BIORESEARCH BULLETIN
Sapience Research Labs

ORIGINAL PAPER OPEN ACCESS

Bacteriological assessment of some swimming pools within Ilorin Metropolis, Kwara, Nigeria.

Sule IO, Oyeyiola GP.

Received 7 April 2010 /Accepted 15 April /Published Online: 22 June 2010

Abstract

Six swimming pools within Ilorin metropolis were analysed after treatment prior to use by bathers and after use in order to determine their physicochemical and microbiological parameters. These swimming pools were Kwara hotel both adult and children swimming pools, Bekandims, Stella, Kingstone and Successxs swimming pools. The pH ranged from 4.8 to 6.9 and 4.9 to 7.6 before and after use by bathers respectively. Residual chlorine also ranged from 8.95 to 11.08 ppm and 7.17 to 10.08 ppm before and after use by bathers respectively. The total bacterial count ranged from 2.0 to 2.8×10^3cfu/ml and1.4×10^2 cfu/ml to 3.0×10^3 cfu/ml before and after use respectively. Faecal coliform counts ranged from zero to 4 cfu/ml and zero to 6 cfu/ml before and after use by bathers while their corresponding values of total coliforms were zero to 200 cfu/ml and 4 to 300 cfu/ml respectively. T-test statistical analysis showed that there were significance between the total bacterial count and the free residual chlorine contents of the pools water before and after use by the bathers. A total of thirteen bacterial species viz: *Enterobacter aerogenes, Staphylococcus aureus, Pseudomonas* sp., *Bacillus* sp., *Streptococcus* sp*., Micrococcus luteus*, *Aeromonas aerogenes*., *Aerococcus* sp*., Lactobacillus* sp., *Klebsiella* sp*., Citrobacter freudii., Corynebacterium* sp., and *Escherichia coli* were isolated. The possible sources of contaminations were identified and mitigation measures highlighted.

Keywords: Water supply, bacteriological, physicochemical, swimming pools.

Sule IO.
Department of Microbiology,
University of Ilorin, Ilorin, Nigeria.

E-Mail: ismailaolawales@yahoo.co.uk,

Web address:
http://bioresonline.org/archives/A102.pdf

Article citation:
Sule IO, Oyeyiola GP. 2010. Bacteriological assessment of some swimming pools within Ilorin Metropolis, Kwara, Nigeria.
Bioresearch Bulletin 1: 013-017.

INTRODUCTION

A swimming pool is an artificially enclosed body of water intended for swimming or water based recreation. Bathing and swimming for pleasure has been practiced by many land animals for unrecorded ages, and human record of the pleasure of immersion in water go back several thousand years ago (Perkins, 1988).

The depth of a swimming pool depends on the purpose of the pool, and whether it is open to the public or strictly for private use. Many countries now have strict pool fencing laws for private pools which require pool areas to be isolated so that unauthorized children younger than six years can't enter (EPA,2007). Public pools are often found as part of a larger leisure center or recreational complex. Public pools may belong to a hotel or holiday retort as an amenity for the recreation of their guests (Kate and Dominck, 2008).

The water supply to a pool is usually taken from the mains of a public supply. Swimming pool sanitation refers to both visual clarity and levels of microflora such as bacteria, protozoans and viruses in swimming pools (Totkova *et al*., 1994).The goal of sanitation is to prevent the spread of diseases and pathogens between users.

Swimming pool water may become contaminated by micro-organisms from infected swimmers, incoming water from an unsanitary source, airborne contamination and droppings from birds is possible (Podewils *et al*., 2007).

Contaminated water can lead to a variety of disease including diarrhoea, skin, ear and upper respiratory infections particularly if the swimmer's head is submerged or water swallowed.

Some potential protozoans diseases in poorly maintained public swimming pools include cryptosporidiosis (caused by Cryptosporidium) and Giardiasis caused by Giardia sp. and amoebic meningoencephalitis caused by *Naegleria foweri* (CDC, 2006).

E. coli and *Shigella* are relatively sensitive to chlorine or bromine so most outbreaks have occurred in locations where no disinfectants are added. Non faecal human shedding (from mucus, saliva, skin) in the swimming pool is a potential source of non-enteric pathogenic organisms. Other non-enetric pathogens that can be found in swimming pools are *Legionella* spp., *Pseudomonas aeruginosa, Mycobacterium* spp., *Staphylococcus aureus, Leptospira interrogan, Molluscipoxvirus, Human papilloma virus, Acanthamoeba* spp., *Trichophyton* spp., and *Epidemophyton floccosum,* that usually produce dermic or respiratory infections. (Eric *et al*., 1982).

Strong oxidizing agents are often used especially simple chlorine compounds such as sodium hypochlorite, dichlor or trichlor .When any of these pool chemicals are used, it is very important to keep the pH of the pool in the range 7.2 to 7.6 (CDC, 2006).

A pool that is in proper balance should have a pH of 7.6, calcium Hardness of 120 ppm and a residual chlorine level of 1.0 to 2.0 ppm.

The objectives of this study is to determine the level of sanitation of the swimming pools; determine the species of bacteria which might be present in it and to evaluate of some of its physicochemical quality.

MATERIALS AND METHODS

Collection of Water Samples

Water samples were collected from the following pools: Kwara hotel (Adult), Kwara hotel (Children), Bekandims, Stella obasanjo multipurpose complex, Kingstone hotel, and Successxs hotel. The water sample was collected into different sterile sampling bottles using methods as described by APHA (1985) and Fawole and Oso (2005). The bottles were properly tightened and taken to the laboratory immediately for analysis.

Physicochemical Analysis

Residual Chlorine was determined as described by B.P.(1993) using 0.1N silver nitrate solution while the pH was determined according to standard methods (ASTM, 1985).

Bacteriological Analysis :

The total bacterial count was determined using standard plate count (SPC) as described by APHA, (1985).The total and faecal Coliform count were determined using MacConkey agar and Eosin methylene blue agar respectively by pour plate technique (Salle,1973).

Characterization and identification of isolates

Bacterial isolates were characterized on the basis of colonial morphology, cellular morphology, staining reactions and biochemical characteristics. The tests were carried as described by Joklik *et al*., (1992). Isolates were identified according to Bucchanan and Gibbon (1974).

Statistical analysis:

T- test was used to determine if there is significant difference between the results obtained

for each parameter before and after use by the bathers (Bello and Ajayi, 2000).

RESULTS

The pH of the swimming pools water prior to use after disinfection and after use ranged from 4.8 - 6.9 and 6.4 - 7.6 respectively. Similarly, the residual chlorine level ranged from 8.95 - 11.08mg/l and 7.17 - 10.08mg/l before and after use respectively (**Table 1**).

Table 1: Some physicochemical parameters of water samples from the Swimming pools

Swimming Pools	pH		Residual chlorine (ppm)	
	Before use	After use	Before use	After use
Kwara hotel (Adult)	6.6	7.0	9.80	9.44
Kwara hotel (Children)	6.5	7.0	9.73	9.30
Bekandims hotel	6.9	6.4	9.94	8.66
Stella	6.5	6.9	9.23	7.31
Kingstone hotel	5. 9	7.6	11.08	10.08
Successxs hotel	4.8	4.9	8.95	7.17

The total bacteria count of the pools water prior to use and after use ranged from 2 – 2800 cfu/ml and 140 – 3000 cfu/ml respectively (**Table 2**).The total coliform count ranged from zero to 200 cfu/ml and 4 – 300 cfu/ml before and after use while their corresponding values of faecal coliform were zero to 4 cfu/ml and zero to 6 cfu/ml (**Table 3**).The distribution of the various bacteria species isolated were as depicted in **Table 4.**

The results of the T-test statistical analysis showed that there were no significant difference between the results obtained from the pools water prior to use by bathers and after use ($p>0.05$) for these parameters: pH, faecal coliforms and total coliforms. However, there were significant differences in the bacterial counts and the free residual chlorine levels before and after use by the bathers.

Table 2: Total Bacterial counts of the swimming pool water samples

Swimming Pools	Total Bacterial count (cfu/ml)	
	Before use	After use
Kwara hotel (Adult)	2	140
Kwara hotel (Children)	30	690
Bekandims	33	800
Stella	2800	3000
Kingstone	23	170
Successxs	36	230

DISCUSSION

It is obvious from the results that none of the swimming pool fully complied with the WHO Standards. This is similar to the observation of Attah *et al.(2007)* who found that none of the surveyed public swimming pool was in full compliance with the Jordanian standards for swimming pools water.

Only one of the water from the swimming pools(17%) had pH within the range of pH 7.2 – 7.8 (WHO,2008). Adrian *et al.*(1984) found that 37% of the swimming pools in South Australian had pH outside the recommended level. Furthermore, the residual chlorine level of the pools are well above the standard of 5mg/l (WHO,2008) and this may be responsible for the low pH recorded due to excessive use of the disinfectant (hypochlorite).

Five out of the six swimming pools (83.3%) met up in terms of bacterial count of less than 100 cfu/ml before use by bathers after disinfection. The high bacteria count at Stella's pool prior to use by bathers could probably come from contaminated water source or ineffective treatment (Table 2).

The immediate environment of all the pools were cleaned and tiled. Le Chevallier *et al.*(1998) has reported the occurrence of coliforms in the presence of disinfectant residual. All the pools had increment in bacterial load after use by bathers. This is in conformity with the work of other workers who reported that bathers tend to shed bacteria from faecal and non- faecal sources (Craun *et al.*,2005). Another perspective to increase bacteria count after use could be due to stirring up of sediments harbouring micro-organisms which chlorine did not act upon. Fifty percent of the swimming pools had zero coliform count while only one (16.7%) had faecal coliform count of 4 cfu/ml prior to use (Table 3). All the pools had varying number of total coliforms after use by the bathers whereas 33.3% had faecal coliforms.

Table 3: Total coliform and faecal coliform count of water samples from the swimming pools

Swimming Pools	Total Coliform count (cfu/ml)		Faecal Coliform count(cfu/ml)	
	Before use	After use	Before use	After use
Kwara hotel (Adult)	0	6	0	0
Kwara hotel (Children)	0	26	0	0
Bekandims	0	4	0	0
Stella	200	300	0	0
Kingstone	18	40	0	2
Successxs	6	20	4	6

Table 4: Distribution of Bacterial isolates in some swimming pools water within Ilorin Metropolis

Isolates	Kwara hotel (Adult)	Kwara hotel (Children)	Bekandim	Stella	Kingstone	Successxs
Enterobacter aerogenes	-	-	+	+	-	+
Staphylococcus aureus	+	+	+	+	+	+
Pseudomonas sp.	-	-	-	+	-	+
Bacillus sp.	+	+	+	+	-	+
Micrococcus luteus	+	+	-	-	+	-
Aeromonas aerogenes	-	+	+	+	-	+
Aerococcus sp.	+	-	-	-	-	-
Lactobacillus sp.	-	-	+	+	+	+
Klebsiella sp.	-	+	-	+	-	+
Citrobacter freudii	+	+	+	-	-	-
Corynebacterium sp.	-	-	+	+	+	+
Escherichia coli	-	-	-	-	+	+
Streptococcus sp.	-	+	+	+	-	+

KEY +: Isolated - : Not isolated

It is recommended that swimming pools operators should use the required disinfection regime allowed (5mg/l) rather than superchlorination; the disinfectant used should be thoroughly mixed in the pool; good water source should be used for disinfection ; poster signs should be provided to enlightened the swimmers about good sanitary habits; Health authority should regularly monitor the pools for compliance with regulations; people should be encouraged to shower before swimming ; footbaths should be provided to minimize soil contamination.

CONCLUSION

It is concluded from this study that most of the swimming pools are deficient in all or part of the standards and efforts should be geared to brace up with the challenges rather than resulting to superchlorination.

REFERENCES

Adrian E, David MR, Cameron AS, Robinson BS, Reginald PW, Jane AL, and Peter EC. 1984;. Determinants of the Microbiological Characteristics of South Australian Swimming Pools. *Applied and Environmental Microbiology* 47(2):325-328.

American Public Health Association (APHA). 1985. Standard Methods for the Examination of water and waste water. 16th edition, Washington, D.C.

American Society for Test and Measurements (ASTM). 1985. Annual American Society for Test and Measurements Standards.

Attah R, Yousef K, Ahmed A and Ashraf A. 2007. Sanitary Conditions of Public Swimming Pools in Amman, Jordan. *Int. J. Environ. Res. Public Health.* 4 (4):301-306.

Bello R and Ajayi OOS. 2000. *Research Methods and Statistical Analysis*. Haytee Press and Publishing Co. Ltd., Ilorin. 131-139.

British Pharmacopoeia. 1993. International Edition, HMSO publication center, London. 1:604-605.

Bucchanan RE, Gibbons NE. 1974. *Bergey's Manual of Determinative Bacteriology.* (8th edition). The Williams and Wilkins Co., Baltimore. 1268.

Centers for Disease Control and Prevention (CDC). 2006. Healthy Swimming:_Chlorine and pH.

Craun GF, Calderon RL, Craun MF. 2005. Outbreaks associated with recreational water in the United States. *Int. J. Environ. Health Res*., 15(4): 243-62.

Environmental Protection Agency (EPA). 2007. Bacteria Water Quality. *Standards for Recreational Waters (fresh and marine waters)*. 80-81.

Eric DM, Ronel SV. 1982. *Water Quality*, Academic press, London. 295.

Fawole MO, Oso BA. 1988. *Laboratory manual of Microbiology*. Spectrum books limited, Ibadan 127.

Joklik WK, Willett HP, Amos DB, Wilfert CM. 1992. *Zinsser Microbiology* 20th Edition , Appleton and lange, California. 231.

Kate R, Dominick T. 2008. Wild swim; river, lakes, lido and sea: the best places to swim outdoors in Britain, London, Guardian Books 208.

Le chevalier MW, Cawthon CD and Lee RG. 1988. Factors promoting survival of bacteria in chlorinated water supplies. *Journal of Applied Environmental Microbiology* 54(3):649-654.

Perkins PH. 1988. Swimming pools. *Applied Science*, Elsevier, London and New York. 257-296.

Podewils LJ, Zanardi B and Hagenbuch M. 2007. Outbreak of norvirus illness associated with a swimming pool. *Epidemiol. Infect* 135(5):825-833.

Salle AJ. 1973. *Bacteriology of Water and Fundamental Principles of Bacteriology*. 7th edition. Mc Graw Hill Book Company, Inc. Washington D.C. 687-710.

Totkova A, Klobusicky M and Tirjakova A. 1994. Helminth and Protozoal findings in the water of school swimmings. *Epidermol. Mikrobiol. Imunol*., 43(3):130-136.

World Health Organisation (WHO). 2008. Guidelines for Drinking Water Quality. 3rd. Edition, Incorporating the first and second addenda, 1. Recommendations. (http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en).