



## Article Info

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## Evaluation of Microalgae Contamination and Water Quality Standards in Different Drinking Water Sources from Kabayi Community, Mararaba Nasarawa State

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Access to safe drinking water remains a pressing public health challenge in many developing regions. This study assessed the physicochemical quality and microalgal contamination of drinking water sources in Kabayi Community, Mararaba, Nasarawa State, Nigeria. Water samples were collected from wells, boreholes, and sachet water and analyzed using standard physicochemical procedures. Parameters measured included pH, temperature, total dissolved solids (TDS), electrical conductivity, hardness, and nutrient concentrations (nitrate and phosphate). Statistically analysis was conducted using ANOVA in R. Microalgae were morphologically identified and characterized microscopically to determine species composition and abundance. Our results revealed notable variations in physicochemical parameters among the different water sources. Well water from the Power Bakery area exhibited the highest conductivity (88.7  $\mu\text{S}/\text{cm}$ ), total dissolved solids (TDS)  $191.2 \pm 5.23$  ppm, and nitrate concentration (5.5 mg/L) compared to borehole and sachet water samples. Nevertheless, all measured parameters remained within the permissible limits set by the World Health Organization (WHO). Several algal genera, including *Chlorella*, *Chlamydomonas*, *Scenedesmus*, *Euglena*, and *Microcystis*, were detected in well water, while *Oscillatoria* and *Chlamydomonas* were observed in borehole water samples suggesting possible contamination from surface runoff and inadequate sanitation. In contrast, sachet water samples showed no algal presence and largely complied with WHO drinking water standards. Our study highlights potential health risks associated with untreated groundwater sources and emphasizes the need for regular monitoring and effective water management strategies. These findings provide essential baseline data to guide policymakers and local authorities in developing sustainable interventions for ensuring potable water access in Kabayi community.

**Keywords:** Microalgae, Water quality, Physicochemical, Contamination, Water source.

## 1. Introduction

Safe and clean drinking water is fundamental to human health, economic development, and environmental sustainability (Magaji and Ajayi, 2020). Water plays an essential role in supporting life, maintaining hygiene, and facilitating agricultural and industrial activities. The World Health Organization (WHO, 2022) emphasizes that potable water must be free from harmful microorganisms, toxic substances, and excessive chemical impurities to prevent waterborne diseases. Globally, inadequate access to safe drinking water contributes significantly to the burden of gastrointestinal infections, cholera, typhoid, and other public health concerns (García-Ávila et al., 2022). Ensuring the safety of drinking water, therefore, remains a core component of sustainable development and community well-being.

Despite international efforts to improve water accessibility, approximately two billion people worldwide still rely on water sources contaminated with faeces or other pollutants (UNICEF & WHO, 2022). In many developing countries, including Nigeria, population growth, unplanned urbanization, poor waste management, and inadequate sanitation systems have intensified the degradation of water quality (Kalu et al., 2023; Atiku et al., 2018). In peri-urban communities such as Kabayi, Mararaba, in Nasarawa State, water sources such as wells, boreholes and sachet water often considered reliable are increasingly threatened by poor sanitation infrastructure, agricultural runoff, microbial contamination, unregulated urban expansion, and inadequate water management practices increasing the likelihood of contamination from both natural and

anthropogenic sources (Goshtasbi et al., 2022; García-Ávila et al., 2022; Osaji et al., 2021). Studies in various Nigerian regions have reported physicochemical irregularities, elevated levels of dissolved solids, and microbial pollution in community water sources (Ajobiwe et al., 2019; Atiku et al., 2018; Osaji et al., 2021). Sachet water, widely consumed across Nigeria as an affordable alternative, is also not exempt from contamination due to lapses in quality control during production and distribution (Magaji and Ajayi, 2020; Onwughara et al., 2013). These challenges highlight the need for continuous monitoring of both surface and groundwater systems to ensure compliance with WHO standards and to safeguard public health.

While numerous studies in Nigeria and other developing regions have focused on bacteriological and physicochemical parameters of water quality (Martínez-Burgos et al., 2024; Magaji and Ajayi, 2020; Ajobiwe et al., 2019), limited attention has been given to microalgal contamination. Microalgae are photosynthetic microorganisms commonly found in aquatic systems, and although many are harmless, some genera, such as *Microcystis* and *Oscillatoria* can produce harmful toxins that pose health and ecological risks (García-Ávila et al., 2022; Shokunbi et al., 2021; Chia et al., 2013). Their occurrence in drinking water may indicate nutrient enrichment, inadequate protection of wells, or poor purification practices. The lack of data on microalgal composition in domestic water sources represents a critical gap in understanding the biological integrity of community water supplies (Martínez-Burgos et al., 2024; Yu et al., 2024). Therefore, this present study aimed to evaluate the physicochemical quality and microalgal contamination of different drinking water sources in Kabayi Community, Mararaba, Nasarawa State, Nigeria, to determine their compliance with WHO standards and assess potential public health implications.

## 2. Materials and Methods

### 2.1 Description of the Study Area

The study was conducted in the Kabayi community of Nasarawa State, which is generally considered part of the Abuja metropolitan area. The Kabayi community is located to the east of Abuja, the capital city of Nigeria, which lies at the centre of the country. The community is situated at a latitude of 9.072264 and a longitude of 7.491302, with an elevation of 491 meters.

### 2.2 Sample Collection

Water samples were collected from three different sources in the Kabayi community of Nasarawa State using clean and sterilized plastic containers, triplicate samples from 2 wells, 2 boreholes, and 1 sachet water source were collected. The borehole water samples were obtained from Zone 4 and Bedrock Street, while the well water samples were

taken from Zone 4 and Power Bakery. Additionally, samples of sachet water were collected from De Great Table Water Company. The sample locations were randomly selected, and the water samples collected were immediately transported to the Biological Sciences Laboratory of the Department of Biological Sciences, National Open University of Nigeria. Physicochemical and microalgal examination was carried out using standard methods (APHA, 2017; van-Vuuren, 2006).

### 2.3 Determination of Physicochemical Parameter

The physicochemical parameters of the water samples were determined using the method described by APHA (2017).

### 2.4 Determination of temperature, colour and turbidity

Water Temperature was measured using a thermometer. The bulb of the thermometer was dipped into the water at a depth of 2 cm and allowed to stabilize and then the readings were taken and recorded in degree Celsius (°C) (APHA, 2017). Colour measurement was carried out using the HACH DR 5000 spectrophotometer, 10ml of filtered de-ionised water was used as the blank. This blank was placed in a sample cuvette to calibrate the spectrophotometer, entering the programmed value of 120 at the wavelength of 455nm for colour measurement. The sample was also prepared through filtration. Subsequently, 10ml of the prepared sample for analysis was placed in the cuvette and measured. The results were recorded in mg/L. The turbidity of the water samples was determined according to the method described by APHA (2017). 10 ml of deionized water was poured into a cuvette which was used to standardize the spectrophotometer and then 10 ml of each sample was poured into another cuvette which was inserted into the spectrophotometer and the reading was noted and recorded at 430nm on a turbidity meter. The average of the readings was recorded in NTU.

### 2.5 Determination of pH, electrical conductivity and total hardness

The pH meter was standardized with a buffer of pH 7 before taking the measurements. The value of each sample was taken after submerging the pH probe in the water sample and holding it for a couple of minutes to achieve a stabilized reading. After the measurement of each sample, the probe was rinsed with deionized water to avoid cross-contamination among different samples (USEPA, 2014). Conductivity was determined using the exttech-exstik II EC500 model field kit. The probe was immersed in the water and the meter reading was recorded in  $\mu\text{S}/\text{cm}$  (APHA, 2017). The total hardness was measured titrimetrically according to the method described by APHA (2017). About 20 ml

of the water samples were titrated with 0.02 M EDTA solution (ethylene diamine tetraacetate), which was added to 2 ml of ammonia buffer in the presence of Erichrome black dye. The total hardness was calculated as shown below.

$$\text{Total hardness (mg/L)} = \frac{\text{Volume of EDTA} \times N \times 50 \times 100}{\text{Sample volume}}$$

Total Dissolved Solids (TDS) was determined using a multi-meter (exttech–exstik II EC500). The TDS meter was powered on, reset to zero, and then the electrode was submerged into the sample spot to the depth at which the water covers the membrane. Readings were accurately taken and noted in mg/L as described by APHA, 2017.

## 2.6 Determination of chloride ion and nitrate

Chloride ion was measured using Argentometric Method (Mohr method). The Mohr Method uses silver nitrate for titration. This corresponds to 1 mL of 0.0141, which equals to 1mg chloride in solution. The silver nitrate solution was standardized against standard chloride solution, prepared from sodium chloride (NaCl). During the titration, chloride ion was precipitated as white silver chloride. The indicator (potassium chromate) was added to visualize the endpoint, demonstrating the presence of excess silver ions. In the presence of excess silver ions, the solubility product of silver chromate was exceeded and a reddish-brown precipitate was formed. 1.0ml indicator solution (potassium chromate) was added to 100 ml sample in a conical flask. The sample pH was measured. This was titrated with standard silver nitrate solution to pinkish yellow end point and volume of titrant used was noted down. Chloride ion concentration was calculated using the equation below:

$$\text{Chloride Ion Concentration (mg/L)} = \frac{A \times N \times 35450}{V \text{ of sample}}$$

Where: A = volume of titrant used, N is the normality of silver nitrate (here we used N/71 or 0.0141 N), and V sample is volume of sample used (mL). The average of the replicates was taken and recorded in mg/l (APHA, 2017).

To determine the nitrate concentration, 100 mL of the water sample was poured into a clean dry crucible and kept in an oven at 100°C till dryness. It was removed and allowed to cool, after which 2 ml of phenol disulfuric acid was added and swirled around uniformly. After 10 minutes, 10ml of distilled water was added in which 5ml of ammonia solution

was also added and the colour change was read at 430nm on colorimeter (APHA, 2017).

## 2.7 Microalgae Isolation and Identification

The water samples were also used for the determination of microalgae species. 100ml of the water samples was added to a 500ml conical flask containing 150 mL of sterilized BG11 medium. The water samples were kept in a nutrient solution to keep the microalgae species alive and to allow them to grow. Agar plates were prepared by dissolving 2% agar (w/v) in BG 11 medium. These plates were autoclaved at 121°C for 15 minutes. Then these plates were allowed to cool down and 5 ml of warm agar medium was put in the plates. These plates were allowed to cool, kept in an inverted position and at least 4 hours before streaking. Washed microalgae were allowed to streak through loop in plates in axenic condition and kept for at least seven days to grow microalgae. Repeated streak-plating were carried out to peak up a single colony from earlier streaked plates and make it free from bacteria and fungi. Subsequently, single colonies were picked up by loop and allowed to grow, and all experiments were conducted in triplicate. Microalgae species were microscopically identified and confirmed using a key described by van-Vuuren (2006).

## 2.8 Data Analysis

The findings from the study were analyzed statistically using R version 4.4.4. Analysis of Variance (ANOVA) was utilized to assess the differences among samples, and the mean  $\pm$  Standard Deviation of the values were calculated. Differences were regarded as significant at a 5% level ( $p < 0.05$ ).

## 3. Results and Discussion

### 3.1 Results

#### 3.1.1 Physicochemical Parameters of Borehole and Well Water

The results of physicochemical parameters analyzed for the different water samples in terms of pH, total dissolved solids, temperature, turbidity, water hardness, alkalinity, odour, colour, chloride, nitrate and conductivity showed variations in the different samples collected. The results obtained from the physicochemical analysis are presented in Table 1.

**Table 1:** Physicochemical Parameters of Sachet, Borehole and Well Water (Values represent mean  $\pm$  standard deviation for n =3)

Parameters	SHW	BS1	BS2	WS1	WS2	WHO Limit
Colour	10 $\pm$ 1.0	11 $\pm$ 1.0	11 $\pm$ 1.0	12 $\pm$ 2.0	15 $\pm$ 2.0	15TCU
Alkalinity	9.5 $\pm$ 0.01	8.9 $\pm$ 0.41	8.7 $\pm$ 0.11	9.1 $\pm$ 0.0	9.7 $\pm$ 0.11	NA
Turbidity (NTU)	1.70 $\pm$ 0.0	2.20 $\pm$ 0.0	2.8 $\pm$ 0.0	3.7 $\pm$ 0.0	3.8 $\pm$ 0.0	<5
pH	6.6 $\pm$ 0.10	6.8 $\pm$ 0.20	6.7 $\pm$ 0.20	7.6 $\pm$ 0.10	7.8 $\pm$ 0.10	6.5-8.5
Temp. ( $^{\circ}$ C)	29.1 $\pm$ 0.0	28.2 $\pm$ 0.0	28.2 $\pm$ 0.0	28.0 $\pm$ 0.0	28.0 $\pm$ 0.0	NS
Conductivity $\mu$ S/cm	80.1 $\pm$ 1.20	80.4 $\pm$ 1.30	80.7 $\pm$ 1.10	82.1 $\pm$ 1.60	88.7 $\pm$ 1.40	500
TDS (ppm)	92.2 $\pm$ 2.41	95.6 $\pm$ 2.32	101.2 $\pm$ 4.70	188.0 $\pm$ 6.74	191.2 $\pm$ 5.23	<600
Hardness mg/l	102 $\pm$ 0.00	132 $\pm$ 2.00	110 $\pm$ 1.00	142 $\pm$ 2.00	150 $\pm$ 1.00	<200
Chloride (mg/l)	17.0 $\pm$ 0.0	25.3 $\pm$ 0.60	26.18 $\pm$ 0.21	47.5 $\pm$ 0.50	59.18 $\pm$ 0.11	<250
Nitrate (mg/l)	1.2 $\pm$ 0.0	2.4 $\pm$ 0.0	2.2 $\pm$ 0.0	5.4 $\pm$ 0.0	5.5 $\pm$ 0.0	50

**Keys:** TDS= Total Dissolved Solids, WHO= World Health Organisation, NA=Not Available, NS= Not specified, TCU= True Colour Units, NTU= Nephelometric Turbidity Units, PPM= Part per million,  $\mu$ S/cm= micro siemens/ centimetre. SHW= Sachet water; BS1= Borehole Bedrock Street Kabayi; BS2= Borehole Zone 4 Street Kabayi; WS1= Well water Zone 4 Street Kabayi; WS2= Well water Power Bakery Kabayi

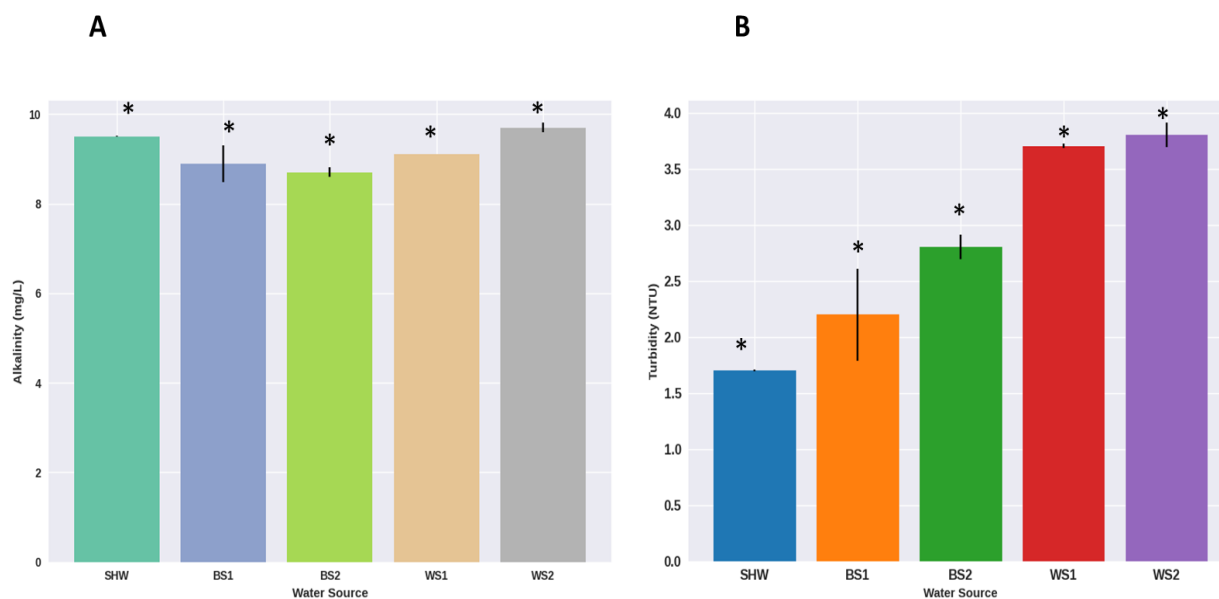
### 3.1.2 Colour, Odour, pH and Temperature

In this study, the colour of the water samples ranged from 10 TCU to 15 TCU in the sachet, borehole and well waters, which were all within the WHO limits. All the water sources were also odourless. The pH levels of the various water sources differed, with borehole water exhibiting values between 6.7 and 6.8, well water ranging from 7.6 to 7.8, and sachet water measuring at 6.6. The temperatures across all water sources were reported to be between 28 $^{\circ}$ C and 29 $^{\circ}$ C.

### 3.1.3 Alkalinity and Turbidity

Water alkalinity recorded in the study ranged between 8.7mg/L to 9.9mg/L for borehole water,

9.1mg/L to 9.7mg/L for well water and 9.5mg/L for sachet water. The highest value was recorded to be 9.7mg/L while the lowest value was recorded to be 8.7mg/L found in well water 2 (Power bakery Kabayi) and borehole water 2 (Zone 4 street Kabayi), respectively. (Figure 1A). From our results, the turbidity of the water sources ranged between 1.7 and 3.8 NTU. The values recorded for borehole water samples were 2.2 to 2.8 NTU (Bedrock Street and Zone 4 Street Kabayi, respectively), while those of the well water samples were 2.2 to 2.8 NTU (Zone 4 Street and Power Bakery, respectively). The sachet water had the lowest turbidity value of 1.7 NTU (Figure 1B).

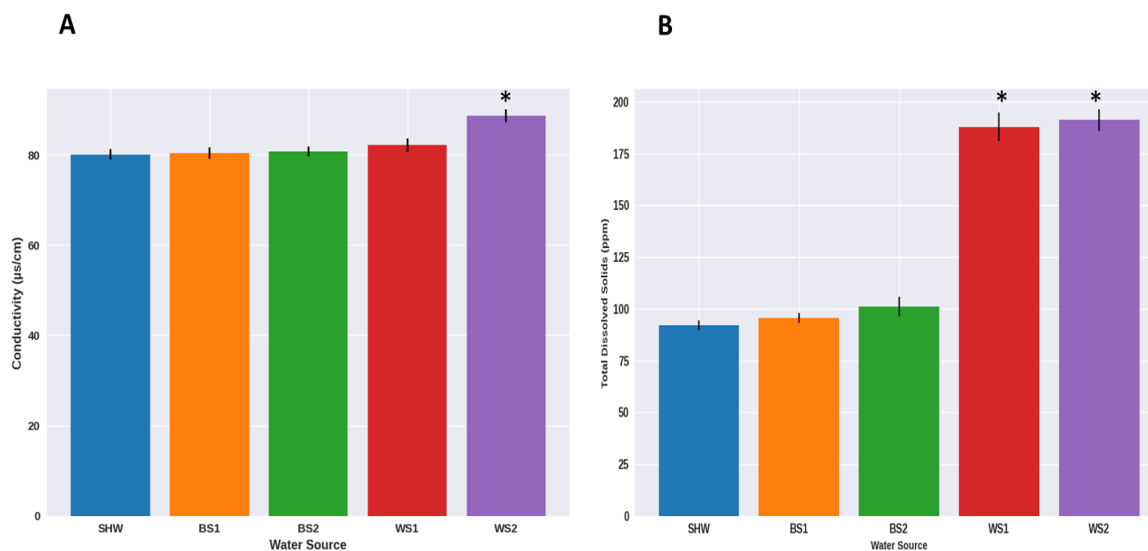


**Figure 1:** Alkalinity of values of sachet, well and borehole water samples (A), Turbidity (NTU) obtained from all the water samples in Kabayi Community (B). Bars represent mean (n=3), and error bars represent the standard deviation. Bars with an asterisk (\*) show significant differences ( $p < 0.05$ ).

### 3.1.4 Conductivity and Total Dissolved Solids

Our findings showed that the conductivity values for the well water samples collected varied from 82.1 $\mu$ s/cm to 88.7 $\mu$ s/cm across the two distinct water samples taken from the study area. The data from the borehole water sample indicated that the conductivity values ranged from 80.4 $\mu$ s/cm for Bedrock Street to 80.7 $\mu$ s/cm for Zone 4 Street,

respectively. The sachet water recorded a conductivity of 80.1 $\mu$ s/cm (Figure 2A). Power Bakery Kabayi, a source of well water, recorded the highest TDS value of 191.2 ppm, while the sachet water showed the lowest TDS value of 92.2 ppm. The borehole waters of Bedrock Street and Zone 4 Street recorded 95.6 ppm and 101.2 ppm, respectively. All values were within the WHO limits (Figure 2B).

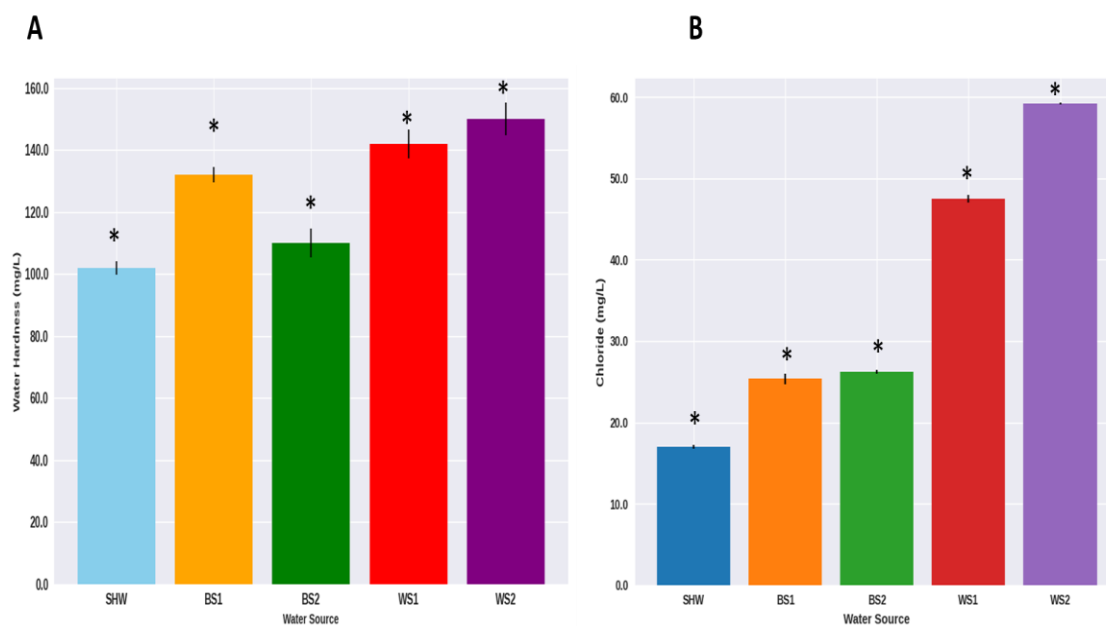


**Figure 2:** Conductivity values for sachet, well and borehole water samples (A), Total dissolved solids of well, sachet and borehole water samples from Kabayi community (B). Bars represent the mean (n=3), and error bars represent the standard deviation. Bars with an asterisk (\*) show significant differences ( $p < 0.05$ ).

### 3.1.5 Water Hardness, Chloride and Nitrate

Our results revealed that the water hardness in samples from well water 1 and 2 were 142 and 150 mg/L, respectively. The borehole water samples collected showed a range between 110 mg/L and 132 mg/L. Additionally, the sachet water sample measured at 102 mg/L (Figure 3A), marking it as having the lowest levels of chloride and nitrate, which were 1.7 mg/L and 1.2 mg/L, respectively. Conversely, the Power Bakery well water had the

highest chloride concentration at 59.18 mg/L, alongside a nitrate concentration of 5.5 mg/L (Figure 3B). The borehole water samples taken from Bedrock Street and Zone 4 had chloride concentrations of 25.30 mg/L and 26.18 mg/L, with nitrate levels of 2.4 mg/L and 2.2 mg/L, respectively. Although these water sources displayed differences in concentration, all values remained within the limits established by the World Health Organisation (WHO).



**Figure 3:** Water hardness values for well, sachet and borehole water samples (A), Chloride concentrations recorded from sachet water, well and borehole water samples (B). Bars represent mean (n=3), and error bars represent the standard deviation. Bars with an asterisk (\*) show significant differences ( $p < 0.05$ ).

### 3.1.6 Microalgae Isolated from the Water Samples

Table 2 presents the percentage frequency of different microalgae species recorded from well and borehole water sources. Our findings showed that *Chlamydomonas* sp had the highest occurrence of microalgal taxon across the sampled sites, occurring in all three major water sources with relatively high frequencies. In well water from Zone 4, *Chlamydomonas* sp showed the highest occurrence, accounting for 20% of the total microalgal frequency, while *Scenedesmus* sp and *Euglena* sp were comparatively less abundant, each contributing 5%. In well water from the Power Bakery area, microalgal diversity was slightly higher but with lower individual frequencies. *Chlamydomonas* sp remained dominant at 10%, whereas *Microcystis* sp and *Chlorella* sp each recorded 5%. Furthermore, the borehole bedrock samples were characterised by a more even distribution of species, with *Chlamydomonas* sp accounting for 10%, while *Oscillatoria* sp, *Chlorococcum* sp, and *Oedogonium* sp each contributed 5%. Similarly, in borehole water from Zone 4, *Chlamydomonas* sp was again the most frequent species at 15%, followed by *Chlorella* sp and *Oscillatoria* sp, each with 5%.

**Table 2:** Composition of Microalgae species isolated from Well Water, Sachet and Borehole Water Source in Kabayi Community

Microalgae species	Water Source	Percentage frequency (%)
<i>Chlamydomonas</i> sp	Well water zone 4	20
<i>Scenedesmus</i> sp	Well water zone 4	5
<i>Euglena</i> sp	Well water zone 4	5
<i>Microcystis</i> sp	Well water power bakery	5
<i>Chlamydomonas</i> sp	Well water power bakery	10
<i>Chlorella</i> sp	Well water power bakery	5
<i>Oscillatoria</i> sp	Borehole bedrock	5
<i>Chlamydomonas</i> sp	Borehole bedrock	10
<i>Chlorococcum</i> sp	Borehole bedrock	5
<i>Oedogonium</i> sp	Borehole bedrock	5
<i>Chlorella</i> sp	Borehole zone 4	5
<i>Oscillatoria</i> sp	Borehole zone 4	5
<i>Chlamydomonas</i> sp	Borehole zone 4	15

### 3.2 Discussion

The evaluation of sachet, borehole, and well water sources in Kabayi community showed that all measured physicochemical parameters were within the permissible limits of the World Health Organization (WHO, 2022). This implies that the water sources are suitable for domestic consumption chemically (García-Ávila et al., 2022; WHO, 2022). The pH values ranged from 6.6 in sachet water to 7.8 in well water, all within the acceptable range (6.5–8.5), confirming that the waters are neither corrosive nor alkaline beyond safe limits. The slightly higher pH in well water may reflect mineral interactions within the subsurface strata, while the near-neutral pH in sachet and borehole water suggests effective filtration. The recorded temperatures (28–29°C) reflect tropical ambient conditions typical of groundwater and surface water in Nigeria (Osaji et al., 2021).

Additionally, turbidity (1.7–3.8 NTU), total dissolved solids (92.2–191.2 ppm), and conductivity (80.1–88.7  $\mu\text{S}/\text{cm}$ ) were all below WHO thresholds (<5 NTU, <600 ppm, <500  $\mu\text{S}/\text{cm}$ , respectively). These low values confirm minimal suspended solids and low mineralization (Kalu et al., 2023; Shokunbi et al., 2021). Hardness (102–150 mg/L), chloride (17.0–59.18 mg/L), and nitrate (1.2–5.5 mg/L) concentrations were also below their respective

WHO limits, indicating low contamination from geological or anthropogenic sources (Goshtasbi et al., 2022; Fisher et al., 2015). The elevated chloride and nitrate in well water (Power Bakery) may result from surface runoff or localized organic waste infiltration but are not high enough to pose health concerns (WHO, 2017). Our findings demonstrate that all water sources in Kabayi possess acceptable physicochemical quality and comply with global drinking water standards.

Furthermore, the presence of microalgae in the water samples revealed important biological variations among the sources. Eight genera were identified: *Chlamydomonas* sp., *Scenedesmus* sp., *Euglena* sp., *Microcystis* sp., *Chlorella* sp., *Oscillatoria* sp., *Chlorococcum* sp., and *Oedogonium* sp. Among these, *Chlamydomonas* sp. was the most dominant (55%), occurring across nearly all samples. The detection of cyanobacterial species such as *Oscillatoria* sp. and *Microcystis* sp. in borehole and well water is of particular concern, as these taxa are capable of producing cyanotoxins under favourable conditions (García-Ávila et al., 2022). Although physicochemical parameters indicated safe water quality, the occurrence of these microalgae implies biological contamination, likely resulting from nutrient seepage or poor well protection (Martínez-Burgos et al., 2024).

Cyanobacterial toxins, if produced, can cause liver and neurological disorders, highlighting the need for continuous biological surveillance even when chemical parameters meet WHO standards (Kulnev and Pochechun, 2016; Arsad et al., 2021). Conversely, the absence of microalgae in sachet water indicates effective industrial purification and packaging, confirming its superior biological quality.

The physicochemical profiles obtained in this present study are consistent with the studies of Magaji and Ajayi (2020), who observed similar compliance with WHO limits in groundwater sources, though with occasional site-specific elevations linked to local geology and anthropogenic activities. Similarly, Osaji et al. (2021) reported pH values between 6.2 and 7.5, and TDS concentrations below 200 mg/L, aligning with our present findings. The microalgal composition detected, dominated by *Chlamydomonas*, *Chlorella*, and *Oscillatoria*, which is consistent with the observations from Shankar, (2017) where similar taxa were associated with moderate nutrient levels and photic water conditions. Cyanobacterial species such as *Microcystis* and *Oscillatoria* have been reported in community wells and boreholes, often linked to nutrient runoff or stagnant water conditions (Martínez-Burgos et al., 2024; Stemmler et al., 2016; Chia et al., 2013). The presence of these species in Kabayi borehole and well water samples, therefore, reflects a broader ecological pattern observed in tropical environments, highlighting the importance of combined chemical and biological assessments in evaluating potable water safety.

Our findings revealed significant implications for water safety and public health in Kabayi community. Although all sources meet WHO physicochemical standards, the biological contamination detected in borehole and well water suggests potential risks if the sources are not routinely managed and monitored (Li et al., 2023; WHO and UNICEF, 2021; Teneva et al., 2020). The dominance of *Chlamydomonas sp.* and the presence of cyanobacteria indicate possible nutrient enrichment from runoff or nearby waste disposal sites (García-Ávila et al., 2022). Regular cleaning of wells, protection from surface runoff, and covering of borehole heads are essential preventive measures. Sachet water, though currently safer, also requires regular monitoring to ensure consistent production standards (Magaji, 2020). This study highlights that physicochemical conformity alone cannot guarantee water safety. The presence of microalgae, especially cyanobacteria, points to emerging biological threats that demand proactive intervention in Kabayi community.

#### 4. Conclusion

This study aimed to evaluate the physicochemical quality and microalgal contamination of different

drinking water sources, such as sachet, borehole, and well water in Kabayi community, Mararaba, Nasarawa State. Our findings revealed that all measured physicochemical parameters, including pH, temperature, turbidity, total dissolved solids (TDS), conductivity, hardness, alkalinity, chloride, and nitrate, were within WHO permissible limits. The pH values (6.6–7.8) indicated slightly acidic to mildly alkaline conditions, while turbidity (1.7–3.8 NTU), TDS (92.2–191.2 ppm), and conductivity (80.1–88.7  $\mu\text{S}/\text{cm}$ ) reflected acceptable clarity and low mineralization. The highest water hardness (150 mg/L), chloride (59.18 mg/L), and nitrate (5.5 mg/L) values were recorded in well water, though all remained within safe thresholds. These results confirm that, chemically, the water sources are suitable for consumption. However, microalgae isolation revealed biological contamination in well and borehole water sources, with *Chlamydomonas sp.* emerging as the most dominant species across all water sources (55%), demonstrating its broad ecological tolerance and adaptability. Other microalgal species occurred at lower and relatively uniform frequencies. The occurrence of cyanobacterial taxa (*Microcystis* and *Oscillatoria*) indicates potential ecological risk and highlights the importance of biological monitoring. Routine assessment of both physicochemical and biological parameters should be implemented to ensure sustained water quality in Kabayi. Further studies examining seasonal variation and potential cyanotoxin production by identified microalgae are recommended to better understand long-term risks.

#### Conflict of Interest

The authors declare no conflict of interest.

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