Analysis of Bacteriological Quality of Some Selected Swimming Pools in Port Harcourt Metropolis

Zorasi C. B., Richard, O. & Nonso, A.
Department of Science Laboratory Technology,
Ken Saro Wiwa Polytechnic,
Port Harcourt, Nigeria.

Amakiri , S.
Department of Physics,
Rivers State College of Health Science and Technology,
Port Harcourt, Nigeria.
Correspondence email: collinzi4u@yahoo.com.

Abstract
To ascertain microbiological qualities of swimming pools water for contamination and compliance with laid down Standards to protect Swimmers health were carried out in four different pools within Port Harcourt city. Water sample were analyzed to determine their bacteriological parameters such as total heterotrophic bacteria, total coliforms, fecal coliforms, Salmonella Species, Vibrio Species and Escherichai Coli. The four swimming pools were; Uniport swimming pool, Everich swimming pool, Presidential swimming pool and Protea hotel swimming pool. The result of the analyses shows that the total heterotrophic bacteria count of different swimming pool samples ranged from 1.0 × 10^5 to 2.3 × 10^6cfu/ml. The fecal Coliforms also had counts ranging from 5×10^0 to 4 × 10^1 cfu/100ml. No growths were observed for Salmonella, E. Coli and Vibrio Species in all sample tested. The presence of these bacteria indicates the presence of entrance pathogenic bacteria in the pool(s) which constitute public health hazard for Swimmers. Finally, the bacteria species isolated were enterobacter Sp, Stapylococcus aurenus, Pseudomonas Sp, Streptococcus Sp, Micrococcus Sp, Aeromonas acropgenes, Lactobacillus Sp, Websiella Sp, and Citrobacter Sp.

Key words*: Bacteria; Pathogenic; Swimming Pool; Hazard; Water Quality.*

INTRODUCTION

Most of the cities in Nigeria have long enjoyed recreational activities that involve water. The municipal pool is where a lot of young Nigerians take their first step in learning to swim (Queensland Health, 2004). Recreational use of water can deliver important benefits to the health and well-being of humans. Yet, there may also be adverse health effects associated with it if the water is polluted or unsafe **(**Esinulo and Ogbuagu, 2016**).** Swimming pools may be private, semipublic or public, and may be supervised or unsupervised (WHO, 2006). Recreational waters include swimming pools, whirlpools, and naturally occurring fresh and marine waters (APHA 2005). A variety of microorganisms can be found in these swimming pools and similar recreational water environments which may be introduced through several means. Microbial hazard describes illness and infection associated with microbial contamination of swimming pool water (WHO, 2006).The risk of illness or infections have been linked to faecal contaminations of

the water. Faecal matter is introduced into the water when a person has an accidental faecal release of stool or diarrhea into the swimming pool water or residual faecal material on swimmers bodies is washed into the pool thereby generating disease outbreak to swimmers (CDC, 2001). Public swimming facilities are continually contaminated with harmful bacteria from urinary and faecal accidents, various orifice, washings and other forms of bacterial contamination (Onajobi ,Okerentugba and Okonko , 2013).Even in the best operated pools, disease transmission is always possible and for a disease transmission episode to occur, there must be three factors present at the same time; the source of pathogen, transmission path and susceptible host (Health Protection NSW, 2013). The source of pathogenic micro organisms is likely faecal material from a person with infection. The transmission pathway is the swimming pool water and susceptible host is a person in the swimming pool water. It is capable of developing an infection (Health Protection NSW, 2013). If one of the above three factors is not present, then transmission of disease will not occur (Health Protection NSW, 2013). Many disease outbreaks related to swimming pools may be prevented or reduced if the pool is properly managed. Non faecal human shedding from vomit, mucus, saliva or skin in the swimming pool or similar recreational water environment is a potential source of pathogenic organisms. Some bacteria, most notable non-faecally derived bacteria may accumulate in biofilms and present an infection hazard. In addition, certain free living aquatic bacteria and amoebae can grow in pool, natural space or hot tub waters and cause a variety of diseases such as respiratory, dermal or central nervous system infections (WHO, 2006). The increase of water borne disease outbreak and illness related to public swimming facilities in the past few decades suggests a need to analyze the bacteriological composition of swimming pool facilities to better protect public health safety (Onajobi, Okerentugba, and Okonko, 2013). Unless water is adequately treated, contamination may lead to outbreak of diseases such as skin ulcers, gastroenteritis, conjunctivitis, trachoma, ear infection (such as otitis media), cholera, dysentery, eczema and skin rashes (Cairncross *et al*.,1980 and UNDP, 1989).This paper investigates the microbiological qualities of swimming pool water to see if these pools in some selected locations in Port Harcourt metropolis are in compliance with the standards for swimming pool water (WHO, 2006).

MATERIALS AND METHODS

The materials used includes: glassware, conical flask, pipette, test tubes, Petri-dishes and foil. All glass wares were washed clean with detergent and water whereas Petri dishes, conical flasks, pipettes, test tubes etc used were sterilized by auto claving at 15Psi and at the temperature of 120^0C for 15mins. Recreational water bodies, which are frequently visited by many people and those which are easily accessible for public use were selected(Bekele and Leta, 2014). A total of four swimming pools were selected for the study. These four pools are located within Port Harcourt metropolis; namely; University of Port Harcourt swimming pool (USP), Everich swimming pool (ESP), Presidential Hotel swimming pool (PSP) and Protea Hotel swimming pool (PHSP). A total of 12 samples (comprising of three each) of four swimming pools were obtained from the different sites within Port Harcourt metropolis. Water samples collected from each swimming pool or recreational site was done following APHA (1998) guidelines. Each water sample was collected at depth of 20-30cm at a point about 50cm away from the pool edges (Bekele and Leta, 2014) into sterile glass bottles (each with capacity of 1.5L). Sodium Thiosulphate was added for complete neutralization of residual chloride from different regions of each swimming pool. The samples were aseptically collected in an interval of two weeks period

and were immediately taken in cold packs under aseptic condition to the laboratory for bacteriological analysis (Onajobi, et al, 2013). All samples were collected during the peak of bathing periods (weekends) in the evening. The sample bottles were labeled A – D based on the site of collection and period of collection for easy identification.

SOLID MEDIA PREPARATION

The swimming pool water samples were examined in terms of bacteriological parameters using the standard procedures of the American Public Health Association, (APHA, 1992) guidelines.

Samples Preparation for Bacteriological Analysis

The standard pour plate method was adopted in this study (Onajobi, et al, 2013).Ten-fold serial dilution of each sample was prepared aseptically in sterile physiological saline solution up to 10^{-3} dilution factor and 0.1ml aliquot of each dilution was seeded onto duplicates sterile agar plates of Nutrient Agar (oxoid), Eosin Methylene Blue Agar (oxoid), MacConkey Agar, MacConkey Broth, *Salmonella/Shigella* Agar. The plates were properly swirled and incubated at 37^{o}C in an inverted position for 24 -48 hours under anaerobic conditions. Different cultere plates were examined for microbial growth after incubation time. Colonies were counted using the colony counter (Gallenkamp, England). The number of colony forming units per ml (cfu/mL) was calculated by multiplying the number of colonies by the dilution factor. The counts were used to estimate total heterotrophic count, total *E. coli* count, total Salmonella/ Shigella count and total feacal coliform which were incubated at 44^{o}C. These methods are as follows:

i) Nutrient Agar for Enumeration of Total Heterotrophic Bacteria.

The medium was prepared by weighing 2.8g of nutrient agar and transferred into 250ml conical flask and 100ml of deionized water gradually added to it. This was subjected to boiling to dissolve completely by heating over Bunsen burner flame for 30mins. The medium was sterilized at 121^{0}C for 15mms using the autoclaving at 15Psi.The medium was allowed to cool down to 45^{0}C and about 15ml of the medium was poured into sterile Petri-dishes. The plates were allowed to set and dried in an oven before use.

ii) MacConkey Agar for Enumeration of Total Coliform /Faecal Coliforms

5.2g of MacConkey agar was weighed using weighing balance. The 5.2g MacConkey agar was transferred into 250ml conical flask and 100ml of distilled water was gradually added to it. This was brought to boiling to dissolve completely by heating over Bunsen burner flame for 30mins. The medium was sterilized at 121^{0}C for 15mins using the autoclave at 15 Psi. It was allowed to cool down to 45^{0}C; and about 15ml of the medium was poured into sterile Petri-dishes. The surface gel was dried before inoculation.

iii) TCBS Agar Enumeration of Vibio Species

8.7g of TCBS agar was weighed and transferred into 250ml of conical flask. Then, 100ml of distilled water was added to it and mixed properly. This was brought to boiling for 1mins to dissolve completely by heating with frequent agitation. The medium was allowed to cool down for 45-50^{0}C, swirled gently and formation of bubbles was avoided while pouring into Petri-dishes.

iv) Salmonella Shigela Agar for Enumeration of Salmonella – Shigela

6.3g of the Salmonella – Shigela (SS) agar was weighed and transferred into 250ml of conical flask. 100ml of distilled water was added to it. The mixture was brought to boil with frequent agitation and allowed to simmer gently to dissolve the agar. The mixture was cooled to about 50^0C and poured into Petri-dishes and allowed to set.

v) Eosin Methylene Blue Agar Enumeration of E. Coli (Escherichia coli)

3.6g of the medium was weighed using weighing balance. 3.6g of Eosin Methylene blue agar was transferred into 250ml of conical flask and 100ml of distilled water was gradually added to it and mixed properly. This was brought to dissolve completely by heating over Bunsen burner flame for 30mins. The medium was sterilized at 121Psi. The medium was allowed to cool down to 40 – 45 ^{0}C swirled gently. Formation of bubbles was avoided while pouring into Petri-dishes.

PREPARATION OF DILUENT

1ml of each water sample was pipetted into 9ml normal saline to form tenfold serial dilution of 10^{-1}-10^{-4} was carried out using 9:1 dilution ratio for each sample. 0.1 ml aliquot of the pre-enrichment broth of 10^{-1} and 10^{-4} dilution was aseptically selected with a sterile pipette and spread plated in duplicates with flame sterilized glass spreaders on well dried agar plates. The plates inoculated at appropriate temperature for 24hrs. After 24hrs of inoculation, the colonies were counted and expressed in cfu/ml (that is colony forming units and ml is milliliter).

RESULTS

Microbial indicators, total heterotrophic (TH), total caliform (TC), Faecal coliforms (FC), salmonella species (SS), Vibro species (VS) and Escherichai coli (EC) test were conducted and results of microbiological characteristics are presented below in table 1.1

Table 1.1 bacteria count of different swimming pool samples

Microbial parameters	UPSP	ESP	PSP	PHSP
Total Heterotrophicbacteria (cfu/ml)	1×10^5	2×10^5	2.3×10^6	1×10^5
Total coliforms (cfu/ml)	3×10^2	6×10^2	2.4×10^3	2×10^2
Facial coliforms (cfu/ml)	3×10^0	2×10^1	4×10^1	1×10^1
Salmonella species (cfu/ml)	-	-	-	-
vibro species (cfu/ml)	-	-	-	-
Escherichai coli (cfu/ml)	-	-	-	-

From table 1.1, the total heterotrophic bacteria counts of different swimming pool sample range from 1.0×10^5 to 2.3×10^6 cfu/ml while the corresponding values of total coliform range from 2×10^2 to 3×10^3 cfu/ml. The faecal coliforms also had counts range from 5×10^0 to 4×10^1

cfu/ml. No growth was observed for salmonella, Vibro Species and Escherichai coli in all sample tested.

DISCUSSION

The selected swimming pools were tested for total bacteria counts as shown in table 1.1. the presence of these bacteria indicator indicates the possible presence of entrance pathogenic bacteria into the pool. This incidence constitutes public health hazards because swimmers can accidentally swallow contaminated pool water during swimming which can result in outbreak of disease like cholera, typhoid, shigellosis and paratyphoid fever, gastroenteritis and diarrhea. Furthermore, high bacteria count could probably come from contaminated water source or ineffective socio-economic activities and levels of the users and the location of the pools could affect its qualities. Moreover, it could be that the pools staff are not doing a proper control process either due to lack of training of operators or the use of improper methods of disinfection as using manual chlorination by untrained operator instead of using automatic disinfection that will produce fixed and continuous chlorine dose.

CONCLUSION

Swimming pools are important as it serves as one of the popular sports and training venue for one learning how to swim and as a recreational tool. It requires special attention because of the health hazards of swimming pools. It is essential to monitor water quality in swimming pools to ensure safety of water and compliance with standards. Based on the result of this study, most of the swimming pools in this study did not meet up in terms of the bacteriological standard of pools as specified by world health organization (WHO, 2004). Therefore, this call for urgent action by all concerned: the operators, the users and the various health authorities in order to stem the incidence of recreational diseases. Corrective measures to protect swimmers from related hazards associated with swimming pools includes: to ensure that a public space does not pose risk to health of the general public. The pool water should be tested for certain organisms. It is recommended that a bacteriological sample for each public swimming pool be submitted to a national [aquatic federation] association for testing authority or equivalent registered private analyst every month of continuous operation. People should be encouraged to shower before swimming and constant monitoring of the pools should be put in place for compliance with regulations.

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