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Research Paper

Microbiological evaluation of two swimming pools in Sokoto State, Nigeria

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Swimming pools are place where people attend for recreational activities, rehabilitative treatment or sport. This makes the swimming pools to be a reservoir of different types of microorganisms, hence the risk of transmission of infections among bathers. The aim of this study is to investigate the prevalence of microbial population in the two public swimming pools. Two different swimming pools in Sokoto metropolis, were investigated for their microbial presence. Water samples were collected from three different locations in each of the pool (surface, bottom and edge of the pool). Samples were serially diluted and cultured. The spread plate technique was adopted using standard plate count agar for the determination of total heterotrophic bacterial and fungal counts. Bacterial and fungal isolates were identified using standard methods. Microorganisms isolated includes *Bacillus anthracis, Staphylococcus aureus, Bacillus cereus, Pseudomonas aeruginosa, Bacillus subtilis, Vibrio cholera, Rhizopus sp, Fusarium sp, Trichophyton mentagrophytes, Mucorsp, Candida albicans, Aspergillus niger* and *Aspergillus flavus*. The heterotrophic bacterial count ranged from $3.7x10^6$ CFU/ml in sample H_2 to $1.60x10^7$ CFU/ml in sample H_3. Test for coliform yielded no growth. Fungal counts ranged from $1.0x10^3$ CFU/ml in sample G_1 and G_2 to $1.8x10^4$ CFU/ml in sample H_3. There was no significant differences between the means of the microbial counts of the two swimming pools ($p>0.05$). In conclusion, the absent of Coliform and fecal coliform bacteria and low colony counts below 200cfu/ml showed that the two swimming pools has met the WHO standard that has been accepted by Nigeria. This study is limited to few samples because only two active swimming pools were available during this research.

Key words: Swimming pool, Bacteria, Fungi, Serial dilution, Colony counts, WHO.

INTRODUCTION

Water is one of the most essential needs of man, both for food and for recreation. Life in this planet earth originated in water, water is basic to the life of modern man, no other substances serves man in so many ways as less crucial for the society as a whole than for the well-being of each individual (Alfred and Mandu-Uwen, 2004). Natural waters are the major sources of swimming pool water. The portability of swimming pool water is enhanced by frequently changing the water and the use of disinfectant, such as chlorine (Alice, 1997).

Swimming pools are concrete tanks or large artificial basins containing water for swimming. The swimming pool water should meet portable water standard by being transparent, odourless, and tasteless liquid having a freezing point of 0ºC and boiling point of 100ºC (Alico and Dragonjac, 2006). American National Standard for water Quality in Public Pools and ANSQPP,

(2009) reported that a swimming pool may be infected with pathogenic microorganisms entering the pool directly or indirectly through contaminated air, soil, dust, rain water and sewage, human or animal excrement. Unless the water is adequately treated, contamination may lead to outbreaks of diseases, such as skin ulcers, gastroenteritis, conjunctivitis, trachoma, ear infection such as otitis media, cholera, dysentery, eczema and skin rashes (American public Health Association (APHA),1985; Ayandele *et al*., 2015).

A variety of microorganisms can be found in swimming pools, which may be introduced in the pool water in a number of ways. In many cases, the risk of illness or infection has been linked to faecal contamination of the water, due to faeces released by bathers or, in outdoor pools, may be the result of direct animal contamination (Bello *et al*., 2012; Cairncross *et al*., 2000). Microbiological evaluation has, for many years, been the most significant method for sanitary and quality control of swimming pools. Infectious diseases which can be transmitted by recreational water include skin, eye and ear infections and gastroenteritis, consequently the levels of microorganisms in recreational water are important for indexing the health hazard associated with swimming (Cairns and Dickson, 2003).
The best indicator in the assessment of the safety of swimming pool water is disputed. Some researchers emphasize that the microbiological quality of swimming pools is best measured by using bacteria that indicate fecal contamination as fecal coliform and enterococci, while others consider that the risk of infection is more associated with microorganisms derived from the skin, mouth, and upper respiratory tract of bathers rather than fecal contamination (Collins and Lyne, 1976).

Another important factor to assess bathing water quality is related to the density of the bathers. High density of swimmers leads to a risk of contact with pathogens that are similar to the risk involved in bathing in water considered improper because of fecal pollution (Cruickshank *et al*., 1795). Therefore, it has been proposed that no single indicator microorganism is suitable, so fecal indicators and microorganisms from the mouth, nose and skin areas of bathers should be considered concurrently in assessing the effect of chlorination and the safety of pool water (Fair *et al*., 2001). Nigeria has no swimming pool water standard but has adopted that of the (WHO 2006; Bello *et al*., 2012).The aim of this study is to investigate the prevalence of microbial population in the two public swimming pools base on microbiological indices.

MATERIALS AND METHODS

Study area

The study area used in this work is Sokoto, Sokoto state. Two outdoor swimming pools from Giginya Coral hotel and Happy Island Park in the city were used for this study.

Sample collection and handling

Water samples were aseptically collected from two different swimming pools located in Sokoto metropolis using the techniques described by Cruickshank *et al*. 1795 and Okafor, (1985) (Favero *et al*., 2004). The samples were collected using white sterile plastic containers, which were previously rinsed with distilled water. Three samples were collected from each swimming pool in compliance with American Public Health Association (APHA) standard methods (Fawole and Oso, 2001). The samples were collected from the water surface, at the bottom and at the edge of the pool. The collection was in the evening after bath. All samples were labelled based on their collection sites.

Sample processing

The spread plate technique of Collins and Lyne (1976) was adopted using standard plate count agar.Nutrient Agar, potato Dextrose Agar, MacConkey broth were used for the isolation of microorganisms present in the swimming pools by using standard microbiological methods (Galbraith, 2000). The bacterial plates and fungal plates were incubated at 37°C for 24 h and 25°C for 72 h respectively.

Characterization and identification of isolates

The characterization and identification of bacterial isolates were based on the technique of Fawole and Oso, (2001). Bacteria were identified using colonial morphology and Gram staining reactions and cell morphology from heat fixed smears were done. Colonies were further characterized using various biochemical tests such as sugar fermentation test, urease test, catalase reaction, citrate utilization, indole test, methyl red and vogues proskauer test which were carried out on pure culture of isolates (James and Natalie, 2001). For fungal identification, the techniques of James and Natalie, (2001) were adopted using lactophenol cotton blue stain. Pure fungal isolates were stored and identified by microscopy (Lagerkvist *et al*., 2004).

RESULTS

Table 1 showed the Total Microbial Counts of microorganisms present in the two swimming pools samples. Total bacterial counts ranged from 3.7×10^6 to

Table 1. Standard plate counts of isolates from the two selected swimming pools in Sokoto, Nigeria.

Samples	Bacterial counts CFU/ml	Safety status	Coliform counts CFU/ml	Fungal counts CFU/ml	Safety status
G_1	$1.28x10^7$	Safe	Nil	$1.0x10^3$	Safe
G_2	$7.2x10^6$	Safe	Nil	$1.0x10^3$	Safe
G_3	$7.8x10^6$	Safe	Nil	$3.0x10^3$	Safe
H_1	$7.5x10^6$	Safe	Nil	$1.5x10^4$	Safe
H_2	$3.7x10^6$	Safe	Nil	$1.3x10^4$	Safe
H_3	$1.60x10^7$	Safe	Nil	$1.8x10^4$	Safe

KEY: G= Giginya coral hotel; H=Happy Island
1=Surface; 2=Bottom; 3=Edge
Acceptable limit for safety: 200 cfu/ml (WHO)

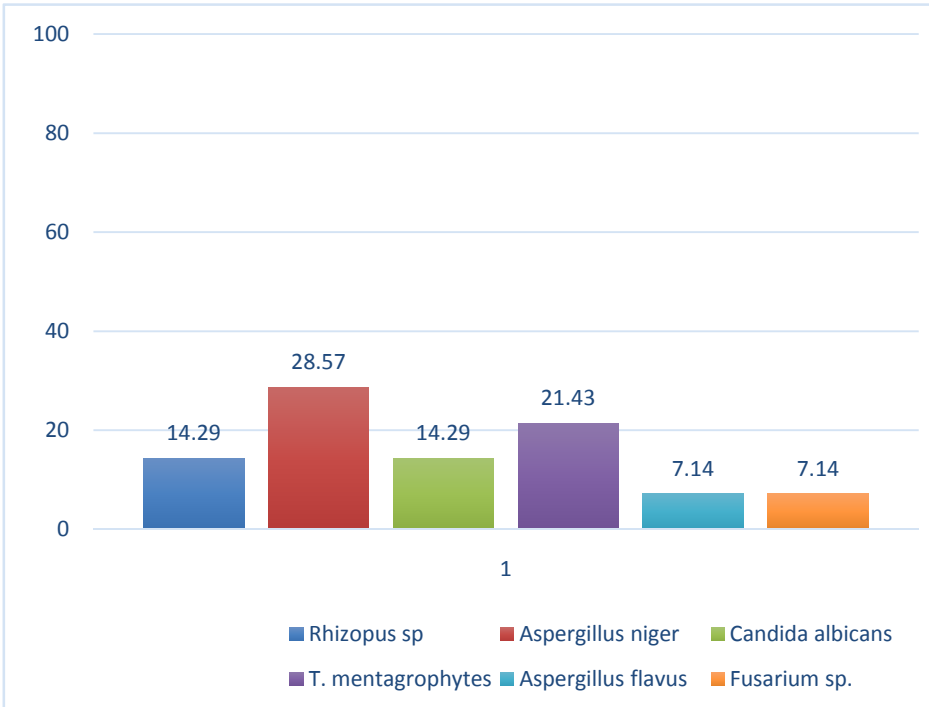

Figure 1. Occurrence of bacterial isolates from the two swimming pools.

1.60×10^7CFU/ml, while the two swimming pools yielded no growth of coliform bacteria. Fungal countsfrom the two swimming pools ranged from $1.0x10^3$ to $1.8x10^4$ CFU/ml. Figure 1 showed that *Bacillus cereus*had the highest percentage of occurrence of (33.3%), *Bacillus subtilis* (25%), *Staphylococcus aureus* (16.7%), while *Bacillus anthracis*, *Pseudomonas aeruginosa*, and *Vibrio cholera* were the least isolated with (8.3%). Figure 2 showed the occurrence of fungal isolates from the two swimming pools. *Aspergillus niger* had the highest percentage occurrence of (28.57%), followed by *Trichophytonmentagrophytes* (21.43%), *Rhizopus* (14.29%),*Candida albicans* (14.29%), while the least isolated were *Aspergillusflavus*, *Fusarium sp.* and *Mucor sp.* (7.14%)

DISCUSSION

Total viable counts (TVC) of the two swimming pools were analysed. The high microbial count might be as a result of resistant of these microorganisms to the chemicals such as calcium hypochlorite used in the treatment of these swimming pools. Similar report was also made by Nichols,(2006). The bacterial counts of 1.28 x 107 cfu/ml in sample 'G' and 1.60 x 107 in sample

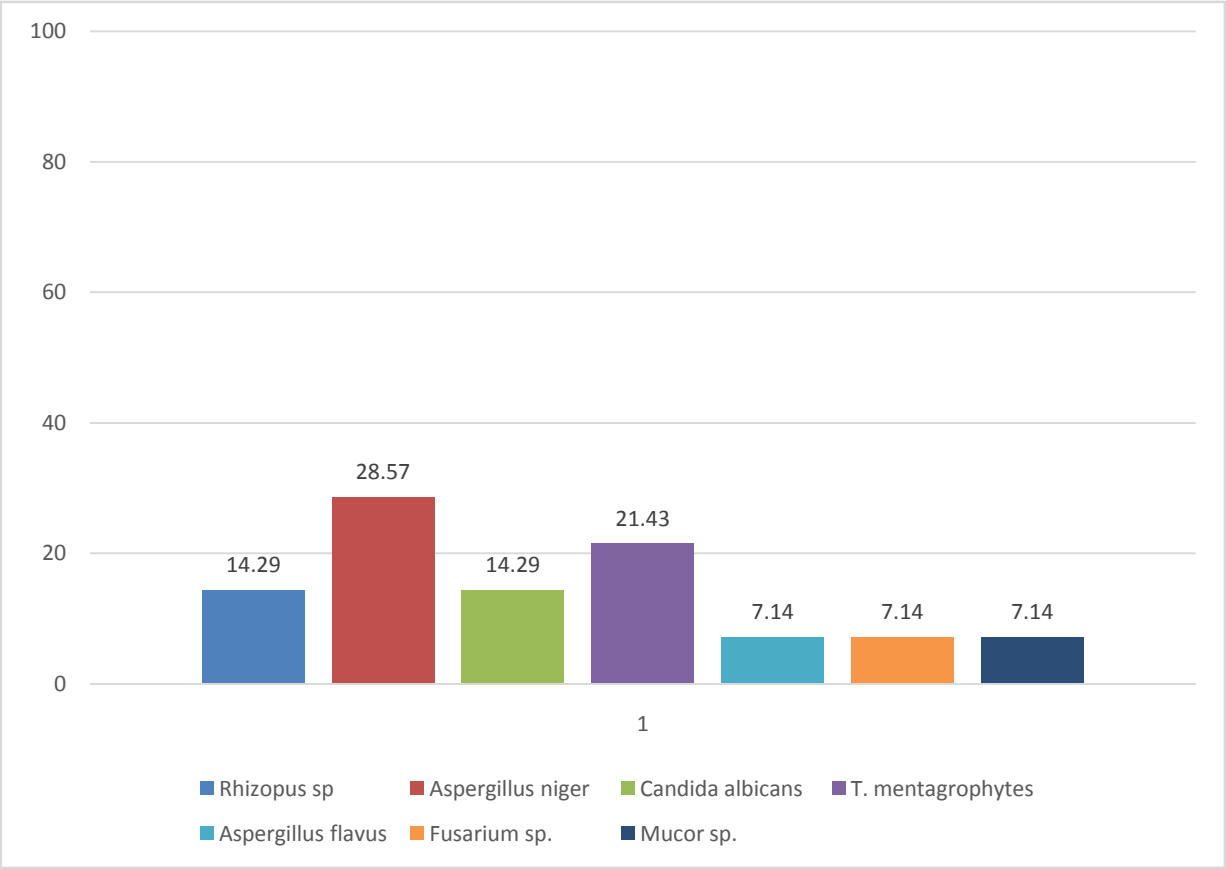

Figure 2: Occurrence of fungal isolates from the two swimming pools.

'H', coupled with absence of coliform bacteria showed that the two swimming pools are within the criteria set by WHO (2006) standard for recreational water (Bello *et al*., 2012). Heterotrophic plate count of bacteria should not exceed 200 cfu/ml according to Okafor, (1985). Though, no coliform was found, other bacteria and fungi of known human pathogens were isolated. Presence of these microorganisms might be due to faecal contamination from humans and animals according to (Nichols, 2006) or through contaminated air, soil, dust, rain water or sewage (American National Standard for water Quality in Public Pools and Spas. (2009). Bacteria such as *Bacillus cereus*, *Pseudomonas aeruginosa* and *Staph. aureus* were encountered in this work. These microorganisms were also detected from swimming pools in lagos, Ilorin and South-South zone of South-eastern Nigeria (Osei-Adjei *et al*., 2014; Papadopoulou, 2008; Prescott *et al*., 2002).

Fungal pathogens of human such as *Aspergillusniger*, *Candida albicans* and *T. mentagrophytes* were also encountered in this work. This agreed with the research carried out in Greece and Lagos, Nigeria (Seyfried *et al*., 2005b, Osei-Adjei *et al*., 2014). Presence of these fungi might be attributed to the moist environment of the swimming pools which favours the growth of the fungi. This work also showed that microbial count is higher at the surface and the edge of the pools. This might be as a result of direct air contamination of the pools (American National Standard for water Quality in Public Pools and Spas. (2009). Statistical analysis carried out also showed there is no significant difference in the mean colony counts of the two swimming pools (p=0.811). According to (UNDP, 2004) *Aspergillus niger* is responsible for *Aspergillosis*, usually an infection of the external ear (otomycosis) which may result in ulceration of the lining of the ear canal and perforation of the tympanic membrane.*Candida albicans* causes *Candidiasis*, which is an acute or subacute infection that produce lesions in the mouth, vagina or lungs of infected persons. *T. mentagrophytes* is the etiologic agent of foot and nail disease.It is also responsible for ringworm of the scalp, beard hair, groin and buttocks while *Fusarium* is known for eye infection in humans and animals (WHO, 2006). Bacteria such as *Pseudomonas aeruginosa* are

linked to surface run-off water, and are frequently being isolated from the ears of swimmers with otitis media while *Staph. aureus* is usually contributed by bathers in the swimming pools (Osei-Adjei *et al*., 2014). *Staph. aureus, Bacillus species* and *Vibrio cholera* are known enterotoxin producers when ingested into the body, therefore the presence of these bacteria in pools is a threat to public health (WHO, 2006).

Conclusion

From the result obtained in this study, presence of these microorganisms of known human pathogens constitutes a serious health risk to the bathers. Therefore, managers are advised to intensify effort to ensure proper control of the swimming pools based on standard level and sanitation of the area around the pools. This study was carried out during rainy season when only few people were patronizing the pools, hence the need to conduct this research during hot season. The study was also limited to few samples because only two active swimming pools were available during this research.

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