STREAMS AND HAND-DUG WELLS: BACTERIOLOGICAL COMPOSITIONS AND PERIODIC VARIATIONS. BENUE AND EBONYI STATES IN FOCUS

By

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Abstract

Water is an essential component of human existence. However, there is a growing concern about the shortage and quality of water supply in many societies in developing countries. Consequently, many people resort to unhealthy sources to get water for various purposes, thereby being exposed to multiple waterborne diseases. The study examined the probable variants in bacteriological contamination of streams and handdug well water in Benue and Ebonyi States, Nigeria. Seven streams and seventeen hand-dug wells were examined, and water samples were collected from these sites. They were analyzed for total bacteria count in relation to seasonal differences (wet and dry seasons). The study was conducted between August 2020 to March 2021, and the World Health Organization's standard procedure of water examination was observed. The findings revealed that the streams and hand-dug wells examined were highly contaminated with microorganisms in both seasons. Hence, supporting the understanding that streams and wells as sources of water supply are frequently contaminated regardless of the season. The contamination of all streams and wells could be attributed to various factors ranging from human activities to climate change. The finding, recommendations, and future directions are discussed.

Keywords: *Streams, Wells, Bacteria, Contamination, Periodic Variations*

Background

Waterborne disease is a ubiquitous part of human living, and as crucial as water is to living organisms. It is primarily the means of disease transmission.

Accordingly, availability and purity of water is a determinant of healthy living. Organisms regularly need water for operations such as maintaining body homeostasis, digesting and transporting nutrients, including waste disposal, and also for intercellular and extracellular fluids activities. Nevertheless, water is a significant source of disease transmission, and the continued pollution of water sources results in severe water-related diseases (WHO, 2008).The need for safe water, especially for drinking purposes, becomes a primary concern. Research suggests that water contamination by human and environmental waste is responsible for contemporary illnesses such as typhoid fever, dysentery, cholera, hepatitis, and giardiasis (Ishaku et al., 2011; Khan et al., 2018; Nasinyama et al., 2000; Nwidu et al., 2008; Omalu et al., 2010; Onyeze et al., 2013). Also, research has associated water diseases with increased mortality and morbidity across the globe (Banda et al., 2007; Chiori, 2018; El-Kowrany et al., 2016; Fonyuy & Innocent, 2014; Hasan et al., 2019; Manoharan et al., 2019; Shrestha et al., 2018; Spallholz et al., 2004; Wen et al., 2020). Nonetheless, insinuation suggests that variations in seasons worsen waterborne related diseases.

Water crises have been a reoccurring issue among the developing countries, and Nigeria is not excluded(Adeniji-Oloukoi et al., 2013; Akinde et al., 2019; Obeta & Nwankwo, 2015; Okafor & Ogbu, 2018; Uduma & Arciszewski, 2010; Yusuff et al., 2014). Majority of the people caught in the provoking situation of a limited supply of water are forced to source water in various means considered

unhealthy. For instance, in Nigeria today, stream and hand-dug well sources remain the primary source of drinking water for many households (Adejuwon et al., 2018; Adeoye et al., 2013; Afeni & Ibitolu, 2018; Ewuzie et al., 2020; Jibiri et al., 2010; Kaoje et al., 2019; Nnorom et al., 2019; Oginni & Fadipe, 2016; Ojo et al., 2021; Oluyege et al., 2009). This regrettable situation is obtainable within both the rural and urban communities. Streams refer to primarily small and narrow surface water flowing within a channel. Usually, streams do not have water round the year. On the other hand, wells are small diameter holes with a protective covering. Hand-dug wells are burrowed at various depths depending on availability and groundwater levels. In many cases, they are insufficiently dug and could lead to contamination with pathogenic bacteria.

The dry season in the Nigerian context usually starts from late October and lasts to early March, whereas the rainy season begins in April and lasts until early October (Ebele et al., 2020). Therefore, the change accompanying the seasonal variation contributes significantly to water quality in streams and hand-dug wells. Perhaps water quality is of great importance and comprises water's chemical, physical, biological, and radiological properties (Ocheje et al., 2019). Water availability in streams and wells is subject to the time of year. Thus, the water level increases during the rainy season and decreases in the dry season. Equally, variations in water level impact the quality of water resources and pose a considerable risk to human health. Hassan et al. (2008)contend that the properties associated with water in streams and wells are affected mainly by natural factors, including erosions, precipitation rate, climate processes, and human activities. Thus, the water changes occasioned by seasons play a critical

role in these processes and have been linked to run-off, nutrient enrichment, and growth of many aquatic organisms (Nouri et al., 2011).These activities reduce water quality, and gradually limit water availability and expose water to various water-related diseases. Perhaps, water quality disparities affect the dynamics of microbial pathogens, which can also impact the frequency and spread dynamics of waterborne diseases(Ali & Ahmad, 2020).

Coliform bacteria are commonly classified as genera *Escherichia. Citrobacter, Enterobacter*, and *Klebsiella* (The environmental agency, 2002). Since the available source of these organisms is widely accepted as the intestinal tract of warm-blooded animals, it is emphasized that fecal and non-fecal origin bacteria are members of this group. Apart from bacteriological pollutants of water, other contaminants include chemical, physical and biological indicators. An example of these is cyanide, iron, arsenic, turbidity, organic matter, and others. If these indicators occur at a higher limit than required, pollution occurs.

Previous studies have consistently indicated the health dangers associated with sourcing water from wells and streams because of the pollutant processes (Akanni et al., 2019; Atojunere, 2021; Izah et al., 2016; Magaji & Chup, 2012; Okafor et al., 2021). It is observed that disease-causing bacteria from water sources such as streams and wells are varied due to the period. However, waterborne diseases such as cholera were commonly reported in Ebonyi and Benue state of Nigeria (Idoga et al., 2019; Maxwell et al., 2012; Ogbeyi, 2017; Onwe et al., 2020; Romanus et al., 2020). Thus, this study intends to analyze the

seasonal disparities in the bacteriological qualities of unhealthy water sources such as streams and well in Nigeria's Ebonyi and Benue states.

Materials and Methods

The following materials and reagents were utilized for the study. Microscope, Autoclave, Hot air oven, Refrigerator, weighing balance, conical flask, Wire loop, Petri- dish, Bunsen burner (Gas flame). Culture media- MacConkey Agar, MacCkonkey broth, and Nutrient Agar. The present study depended on the analyses of the collected streams and well water samples from the study areas, including Abakaliki in Ebonyi state and Markudi in Benue state. Dual arrays of the stream and well water samples were collected from various streams and wells during the rainy season (July/August) and the dry season (December/February). The rationale for the different seasons is to ascertain the bacteriological variations. Quality assurance measures were observed in that sterilized containers were used for water sample collection, adequate preservation and storage were followed. The most probable number (MPN) was used. All materials were sterilised to avoid contamination.

MacConkey Agar powder was dissolved in distilled water, sterilized by autoclaving, conveyed aseptically into sterile Petri dishes, and allowed to solidify. The surface of the agar was dried before inoculation. Nutrient agar was dissolved in distilled water and sterilized by autoclaving for some minutes. Afterward, transferred aseptically into sterile bottles with Durham tubes and allowed to cool before incubation. Serial dilution of the same samples collected was made, and the sterilized media was pipette into bottles. The samples were inoculated into a bottle with Durham tubes and mixed. This dilution was

transferred with a fresh pipette into another sterile media. The samples were incubated using a laboratory incubator for 24 hours and observed for gas and acid production. Those that show acid and sufficient gas to fill the concavity at the top of the Durham tube were considered presumptive test positive. The samples that showed positive at the presumptive test were aseptically inoculated in a Mac Conkey Agar for isolation and organism identification. This was inoculated for 24 hours and observed for growth.

Results

Following the bacteriological analysis of the collected samples from the streams and hand-dug wells from the study areas within the rainy and dry seasons, respectively. The investigation revealed that the streams and well under examination were heavily contaminated with *E Coli, Klebsiella,* and Coliform irrespective of the season, which is against the acceptable recommendation of the World Health Organization (WHO, 1971) of 0 Bacteria Colony count/100 mL for untreated water.

Table 1:
Table showing the bacteriological contents of the hand dug wells examined in Markudi and Abakaliki

Wells	Total count of bacteria rainy season	Total count of bacteria during during dry season
well1	$4.1x10^5$	$3.5x10^5$
well2	$5.1x10^5$	$4.5x10^5$
well3	$4.2x10^5$	$5.4x10^5$
well4	$1.5x10^5$	$2.3x10^5$
well5	$2.6x10^5$	$2.1x10^5$

well6	$4.1x10^5$	$8.3x10^5$
well7	$5.1x10^5$	$3.2x10^5$
well8	$4.2x10^5$	$3.3x10^5$
well9	$1.5x10^5$	$4.1x10^5$
well10	$2.6x10^5$	$3.6x10^5$
well11	$4.1x10^5$	$1.4x10^5$
well12	$5.1x10^5$	$3.5x10^5$
well13	$4.2x10^5$	$4.5x10^5$
well14	$1.5x10^5$	$5.4x10^5$
well15	$2.6x10^5$	$2.3x10^5$
well16	$4.1x10^5$	$2.1x10^5$
well17	$5.1x10^5$	$8.3x10^5$
Mean	$3.7x10^5$	$3.6x10^5$

Table 2:
Table showing the bacteriological contents of the streams examined in Markudi and Abakaliki

Streams	Total count of bacteria during dry season (Mg/ L_1)	Total count of bacteria during rainy season (Mg/L_1)
Stream1	$5.1x10^5$	$1.6x10^5$
Stream2	$4.1x10^5$	$1.5x10^5$
Stream3	$6.2x10^5$	$4.1x10^5$
Stream4	$2.3x10^5$	$8.3x10^5$
Stream5	$1.0x10^5$	$6.4x10^5$
Stream6	$1.1x10^5$	$1.3x10^5$
Stream7	$2.1x10^5$	$2.2x10^5$
Mean	$3.2x10^5$	$3.7x10^5$

Discussion

The study investigated the bacteriological compositions and periodic variations in streams and hand-dug wells in Benue and Ebonyi States. From the findings, it is observed that all the streams and hand-dug wells examined were polluted with an average of $3.7x10^5$ mg L^{-1} in the rainy season and $3.6x10^5$ mg L^{-1} in dry season for the wells. The streams analyzed were contaminated with a mean average of $3.2x10^5$ in the dry season and $3.7x10^5$ in the rainy season. The samples collected recorded a heavy growth of Coliform per 100ml of water in both instances, indicating bacteria in both wet and dry seasons. This finding is in agreement with (Sule et al., 2014). However, (Mile et al., 2012) reported strong positive correlations in both seasons in relation to bacterial contamination and an indication of a common source. Perhaps, the result contradicts previous studies indicating seasonal variations in bacteriological contaminations (Egwari& Aboaba, 2002; Utsev & Aho, 2012).

The study results reveal that the various streams and wells understudy in Markudi and Abakaliki were heavily polluted with *E Coli, Klebsiella spp,* and *Coliform*bacteria and therefore signifies the probable presence of fecal contamination. The confirmation of the existence of these microorganisms in hand-dug wells requires consistent evaluation to mitigate the incidence of waterborne disease(Mile et al., 2012). The probable explanation for bacteria in streams and wells in both the rainy and dry seasons could be attributed to the provocative human activities and weather conditions.

Conclusion, recommendation, and future direction

Testing water at the different seasons of the year aims to assess the variations in contamination present during other times of the year. The result showed that water contamination occurs at all times of the year, suggesting that water sources be examined at every point in time regardless of the season. This is because water-polluting sources vary and are aided by various factors such as human activities. For instance, people continue to wash clothes and swim in stream water that serves as drinking water to other people. Also, the unstable weather conditions occasioned by climate change influences the growth of microorganisms in water sources. Periodic cleaning of hand-dug wells contributes to the increase of bacteria inside the well. Following the incessant water crises witnessed in some states of Nigeria, for instance, Benue (Utsev& Aho, 2012) and Ebonyi (Iganga et al., 2015). It is imperative to enlighten the citizens and communities on measures of examining and combating microorganisms in water sources to minimize the occurrence of waterborne diseases and save lives. Future research should be directed at finding best practices of keeping water sources free from bacteriological contamination and understanding the direction and pattern of growth of these microorganisms.

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