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WATER AVAILABILITY AND QUALITY IN RURAL AND URBAN MARKETS IN ABIA STATE, NIGERIA: IMPLICATIONS FOR WATER, SANITATION AND HYGIENE

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ABSTRACT

This study assesses the availability and quality of water sources in Ubani (urban) and Ndoro (rural) markets in Abia State, Nigeria, focusing on both physicochemical and bacteriological properties. The findings have important implications for Water, Sanitation, and Hygiene (WASH) practices. A mixed-method approach was employed, combining quantitative (water sampling, laboratory analysis), and qualitative (a structured questionnaire) techniques to assess water availability, quality, and usage patterns. Water samples were collected from three sources (borehole, rainfed wells, and tanker-supplied water) during dry and wet seasons. Physicochemical parameters analyzed included pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), nitrate, and Dissolved Oxygen (DO). Bacteriological assessments detected coliforms, *Escherichia coli*, and *Klebsiella spp*. using the Most Probable Number (MPN) method. Sachet water was the most widely used water source, with 81.1% of respondents in Ubani and 77.1% in Ndoro relying on it, yet more than half reported difficulties in accessing water. Distances to water sources in the market varied, ranging from 250m to 1.5km. Seasonal variations in water quality were significant ($p < 0.05$). In Ubani market, BOD increased from 4.82 mg/L in the dry season to 9.07 mg/L in the wet season, while DO rose from 2.78 mg/L to 4.63 mg/L. Similar trends were observed in Ndoro, with BOD rising from 4.80 mg/L to 8.52 mg/L. The TDS levels in Ubani market were 174.5mg/l in the dry season and 192.63mg/l in the wet season whereas that of Ndoro market was 44mg/l and 29mg/l. The pH in Ubani was 6.68 (dry) and 6.11 (wet), while Ndoro recorded 3.96 (dry) and 4.55 (wet). Nitrate levels also fluctuated significantly between seasons. Bacteriological analysis revealed *E. coli* concentrations of 1.72×10^5 cfu/ml in Ubani's rainwater and Klebsiella spp. counts of 2.2×10^5 cfu/ml in Ndoro's borehole water, exceeding WHO limits. The findings of the study reveal the vulnerability of market water sources to contamination, especially during the wet season, posing public health risks. The study highlights the urgent need for water quality monitoring, treatment improvements, and public health education on safe water practices.

KEYWORDS: Water availability, Water quality, Seasonal variation, WASH, Markets.

INTRODUCTION

Water is essential to the survival of all living organisms. According to the World Health Organization (2009) over 1.1 billion people suffer from diseases caused by contaminated water. Water quality, a key component of the Water, Sanitation, and Hygiene (WASH) framework is crucial for preventing the spread of waterborne diseases, particularly in high-density environments such as markets.

Yaya *et al.,* (2018) stated that among the requirements for maintaining well-being are water, sanitation, and hygiene. Poor water quality can result in the transmission of infectious diseases like cholera, typhoid, and dysentery, which are responsible for significant morbidity and mortality, especially in developing countries. About half of all urban settlers in Africa have inadequate access to WASH exposing them to greater risk of contracting diarrheal and enteric illnesses like malaria, typhoid fever,

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and cholera (National Planning Committee, 2004; UNICEF, 2017). Overcrowding and other adverse environmental factors raise the likelihood of these kinds of sicknesses. Unsafe water supplies, along with poor sanitation and hygiene practices, are estimated to be accountable for around 88% of diarrheal illnesses (WHO, 2004).

Water-borne infections are more common in people who do not have basic access to clean water and sanitary facilities. In Nigeria, markets are essential hubs for commerce and other socio-economic activities unfortunately; they are also hotspots for potential health risks. This is due to the high density of people, poor availability and access to quality WASH service and low capacity to enforce hygiene measures (Petrikova and Farlow, 2020). The inability of government to meet the ever increasing water demand is forcing people to resort to ground water sources such as shallow wells, boreholes and water vendors as alternative water resources. Water availability and quality are critical factors in ensuring better public health, particularly in densely populated areas like markets. Abia State, Nigeria has several markets because of the involvement of people in trade and commerce; and as a result, vendors and customers rely on local water sources for drinking, cooking, and sanitation. The availability and quality of water in these markets are potential causes of conflicts and exposure to diseases from environmental contaminants especially during the rainy season. Despite the importance of clean water to support economic activities and for preventing waterborne diseases, there is limited information on the current availability and quality of water in these markets. The need to assess the physicochemical and bacteriological parameters of water sources in Ubani and Ndoro markets is urgent, particularly as poor water quality can result in significant health risks. An assessment of the availability and quality of water, particularly physicochemical and bacteriological parameters of water sources, in Ubani and Ndoro markets supports the WASH program in Abia State. This study assessed the availability, physicochemical and bacteriological quality of water sources in Ndoro market (rural) and Ubani market (urban) and evaluates their compliance with WASH standards.

MATERIALS AND METHODS

Study Area

Ubani and Ndoro markets where the study was conducted are located in Umuahia and Ikwuano Local Government Areas (LGAs) respectively in Abia State, Nigeria. These markets were chosen for their prominence in size and commercial importance in Abia State. Ubani is an urban market considering its location while Ndoro is a rural market that majorly buys and sells once a week.

Ikwuano LGA has a total landmass of approximately 281km^2 and a population of about 137,993 (2006 Census). The study area lies between latitudes 5^o 19′ N and 5^o 29’N and longitudes 7^o 32’E and 7^o 40’ (Chukwu and Ajuamiwe 2013); bounded by Bende L.G.A in the north, Umuahia L.G.A in the northwest, Isialangwa L.G.A in the southwest and Akwa Ibom State in the southeast (Danladi and Ray, 2014). It has a total land mass of 281km^2 and a population of about 137,993 (2006 Census) and consists of mainly rural communities.

Umuahia North LGA lies between latitude 5° 29' N and 5° 33' N and longitude 7° 7' E and 7° 28' E; bounded by Bende LGA to the East; Obowo LGA and Ihitte-Uboma LGA in Imo State to the West; Umuahia South LGA to the South; and Isikwuato LGA to the North (Ugbonta et al., 2023). Umuahia, the capital city of Abia State, serves as its headquarters area and the communities mostly have urban setting. Commerce and industry thrive in Umuahia North LGA and it is home to a number of market centres such as Ubani and the industrial market in Azueke Ndume Ibeku.

Research Design

A mixed-method approach was employed, combining both quantitative and qualitative techniques. The data collection methods included questionnaires and water quality analysis to evaluate water availability and quality respectively. Global positioning system (GPS) was used to collect coordinates and estimate the distance of the water source from the market centre.

Questionnaire Survey

Structured questionnaires were administered randomly to market stakeholders, including vendors and users, to collect information on water availability in dry and wet seasons, ease of access, water sources and usage. The responses gathered information on the source and accessibility of water for daily use. The sample size (385) for the questionnaire survey was derived using the Cochran’s 1977 formula for determining sample size for an infinite population.

GPS Field Survey and Sample Analysis

A GPS survey was conducted using the Garmin eTrex 30 device to map water sources by recording their GPS coordinates. GIS tools were then used to calculate the straight-line (Euclidean) distances from the market centers to each available water source.

Physicochemical Analysis

Water samples were collected during the dry season (January) and wet season (May) from multiple sources in Ubani and Ndoro markets. A total of three water sources were sampled (Borehole water, rainfed wells and tanker-supplied water). These water sources were selected because they were the only existing/available sources of water in the markets.

Replicate samples were collected for each water source to ensure reliability and reproducibility. Water samples were collected in sterile bottles in the morning (7am-9am). Water from taps was allowed to follow out for about 2 mins before been collected in 200ml sterile containers. For the rain-fed wells, the sterile containers were held near base and plunged into the water with neck facing downwards to about 30 cm depth. Samples were stored in ice packs and taken to Grifeon Projects Ltd Laboratory within 24hrs for analysis. Physical parameters analyzed in the study were pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), and Temperature while chemical water quality parameters in the study included Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate (NO_3) and Dissolved Oxygen (DO). Parameters such as pH, EC, TDS, Temperature and DO were measured onsite using a Hanna Multimeter Probe while COD, NO_3 were measured using Thermo Fisher Scientific spectrophotometer.

Bacteriological Analysis

The 5 tube test using the Most Probable Number (MPN) approach, as detailed by APHA (2005), was utilised to acquire the coliform count. The method is predicated on the amount of bacteria that are most likely to be found in a sample (APHA, 2005). On nutrient agar slants, stock cultures of the isolates with various cultural traits were created. To verify morphology, gram staining was employed, and biochemical tests were carried out to facilitate isolate identification. Results were compared with WHO standards (2022) for drinking water, which recommend zero coliforms per 100 mL for safe drinking water.

Data Analysis

The data obtained was analysed using SPSS version 22.0. A T-test was used to compare the means of the results from both markets. The questionnaire responses were analyzed using descriptive analysis and presented in percentages.

RESULTS

Water Availability, Ease of Access and Distance from the Market Centre

The results of the survey on water availability, ease of access and distance to the market centre are presented in tables 1, 2 and 3. Table 1 show that 81.1% and 77.1% of respondents from Ubani and Ndoro markets respectively, considered sachet water as the most available source of water. In Ubani, 4.7% of respondents reported using rainwater and well water, while neither source was used in Ndoro market (0%). Borehole water was used by 4.7% of respondents in Ubani, compared to 22.9% in Ndoro. Additionally, 4.7% of respondents in Ubani and 0% in Ndoro stated that they did not use any of the water sources mentioned. Table 2 shows that 57.4% of respondents in Ubani Market reported difficulty in accessing water. In Ndoro Market, 52.9% reported similar challenges, but a higher proportion of respondents found water access easier compared to Ubani.

The distance from the sources of water to the market centre is presented in table 3. The distance from the sources of water in Ubani market (Tanker-supplied Water-Ubani, Rain Water-Ubani, Rain Water-Ubani II, Borehole Water-Ubani) to the market centre is 300m, 1km, 1.5km, 500m respectively. In Ndoro the Rain Water-Ndoro is 1km away from the market centre while Borehole Water-Ndoro is 100m.

Table 1: Responses on Water Availability in Ubani and Ndoro Markets

Water Source	Ubani Market (n = 380)	Ndoro Market (n = 380)
Rain Water	18 (4.7%)	0 (0%)
Well Water	18 (4.7%)	0 (0%)
Borehole Water	18 (4.7%)	87 (22.9%)
Sachet Water	308 (81.1%)	293 (77.1%)
None of the above	18 (4.7%)	0 (0%)

Table 2: Responses on Ease of Water Access in Ubani and Ndoro Markets

Ease of Access	Ubani Market (n = 380)	Ndoro Market (n = 380)
Very Easy	36 (9.5%)	12 (3.2%)
Easy	126 (33.2%)	189 (49.7%)
Difficult	144 (37.9%)	179 (47.1%)
Very Difficult	74 (19.5%)	0 (0%)

Table 3: Distance from Water Sources from the Market Centre

Sample Code	Distance from Market Centre
US1a	300m
US2a	500m
NS1a	100m
RWN	1km
RWU	1km
RW2U	1.5km

US1a (Tanker-supplied Water Ubani), US_2a (Borehole Water Ubani), NS_1a (Borehole Water Ndoro), RWN (Rain Water Ndoro), RWU (Rain Water Ubani), RW_2U (Rain Water Ubani II)

Water Quality

The result of the water quality assay of water used in Ubani market and Ndoro market is presented in Table 4. From the result, the mean value of the biological oxygen demand was significantly lower ($p \leq 0.05$) in the dry season (4.82±0.64mg/l) compared to the mean value in the wet season (9.07±1.74mg/l) in Ubani market. In contrast, Ndoro Market showed no significant seasonal variation, with BOD values of 4.8±0.00 mg/L in the dry season and 8.52±2.37mg/L in the wet season. The mean value of COD recorded in Ubani market was 12.69±0.11mg/l and 14.06±3.56mg/l while that of Ndoro market was 15.53±0.11mg/l and 12.65±4.30mg/l for the dry and wet seasons respectively. Nitrate levels showed significant seasonal variation, with mean values of 0.39±0.04mg/L (dry) and 0.3±0.03mg/l (wet) in Ubani Market, and 0.31±0.01mg/l (dry) and 0.25±0.01mg/l (wet) in Ndoro Market. In Ubani Market, the pH was 6.68±2.28 during the dry season and 6.11±1.16 during the wet season. In Ndoro Market, the pH was 3.96±0.02 in the dry season and 4.55±1.07 in the wet season. However, the differences in pH between the seasons were not statistically significant for either market. The levels of electrical conductivity (EC) were below the 2022 World Health Organization's permissible (WHO_{PL}) limit of 100µS/cm for both seasons (369.5±120.67µS/cm and 386.25±216.68µS/cm) in Ubani market. In Ndoro market, EC values for dry and rainy seasons were 92±1.41µS/cm and 61.00±46.20µS/cm respectively and within the WHO_{PL}. The TDS levels in Ubani market were 174.5±46.77mg/l in the dry season and 192.63±107.75mg/l in the wet season whereas that of Ndoro market was 44±1.41mg/l and 29±24.50mg/l. The differences in levels of TDS were not statistically significant for the both markets. There was a significant variation in the temperature values obtained from Ubani market with the dry season recording 32.05±1.03^{0}C and the wet season recording 30.68±0.59^{0}C. Temperature levels in Ndoro market ranged from 27.65±0.21^{0}C of the dry season to 27.38±1.65^{0}C of the wet season with no statistically significant variation ($p \leq 0.05$). DO showed no significant variation in Ubani market with dry season values of 2.78±0.62mg/l and rainy season values of 4.63±1.68mg/l. Ndoro market on the other hand showed significant variation in the DO levels recorded for dry (3.6±0.00mg/l) and rainy (4.73±0.28mg/l) seasons.

Table 4: Seasonal Variation in Water Quality from Ubani and Ndoro Markets

Parameters	Season	UBANI		NDORO		WHO_{PL}
		Mean±SD	Sig. (2-tailed)	Mean±SD	Sig. (2-tailed)	
BOD (Mg/l)	Dry Season	4.82±0.64	0.001***	4.80±0.00	0.104^{NS}	5
	Wet Season	9.07±1.74		8.52±2.37		
COD (Mg/l)	Dry Season	12.69±0.11	0.469^{NS}	15.53±0.11	0.423^{NS}	100
	Wet Season	14.06±3.56		12.65±4.30		
NO_3 (Mg/l)	Dry Season	0.39±0.04	0.004**	0.31±0.01	0.003**	3
	Wet Season	0.31±0.03		0.25±0.01		
pH	Dry Season	6.68±2.28	0.573^{NS}	3.96±0.02	0.501^{NS}	6.5 -8.5
	Wet Season	6.11±1.16		4.55±1.07		
EC (µS/cm)	Dry Season	369.50±120.67	0.890^{NS}	92.00±1.41	0.422^{NS}	300
	Wet Season	386.25±216.68		61.00±46.20		
TDS (Mg/l)	Dry Season	174.50±46.77	0.759^{NS}	44.00±1.41	0.456^{NS}	500
	Wet Season	192.63±107.75		29.00±24.25		
TEMP (0C)	Dry Season	32.05±1.03	0.014*	27.65±0.21	0.835^{NS}	27
	Wet Season	30.68±0.59		27.38±1.65		
DO (Mg/l)	Dry Season	2.78±0.62	0.063^{NS}	3.60±0.00	0.006**	4
	Wet Season	4.63±1.68		4.73±0.28		

Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate (NO_3), Electrical Conductivity, Total dissolvable Solid (TDS), Temperature (TEMP), Dissolved Oxygen (DO)

Bacteriological Analysis

The results of the bacteriological assay on water sources around Ubani market and Ndoro market are presented in tables 5 and 6. The results indicate that during the dry season, there was no significant bacterial growth in the water samples from both markets after 48hrs of incubation at 37^{o}C, no isolated organism and microbial count. During the rainy season in Ubani market, the two rain-fed shallow wells (RW_2U AND RWU) showed the presence of bacterial growth. *Staphylococcus aureus* and *Klebsiella spp* were isolated from RW_2U with a colony count of 2.4×10^4cfu/ml and 2.3×10^4cfu/ml respectively. However total heterotrophic count (1.2×10^5cfu/ml) was only recorded for *Staphylococcus aureus*. The second rain-fed shallow well (RWU) had presence of *Escherichia coli* (1.72×10^5cfu/ml) with a total heterotrophic count of (3.2×10^5cfu/ml) and *Klebsiella spp* (2.2×10^5cfu/ml) with no heterotrophic count. Whereas, the rain water source (RWN) in Ndoro market showed no significant bacterial growth after 48hrs of incubation at 37^{o}C. Tanker-supplied water (S_1BU) in Ubani market did not show any significant bacterial growth after 48hrs of incubation at 37^{o}C. Borehole water both in Ubani (MFBU) and Ndoro (S_2BN) markets showed significant growth of *Klebsiella spp* with colony counts of 1.5×10^5cfu/ml and 2.2×10^5cfu/ml respectively. Apart from the water sources were no bacterial growths were recorded, all the other sampled sources exceeded the WHO standard of 0cfu/100ml. There were no *salmonella* and *vibrio cholerae* count in all the isolates.

Table 5: Bacteriological Parameters of Water Samples obtained from Ubani and Ndoro Markets during the Dry Season

Sample Code	Isolated organism	Microbial Load
US1a	No significant bacterial growth after 48hrs of incubation at 37°C	Nil
US2a	No significant bacterial growth after 48hrs of incubation at 37°C	Nil
NS1a	No significant bacterial growth after 48hrs of incubation at 37°C	Nil

US1a (Tanker-supplied Water Ubani), US2a (Borehole Water Ubani), NS1a (Borehole Water Ndoro)

Table 6: Bacteriological Parameters of Water Samples obtained from Ubani and Ndoro Markets during the Wet Season

Sample Code	Isolated organism	Colony count (cfu/ml)	Total Heterotrophic count	*Salmonella* count	*Vibrio cholerae* count	WHO Standard
RW_2U	*Staphylococcus aureus*	2.4×10^4	1.2×10^5 (cfu/ml)	Nil	Nil	0 cfu/100 ml
	Klebsiella spp	2.3×10^4				
S_2BN	*Klebsiella* spp	2.2×10^5	Nil	Nil	Nil	0 cfu/100 ml
RWN	No significant bacterial growth after 48hrs of incubation at 37°C					0 cfu/100 ml
S_1BU	No significant bacterial growth after 48hrs of incubation at 37°C					
RWU	*Escherichia* coli	1.72×10^5	3.2×10^5 (cfu/ml)	Nil	Nil	0 cfu/100 ml
	Klebsiella spp	2.2×10^5				
MFBU	*Klebsiella* spp	1.5×10^5	Nil	Nil	Nil	0 cfu/100 ml

RW_2U (Rain Water Ubani), S_2BN (Borehole Water Ndoro), RWN (Rain Water Ndoro), S_1BU (Tanker supplied water Ubani), RWU (Rain Water Ubani), MFBU (Borehole Water Ubani).

DISCUSSION

One of the most crucial aspects of water use is accessibility, despite the fact that there have been many disagreements over what constitutes accessibility (Emenike *et al*., 2017). This study finds that sachet water, borehole, well, and rain-fed water were the primary water sources in the markets. In both Ubani and Ndoro markets, sachet water was the most common source, but access to water remained difficult for at least 50% of respondents. The heavy reliance on sachet water in both markets indicates limited access to public water infrastructure, which may reduce water usage for hygiene, a key WASH component. Although sachet water is generally perceived as safer, it may not always meet regulatory standards.

Dada (2009) found that while their sampled brands displayed mandatory National Agency for Food and Drug Administration and Control (NAFDAC) certification numbers, none complied with the regulator's established requirements.

In Ndoro, the absence of rain or well water points to a greater reliance on sachet or borehole water, which can limit access due to cost or infrastructure issues. The shortest distance of a water source to the market centre was 100m for the borehole water in Ndoro whereas the longest distance was 1.5km for the rain-fed shallow well in Ubani market. The WHO classifies water access as basic (Within 500 meters), Intermediate (500 meters to 1 km), where fetching water is manageable but still time-consuming and limited (above 1 km) where users may be water-stressed. Based on this classification, access to borehole water in Ndoro market is basic (100m) whereas access to the rain catchment is intermediate (1km). In Ubani market, access is basic for tanker-supplied water and borehole water; intermediate for rain-fed well I and limited for rain-fed well II. Oyerinde and Jacobs (2022) observed that long distances to water sources reduce the frequency of water use for personal and environmental sanitation, potentially leading to WASH challenges like a higher risk of waterborne diseases. Markets with basic access, like Ndoro, are better positioned to maintain hygiene through regular water use, while those with intermediate or limited access, like Ubani, may face challenges, particularly in food handling areas. Reliance on rain-fed wells during the dry season can exacerbate water scarcity, forcing users to resort to unsafe sources.

The results of this study reveal significant concerns about the physicochemical and bacteriological quality of water sources in Ubani and Ndoro markets, particularly in relation to WASH standards. Both markets exhibited seasonal fluctuations in water quality, with contamination levels increasing significantly during the wet season. This underscores the heightened vulnerability of these water sources to seasonal runoff and pollution. The BOD values in both Ubani and Ndoro markets were significantly higher during the wet season than in the dry season, reflecting a rise in organic matter possibly from increased runoff. In Ubani, BOD increased from 4.82mg/l in the dry season to 9.07mg/l in the wet season ($p < 0.05$), while in Ndoro, it rose from 4.80mg/l to 8.52mg/L ($p > 0.05$). This sharp increase points to an accumulation of organic pollutants, which likely contributes to oxygen depletion in the water sources; a finding consistent with Ladokun and Oni (2015), who observed similar values in potable water sources in Ibadan. The highest (15.53mg/l) and lowest (12.65mg/l) COD values recorded in this study were in Ndoro market during the dry season and were within the WHO's permissible limit of 100mg/l. The lowest level of nitrate was recorded in during the rainy season in Ndoro market (0.25mg/l) whereas the highest value was recorded in Ubani market (0.39mg/l). This agrees with Aduwo and Adeniyi, (2019) that NO_3 was significantly higher ($p<0.05$) in the dry season than in the rainy season in a research farm lake in Osun State.

No significant differences ($p>0.05$) existed in pH values obtained in the both markets and values were within the WHO permissible limit of 6.5 - 8.5. It was observed that pH was higher in the dry season (6.68) than in the wet season (6.11) in Ubani market; however in Ndoro, the pH was higher in the wet season (4.55) than the dry season (3.96). This shows that the water sources in both markets were acidic and slightly acidic respectively. This shows that the water sources in the markets were slightly acidic and acidic respectively. This difference in mean pH values between the rainy and dry seasons may have been influenced by environmental and hydrological factors such as onset of rainfall, runoff and contamination. The respective values of TDS in Ubani market during the dry and rainy season were 174.5mg/l and 192.5mg/l while in Ndoro market, the values were 44mg/l and 29mg/l. the values did not exceed the WHO permissible limit. Furthermore, the highest value of EC (369.50µS/cm) was recorded in Ubani market during the dry season whereas the lowest value (61µS/cm) was recorded in Ndoro market during the wet season. The level of EC in Ubani was considerably higher than the WHO's (2022) recommended limit of 100µS/cm. This indicates elevated salinity and dissolved ion levels, likely resulting from soil erosion and improper waste management practices. The values of TDS and EC in this study negates the findings of Yusuf *et al*., 2021, who reported higher TDS and EC levels in the rainy season as compared to the dry season. Temperature levels were lower in the wet season as compared to the dry season in the both markets and this may be attributable to the onset of rainfall. The lowest temperature recorded was in Ndoro market (27.38^0C) whereas the highest was in Ubani market (32.05^0C). Dissolved oxygen in the both markets were within the 2022 WHO permissible limit of 50mg/l however, there was a significant variation ($p < 0.05$) in DO levels in Ndoro market with values of 3.6mg/l and 4.73mg/l respectively.

This could likely be due to contamination from human activities in the rain fed water source in the market. When the DO of water is
high the pollution is low when the DO is low, the pollution level is high (Ladokun and Oni, 2015). During the dry season, there was no significant bacterial growth in the water samples from both markets after 48hrs of incubation at 37^{o}C, no isolated organism and microbial count. The bacteriological analysis revealed the presence of coliform bacteria, including *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella spp*., in multiple samples during the rainy season. Apart from the water sources were no bacterial growths were recorded, all the other sampled sources exceeded the WHO standard of 0cfu/100ml. Coliform contamination is a key indicator of fecal pollution, which poses severe health risks, particularly through the transmission of diseases like diarrhea, cholera, and typhoid. *Staphylococcus aureus* in a rainfed water source in Ubani market had the highest colony count of 2.4×10^{4}cfu/ml with a heterotrophic count of 1.2×10^{5}cfu/ml. This indicates poor hygiene practices in the water sources since it is part of the commensal skin flora. The presence of *E. coli* in rainwater from Ubani market (1.72×10^{5}cfu/ml) suggests direct contamination from human or animal waste, while the high heterotrophic counts further highlight the unsanitary conditions in the market's water sources. Locating sanitary facilities away from water sources, lining the water sources, and disinfecting drinking water through boiling, flocculating, or chlorine tablet solutions are some possible treatments for *E. coli* contamination (WHO, 2022). Borehole water from Ndoro market also showed significant contamination, with *Klebsiella spp*. colony and counts reached 2.2×10^{5}cfu/ml. Such contamination indicates that the borehole water is not properly protected, uncleanliness of the water storage facility and absence/inadequate water treatment thereby exposing the end users of the water to possible pathogenic diseases.

Edeki *et al*., (2023) observed similar contamination patterns in Delta State, particularly in boreholes and rainwater-fed systems, which are often vulnerable to contamination during the wet season due to poor sanitation and runoff. In the study fecal contamination was linked to improper waste management and the proximity of water sources to sewage systems, which mirrors the conditions observed in Ubani and Ndoro markets. Seasonal contamination spikes in Ubani and Ndoro align with Kumpel et al. (2017), who noted increased pollutants from runoff during the rainy season. High heterotrophic bacterial counts also reflect unsanitary conditions, consistent with Edeki et al. (2023), who found high microbial loads in water exposed to environmental contamination. Thus, among many other things open defecation, careless waste management, poor urban design, and the ensuing interaction between ground and surface waters could be identified as the origins of microbiological pollution (Yusuf *et al*., 2018). There were no *salmonella* and *vibrio cholerae* count in all the isolates.

CONCLUSION

This study highlights significant challenges in maintaining safe water quality in Ubani and Ndoro markets, where both physicochemical and bacteriological contamination pose health risks, especially during the wet season. The presence of *Escherichia coli* and *Klebsiella spp.* in rainwater and borehole sources indicates a heightened risk of waterborne diseases like diarrhea, cholera, and typhoid, worsened by inadequate sanitation and hygiene practices. These risks are further aggravated by limited water access, with over half of respondents in both markets facing difficulties in obtaining water. The distance to water sources also complicates access, as users must travel far to reach some sources, making frequent use challenging. Regular monitoring and treatment of water sources, particularly during the rainy season, alongside efforts to improve water accessibility, are crucial to reducing contamination and promoting better hygiene practices.

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