Original Research Article

Physicochemistry and Microbiological Quality of Surface water Body Around Port terminals

Abstract

Anthropogenic activities around the sea port are capable of causing changes on the physiochemical and microbiological quality of water bodies along the port terminals. Hence this study was aimed to investigate the physicochemical and microbiological quality of surface water along Port terminals. Surface water samples were collected from Onne port terminal using sterile containers. The samples were collected during wet and dried season between January to June. The sterile bottles were filled with surface water sample and transported in an ice packed container to Department of Microbiology laboratory of the Rivers State University for microbiological and physiochemical analyse using standard methods. Statistical analyses were carried out using ANOVA and All pairs tukey-kramer. Results of the physicochemical parameters showed that certain physiochemical parameter such as temperature, total dissolved solid, total suspended solid, nitrate as well as heavy metals were significantly higher during the dry season than the wet season of the surface water along the port terminals are above the permissible limit which indicates contamination of the water bodies due to port activities in these regions Seasonal variation with respect to microbial counts shows that Total heterotrophic bacteria, Total heterotrophic fungi, Total coliform and Faecal coliform recorded a mean value (cfu/ml) of $3.9\pm1.77 \times 10^6$, $0.8 \pm0.05 \times 10^4$, $7.4 \pm1.3 \times 10^4$, and $3.6 \pm0.17 \times 10^4$ respectively for wet season while dry season had $1.6\pm0.77 \times 10^6$, $0.5 \pm0.01 \times 10^4$, $4.6 \pm0.17 \times 10^4$ and $2.7 \pm1.03 \times 10^4$ cfu/ml respectively. In this study, ten bacteria isolates belonging to the genera E. coli, Vibrio, Pseudomonas, Klebsiella, Bacillus, Shigella, *Staphylococcus*, *Salmonella*, *Proteus*, *Bacillus* were obtained. The levels of the physicochemical and microbiological parameters determined for the surface water has helped to ascertain the water quality of water bodies along sea port terminals and with the dynamic nature of the surface water and human activities along the port indicated that the surface water of along the port terminals is highly impacted by human activities. Therefore, proper waste management approach and personal hygiene should be maintained during operation at port terminals to avoid further contamination of the receiving water bodies as well as emergence of certain water borne diseases**.**

Keyword: Port Terminals, Microbiological, Physicochemical, Quality, Anthropogenic

1.0: Introduction

Water is an Indispensable and multipurpose natural resource and exist in the three states of matter; gaseous, liquid and solid phases (Obire *et al.,* (2003), The chemical composition of surface water is derived from atmospheric, soil, and rock source. Water is a valued natural resource for the existence of all living organisms. Water is used for domestic activities, irrigation in agriculture, as a means of transportation and recreational activities among others. Water quality monitoring and evaluation is a major step to water quality management; thus, there has been an increasing demand for monitoring water quality of many rivers by regular measurements of various water quality variables (Bartam & Balance 1996). The relative distribution of the chemical composition to surface waters from each these sources is a function of the climate being modified by increasing human activities. Water is an abundant natural resource, crucial for the sustenance in all aspects of life and it is a valuable resource that needs to be well-cared-for (Adejuwon and Adelakun 2012). The increasing human population, urbanisation, rapid industrialisation and expanding food production /processes and various activities around the sea Port terminals pose a lot of pressure on water resources. (Ngah *et al,*. 2017). The river water quality is influenced by a range of factors such as weather, surface water runoff, and waste discharge from various operations around port terminals which result in changes in water quality parameters (Ogbonna). This can be observed in the variation of the impact that port activities such as shipping, dredging, ballast water discharges, storage and transportation of hazardous materials can have on receiving waters (Simpi, 2011).

According to Lawson, (2011), Sea port activities, particularly ship operations are the prime factor causing maritime pollution around port terminals .Other port activities like shipping, dredging, ballast water discharges, storage and transportation of hazardous materials generate several wastes such as industrial effluens, sewage, urban and river runoff, natural seepage, offshore oil production, ships, and others into the environment thus, causing pollution of coastal water and the sounding environment (Bailey and Solomon, 2004) soil (Ogbonna *et al.*, 2007) and water sources (Gupta *et al* 2015). Untreated water and faecal contamination of surface water can serve as the major vehicle of pathogen spread and other environmental health hazard. The presence of microbial pathogens in polluted, untreated and treated water poses a considerable health risk to the general public (Meme *et al.*, 2014). Routine microbiological monitoring of water for pathogenic bacteria is required, as a measure to prevent the spread of water borne diseases such as diarrhea, dysentery and typhoid (Ochuko and Thaddeus, 2013 Ogbonna 2014). The spectrum of water borne infections is also expanding, and many infectious diseases once believed to be conquered are on the rise. The present study is therefore to evaluate the impact of port activities on the physiochemical quality of surface surface quality and the associated microorganisms

Materials and Methods

2.1 Description area of Study

The study was carried out in Onne, Eleme Local Government Area of Rivers State. Onne is where one of the two prominent sea ports for oil and gas exploration is sited,

2.2. Sample collection

Surface water samples were collected from Onne and Warri port terminal at five different stations with sterile containers. Surface water samples were collected from both ports between January to June over a period of six months covering both wet and dried seasons. Each sample bottle was rinsed with

the appropriate water sample before the final collection. The sterile bottles were filled with surface water and transported in an ice packed cooler to the Department of Microbiology Research Laboratory of the Rivers State University for analyses.

2.3: Microbiological Determinations

Microbiological determinations of the water samples included cultivation and enumeration of total cultural aerobic heterotrophic bacteria using standard medium of nutrient agar (Oxoid) plates, and total coliform counts and faecal coliform using standard analytical methods Isolation and characterization of culturable aerobic heterotrophic bacteria using standard (morphological and biochemical) tests was also carried out according to methods prescribed by Prescott *et al*., (2005).

2.4: Identification of Bacteria Isolates

Cultural characteristics (pattern of growth, pigmentation and appearance of isolates) were observed after 24 hours of incubation at 37°C; Gram staining and biochemical reactions exhibited by the isolates in test methods of to Holt (1977). Further identification was made by comparison of their cultural, morphological and physiological characteristics with those of known taxa. Molecular analysis was also carried out on isolates for more detailed identification.

2.5: Physico-Chemical Characteristics

The quality of water is based certain physicochemical properties, in this study pH, Electric conductivity, dissolved oxygen, Biological oxygen demand and total dissolved salts were measured using their respective meter. PH was measured using a pH meter (HANNA, HI 9125) and conductivity, total dissolved salts using a calibrated Conductivity Meter (HANNA, Conductivity meter). Turbidity measurements were conducted using a portable turbidity meter (APHA, 2012). Total hardness was evaluated by burette titration. Total alkalinity, chloride, nitrate-N, sulfate and major cations were determined according to standard methods The metals concentrations were determined using Atomic absorption spectrophotometer (AAS) in duplicate and the mean value was recorded plus or minus standard deviation.

3.0 Results and Discussion

The results of the physico-chemical parameters and microbial counts of surface water obtained from Onne Port terminals during the 6 month investigation period are as presented in Table 1. Seasonal variation with respect to microbial counts shows that Total Heterotrophic Bacteria, Total Heterotrophic Fungi, Total coliforms counts and Faecal coliforms counts recorded a mean value (cfu/ml) of $3.9\pm1.77 \times 10^6$, $0.8 \pm0.05 \times 10^4$, $7.4 \pm1.3 \times 10^4$, and $3.6 \pm0.17 \times 10^4$ respectively for wet season while dry season had $1.6\pm0.77 \times 10^6$, $0.5 \pm0.01 \times 10^4$, $4.6 \pm0.17 \times 10^4$ and $2.7 \pm1.03 \times 10^4$ cfu/ml respectively. In this study, ten bacteria isolates belonging to the genera *E. coli, Vibrio, Pseudomonas, Klebsiella, Bacillus, Shigella, Staphylococcus, Salmonella, Proteus, Bacillus* (Figure 1 and 2)

The presence of these microorganisms particularly *E.coli* in the water system is universally accepted to indicate fecal contamination, and possible presence of other pathogenic organisms (Reynolds, 2016). *E. coli* is a subgroup of fecal coliforms used as an indicator of fecal contamination. Although vast majority of *E. coli* are completely harmless, some strains of the bacteria have acquired genetic capabilities which enable them to encode virulence factors (Meregini-Ikechukwu et al., 2020). Pathogenic *E. coli* strains cause diverse forms of bacterial induced illnesses with symptoms ranging from mild diarrhoea to severe complication and even death (Rocourt, 2013).

Table 1 : Physicochemical and Microbiological Characteristics of Surface water from Onne Port Terminals

Parameters			**t-test**	**WHO 2003 Limit**
	Dry	**Wet**		
pH	5.6±0.15	6.72±0.24	**<0.0001***	**6.5-8.5**
Temperature	30±1	26.6±0.54	**0.0002***	NS
Electric Conductivity (µS/cm)	14168±1.90	1847.2±2.30	**0.0035***	1000
Total Dissolved Solid	2622±1.70	917.2±2.70	**<0.0001***	500
Total suspended solid	7.6±0.54	1.4±0.548	**<0.0001***	25
Dissolved Oxygen	2.08±0.19	3±0.6	**0.0114***	
Biological Oxygen Demand	0.78±0.19	0.8±0.25	0.8921	5.0
Chemical Oxygen Demand	1.56±0.38	1.6±0.51	0.8921	NS
Turbidity	0.2±0	0.14±0.05	**0.0400***	1
Bromine	0.6±0	0.2±0	**<0.0001***	0.5
Chlorine	0.3±0	0.1±0	**<0.0001***	
Nitrate	5.98±0.74	0.262±0.06	**<0.0001***	45
Sulphate	694±1.9	250±2.01	**0.0080***	200
Phosphate	2.316±0.44	0.844±0.21	**0.0002***	
Lead Pb	0.647±0.10	<0.001±0	**<0.0001***	0.01
Nickel Ni	0.42±0.04	<0.001±0	**<0.0001***	
Zinc Zn	0.18±0.016	0.015±0.08	**<0.0001***	5.0
Iron Fe	0.791±0.151	0.531±0.143	**0.0234***	0.05
Copper Cu	0.064±0.009	0.018±0.015	**0.0004***	0.05
Cobalt Co	0.43±0.047	0.21±0.095	**0.0016***	0.05
Chromium Cr	<0.001±.0	<0.001±.0	1	0.05
Cadmium Cr	0.115±0.007	0.1±0.004	**0.0033***	0.01
Magnesium	18.72±1.495	69.775±3.013	**<0.0001***	0.05
Total Petroleum Hydrocarbon (TPH)	0.184±0.065	0.252±0.008	0.5075	0.05
Polycyclic aromatic hydrocarbon (PAH)	0.004±0.002	0.005±0.004	0.7518	0.02
Total Heterotrophic Bacteria (cfu/ml)	$1.6\pm0.77 \times 10^6$	$4.4\pm1.91.2 \times 10^6$	**0.0004***	100
Total Heterotrophic Fungi (cfu/ml)	$0.8 \pm0.51 \times 10^4$	$1.6\pm0.05 \times 10^4$	**0.0002***	0
Total Coliform (cfu/ml)	$4.6 \pm1.79 \times 10^4$	$3.9\pm0.81 \times 10^4$	0.108	0
Feacal coliform (cfu/ml)	$2.7 \pm0.03 \times 10^4$	$1.8\pm0.44 \times 10^4$	**<0.0001***	0

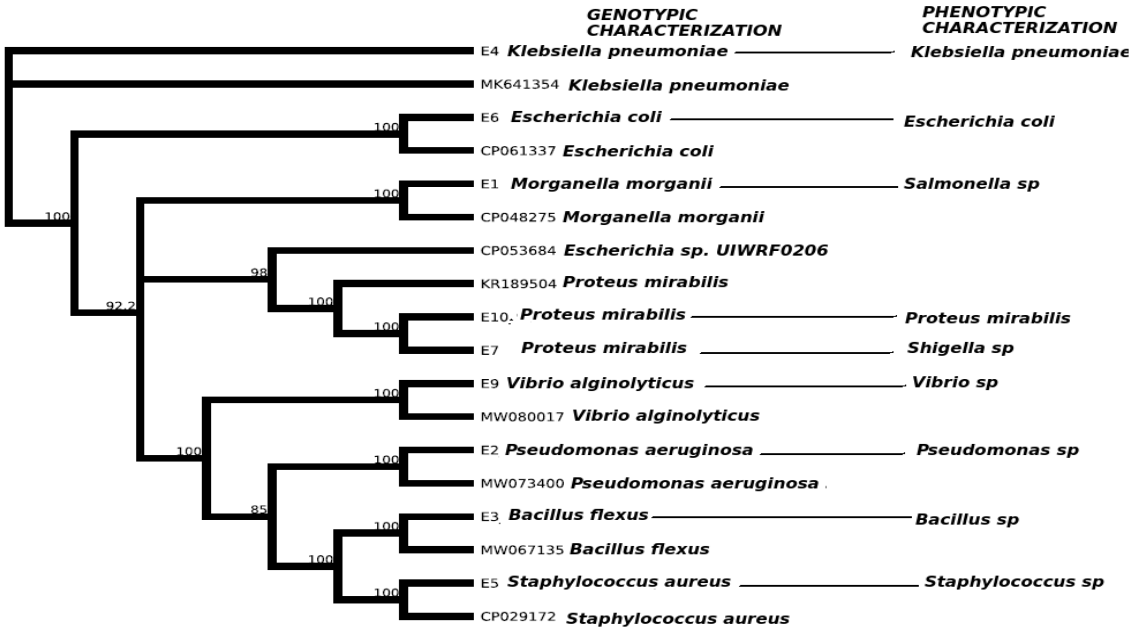

Figure 1: **Evolutionary distances between the bacterial isolates**

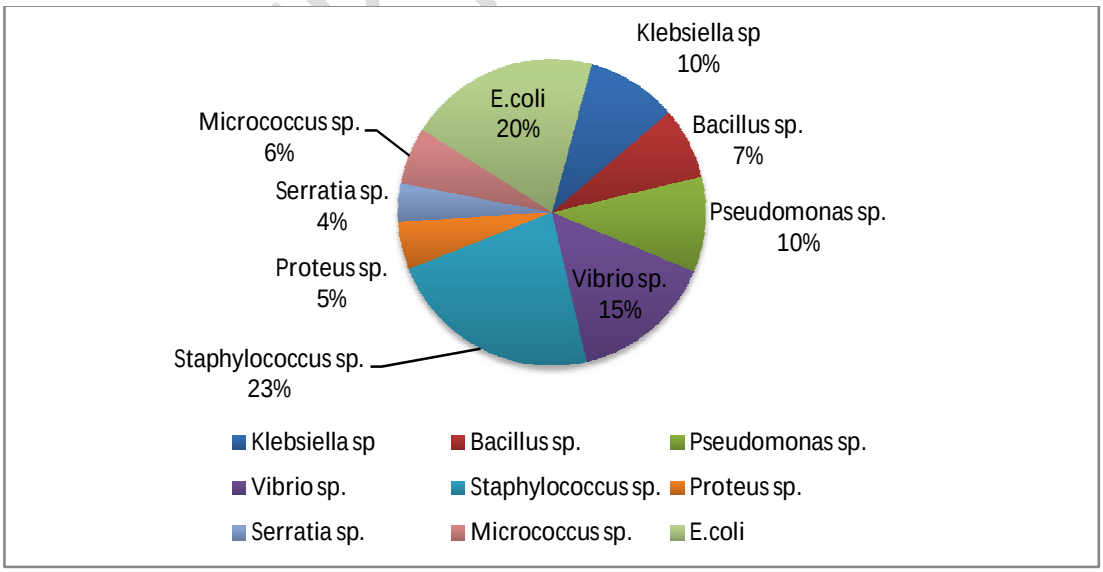

Figure 2: Percentage Occurrence of the Bacterial Isolates

As summarized in Table 1 below, certain physiochemical parameter such as temperature, total dissolved solid, total suspended solid, nitrate as well as heavy metals were significantly higher during the dry season than the wet season of the surface water along the port terminals are above the permissible limit which indicates contamination of the water bodies due to port activities in these regions.

This investigation has revealed the physicochemical characteristics and bacterial types including coliforms which are indicators of faecal pollution and of water quality of the surface water. The pH range for optimum growth of most aquatic bacteria is pH 6.5 and 8.5 (Rheinheimer 1974), which include the range of values reported in this study and for surface water from Onne port terminals

The seasonal variation of the physicochemical parameters showed that the pH which is a measure of the hydrogen ion activity of the water It is also an indicator of the acidic or alkaline nature of a water body, whether high or low pH determines the type of aquatic species is one of the most important parameters commonly measured in natural and wastewaters to ascertain their quality status. Generally, pH values measured in the present study are indicative of slightly acidic water (5.6) for the dry season, and slightly alkaline (6.72) for the (wet season). The mean pH values of the dry season were frequently below the acceptable range of 6.5 - 8.5 prescribed by the regulatory agency (WHO, 2003). The pH range for optimum growth of most aquatic bacteria is pH 6.5 and 8.5 (Rheinheimer 1974), which include the range of values reported in this study. Biochemical Oxygen Demand (BOD5) is used as an index to determine the amount of dissolved oxygen required by aerobic biological organisms (microorganisms) to decompose organic materials and also biological activity in the water. Hence high concentrations of BOD are an indication of organic pollution. It is also the measure of the biological activities in a water body, gives an indication of the organic load of water bodies, especially those receiving organic effluent. BOD mean values for Onne surface water ranged from 0.8±0.25 mg/L, for the wet season (Table 1), and from 0.78±0.19 mg/L,, with mean value of 6.14 mg/L for the dry season . Very low BOD of 0.78±0.19 mg/L was observed during the dry season sampling at Onne port terminal. Ephraim and Ajayi (2015) interpreted low BOD values as an indication of limited levels of organic matter decomposition requiring oxygen from the water.

Heavy metals occur naturally as elements with high atomic weight and density which is at least 5 times greater than water, they can mostly be found in industrial, domestic effluents, agricultural, medical and technological applications and this led to their wide distribution in the environment, which poses a threat to human health and the environment. Their level of toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as status of exposed individuals and environment. Due to their high degree of toxicity, these metallic elements are of public health significance and considered as systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure (Paul *et al.*, 2012). Heavy metal Concentrations of Copper (Cu), Chromium (Cr), Manganese (Mn), and Cadmium Heavy metal distribution has been one of the critical concerns in natural environments due to their toxicity and biomagnification attributes. Many regulations have been established to avoid heavy metal concentrations in the environment specially waters to exceed quality criteria for environmental protection. However, anthropogenic activities such as port activities have discharged significant amounts of heavy metals into surface water and rivers. Metal bioaccumulation in surface threatens ecosystems, reservoirs and habitats or food sources for aquatic fauna and flora due to the potential of metal mobilization and the subsequent uptake into food web.

Summary and Conclusion

The levels of the parameters determined for the surface water has helped to ascertain the water quality of water bodies along sea port terminals and with the dynamic nature of the surface water and human activities along the port indicated that the surface water of along the port terminals is highly impacted by human activities. Though pH levels fell within permissible limits for drinking water, other parameters such as turbidity, DO, BOD, total heterotrophs and total coliform MPN were not within permissible limits of interim standards for drinking water.The high bacterial population is as a result of increased nutrient load from the various activities along sea port which contributed to the organic pollutant load of the water. Bacteria isolated are potential pathogens of various diseases affecting man and other animals. Moreover, the presence of *Escherichia coli* which is an indicator of faecal pollution and other coliform organisms is sufficient to conclude that the water is highly polluted with pathogenic organisms able to initiate different enteric diseases. Therefore, proper waste management approach and personal hygiene should be maintained during operation at port terminals to avoid cross contamination of the environment.

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