SEASONAL VARIATION OF MICROBIOLOGICAL QUALITY OF WATER FROM WATARI DAM, KANO STATE

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ABSTRACT

Seasonal variation of Microbiological quality of water from Watari Dam, Kano was conducted between May 2012 and March 2013. Four sampling sites (A, B, C and D) were chosen on the Dam based on the ecological setting of the study site. Samples collected were subjected to microbiological analysis, which include viable mesophilic plate count and MPN index for coliforms. The presence of faecal coliform (*E. coli*) through a multi-tube test was determined. The results showed that all the water samples contains high microbial load, and the existence of faecal coliform (*E. coli)* beyond the World Health Organization standard limit. High bacterial count was recorded at site A with 1.05 x 10^5 to 2.15 x 10^4 cfu/ml followed by site B with 1.02 x 10^4 to 1.94 x 10^4 cfu/ml, and the least was 0.68 x 10^4 to 2.15 x 10^3cfu/ml recorded at site C with viable mesophelic count ranging from 0.88 x 10^5 to 2.60 x 10^4cfu/ml. The seasonal variation in dry season had the higher bacterial count compared to wet season. The high bacterial counts recorded could be due to the favourable environment coupled with anthropogenic activities around the sampling sites. The presence of faecal coliform (*E.coli*) in the water sample is an indication of a potential threat to public health. It is therefore recommended that there should be adequate treatment of water before consumption.

Keywords: Watari Dam, Microbioloical Quality, Seasonal Variation, Federal College of Education (Technical) Bichi, Reservoir tank.

INTRODUCTION

The quality of drinking water is a powerful environmental determinant of health (WHO, 2010). Badlyans and Kennedy (2002) reported that underground water reservoir and dams water are the main sources of water supply in cities and for industrial and agricultural purposes. The quality of water is of vital concern for mankind because it is directly linked with human health (Abdulazeez, 2015). Freshwater has become a scarse commodity due to over exploitation and pollution (Muhammad and Saminu, 2012). Pollution is caused when a change in the physical, chemical or biological condition in the environment harmfully affects quality of human life including other animals and plants' life (Oketola *et al.,* 2006). Therefore, it should be exploited reasonably and there should be prevention of unnecessary use of it and also the loss of its quality as possible. Studies show that the amount of available water resources in the world are limited and a low proportion of water dams as freshwater resource shows the quantitative and qualitative necessity of this precious source. Dams water is a vital and trusted source in many countries widely used in rural and urban areas (Pourmoghadas, 2002). Dams water are the important reason of hydrological cycle therefore all human activities such as over-exploitation of them may have harmful effects on water resources and ecology of that area. Microbial quality of water is one of the main points that are directly relevant to personal and public health. More than anything, Human health depends on clean and sanitary water. Essentially, human life depends on safe water and efforts to provide safe water is a huge and holy struggle. Many health problems in developing countries are mainly due to the lack of clean water (Levinson, 2008). According to Ibrahim (2009), Water resources are of critical importance to both natural ecosystem and human development. Cheesbrough (2004) reported that the World Health Organization (WHO) estimated that up to 80% of ill health in developing countries is water and sanitation related. Olukosi *et al.* (2008) reported that contamination remains a problem of global concern, contributing to high morbidity and mortality rates from water borne diseases. In Nigeria, most of the major sources of water are open (Garba *et al.,* 2009). Also, livestock are reared within compounds and are allowed to roam freely in search of food. Hence they serve as source of faecal contamination of water sources (Tabukum *et al.* 1996; Atiribom*et al.* 2008). However, in all cases, faecal coliform contents and *E. coli* is used as the major tool in the assessment of the health risk borne by pathogen in water (Mishra *et al.* 2010). In view of the forgoing, this research aims at assessing the seasonal variation of microbiological water quality from Watari Dam, Kano State which supplies water to Federal College of Education (Technical) Bichi and the surrounding communities.

MATERIALS AND METHODS

Study Area

Watari Dam is a man-made lake built between 1977 – 1980. It is situated 2km from Bagwai town and 8km south West of Bichi town, Kano state, with surface area 1,959 hectares, with active storage capacity of 92.74million liters. The dam is located between latitude 12°9'24"N and 8°8'12"E with two distinct seasons (wet and dry). The rainy season which last from May to October and the dry season which lasts from November to April. The mean annual temperature is between 16 – 43^{0}C and the mean annual rainfall ranges from 700 – 813mm (Adamu *et al.,* 2014).

Sampling Sites

Four sampling sites designated as A, B, C and D were selected for the purpose of this research.

Site A: Is at the dam site where human activities like fishing, washing, sand collection and other domestic activities take place.
Site B: Is at the lower point of the dam where there are less human activities.
Site C: The reservoir tanks used at Federal college of Education (Technical) Bichi.
Site D: The outlet point of the reservoir tank where there is a lot of student activities like washing of clothes and other activities.

Sample Collection

Samples were collected on monthly basis between the hours of 9am – 11am from May 2012 – March 2013 from four sampling station that cut across two season of the year. Two sets of bottles were used, one set using four sterile 250ml glass bottles with tight metal screw caps and a wide mouth for microbiological test that were used in the four sampling stations. 250ml sterile bottles were used in stations A and B where the screw cap was open at the point of collection without rinsing the bottle then lowered into the water body, immediately it was filled up and covered carefully. 250ml sterile bottles were used at Federal College of Education (T) Bichi reservoir tank. A rope of about 2 meter length was tied around the neck, opened only at the point of collection and then gradually lowered into the reservoir tank, filled up, withdrawn and covered. At Site D, sample was obtained by flaming the tap using spirit lamp and allowing the tap to run for about two minutes. 250ml sampling bottle was then used to obtain sample by opening at the point of sampling, filled up and closed. All the sample bottles were labeled with the site, date and time of collection and transported to the laboratory in an iced box (Cheesbrough, 2006).

Enumeration of Aerobic Mesophilic Bacteria

This was carried as described by Cheesbrough (2006), serial dilutions were made of each sample in sterilized distilled water by transferring 1ml of the sample after thorough mixing using sterile 1ml pipette into 9ml of sterile distilled water to obtain 10^{-2}, similar dilutions were carried out subsequently as (10^{-3}, 10^{-4} and 10^{-5}). One mililitre from each sample dilution was placed in a separate sterile petridish. Fifteen millitre(ml) of cooled molten nutrient agar and potato dextrose agar at the temperature of 40 – 45^{0}C was poured separately into each of the five duplicate petridishes and covered. The plates were then rocked gently for thorough mixing and then allowed to solidify undisturbed. The nutrient agar plates were then appropriately labeled with sampling site, media used and dilution factor inoculated. The plates were then incubated at 37^{0}C for 24 hours. Number of colonies on each plate were counted and expressed as cfu/ml (colony forming units) ml^{-1} and the potato dextrose agar plates were incubated at room temperature for up to five (5) days.

Most probable number (MPN)

This was carried out as described by Cheesbrough (2006). Double strength and single strength lactose broth media were prepared according to manufacturer's instructions. Three (3) sets of tubes were used. First a set of five tubes each containing 10mls of double strength lactose broth with an inverted Durham's tube introduced into it, then another 5 tubes containing 5mls of single strength lactose broth and the last set of five tubes containing 5mls of single strength lactose broth with Durham's tube inverted in them. Each of the test tubes that contain lactose broth and Durham's tube was capped with cotton wool and autoclaved at 121^{0}C for 15mins. After cooling to room temperature, ten millitre of the samples water were inoculated into five tubes containing 10mls of sterile double strength lactose broth. One millilitre of each sample was inoculated into 5 tubes each containing 5mls of sterile single strength lactose broth. Lastly 0.1ml of sample was inoculated into 5 tubes containing single strength lactose broth with inverted Durham's tubes. All the tubes were inoculated at 37^{0}C

for 24hours to 48 hours for faecal coliform. After incubating, the tubes were examined for gas production. The total numbers of tubes with gas production were counted and the result was compared with standard probability table to determine the most probable number (MPN) of coliform bacteria in 100 ml of water sample.

Characterization and Identification of Bacterial Isolates

Coliform bacteria were confirmed by inoculating a loop full from lactose broth (positive) tube after incubation onto an Eosine Methylene Blue (EMB) agar plate. The plates were incubated at 37^0C for 24 hours, on following incubation bluish black colonies with green metallic sheen were suspected to be *E. coli.* Gram staining, Fungal identification and biochemical tests in order of Triple Sugar Iron (TSI), Motility, Indole and Methyl-red as described by Cheesbrough (2006).

RESULTS

Table 1: Bacterial count in Site A from May 2012

Month	MPN	APC(cfu/ml)	Organims detected *(E. coli)*
May, 2012	240	1.89×10^5	-
Jun.	150	1.43×10^4	+
Jul	<93	1.05×10^5	+
Aug	43	2.07×10^4	+
Sep	<93	1.20×10^4	+
Oct	<21	1.16×10^5	-
Nov	460	2.15×10^3	+
Dec	93	2.08×10^4	+
Jan, 2013	240	1.84×10^5	+
Feb	84	1.24×10^4	+

Key: MPN= Most Probable Number, cfu= Colony Forming Unit, APC = Aerobic Plate Count,+ = Positive, - = Negetive

Table 2: Bacterial count in Site B from May 2012 to February 2013

Month	MPN	APC(cfu/ml)	Organims detected *(E.coli)*
May, 2012	43	1.59 x 104	+
Jun	3	1.3 x 105	-
July	93	1.50 x 104	+
Aug	56	1.67 x 105	+
Sep	3	1.02 x 104	-
Oct	<28	1.17 x 105	+
Nov	240	1.94 x 104	+
Dec	150	1.50 x 104	+
Jan, 2013	93	1.82 x 105	+
Feb	240	1.48 x 105	+

Key: MPN= Most Probable Number, cfu= Colony Forming Unit, APC = Aerobic Plate Count, += Positive, - =Negative

Table 3: Bacterial count in Site C from May 2012 to February 2013

Month	MPN	APC(cfu/ml)	Organims detected*(E.coli)*
May, 2012		1.1001.85 x 104	+
Jun	240	2.10 x 104	+
Jly	39	1.14 x 104	+
Aug	<3	1.07 x 105	-
Sep		>1.1002.82 x 105	+
Oct	93	1.49 x 105	+
Nov	<21	0.88 x 105	-
De c	<28	0.91 x 105	-
Jan, 2013	460	2.60 x 104	+
Feb	<93	1.90 x 104	+

Key: MPN= Most Probable Number, cfu= Colony Forming Unit, APC = Aerobic Plate Count, += Positive, - =Negative

Table 4: Bacterial count in Site D from May 2012 to February 2013

Month	MPN	APC(cfu/ml)	Organims detected*(E.coli)*
May, 2012	40	1.1001.24 x 10^4	+
Jun	<30	1.68 x 104	-
July	90	1.84 x 104	-
Aug	28	1.48 x 104	+
Sep	>30	1.92 x 10-4	-
Oct	460	2.15 x 103	+
Nov	30	1.93 x 104	-
Dec	31	1.03 x 105	-
Jan, 2013	93	1.92 x 105	+
Feb	240	1.94 x 104	+

Key: MPN= Most Probable Number, cfu= Colony Forming Unit, APC = Aerobic Plate Count, += Positive, - =Negative

Table 4: Occurrence of fungi in the study area from May 2012 to February, 2013

Taxon Identified	SITES A	B	C	D	TOTAL	FREQUENCY
Rhizopus spp	13	08	06	17	44	21.9%
Penicillium spp	10	16	11	05	32	21.1%
Aspergillus spp	16	05	12	07	40	26.5%
Cladosporium spp	06	05	15	09	35	23.2%
Total Org/Site	45	24	44	38	151	99.9%
Frequency/Site %	29.8	15.9	29.1	25.2	100%	

Key: Org = Organims, % = percentage

DISCUSSION

Watari Dam is a very large unprotected dam with animal grazing, drinking water around it as well as fishing with some irrigation activities. Also, some farmers make use of animal dung as fertilizer. All these could be partly responsible for the contamination observed. The result of microbiological analysis of the water samples were presented in tables above. The presence of Coliform, and fungi indicated that the water is not potable (Shittu *et al*., 2008). At site A the Total Plate count was recorded with 1.05 x 10^5 to 2.15 x 10^4 cfu/ml, the MPN

ranges from 43 to 240cfu/ml and with 66.7% detection of *E. coli*, the result is higher than that of site B with mesophelic count range from 1.02 x 10^4 to 1.94 x 10^4 cfu/ml, the MPN ranges from 3 to 150 with 44% detection of *E. coli.* which were above the recommended safe limit of 1.0 x 10^2 cfu/ml for drinking water by NSDWQ (2007), WHO (2004), as Adekoyini and Salako (2012) reported the contamination of drinking water were due to human or animal origins, therefore, this indicates that the higer bacterial count were due to contamination with faecal matters as human activities like farming, fishing, washing, sand collection and other activities taking place around the sampling site. At site C the MPN ranges from <3 to 460 and viable mesophelic count range from 1.14 x 10^5 to 2.82 x 10^5cfu/ml with 71% *E. coli* detection, which is lower than that of Site D were the coliform count range from 0.68 x 10^4 to 2.15 x 10^3cfu/ml, with MPN of <3 to 460 and 77% *E. coli* detection. Therefore, this indicates that the higher bacterial count were due to contamination with faecal matters, this happens due to the position of the College reservoir tank being made between the toilets of two hostels and much human activities like washing and other activities are taking place which make the site prone to surface pollution. Also, the dumping of refuse and human excreta in and around the water is still prevalent (Anima *et al.,* 2010), suggesting the possibility of contamination from pathogenic bacteria and other sources. Direct consumption of the water could result in opportunistic infection which can lead to the development of gastroenteritis, diarrhea and dysentery, nausea, headaches, and other special risk, as Adekoyini and Salako (2012) reported. Much of the samples analysed were found to contain faecal indicator (*E coli*). Parihar *et al*. (2003) and Mohan *et al.*(2007) reported that the faecal coliform bacterium is the primary bacterial indicator for faecal pollution in water and the presence of *E. coli* indicates contamination by human or animal wastes (Adekoyeni and Salako, 2012). This shows that all the water from the four sampling sites were above permissible limit and are not fit for direct consumption as per APHA (2007), WHO (2004), EPA (1999) as minimum guide for drinking water.

The seasonal variations happen during two seasons of wet and dry, in which the dry season reveals higher bacterial counts which happens as a result of high abundance of dust in the surrounding air which may be responsible for increased level of pollution, as Ghaware and Jadhao (2015); Stephen *et al*.(2013) reported, more bacterial abundance from water samples analyzed in the dry season against bacterial abundance in the rainy season. However, in the dry season, the number/frequency of *E. Coli* is higher as reported by Obi *et al*., 1998, due to concentration of the organism during the dry season. In Wet season high bacterial population was recorded by Shehane *et al.,* (2005) as due to increased land run off and faecal inputs into dam from nearby farms and various sources. Most often, in rainy season, the frequency and/or number of total and faecal coliform *(E. coli)* in water sources increase as faeces of human and/or animal are washed into dam and water outlet premises of the reservoir.

Though, the analyses conducted proved microbial presence or contamination of the various samples collected; the degree to which each sampling site was contaminated really differed. The high incidence of total coliform counts recorded in the dry season were more than the rainy season for dam and the reservoir tank, more bacterial contaminants from incinerators, refuse dumps, human defecate and other activities might have been washed around the water bodies can cause highly contaminated and potential sources of conveying microbial pathogens (Dufour *etal.* 2003). The high count in site C agrees with the results of Wasfy *et al.* (2000) that there might have been accumulation of bacteria in the respective water reservoirs due to reduction in the water volume.

The occurrence of fungal species in this study from May 2012 to February 2013 include *Aspergilus* sp. which occurs most frequently with *26.5%* in all the four sites followed by *Cladosporium* species with 23.2%, *Rhizopus* sp. with *21.9%* and *Penicillin* sp. which has least occurrence in all the four sites. Obi *et al*. (2016, 2011) reported *Aspergilus niger* as normal flora of soil, Shittu *et al.* (2008) reported that the presence of fungi indicated that the water is not potable. Microbiological pollution of fungi in drinking water can be responsible for serious disease such as hepatitis Kawther and Alwakeel, (2007).

CONCLUSION

Bacterial counts of all the four sampling sites show that the water is not fit for direct consumption as per APHA (2007), NSDWQ (2007) and WHO (2004) recommendations for drinking water. Isolation of *E. coli* in most of the samples analyzed is an indication of a potential threat to public health. Based on the findings of this study, drinking the water examined is likelihood of contracting diseases caused by the microorganisms detected. It is therefore recommended that the populace needs to be educated on the importance of maintaining clean and hygienic environment around the reservoir. Government at all levels and regulatory authorities should enforced water pollution and abatement laws in order to track down any adverse environmental changes on the water bodies.

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