Occurrence of Coliforms and water borne pathogens in two coastal waters in Lagos, Nigeria

Ogochukwu Agwu [1], Theresa Oluwagunke [1]

[1.] Department of Biological Oceanography, Nigeria Institute for Oceanography and Marine Research. PMB 12729, Victoria Island, Lagos, Nigeria

Abstract: The abundance of coliforms and some water borne pathogens were investigated in the surface water of Badagry Creek and Ologe Lagoon at two different sampling events. The average surface water temperature was 31.24°C, while the pH ranged from 7.14 to 7.28 at the first sampling, and 8.16 to 8.40 at the subsequent period. The salinity at Badagry Creek was from an average of 0.29 – 7.36‰ but Ologe Lagoon had a lower range of 0.04 – 0.05‰. The conductivity also varied from 0.034 – 0.4 to 5.59 – 12.86 S/m for Ologe Lagoon and Badagry Creek respectively. Although total coliforms were widespread across the sampling sites, Badagry Creek had higher population (0 – 290 MPN/100 ml) than the values (0 – 90 MPN/100 ml) encountered at Ologe Lagoon. The quality of the water bodies was further emphasized by the population of the water pathogens *Vibrio* species (3 – 4.05 x 10^2 cfuml^{-1}; 4.5 x 10^1 – 6.77 x 10^2 cfuml^{-1}) and *Salmonella/Shigella* species (2.15 x 10^1 – 8.70 x 10^2 cfuml^{-1}; 0 to 2.43 x 10^2 cfuml^{-1}) for Ologe Lagoon and Badagry Creek respectively. The microbiological status of these coastal waters indicates fecal pollution and the risk of the spread of water borne diseases.

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1. Introduction

The West African coastline is richly endowed with numerous rivers, coastal lagoons, estuaries, creeks, inland lakes and swaps. These natural aquatic environments sustain a multitude of flora and fauna thus offering means of livelihood for coastal communities. In addition, they serve various essential roles in water transportation, energy generation, sand dredging and drainage (Iscandri, 1990, Onuorah et al., 2010). Ologe lagoon and Badagry creeks are among the five main water bodies found in Lagos western-Nigeria and like other coastal waters, they ultimately serve as sink for domestic and industrial waste. Presently, they are experiencing unprecedented pressure due to increasing human and industrial activities around them (Akoachere *et al.*, 2008, Onuorah and Wim, 2010).

Recently, the increasing awareness on environmental safety, demands the assessment of the quality of water bodies for domestic, industrial, agricultural and recreational purposes. Microbiological parameters are among the main indicators of surface water quality, since ingestion of contaminated waters encourages the spread of water borne diseases such as cholera and typhoid. Incidences of these waterborne illnesses are usually as a result of pollution of water bodies with untreated and sanitary sewage. Human waste being a major component of sanitary sewage, serves as a typical source of enteric and pathogenic microorganisms. (Abdelzaher, 2008, Walczak, 2008, Ortega *et al.*, 2009). The concentration of fecal bacteria indicators is commonly used to establish the extent of microbial contamination of aquatic environment. However, recently in addition to monitoring of indicator organisms in water, the presence of pathogens is also assessed in order to have a more reliable water quality assessment (Abdelzaher, 2008, Coelho *et al.*, 1999).

Previous studies on the, physico-chemical parameters, trace metals, hydrochemistry and plankton dynamics, fish species diversity including ecology and biology of the cichlid, *Tilapia mariae* (Yusuf and Osibanjo, 2004, Olukolajo and Oluwaseun, 2008, Onuorah and Wim, 2010, Ndimele and Kumolu-Johnson, 2011) had been reported, however, there is dearth of data on the microbiological quality of this two water bodies that are of great socio-economic relevance. Therefore, this study was embarked on to determine the microbiological status of these water bodies in order to establish the public health implications for the users of this water body.

2. Material and Methods

Badagry creek and Ologe lagoon are part of the continuous systems of lagoon and creeks along the coast of Nigeria. A total of ten stations were selected for this study with five stations each for the two water bodies. Badagry creek (Fig 1), the larger of the two is about 60 Km long and 3 km wide, the depth ranges between 1 – 3 m. It lies between longitudes 30' and 3° 45'E and latitude 6° 25' and 6° 30'N. It can be described as fresh and low-brackish water, and is subjective to the tides and floods from Lagos lagoon and Cotonou harbor. Rivers Yewa, Bawa and Doforo creeks empties into it. Ologe lagoon on the other hand has a surface area of 9 – 42 Km^2 and is the smallest of the lagoons in south western Nigeria. It lies adjacent to Badagry creek between longitude 6^o 26' N and latitude 3^o 01' E to 3^o 07' E. It receives water from Rivers Owo, Ore and Opomu and waste waters from Agbara industrial and residential area (FAO 1969).

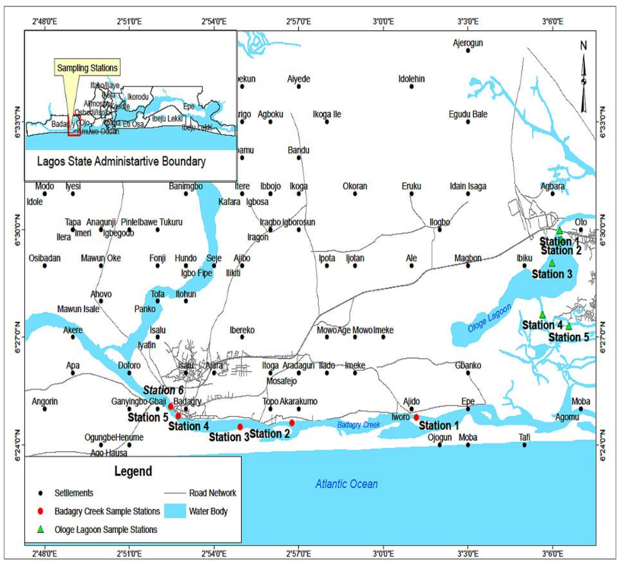

Figure 1 Map of study area showing sampling stations

The two sampling events were carried out in the months of March and May 2012. Surface water samples were collected into 1 L sterile glass bottles and were stored in ice box during transportation to the laboratory. Analysis was carried out within twelve hours of collection. The water salinity, conductivity and dissolved oxygen were calculated using the Horiba U-10 multi-parameter Water Quality Checker. The water and air temperature was measured *in situ* with mercury-in-Glass Thermometer, all equipments were adequately calibrated and checked prior to use.

The most probable number of total colifom in 100 ml of water sample was determined using the multiple tube dilution method. Presumptive positive tubes of 24 to 48 h Lauryl sulphate broth cultures were sub-cultured into brilliant green lactose broth. All cultures were incubated at 37^oC for 24 to 48 h. Counts (MPN) were estimated from probability tables. The water pathogens vibrio and Salmonella/Shigella were enumerated by the membrane filter (pore size 0.45 mm) method. After appropriate dilutions, 10 ml of samples were filtered through the membrane filter. The membrane filters were placed on Thiosulphate - Citrate – Bile - Sucrose (TCBS) agar for the *Vibrio species* and Salmonella Shigella agar for the *Salmonella/ Shigella* species.

3. Results

The mean air temperature at Badagry creek was the same (28.92± 0.19^oC) during the two sampling periods (Table 1). At Ologe Lagoon, 28.8 ± 2.97^oC was recorded in March while 28.90 ± 2.96^oC was noted for the month of May. The surface water pH was almost neutral all through the first sampling time for both Badagry Creek (7.28) and Ologe Lagoon (7.14). Nevertheless, an increase to a basic pH value (8.16 and 8.40.) was noted at the second sampling time, for Badagry and Ologe Lagoon respectively. During this study, a low (0.04 to 0.29 ‰) salinity range was observed, with the exception of Badagry Creek which had the highest mean salinity value (7.36± 0.06 ‰) at the first sampling period. The dissolved oxygen noted in this study ranged between 3.84 to 5.84 mg/l. On the other hand, the mean conductivity at Badagry Creek was 12.86 ± 1.1 and 5.60 ± 1.98 S/m while Ologe Lagoon had 0.34 ± 0.17 and 0.4 ± 0.15 S/m, for the first and second sampling periods respectively.

Table 1. Mean± standard deviations of some physico-chemical parameters of water samples

Physicochemical parameters	1st sampling (March)		2nd sampling (May)	
	Badagry	Ologe	Badagry	Ologe
Air temperature (^oC)	28.92 ± 0.19	28.8 ± 2.97	28.92 ± 0.19	28.90 ± 2.96
Water temperature (^oC)	31.24 ± 0.42	31.34 ± 0.22	31.34 ± 0.56	31.14 ± 0.42
pH	7.28 ± 0.29	7.14 ± 0.08	8.16 ± 0.39	8.40 ± 0.34
Dissolved .Oxygen (mg/l)	5.84 ± 1.47	5.8 ± 1.78	5.6 ± 0.92	3.84 ± 2.6
Salinity (‰)	7.36 ± 0.06	0.05 ± 0.09	0.29 ± 1.25	0.04 ± 0.06
Conductivity (S/m)	12.86 ± 1.1	0.34 ± 0.17	5.598 ± 1.98	0.4 ± 0.15

During the first sampling event (March), the surface water at Badagry Creek showed coliforms population with MPN of between 120 and 290/100 ml (Figure 2A). On the other hand, the range at Ologe Lagoon was between 0 and 9/100 ml (Figure 2B). This difference in the population of the total coliforms in the two water bodies was significant with a p value of 0.006. Interestingly, during the second sampling time, there was no significant difference (p= 0.135) between the populations at the two water bodies, although the population at Badagry Creek (0 – 33 MPN /100 ml) was still higher than the observed values (0 – 2 MPN /100 ml) at Ologe Lagoon. It is also noteworthy that throughout the study, the total coliforms encountered from the surface water at station 5 in Badagry Creek recorded the highest value of 290 and 33 MPN /100ml.

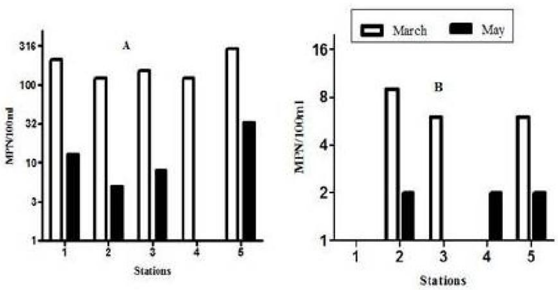

Figure 2. Population of total coliforms in Badagry (A) and Ologe (B) during the two sampling periods

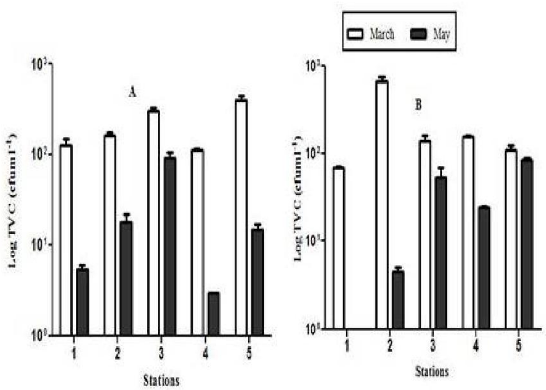

Figure 3. Population of *Vibro* species in Badagry (A) and Ologe (B) during the two sampling periods

At the Badagry Creek, during the March sampling, the least population (1.12 x 10^2 cfuml^{-1}) *Vibro* species was recorded at station 4, while station 5 had the highest population of 4.05x 10^2 cfuml^{-1} (Figure 3A). On the contrary, by the second sampling time, the highest population value of 9.4 x 10^1 cfuml^{-1} occurred in station 3, but station 4 still had the lowest population of 3.0 cfuml^{-1}. The two-way analysis of variance of this population values showed significant difference ($p < 0.0001$) in both the sampling period and within the stations. Similarly, at Ologe Lagoon, the population of this group of organism differed significantly ($p < 0.0001$) at the various station throughout the different sampling time. The population range (6.9 x 10^1 to 6.77 x 10^2 cfuml^{-1}) noted in March was higher than the value (4.5 to 8.5 x 10 cfuml^{-1}) recorded for May (Figure 3B). The surface water from station 2 had the highest population (6.77 x 10^2 cfuml^{-1}) initially, but by the second sampling time, more than a hundred and fifty folds decline to 4.5 cfuml^{-1} was observed. Comparing the population of the *Vibrio* species encountered at Badagry Creek and Ologe Lagoon, it was noted that their population did not differ significantly in March (p = 0.63) or May (p = 0.24).

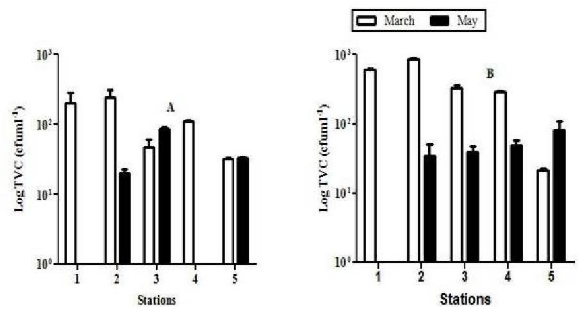

Figure 4. Population of *Salmonella/Shigella* species in Badagry (A) and Ologe (B) during the two sampling periods

The *Salmonella/Shigella* species were isolated from all the stations at the first sampling time of this study (Figure 4 A and B). At Badagry Creek, the population at the five stations was not significantly different (p = 0.135). Meanwhile, there was a significant difference (p = 0.0001) between the populations encountered during the two different sampling periods. This was obvious taking into account the drastic reduction in population at the second sampling period especially at stations 1 which had 2.01 x 10^2 cfuml^{-1} in March and 1.0 cfuml^{-1} in May. Also, station 4 showed 1.12 x 10^2 cfuml^{-1} initially while the organism was completely absent in May. On the contrary, in station 3 the population observed at the second sampling period (8.6 x 10^1 cfuml^{-1}) was higher than the population of 4.75 x 10^1 cfuml^{-1} encountered at the first sampling period. Furthermore, at station 5, there was no apparent difference in the population during the study. In the same way, four of the stations in Ologe Lagoon with the exception of station 5 had higher population of the *Salmonella/Shigella* species at the March sampling period. The populations at the two sampling period were significantly different (p = 0.0001). At the first sampling time, the highest population (8.70 x 10^2 cfuml^{-1}) was observed at station 2 while the least value of 2.15 x 10^1 cfuml^{-1} occurred in station 5. However, during the subsequent sampling, the population at station 5 increased to 8.2 x 10^1 cfuml^{-1} which was the maximum value obtained at that sampling period.

4. Discussions

The survival of bacteria in coastal waters is influenced by many environmental factors such as temperature, salinity, pH, turbidity and supply of organic matter as nutrients (Pommepuy et al., 1992). The mean water temperature for the two water bodies during this study ranged between 31.14 and 31.34^{o}C. These temperature ranges are within the optimal temperature (20 - 40^{o}C) of mesophilic microbes (Leahy and Colwell, 1990).A lower pH value (6.18 ± 0.13) had been earlier reported for Lagos Lagoon (Adebusoye et al., 2008).The lower salinity values noted at Badagry Creek was not surprising since it is closer to the opening into Atlantic Ocean. According to Ortega et al. (2009) and Tang et al. (2012), among all physical-chemical parameters, salinity is most strongly related to microbial community in aquatic environments. Ortega et al. (2009) observed that lower salinity characterized higher levels of bacterial indicators, on the contrary, in this study; Badagry Creek which had higher salinity still displayed higher bacterial population than the lower salinity Ologe Lagoon.

The occurrence of total coliforms was widespread during this study (figure 1). A similar contamination of almost all sampling sites had earlier been reported at Lagos Lagoon (Ajayi and Akonai, 2005). Generally, these feacal indicator organisms occurred more during the first sampling period in both study sites. The higher occurrence of total coliforms at Badagry Creek suggests that this water body receives more feacal waste than Ologe Lagoon. Also, the high occurrence of this group of organism at station 5 of Badagry Creek was not surprising since this sampling point is close to Badagry Market with very high incidence of human activities. Meanwhile, none was present at station 4 during the second sampling period. Furthermore, the survival of coliforms has been associated with rainfall, river discharges, low salinity, temperature and high sanitary sewage disposal (Dionisio et al., 2000; Janelidze, 2011).

According to Leclerc et al. (2002), bacterial pathogens are sturdily resistant in the water environment and to most disinfectants. This was evident in the population of the *Vibrio* and *Salmonella/Shigella* species encountered in this study (Figures 2 and 3). Although the occurrence of coliforms which are usually used as microbial pollution indicators were limited at Ologe lagoon, it was observed that water pathogens were relatively abundant in this water body. This substantiates the fact that direct measurement for pathogens may be necessary to ascertain the pollution status of water body as noted by Ortega et al. (2009). In addition, *E. coli* had shown more mortality than *Salmonella species* (Pommepuy et al., 1992). In the study of Mullipallan Creek (southeast coast of India), Ashokkumar et al. (2011) reported the presence of a good number of *Vibrio* sp., *Salmonella* sp., *Shigella* sp. and *Klebsiella* sp. These water pathogens also occurred along side coliform bacteria.

***Conclusion*:** Bacterial pathogens are excreted by infected individuals, hence, the higher the number of people contributing to sewage and fecal contamination, the more likely the presence of these water pathogens. These pathogens can infect humans through the ingestion of contaminated water, fish and shellfish and also skin contacts especially for swimmers. Water borne diseases such as cholera and typhoid can spread easily through contaminated water. In order to thwart the outbreak and spread of these waterborne diseases among communities residing around this water bodies, adequate scientific monitoring is needed to provide data for effective management and regulations.

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Corresponding Author:
Dr. Ogochukwu A. Agwu.
Department of Biological Oceanography
Nigeria Institute for Oceanography and Marine Research. PMB 12729,
Victoria Island, Lagos, Nigeria

References

1. Abdelzaher AM, Solo-Gabriele HM, Wright ME, Palmer CJ. Sequential Concentration of Bacteria and Viruses from Marine Waters using a Dual Membrane System. J. Environ. Qual. 2008; 37:1648–1655.
2. Adebusoye SA, Amund OO, Ilori MO, Domeih DO, Okpuzor JO. Growth and biosurfactant synthesis by Nigerian hydrocarbon-degrading estuarine bacteria. Rev. Biol. Trop. 2008; 56 (4): 1603 -1611.
3. Ajayi AO, Akonai KA. Distribution Pattern of Enteric Organisms in the Lagos Lagoon, Nigeria. African Journal of Biomedical Research 2005; 8: 163-168.
4. Akoachere JTK, Oben PM, Mbivnjo BS, Ndip LM, Nkwelang G, Ndip RN. Bacterial indicators of pollution of the Douala lagoon, Cameroon:Public health implications. African Health Sciences 2008; 8:85-89.

5. Ashokkumar S, Rajaram G, Manivasagan P, Ramesh S, Sampathkumar P, Mayavu P. Studies on Hydrographical Parameters, Nutrients and Microbial Populations of Mullipallam Creek in Muthupettai Mangroves (Southeast Coast of India). Research Journal of Microbiology. 2011; 6: 71-86.
6. Coelho MP, Marques M, Roseiro JC. Dynamics of Microbiological Contamination at a Marine Recreational Site. Mar. Pollut. Bull. 1999; 38: 1242-1246.
7. Dionisio LP, Rheinheimerà G, Borrego UCTA. Microbiological Pollution of Ria Formosa (South of Portugal). Marine Pollution Bulletin 2000; 40: 186-193.
8. FAO Fisheries survey in the Western and Mid-Western regions of Nigeria. FAO/SF74/NIR6, FAO Rome. (1969).
9. Iscandri N B, Biologicl observations on fresh water systems adjacent to the coast of Sierra Leone. Hydrobiologia 1990; 208:63-73.
10. Janelidze N, Jaiani E, Lashkhi N, Tskhvediani A, Kokashvili T, Gvarishvili T, Jgenti D, Mikashavidze E, Diasamidze R, Narodny S, Obiso R, Whitehouse CA, Huq A, Tediashvili M. Microbial water quality of the Georgian coastal zone of the Black Sea. Mar. Poll. Bull. 2011; 62: 573–580.
11. Leahy JG, Colwell RR. Microbial degradation of hydrocarbons in the environment. Microbiological Reviews 1990; 54: 305 – 315.
12. Leclerc H, Schwartzbrod L, Dei-Cas E. Microbial agents associated with waterborne diseases. Crit. Rev. Microbiol. 2002; 28(4):371-409.
13. Ndimele PE, Kumolu-Johnson CA. Preliminary Study on Physico-chemistry and Comparative Morphometric Characterisation of *Cynothrissa mento* (Regan, 1917) from Ologe, Badagry and Epe Lagoons, Lagos, Nigeria. Int. J. Agri. Res. 2011; 6: 736-746.
14. Olukolajo SO, Oluwaseun KA. Seasonal variation in the distribution and fish species diversity of a tropical Lagoon in south-west Nigeria. J. fish and Aqua. Sci. 2008; 3(6): 375-383.
15. Onuoha PC, Wim V. Hydrochemistry and plankton dynamics of eutrophic tropical Lagoon. Nature and Science. 2010; 8 (9):140-149.
16. Onuoha PC, Nwankwo DI, Wim V. Diatoms of Tropical Eutrophic Lagoon. Journal of American Science 2010; 6(11):452-456.
17. Ortega C, Solo-Gabriele HM, Abdelzaher A, Wright M, Deng Y, Stark LM. Correlations between microbial indicators, pathogens, and environmental factors in a subtropical Estuary. Mar. Poll. Bull. 2009; 58: 1374–1381.
18. Pommepuy M, Guillaud JF, Dupray E, Derrien A, Le Guyader F, Cormier M. Enteric bacteria survival factors. Wat. Sci. Tech. 1992; 25 (12): 93-103.
19. Tang X, Xie G, Shao K, Bayartu S, Chen Y, Gaoa G. Influence of salinity on the bacterial community composition in Lake Bosten, a Large Oligosaline Lake in Arid Northwestern China. Appl. Environ. Microbiol. 2012; 78 (13):4748–4751.
20. Walczak M. Changes of microbial indices of water quality in the Vistula and Brda rivers as a result of sewage treatment plant operation. Int. J. Ocean. and Hydro. 2008; 37 (2):65-75.
21. Yusuf KA, Osibanjo O. Trace metals in water from Ologe Lagoon, Lagos, Nigeria. Asset series b 3 2004; (1): 121-128.

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