 | 16.2 | 2.2 | 16.2 | 16.2 | 5.1 | 20 | 20 | 20 | 20 | 20 | 0 | 2.2 | 0 | 20 |
| **Nov** | 0 | 2 | 5.1 | 20 | 16.2 | 2.2 | 20 | 20 | 20 | 20 | 20 | 2.2 | 0 | 0 | 20 |
| **Dec** | 0 | 2.2 | 0 | 5.1 | 5.1 | 2.2 | 20 | 20 | 20 | 20 | 20 | 5.1 | 2.2 | 2.2 | 20 |
| **Jan** | 0 | 5.1 | 0 | 2.2 | 5.1 | 2.2 | 20 | 20 | 20 | 20 | 20 | 0 | 5.1 | 5.1 | 20 |
| **Feb** | 0 | 2.2 | 0 | 5.1 | 5.1 | 2.2 | 20 | 20 | 20 | 20 | 20 | 0 | 0 | 2.2 | 20 |
| **Mar** | 0 | 2.2 | 0 | 5.1 | 2.2 | 5.1 | 20 | 20 | 20 | 20 | 20 | 5.1 | 0 | 2.2 | 20 |
| **Apr** | 0 | 5.1 | 0 | 5.1 | 2.2 | 5.1 | 20 | 20 | 20 | 20 | 20 | 0 | 2.2 | 0 | 20 |
| **May** | 2.2 | 16.2 | 2.2 | 16.2 | 9.2 | 16.2 | 20 | 20 | 20 | 20 | 20 | 2.2 | 5.1 | 2.2 | 20 |
| **Jun** | 2.2 | 16.2 | 2.2 | 20 | 20 | 5.2 | 20 | 20 | 20 | 20 | 20 | 2.2 | 2.2 | 5.1 | 20 |
| **Jul** | 5.1 | 16.2 | 2.2 | 20 | 20 | 5.1 | 20 | 20 | 20 | 20 | 20 | 5.1 | 5.1 | 5.1 | 20 |
| **Aug** | 2.2 | 20 | 9.2 | 20 | 20 | 2.2 | 20 | 20 | 20 | 20 | 20 | 5.1 | 5.1 | 0 | 20 |
| **Sep** | 2.2 | 20 | 5.1 | 20 | 20 | 2.2 | 20 | 20 | 20 | 20 | 20 | 5.1 | 0 | 0 | 20 |
| **Oct** | 2.2 | 16.2 | 2.2 | 9.2 | 16.2 | 2.2 | 20 | 20 | 20 | 20 | 20 | 5.1 | 2.2 | 0 | 20 |
| **Nov** | 0 | 5.1 | 2.2 | 5.1 | 5.1 | 0 | 20 | 20 | 20 | 20 | 20 | 0 | 0 | 0 | 20 |
| **Dec** | 0 | 9.2 | 0 | 9.2 | 5.1 | 0 | 20 | 20 | 20 | 20 | 20 | 0 | 0 | 0 | 20 |
| **Jan** | 0 | 9.2 | 0 | 9.2 | 9.2 | 0 | 20 | 20 | 20 | 20 | 20 | 0 | 0 | 0 | 20 |
| **Feb** | 0 | 5.1 | 0 | 5.1 | 5.1 | 2.2 | 20 | 20 | 20 | 20 | 20 | 0 | 0 | 0 | 20 |
| **Mar** | 0 | 5.1 | 0 | 5.1 | 5.1 | 0 | 20 | 20 | 20 | 20 | 20 | 0 | 0 | 0 | 20 |
| **Apr** | 0 | 5.1 | 0 | 5.1 | 9.2 | 0 | 20 | 20 | 20 | 20 | 20 | 0 | 0 | 0 | 20 |
| **May** | 0 | 16.2 | 0 | 20 | 16.2 | 0 | 20 | 20 | 20 | 20 | 20 | 9.2 | 16.2 | 5.1 | 20 |

**Summary of the Means:**
Dry Season Mean 9.62
Rainy Season Mean 13.00
First year General Mean 11.44
Second Year General Mean 11.19

**TABLE 2. VARIATIONS IN *E. coli* MPN-INDEX OF THE WATER SOURCES**

| Source of variation | DF | Sum of squares | Mean square | F-value | P>F |
|---|---|---|---|---|---|
| **Rep.** | 5 | 77.95781 | 15.59156 | 2.80 | 0.0173 |
| **Year** | 1 | 5.65003 | 5.65003 | 1.02 | 0.3145 |
| **Rep(year)** | 5 | 24.14047 | 4.82809 | 0.87 | 0.5030 |
| **Season** | 1 | 1029.21025 | 1029.21025 | 184.95 | 0.0001 |
| **Stations** | 14 | 22435.78556 | 1602.55611 | 287.98 | 0.0001 |
| **Season by Stations** | 14 | 1407.13025 | 100.51519 | 18.06 | 0.0001 |
| **Season by Year** | 2 | 11.13025 | 11.13025 | 2.00 | 0.1584 |
| ***Year x Stations*** | 14 | 169.73122 | 12.12366 | 2.18 | 0.0087 |
| ***Season x year x stations*** | 14 | 109.84767 | 7.84626 | 1.41 | 0.1471 |

Alpha = 0.01

**TABLE 3. DUCAN'S MULTIPLE RANGE TEST REFLECTING THE GSM *E. coli* MPN-INDEX OF THE WATER SOURCES**

| DUNCAN'S GROUPING | MEAN | No observations | Station No |
|---|---|---|---|
| **A** | 20.000 | 24 | 9 |
| **A** | 20.000 | 24 | 10 |
| **A** | 20.000 | 24 | 11 |
| **A** | 20.000 | 24 | 8 |
| **A** | 20.000 | 24 | 7 |
| **A** | 20.000 | 24 | 15 |
| **C B** | 3.350 | 24 | 4 |
| **C** | 2.829 | 24 | 2 |
| **D** | 2.767 | 24 | 5 |
| **D** | 2.154 | 24 | 6 |
| **D** | 1.850 | 24 | 12 |
| **D** | 1.692 | 24 | 13 |
| **D** | 1.608 | 24 | 1 |
| **D** | 1.371 | 24 | 14 |
| **D** | 1.364 | 24 | 3 |

Alpha = 0.05

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