Spatial And Temporal Levels Of Microbes Associated With Swimming Pool In Yenagoa Metropolis, Bayelsa State, Nigeria

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ABSTRACT
Swimming pools are means of recreation for tourist as well as economic boots for owners. However, the aesthetic value and public health safety of these pools may be compromised by the anthropogenic activities of the bathers due to non-compliance to aseptic standard global best practices by pool owners or swimmers. This study assessed the microbiological quality of 6 randomly selected public swimming pools in Yenagoa Metropolis, Bayelsa State. The samples were collected and analysed following standard protocols. Results on the spatial bacteriological counts ranged from $0.599 \times 10^2$ to $0.763 \times 10^2$ cfu/ml, and $0.550 \times 10^2$ to $0.866 \times 10^2$ cfu/ml temporal variation. Mild and permissible levels of microbes were detected in some pools with few exceptions. The exceeding parameters reflects non-compliance to standard aseptic or operational measures by the bathers and/or swimming pools operators. This study concludes that there is need to develop an effective monitoring program for health officers in order to ensure strict compliance with ethical operational standards of public pools.

Keywords: Bacterial, Coliforms, Swimming pool, Yenagoa, Water quality

INTRODUCTION
A swimming pool can be described as a man-made structure with limited size of water contained in a holding structure for the purpose of recreation. Swimming, one the popular recreational actives which is a fun, active and a heathy way to special leisure time especially in dry season. It is a relax and great way to beat the dry season heat. Swimming pools are good recreational places where one can practice swimming as a sport. The importance of swimming pools as a recreational tool has special importance as the residence believe is the safe leisure to pass time and exercise. Swimming pool water are routinely treated with disinfectants (chlorine compound and ozone) to minimize risk of microbiological contamination and infection. Modern swimming pool water have recirculation system so that the water can be filtered or treated effectively. Despite the level of treatment and hi-tech systems, the presence of microbes has been reported in some swimming pools and making them a potential risk for infection (Perkins, 1988; Fiorillo & Zucker, 2004).

Typically, microbes can be released from the skin orifices and cloths of bathers (Borgmann-strahsen, 2003; Tate et al., 2003). Typically, major route of entry is through mucosal secretions of the mouth, skin, nose, urine, and fecal matter or other contaminated substances and materials, that serves as vehicle for the transmission of diseases. In some cases, poorly treated water also leads to the reintroduce microbes into the pool. If not untreated, these microbial contaminants can proliferate in their concentration with higher risk of infecting the swimmers. Some microorganisms usually linked to pools contamination include Pseudomonas Aeruginosa, Legionella, Cryptosporidium parvum, Gardia, Microsporidia etc. (Tate et al., 2003; Adrey et al., 2004). There is limited information on the microbiological quality of public
swimming pool in Bayelsa State. This study is focused on bacteriological quality of public swimming pool in Yenagoa metropolis, Bayelsa State, Nigeria.

**MATERIALS AND METHOD**

**Study Area**
Yenagoa metropolis is the capital city of Bayelsa State, Nigeria, with 8 Local Government Areas (LGA), including; Brass, Nembe, Ogbia, Southern Ijaw, Kolokuma/Opokuma, Sagbama and Ekeremoh LGA (Figure 1). It is located on the southernmost part of the Nigerian map with latitude N04° 56’ 57.8’’ and longitude E006° 20’ 08.2’’. Its population is estimated to be over 300,000 (National population census, 2006). Yenagoa metropolis forms part of the wetland of the Niger Delta Region, with shallow aquifers and several networks of creeklets linked to the Epie creek that empties into the River Nun via the Ikoli and Taylor rivers (Angaye, 2019).

![Figure 1: Map of the Study area](image)

**Sampling**
The sampling of this study for water quality assessment was carried out in six public swimming pools including the control station. The sampling stations were coded LA, LB, LC, LD, LE and LX for the control station as presented in Figure 1. The sampling was carried out in a post-monthly manner for the months of January, April, July and October.

**Microbiological Analysis**
Samples for microbiological were preserved in sterilized Mc Catherney Bottles. The microbial enumeration of the pool water samples was carried out using serial dilution and pour plate technique as described in literature (Benson, 2002; Pepper & Gerba, 2004; APHA, 1998; Edet et al., 2017). About 1 ml aliquots of the water samples was dispense into the 9.0 ml of sterile distilled water in plugged test tube and agitated for even distribution, making a dilution factor of $10^{-1}$. Furthermore, serial dilutions ranging from $10^{-2}$ - $10^{-7}$ was achieved from the first aliquot. About 1ml of each dilution from the respective test tubes were aseptically pipetted unto the individual labeled sterilized Petri dish, before the respective medium were poured to the plates.
Total Heterotrophic Bacteria
Nutrient Agar (for bacterial growth) was medium used for the culture and enumeration of Total Heterotrophic Bacterial Count (THBC). It was prepared by weighing 11.2g of nutrient agar into 400ml of distilled water in Erlenmeyer flask (Ajadi et al., 2016). The mixture was agitated thoroughly to ensure even dissolution and heated over a Bunsen burner flame for 30 minutes. The medium was sterilized in an autoclave at 121°C for 15 minutes at 15psi. The medium was allowed to cool down to 45°C, and 15ml of the medium was poured into sterile petri dishes and allowed to solidify before use (Ajadi et al., 2016; Nrior et al., 2016).

Statistical Analysis
Data from this study were sampled in triplicates, and subjected Analysis of Variance (ANOVA) for mean separation. Furthermore, Duncan multiple range was the Post Hoc used to detect the level of significant difference (p<0.05). The 2016 version of Microsoft excel was used for the computation of mean values and the plotting of graphs.

RESULT AND DISCUSSION
The levels of Total Heterotrophic Bacteria count (THBC) in pool LA ranged from 0.367 – 0.787 X10² cfu/ml (p<0.05), with lowest and highest values in January and October respectively (Table 4.14). In pool LB, THBC levels ranged from 0.497 – 0.963 X10² cfu/ml (p<0.05), with the months of January and October having the lowest and highest values respectively (p<0.05). In Pool LC, the lowest and highest THBC values (0.527 – 0.957 X10² cfu/ml) were in January and October respectively (Table 4.14). In pool LD (0.647 – 0.857 X10² cfu/ml), the lowest and highest THBC levels were in the months of January and October respectively (Table 1). The lowest and highest THBC levels of pool LE (0.677 – 0.957 X10² cfu/ml) were in the month January and October respectively (Table 1).

Table 1: Mean background Levels of Total Heterotrophic Bacterial Count

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>April</th>
<th>July</th>
<th>October</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA</td>
<td>0.367±0.04c</td>
<td>0.563±0.03f</td>
<td>0.680±0.02hi</td>
<td>0.787±0.02k</td>
</tr>
<tr>
<td>LB</td>
<td>0.497±0.02e</td>
<td>0.440±0.05f</td>
<td>0.673±0.02hi</td>
<td>0.963±0.05l</td>
</tr>
<tr>
<td>LC</td>
<td>0.527±0.05e</td>
<td>0.583±0.02g</td>
<td>0.717±0.03ij</td>
<td>0.957±0.04l</td>
</tr>
<tr>
<td>LD</td>
<td>0.683±0.02hi</td>
<td>0.647±0.04h</td>
<td>0.857±0.04k</td>
<td>0.840±0.04l</td>
</tr>
<tr>
<td>LE</td>
<td>0.677±0.02hi</td>
<td>0.740±0.04jk</td>
<td>0.750±0.02jk</td>
<td>0.883±0.02k</td>
</tr>
<tr>
<td>LX</td>
<td>0.050±0.04ab</td>
<td>0.000±0.00a</td>
<td>0.083±0.01b</td>
<td>0.050±0.05ab</td>
</tr>
</tbody>
</table>


Figure 2: Spatial levels of THBC across the pools
The spatial mean levels of Total Heterotrophic Bacterial Count (THBC) across the pools ranged from 0.599 – 0.763 x 10^2 cfu/ml (Figure 2). In addition, the lowest spatial mean level of THBC was reported in pool LA, while the highest THBC was reported in LE (Figure 2). The levels of THBC across the different months ranged from 0.550 – 0.866 x 10^2 cfu/ml (Figure 3). The month of January had the minimum mean concentrations of THB, while the months of January had the maximum mean level of THB. In addition, the control station (LX) had mean THB level that was below detection limit (Figure 3).

![Figure 3: Post-monthly levels of THBC](image)

The mean levels of THB reported for this study were lower and inconsistent with levels reported in the study of Ajadi et al., (2016); Agbagwa and Young-Harry (2012); Onifade et al., (2019). This implies that most of the swimming pools in the study area may have complied with bacterial check. Notwithstanding, major bacterial contaminants of pools includes pathogenic enteric bacterial such as: *Enterococcus spp.*, *Escherichia coli*, *Staphylococcus aureus*, *Psudomonas aeruginosa*, *Bacillus spp.*, *Klebsella sp.*, *Citrobacter sp.*, and *Enterobacter sp* (Agbagwa & Young-Harry, 2012; Onifade et al., 2019). Increase in bacterial count might be due to uncontrolled usage of the pool by swimmers and non-compliance to aseptic measures (Agbagwa & Young-Harry, 2012), or the inadequate disinfection of the pool (Papadopoulou et al., 2008). Also, parameter like temperature should be checked because it can also aid the proliferation of bacteria (Leoni et al., 2001). Unfortunately, mild level of coliform was detected in some of the swimming pool which may have been introduced by the bathers (Esinulo & Ogbuagu, 2016), or pool aseptic or operational standards by the pool operators. Similar, exceeding coliform level have also been reported in the studies of Agbagwa and Young–Harry (2012); Onifade et al., (2019).

The detection of coliform in pool reflect poor management on the part of the pool managers. The level of heterotrophic bacterial and coliform have been extensively used as yardstick for microbiological quality of water for recreational purpose (Agbagwa & Young–Harry, 2012). Several opinions have been proffered as to how the quality of swimming pool water can be evaluated. Some authors opined that microbes like heterotrophic bacteria and total coliform should be monitored because they are indicators organisms and of good hygiene, while others considered those of faecal sources of pollution because infection risk is more related to microbes associated with the orifice (Galbraith, 2000; Favero et al., 2004; Seyfried et al., 2005; Mood, 2007).

**CONCLUSION**

This study was based on the microbiological quality assessment of public swimming pools in Yenagoa Metropolis. The microbiological quality of randomly selected public swimming pools was assessed. Results showed that the pools were within the water quality permissible limits of the WHO, apart from a few exceptions. Parameters that didn’t comply with WHO regulatory limit reflects non-compliance to
standard aseptic or operational measures by the bathers and/or swimming pools operators. We strongly recommend the routine regulatory monitoring of public swimming pool in order to mitigate possible microbiological contamination and infection.

REFERENCES


