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Quality assessment and prevalence of antibiotic resistant bacteria in government approved mini-water schemes in Southwest, Nigeria

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ABSTRACT

Availability and accessibility of potable water is fundamental to human health. In Nigeria, access to clean and safe water is still a huge challenge. This study investigated the microbiological quality of source water, drinking water and distributed water in fourteen government approved mini-water schemes in Osun State, Nigeria. Enumeration and characterization of total heterotrophic bacteria, coliforms and pathogens were done with standard procedures. Isolated bacteria were tested for susceptibility to thirteen antibiotics using the disk diffusion techniques. Three hundred and thirty bacteria were identified as β-proteobacteria (4), γ-proteobacteria (231), Firmicutes (90) and Actinobacter (5). The isolated pathogenic bacteria genera from the source and drinking water include *Acinetobacter, Pseudomonas, Enterobacter, Escherichia* and *Klebsiella*. All isolates exhibited varying degrees of resistance to the antibiotics with the highest to ampicillin (80.9%) lowest to rifampicin (2.1%). Most strains (288/330) were resistant to at least one antibiotic while 255 of 330 were resistant to three to eight antibiotics. Multiple antibiotic resistant bacteria were detected in all types of water samples. The presence of pathogens and antibiotic resistant bacteria potentially puts the health of the community members relying on these schemes as their drinking water at risk.

1. Introduction

Availability and accessibility of potable water is fundamental to human health. Access to safe drinking water is now recognized as a human right by the United Nations (Fernando et al., 2016). In developed countries, access to clean water is generally not a matter of concern with large resources being expended to ensure consistent household supply (Fernando et al., 2016). However, in developing countries like Nigeria where the various state governments are responsible for providing and monitoring quality of potable water, access to clean and safe water is still a huge challenge (Hunter et al., 2010; Olaitan et al., 2013). Here, improved access to water is generally delivered through communally managed public water points in rural areas and unreliable distribution systems in towns and cities. Unfortunately, many of these water supply interventions do not last. Inadequate and unsafe water supply results in high prevalent rates of diarrhoea and nondiarrhoeal diseases arising from the presence of biological and chemical contaminants in water (Hunter et al., 2010). It can also affect health by limiting productivity and the maintenance of personal hygiene.

Water in nature is never pure. In order to supply potable water, water sources are treated in water treatment plants or water schemes. However, provision of quality water in many water treatment plants in many developing countries is hampered by a number of challenges. The implication of this is that treated water drawn from taps, even within the premises of most treatment plants is not totally free from both pathogenic and non-pathogenic organisms (Akinyemi et al., 2006; Obi et al., 2007) which may lead to microbial water-borne diseases.

Antibiotics are effective in treating human and animal diseases and huge quantities have been utilized globally for this course as well as in promoting the growth of animals (Dinh et al., 2017). After administration, the used antibiotics are not completely absorbed and metabolized in the target organism and this has led to the excretion of antibiotics into the environment (Zhang et al., 2009). Both proper and indiscriminate use of antibiotics have resulted into the development of resistance to these antibiotics (Bergeron et al., 2015). Studies have indicated that incomplete antibiotics metabolism in animals and improper disposal of antibiotics by the sewage treatment facilities are the main route of antibiotic release into the environment (Everage et al., 2014; Bergeron et al., 2015; Dinh et al., 2017). Antibiotic resistance is not only important in pathogenic organisms, but also important in nonpathogenic organisms because resistance can be transferred among bacteria and this have resulted into public health problems worldwide

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(Xi et al., 2009).

Expectedly, high incidences of water-borne diseases are reported in areas without access to safe and potable water (Hunter et al., 2010), the severity of water-borne diseases becomes higher when the organisms are antibiotic resistant (Fernando et al., 2016). There is dearth of information on microbiological safety of water from mini-water schemes in Osun State, Nigeria. This research was therefore designed to investigate the physicochemical and microbiological quality as well as the antibiotic susceptibility of bacteria isolated from these mini-water schemes. To our knowledge, this is the first study to report the quality and the presence of antibiotic resistant bacteria in water samples from mini-water schemes and their distribution systems in Osun State, Nigeria.

2. Materials and methods

2.1. Description of study sites

The sampling sites were located in rural and sub-urban communities in Osun State. Osun State is located in Southwestern part of Nigeria comprising an area of approximately 9251 km^2 and approximate population of 4.5 million people (2006 Census) with the majority residing in rural areas with the water supplied from the mini-water schemes covered in this study the only source of potable water. Thirty two mini-water schemes (Fig. 1) were established as an alternative to the major water works in urban settings with the aim of supplying potable water to people mostly in the sub-urban and rural communities. However, during the time of sampling, only 14 of these schemes were functional.

Samples of water used in this study were purposively collected from 14 functional mini-water schemes and the related drinking water distribution systems which provide water for the inhabitants of 17 towns and villages that cut across 10 Local Government Areas, and the three Senatorial Districts of Osun State. Three of the schemes process underground water (borehole) while the remaining eleven process surface water (stream, river, spring, pond). The functional schemes are listed in Table 1. The majority of the houses in these communities do not have piped tap water from the water treatment plant. Families in homes without running water use small plastic buckets to obtain their drinking water from a community standpipe after which the water is stored in containers in the home. It is also quite common to use the source water for washing and cleaning purposes. In addition, families sometimes utilize source water as drinking water, or collect rain water for general washing and cleaning purposes.

Table 1
List of functional mini-water schemes where samples were collected.

S/N	Name of Scheme/ Code	Location (Town)	Local Government Area	Source of water
1	Oke-Osun (OS)	Osogbo	Osogbo	Stream
2	Dagbolu (DA)	Dagbolu	Olorunda	Borehole/ stream
3	Iba (IB)	Iba	Ifelodun	River
4	Okuku (OK)	Okuku	Odo-Otin	River
5	Igbaye (IG)	Igbaye	Odo-Otin	Pond/wetland
6	Iree/Eripa (IR)	Iree	Boripe	Spring
7.	Ada (AD)	Ada	Boripe	Stream
8	Iperindo (IP)	Iperindo	Atakunmosa East	Stream
9	Esa-Oke (ES)	Esa-Oke	Obokun	Spring
10	Tooto/Igege (TI)	Tooto	Ola-Oluwa	Borehole
11	Ife- Odan (IF)	Ife-Odan	Ejigbo	River
12	Ejigbo (EJ)	Ejigbo	Ejigbo	River
13.	Kuta/Ile Ogbo (KT)	Kuta	Ayedire	Borehole
14.	Oluponna (OP)	Oluponna	Ayedire	Stream

2.2. Sample collection

Water samples were collected in triplicates thrice between November 2012 and March 2014. In areas serviced with surface water, samplings were done aseptically from four points [raw water from the dam (RW), treated water taken at the treatment plant clear well after treatment procedure prior to distribution (TW) and from two municipal taps in each locality serviced by the scheme (D1 and D2)]. In areas serviced with underground water (boreholes) samples were obtained from three points (storage tanks at the mini-water scheme and from two municipal taps). Fig. 1is the map of Osun State showing the locations of all mini-water schemes while Table 1 is the list of the functional mini-water schemes where samples were obtained.

At each sampling location, water samples for microbiological

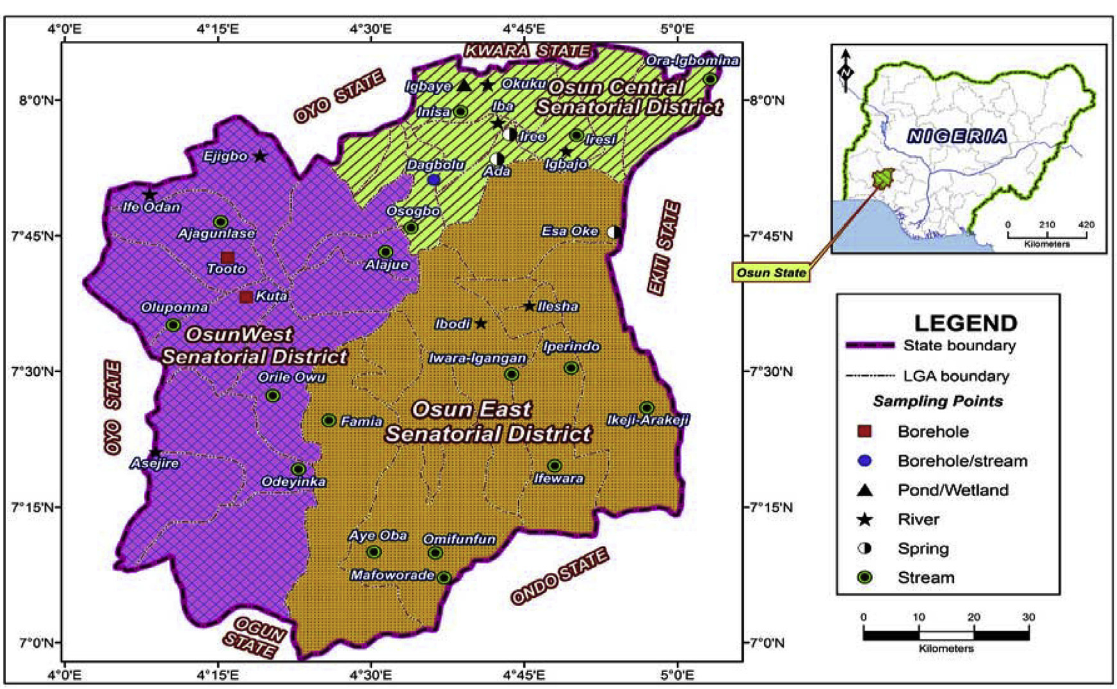

Fig. 1. Map of Osun State showing the locations of all mini-water schemes.