



RESEARCH ARTICLE

Water Sources and Water-Borne Diseases: A Study of Seasonal Disparities in Bacteriological Compositions of Water Sources in Kogi State, Nigeria

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Abstract

Water is an essential component of human living and crucial in metabolism, substrate transport across membranes, cellular homeostasis, temperature regulation, and circulatory function. Access to quality water is a critical concern of any society. However, water shortage remains the central problem of many households across the universe, prompting people to depend on water sources that are considered unhealthy for human consumption. The primary purpose of this study was to examine the bacteriological compositions of water sources in Kogi State based on seasonal disparities. Water samples were obtained from streams and hand-dug wells within the Ankpa and Obajana areas during the rainy and dry seasons. The analysis conducted on the samples revealed that the water sources were heavily contaminated with bacteria at both seasons.

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Introduction:-

Water is an essential component of human living and crucial in metabolism, substrate transport across membranes, cellular homeostasis, temperature regulation, and circulatory function (Armstrong & Johnson, 2018). Accordingly, several environmental functions and human needs critically depend on water. Nonetheless, water is a significant source of disease contamination, and the continued pollution of water sources resorts in severe water-related diseases (WHO, 2008). The role of quality and quantity of water to the overall crises of water-borne diseases requires much attention (Cissé, 2019). Numerous studies have emphasized the role of contaminated water on some contemporary illnesses such as typhoid fever, dysentery, cholera, hepatitis, and giardiasis (Ishaku et al., 2011; Khan et al., 2018; Nwido et al., 2008; Omalu et al., 2010; Onyeze et al., 2013). Additionally, the burden of water-related infectious diseases is implicated in the level of mortality and morbidity worldwide (Banda et al., 2007; Chiori, 2018; El-Kowrani et al., 2016; Emmanuel, 2014; Fonyuy & Innocent, 2014; Hasan et al., 2019; Manoharan et al., 2019; Shrestha et al., 2018; Spallholz et al., 2004; Wen et al., 2020). Perhaps, climate variations exacerbate the challenges of water-borne diseases, especially in developing nations. Accordingly, availability and purity of water is a determinant of healthy living. The need for safe water, especially for drinking purposes, becomes a primary concern.

Over the years, the water shortage has posed a reoccurring challenge among households in developing countries, including Nigeria (Adeniji-Oluko et al., 2013; Akinde et al., 2019; Obeta & Nwankwo, 2015; Okafor & Ogbu, 2018; Uduma & Arciszewski, 2010). The experiences associated with inadequate water supply have prompted many households, especially those in the rural communities, to get the essential commodity from unhealthy sources. For instance, streams and hand dug-wells have provided water to a large number of people in Nigeria for many years (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; Oluyeye et al., 2009). Perhaps, lack of access to potable water is the main reason people consider streams, hand-dug wells, and other unhealthy water sources as their primary water source. Streams are mostly small and narrow surface water flowing within a channel. Typically, streams do not have water flowing through their path, and perhaps, seasons affect the water status of streams. More so, hand-dug wells are small diameter holes with a protective covering. Hand-dug wells are burrowed at various depths depending on the groundwater level and availability. Thus, one of the challenges of wells includes digging the holes enough to overcome contamination of human pathogenic bacteria.

In Nigeria, the dry season typically begins in late October. It lasts to early March, with dry peak conditions between early December and late February. The rainy season starts in April and lasts until early October, with wet peak conditions in June (Ebele et al., 2020). Consequently, seasonal variation and its accompanying climate-related properties greatly influence water quality in streams and hand-dug wells. Water quality entails the chemical, physical, biological, and radiological characteristics of water (Ocheje et al., 2019). It is typically related to the suitability of the water for its specific requirements. Water availability in streams and wells depends on the time of year. Thus, the water level increases during the rainy season and decreases in the dry season.

Conversely, changes in water level affect the quality of water resources and, therefore, pose a significant risk to people's health. Water quality in a stream is determined by the chemical and physical properties (Ocheje et al., 2019). Water properties from streams and wells are primarily affected by natural conditions like erosions, precipitation rate, climate processes, and human activities (Khan et al., 2018).

Nevertheless, seasonal variations are critical determinants of these processes and are implicated in increasing trends in run-off, nutrient enrichment, and growth of many aquatic organisms (Nouri et al., 2011). These impurities in water sources decline the quality of the water, making it increasingly limited, water, making to several water-related diseases. Perhaps, variations in water quality can influence the dynamics of microbial pathogens, which can also affect the prevalence and transmission dynamics of water-borne diseases (Ali & Ahmad, 2020). This points to the importance of continuous strict supervision and control over the quality of public, semi-public, and private water supplies (Anon, 2008). The primary purpose of this study is to examine the seasonal variation in bacteriological qualities of streams and hand-dug wells water sources and determine the prevalence of bacteria in these sources in Kogi State.

Materials and Methods:-

The present study was conducted in Kogi State, Nigeria encompassing different locations in Ankpa and Obajana. The study samples were collected from various streams and wells during the rainy (July/August) and dry (February/March). 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. Multiple tubes technique was used. All material was sterile 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. After that, 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:-

Table 1:- Table showing the bacteriological contents of the hand dug wells examined in Ankpa and Obajana of Kogi State.

Wells during rainy season	Total count of bacteria during dry season	Total count of bacteria
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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
Mean	3.3x10 ⁵	3.2x10 ⁵

Table 2:- Table showing the bacteriological contents of the streams examined in Ankpa and Obajana of Kogi State.

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	3.4x10 ⁵

Discussion:-

The study was conducted to examine the effect of seasonal disparities in the bacteriological composition of water sources. Analysis was performed on the water samples extracted from streams and hand-dug wells in several locations in Ankpa and Obajana in Kogi State, Nigeria. The result revealed that the hand-dug wells water samples were polluted with a mean average of 3.3×10^5 mg L⁻¹ within the wet season and 3.2×10^5 mg L⁻¹ over the dry season. Examining the water samples from the streams indicated a mean average of 3.2×10^5 during the dry season and 3.4×10^5 in the rainy season. Thus, the study revealed that the water samples obtained from streams and wells in the study area are contaminated with a heavy growth of Coliform per 100ml of water in both instances, indicating bacteria in both wet and dry seasons. This finding is aligned with previous studies (Ganiyu et al., 2018; Ishaku et al., 2011; Mile et al., 2012; Samuel et al., 2020; Sule et al., 2014), who reported strong positive correlations in both seasons in relation to bacterial contamination. However, the result contradicts the findings of previous studies, which showed disparities in bacteriological contaminations based on seasons (Adekunle et al., 2007; Egberongbe et al., 2021). For example, Daramola et al. (2019) found an increased number in magnesium (Mg), lead (Pb), potassium (K), and iron (Fe) in water sources during the dry seasons than in the wet season.

Furthermore, the result of the study reveals that the various streams and wells understudy in Kogi State were heavy 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 the sources of water studied suggests measures to purify these sources of water, particularly for drinking and cooking (Mile et al., 2012). The probable explanation for bacteria in streams and wells in rainy and dry seasons could be attributed to the provocative human activities and weather conditions.

Conclusion:-

The present study examined the bacteriological compositions of some streams and hand-dug wells serving as water sources based on the disparities in seasons. The analysis conducted on the collected samples showed that water contamination occurs regardless of the year's season. Thus, suggesting that comprehensive examination of water sources be performed at every point in time irrespective 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 their clothes and

swim in stream water that serves as a drinking water source 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 decrease of bacteria inside the well. The study recommends continued enlightening of users relating to water treatment and preservation.

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