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Original Research Article

Assessment of physicochemical and bacteriological quality of River Galma around Dakace industrial Estate, Zaria, Nigeria

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Abstract

Quality of water is of basic importance to human physiology and man's continued existence depends much on its availability. This study assessed the physicochemical and bacterial quality of River Galma around Dakace industrial layout, Zaria, Nigeria. Four stations were chosen spatially along the water course to reflect a consideration of all possible human activities that are capable of changing the quality of the river water. The water samples were collected monthly for four consecutive months (June to September, 2011) at the four sampling locations. Most probable number (MPN/100 index), total coliform count, total heterotrophic bacteria count, pH, water temperature, turbidity levels and chloride levels were analyzed. The total heterotrophic bacteria count (THB) of the samples ranged from 2.1×10^4 to 4.0×10^9 CFU/ml while the total coliform counts were greater than 2400. Findings from this work showed that water temperature and pH were within the permissible limits of World Health Organization (WHO) standard. The low chloride levels could be attributed to the fact that the chloride was diluted out because of raining season. However, the turbidity levels were higher than World Health Organization (WHO) standard. Also the quality of the water is poor microbiologically because of high total coliform counts and THB recorded which are above the WHO set standards. The water is thus not potable or useful for domestic and agricultural purposes without some forms of physical and chemical treatment.

Keywords: Dakache River, industrial effluent, physicochemical parameters, total coliform count

INTRODUCTION

Water is one of the most indispensable resources hence life is not possible on this Planet without it (Jonathan *et al*., 2012). Water is also a factor of production in virtually all enterprise, including agriculture, industry and the services sector (UNESCO, 2006). The importance of safe drinking water is underlined by the assertion that: "safe drinking water is the birthright of all humankind – as much a birthright as clean air" (TWAS, 2002). It was reported that the majority of the world's population, especially in most parts of Africa and Asia, does not have access to safe drinking water and that as much as 6 million children dies daily as result of waterborne diseases linked to scarcity of safe drinking water or sanitation (TWAS, 2002). In spite of the considerable investments of Nigerian government in water supply programme, over 52% of its population has no access to potable water

(Oluwasanya, 2009). The world health organization (WHO, 2004) pointed out that diseases related to contamination of drinking-water constitute a major burden on human health: and that intervention to improve the quality of drinking-water provides significant benefits to health. Low access to safe water in Nigeria has been attributed to the enormous socio-economic development, growing industrial base, poor planning, insufficient funding and haphazard implementation, to mention a few (Oluwasanya, 2009).

Dakace industrial estate is located at the out sketch of Zaria metropolis where most of the industries are located. These industries discharged their industrial effluent after production into River Galma thus contaminating the river. This river serves as the main source of water for irrigation farming, washing of farm products, rearing of animals and for domestic uses by the local inhabitants of the area.

In this study, water samples from the river within the industrial layout were subjected to physicochemical and bacteriological investigations to ascertain the impact of the effluent on the quality of the river.

MATERIALS AND METHODS

Sample collection

Water samples from River Galma was collected for this study and the samples were collected following standard procedure as described by APHA, 1992 and the samples containers were labeled on the field using appropriate codes. Prewashed plastic bottle was used to collect water sample for physico-chemical analysis, while a sterilized universal sampling bottle was used to collect samples for microbial analysis. The sample samples were temporary stored in ice packed cooler and transported to the laboratory immediately for analysis. These samples were collected on a monthly basis consecutively for a period of four month (June to September 2011)

Microbiological analysis

The total coliform counts were determined using the spread plate method (APHA, 1992). Also the coliform counts were determined as Most Probable Number (MPN) using the multiple tube fermentation test, eosin methylene blue agar were used to confirm the presence of coliform (APHA, 1992).

Physico-chemical analysis

Temperature was determined on site using HACH conductivity / TDS meter (model 44600.00, USA), pH was determined on site electronically using Zeal–tech digital pH meter (model 03112, India) and turbidity also determined on site using HACH portable turbidimeter (model 2100P, USA). Standard laboratory methods as described by the (APHA 1992) for the examination of environmental samples was employed for the analysis of total soluble solids and chlorides.

RESULTS AND DISCUSSIONS

According to US EPA standards, water samples in which coliforms are detected should be considered unacceptable for drinking water as they are regarded as the principal indicators of water pollution. The WHO standards for total and faecal coliforms are 1 to 10/100 ml and 0/100 ml, respectively (USEPA, 2001; WHO, 2003). The results in Table 1 and 2 revealed that all the water samples had very high counts of total and faecal coliforms which could be attributed to human and animal activities on the river because coliforms are of intestinal origin. Therefore a potential health risk exists due to their presence in water and the result is in agreement with Poonkothai and Parvatham (2005) in India that revealed the presence of bacteria at high concentration in automobile wastewater.

Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water in many parts of this country, thus available water is rendered non-potable because of the presence of industrial effluents and high microbial contamination.

The physicochemical parameters indicated that the level of pollution River Galma water varied at different locations (stations) as shown on the graph below.

pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. pH of natural water can provide important information about many chemical and biological processes. It is typically monitored for assessments of aquatic ecosystem health, recreational waters, irrigation sources and discharges, livestock, drinking water sources, industrial discharges, and storm water runoff. The observed pH value from this study conducted, ranges from 6.17 to 7.00 as shown in figure 1. These values are within maximum permissible limit of 6.5 to 8.5 set aside by world health organization (WHO, 2003). The values are favorable to growth of microorganisms which could have contributed to high total coliform count as observed in this study. It is only pH of below 4 or above 9 that can destroy aquatic life and microorganisms.

Water temperature in this study ranges between 25.9℃ to 28.4℃ except station 1 for the month of August

Table 1. Most probable number; MPN (bacteria)

MONTH	STATION 1	STATION 2	STATION 3	STATION 4
JUNE	34	26	12	33
JULY	>2400	>2400	>2400	>2400
AUGUST	>2400	>2400	>2400	>2400
SEPTEMBER	>2400	>2400	>2400	>2400

Table 2. Serial dilution

MONTH	STATION 1	STATION 2	STATION 3	STATION 4
JUNE	$2.1X10^5$	$4.2X10^5$	$6.2X10^4$	$2.1X10^4$
JULY	$6.4\ X10^7$	$3.0\ X10^7$	$2.4\ X10^7$	$1.6\ X10^8$
AUGUST	$4.0\ X10^7$	$1.1\ X10^8$	$1.1\ X10^7$	$4.8\ X10^6$
SEPTEMBER	$4.3\ X10^8$	$3.0\ X10^9$	$4.0\ X10^9$	$1.3\ X10^7$

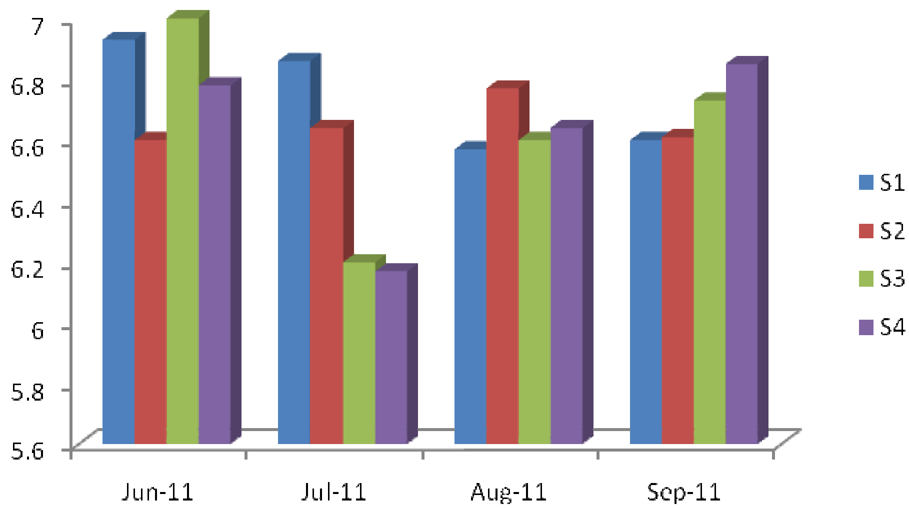

Figure 1. Spatial variation of pH of River Galma around Dakace industrial layout

which had 22.3℃ (Figure 2). This was found to be within the permissible limit of the world health organization (WHO, 2003). Water bodies will naturally show changes in temperature seasonally and daily; however, man's activities can also contribute to changes in surface water temperature. The high temperature could also be as a result of urban, industrial and agricultural activities around River Galma. This result is similar to Fafioye *et al.*, (2005) who reported a range of 26.5 to 31.5 ℃ in Omi water body, Ago iwoye, Ogun state, Nigeria and 26.9±1.1 to 32.1±0.5 reported by Dimowo (2013) in Ogun state, Nigeria. The temperatures observed were higher than 15°C in all the stations and all through the various months which favour the growth of microorganisms. Water temperature is one of the most important physical characteristics of aquatic systems (Deas and Lowny, 2000). Aquatic organisms are sensitive to changes in water temperature and it is an important water quality parameter which is relatively easy to measure. It is one of the most important regulators of life processes in aquatic ecosystems (FOEN, 2011). It has direct and indirect effects on nearly all aspects of stream ecology. Temperature also influences the rate of photosynthesis by algae and aquatic plants. As water temperature rises, the rate of photosynthesis increases thereby providing adequate amounts of nutrients (Boulton, 2012).

Turbidity typically composed of fine clay or silt particles, plankton, organic compounds, inorganic compounds and microorganisms. Sources include erosion, storm water runoff, industrial discharges, microorganisms, and eutrophication. Monitoring of turbidity is an important criterion for assessing the quality of water. The turbidity profile varied throughout the study period and ranged from 158 to 468 NTU. The turbidity values obtained were higher than world health organization standard of 5 NTU (WHO, 2004). The Month of June had the highest turbidity level while the lowest was recorded in the month of September (figure 3). This high turbidity level will makes it not fit for direct domestic use. Also, the excessive turbidity in water can cause problem in water purification processes such as

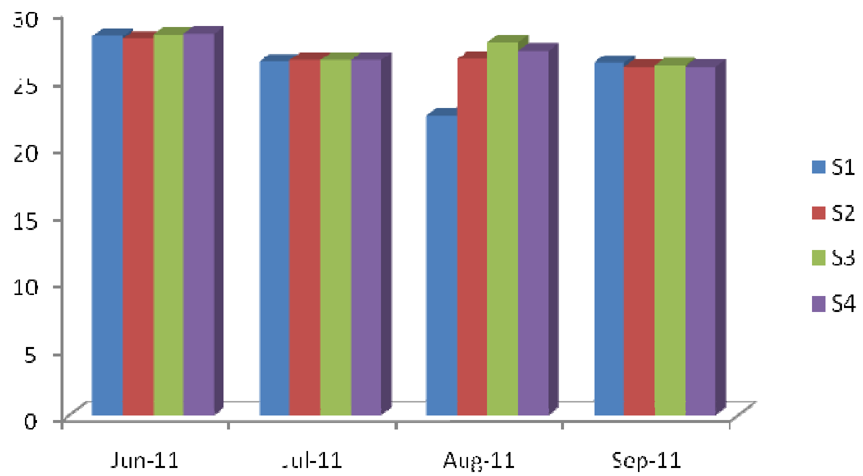

Figure 2. Spatial variation of pH of River Galma around Dakace industrial layout

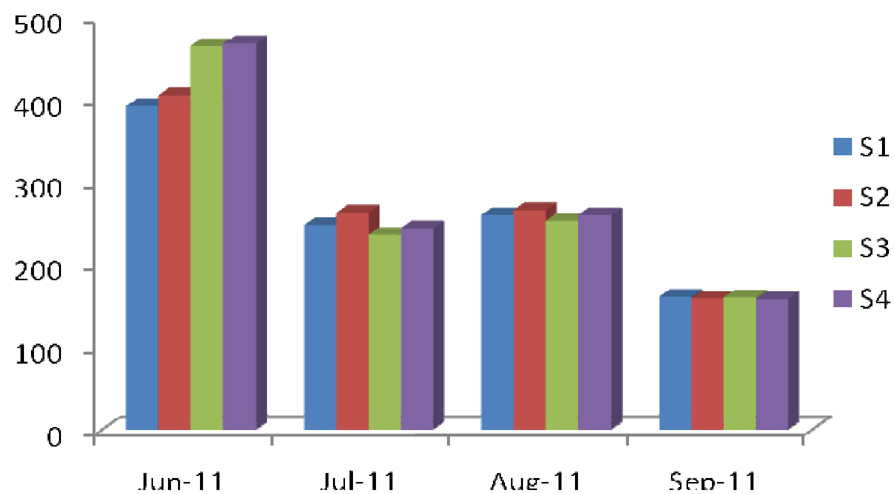

Figure 3. Spatial variation of Turbidity of River Galma around Dakace industrial layout

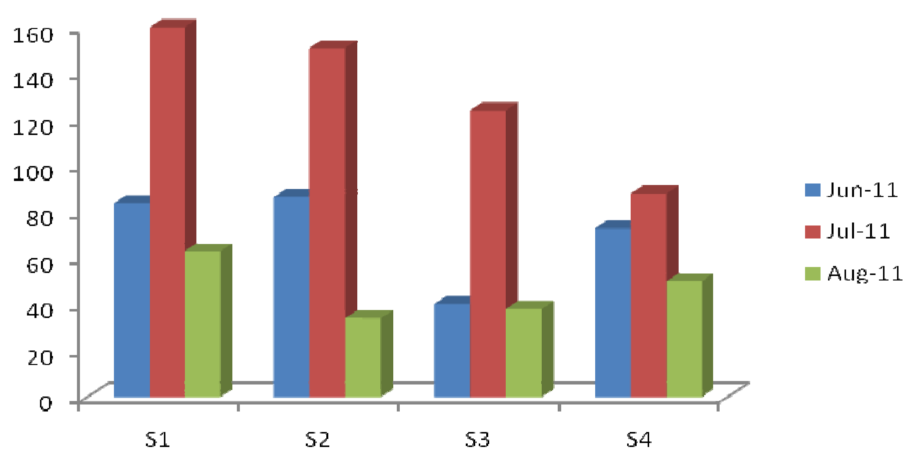

Figure 4. Spatial variation of chloride of River Galma around Dakace industrial layout

flocculation and filtration, which may increase treatment cost (DWAF, 1998). Also high turbid waters are often associated with the possibility of microbiological contamination, as high turbidity makes it difficult to disinfect water properly (DWAF, 1998). There were indications that the entire water was generally polluted for instance the turbidity levels were much more higher than WHO standard and this could have accounted for the high bacterial contaminations throughout the study. This posed a great danger to aquatic lives, the river and people using it for domestic purposes and irrigation. The high level of turbidity could be due to any of the following: industrial effluents, improper disposal of sewage, animal waste and wastewater from domestic activities among others. This finding is similar to Singhal *et al., (*2005) that stated that the origin of pollutants paper and pulp mill industries is mainly from the entry of effluents from surrounding industries.

The chloride concentration serves as an indicator of pollution by industrial effluent. In the present analysis, the chloride content in the study area varied widely. The month of July had the highest value in all the sampling stations. All the stations had the values that were lower than standard of WHO which is 250 mg/L (figure 4). This is probably because it was raining season and the chloride could have been diluted with water.

CONCLUSION AND RECOMENDATION

The present investigations conclude that the water samples subjected to study presented poor quality both in terms of physic chemical and biological parameters. High turbidity as observed in the study is often associated with higher levels of disease causing microorganism such as bacteria and other parasites. Bacterial analysis of the river clearly revealed this as high level of total coliforms was recorded. It will be unsafe to exploit water from this river for domestic and agricultural purposes without some forms of physical and chemical treatments. It is recommended that effective management and maintenance are required in order to minimize acute problem of water related diseases, which are endemic to the health of man. There is also an urgent need for public enlightenment on the state of the water and enforcement of relevant laws regarding proper treatment of industrial waste water before discharging into surface waters.

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