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ASSESSMENT OF PHYSICOCHEMICAL PARAMETERS AND ALGAL SPECIES ABUNDANCE IN SELECTED HAND - DUG WELLS WATER IN NASSARAWA LOCAL GOVERNMENT AREA, KANO STATE

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ABSTRACT
Hand-dug wells are natural, inexpensive solution to widespread water scarcity; however, they could be contaminated with toxic algae. This study aimed to assess the physicochemical parameters and survey algal species in water from three hand-dug wells in Nassarawa Local Government area of Kano State (11°57'53''N; 8°30'50''E). Water samples were collected during May and June 2021. Temperature, pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Biological Oxygen Demand (BOD) Dissolved oxygen (DO), Turbidity (TBDT), Nitrate and Phosphate were determined according to (APHA, 2005). Algal composition (org/L) and identification were by using the guide of Palmer (1980). Analyses of variance was used to determine significant differences between means at (p<0.05). All parameters were within permissible limits of WHO. Site B (lined with rocks) had the highest mean values of TDS (513.67mg/L), EC (596.70mg/L) and TBDT (4.60mg/L). Mean values for DO and BOD showed significant differences between sites. A total of 430 org/L algae were identified belonging to 13 genera consisting of Cyanophyta (51.1%), Chlorophyta (16.2%) and Bacillariophyta (32.7%). Site A (the oldest and unlined) was the most diverse. Site C (lined with concrete) had the highest total number of organisms (42.3%). Oscillatoria sp., Navicula sp., Phormidium sp and Dictyosphaerium sp. occurred in all sites. Nitszchia, Gomphonema and Fragillaria were the least abundant. Hand-dug wells should be protected and conserved to ensure a sustainable supply of water for various purposes.
Keywords: Toxigenic, Cyanophyta, Bacillariophyta Well lining, Metropolis

INTRODUCTION

Human societies are originated and established due availability of water resources to satisfy man's needs of subsistence, health and settlement potentials (Angelakis and Zheng, 2015; Hassan, 2011). Hand-dug wells provide a natural inexpensive solution to potable water scarcity from the ancient to the modern world (Wagner and Lanoix 1959, Vuorinen *et al.* 2007). Kano Metropolis is the second-largest city in Nigeria which faces water shortage like other urban cities in Africa (Gebresilasie *et al.*, 2021; Adamou, *et al.* 2020). Nassarawa local government area with a population of 569,669 (NPC, 2004) is currently the most populous LGA in Kano State (Mohammed and Yau, 2021). Local government areas in Nigeria obtain up to 85% of domestic water supply from mainly borehole and hand - dug wells (Balogun *et al.* 2021; Yakubu, *et al.* (2017); Bakobie *et al.* (2015). Algae are ubiquitous aquatic organisms that are involved in water pollution in several significant ways (Gatz, 2020; Chorus and Bartram, 1999). Nutrients specifically nitrate and phosphorus, temperature over 20°C, sunlight, and quiescent water stimulate algal species growth (Gatz, 2020). There is paucity of data on algal contamination of hand - dug wells in Kano metropolis. Symptoms of poisoning by the main toxic cyanobacteria in drinking water overlap with a range of other gastrointestinal illnesses, largely caused by infectious disease organisms (Adamou, *et al.* 2020). Consequently, during an outbreak of enteric disease the pathogens are investigated (Falconer and HumpageInt, 2005). This study aimed to assess the physicochemical parameters and survey algal species from three hand - dug well water located in wards of the Local Government.

MATERIALS AND METHODS

Description of Study Sites

Figure 1 shows the map of Nassarawa local government area of Kano state (11º57'53''N, 8º30'50''E) and the three wards of the study sites. Table 1 shows the characteristics of the hand - dug wells. The wells were outdoors built by individuals for communal use.

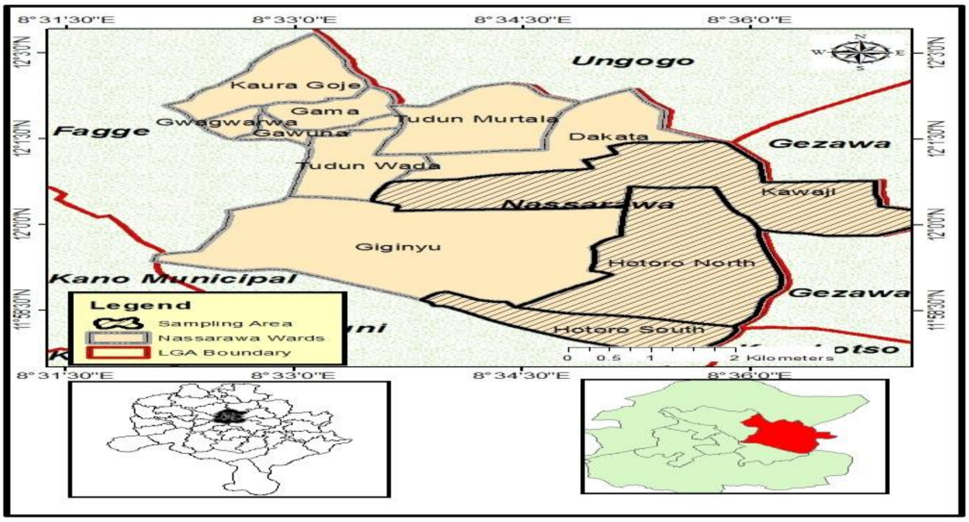

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Fig. 1: Location of the Study Area. (Catography Lab, Geography Dept Bayero University, Kano, 2021)

Table 1: Features of the Hand - Dug Wells Sampled in Nassarawa Local Government

Characteristics	Site A (Hotoro North)	Site B (Hotoro South)	Site C (Kawaji)
GPS Location	11º58′20″ N, 08º35′43″ E	11º58′04″ N, 08º35′33″ E	12º52′02″ N, 08º88′29″ E
Age (years)	76	20	30
Depth (meters)	9	11.7	10.5
Diameter	1.9	1.2	2
Lining Material	Unlined	Rocks Presence of caves	Concrete
Cover	No	No	No
Refuse Disposal	Yes	No	No
Other Surrounding Features	Bore hole wells in proximity	Houses in proximity	Houses, other wells and a cemetery in proximity
Water Quality and Usage	Slightly turbid, potable but mostly used for other domestic purposes	Non potable, turbid, saline, used for laundry	Clear, potable

Determination of Physicochemical Parameters

Water samples were collected four times in the months of May and June 2021 (end of dry season) which excludes contamination from debris brought by rainwater. Extraction was done using clean plastic bucket and clean rope at 8:00am - 10:00am in three in replicates. All physicochemical parameters were all determined according to American Public Health Association (APHA) (2005). Temperature and pH were measured on site. Total Dissolved Solids (TDS) and Electrical Conductivity (EC) were determined using multi-parameter meter (JENWAY 3540). Biological oxygen demand (BOD) and Dissolved oxygen (DO) was determined using the DO meter (Hanna HI9813-6). Nitrate was determined using Kjeldahl distillation method and Phosphate was determined using colorimetric method as described by APHA (2005). Algal collection and identification were according to Palmer (1980) and Suther and Rissik (2009).

Water was collected in dark sterile sampling bottles, immediately preserved with 1.0ml Lugols iodine solution in icebox and transported to the laboratory. The collected samples were condensed to 10ml and 1ml of the subsample was withdrawn for sorting and counting in triplicates using compound microscope (CE BMS 4748920 Model). Mean total number was expressed as org/L and percentage frequency of occurrence determined. Data were analyzed using one-way Analyses of variance to determine significant differences between means at 95% confidence limit.

RESULTS AND DISCUSSION

Physicochemical Parameters of Well Water

Well characteristics (Table 1) were considered in Well selection for the study. From the interaction with user's this is a pioneer water quality assessment of the Wells. Table 2 shows the mean values of water physicochemical parameters of the three sampled Wells compared to, World Health Organization (WHO, 2006, 2017), and Nigerian Standard for Drinking Water Quality (NSDWQ, 2015) standards. All values fall below the permissible limits for drinking water. All significantly differences were at ($p<0.05$) along columns.

Table 2: Mean Water Physicochemical Parameters of Hand - Dug Wells in Nassarawa Local Government

SITE	TEMP (⁰C)	pH	TDS (mg/L)	EC (µS/cm)	TBDT (NTU)	DO (mg/L)	BOD (mg/L)	PO_4 (mg/L)	NO_3 (mg/L)
A	29.21 ±1.34a	7.24 ±0.32a	293.25 ±29.18b	470.70 ±0.00b	2.84 ±0.64b	3.49 ±1.01a	0.53 ±0.46a	0.28 ±0.08a	4.12 ±0.95a
B	29.69 ±1.06a	7.04 ±0.33a	478 .60 ±42.00a	716.10 ±153.90a	4.06 ±0.45a	3.40 ±1.04a	0.75 ±0.47ab	0.29 ±0.05a	2.82 ±0.47b
C	28.58 ±0.99a	7.35 ±0.29a	280.50 ±66.90b	414.60 ±62.70b	1.94 ±0.84c	3.88 ±0.77a	1.30 ±0.71ba	0.25 ±0.08a	3.98 ±0.48a
STD	<40⁰C*	6.5-8.5*	<600*	<1000*	5.0**	5.0***	<10.0***	5.0***	6.5***

Key: EC = Electric conductivity; TDS = Total dissolved solids; DO = Dissolved oxygen; BOD = Biological oxygen demand; TBDT= Turbidity
PO_4 = Phosphate ions; NO_3= Nitrate ions STD= Standard, NTU = Nephelometric turbidity unit, (WHO, 2017)-*, (NSDWQ, 2015)-**, (WHO, 2006)-***

Mean well water temperature and pH values did not vary significantly between the sites. Dabo and Sale, (2017) reported slightly lower temperature (28.3ºC) and higher pH (7.5) in the same local government as in this study, this could be due to seasonal or daily weather fluctuations. Lower temperatures (24.3ºC) and higher pH (7.8) was also reported by Yakubu, *et al.* (2017) in Zaria, while Abba *et al.* (2016) recorded (28.3ºC) in Mubi, these variations are likely as a result of different regional climatic conditions from the study area.

Site B had significantly higher mean values for TDS, EC and TBDT (478.60 mg/L, 716.10 µS/cm and 4.06) respectively than and C. Dabo and Sale (2017) reported by lower values of EC (527.67) and TDS (429.67). Electrical conductivity indicates that the content of soluble and high conducting salts (TDS) present in the water samples (Chindo *et al.,* 2013). Turbidity is the parameter with the highest level of variation between Sites; there were significant differences in the mean values of turbidity across the Sites. The presence of caves in the rocks lining of indicated that the pieces rocks are now in the water possibly creating the higher values of the three parameters. Lower mean values of EC, TDS and TBDT in Site C indicate higher clarity and this could be due of the concrete lining; this is perhaps the reason why the water in Site C was more potable, similar mean values of TBDT 4.5, 3.26 in Janga (Ghana) and Mubi were observed by Bakobie *et al.* (2015) and Abba *et al.* (2016) respectively.

The distribution of dissolved oxygen in water body has been reported to be determined by rainfall, photosynthesis and losses by the chemical and biotic oxidations (Nwankwo and Ehirim, 2010). The mean DO values ranged from the maximum of 3.88mg/l (site C) to the minimum of 3.49 mg/L (site A). All mean values of DO and BOD obtained in this study fell below the 5.0 and < 10 permissible limits of WHO (2006) respectively. Dabo and Sale, (2017) also reported acceptable values of BOD (0.88 mg/L) and DO (2.92 mg/L) while Yakubu, *et al.* (2017) reported BOD values (12.3 - 20.1 mg/L) which were above the permissible limits of WHO (2006). The mean values of DO in this research are satisfactory to support aquatic life perhaps due to good aeration rate and photosynthetic activity as reported by Jaji *et al*. (2007).

Phosphate levels were relatively low with no significant difference between sites: 0.29mg/L (site B) to 0.25 mg/L (site C). Obviously, there was absence of phosphate contamination of the Wells' water from sources such as laundry or agricultural activities. Mean nitrate contents in site A (4.12 mg/L) and site C (3.98 mg/L) were significantly different from site B (2.82 mg/L). Lack of wall lining in site A may have contributed to nitrates percolating from nearby source points such as pit latrines or suck-away systems as observed by Jidauna *et al*. (2013). Nitrate concentration ten times (60.01mg/L) above permissible limit of 6mg/L; was reported by Adedeji *et al.* (2017) in the water Kobomoje Hand - dug Wells in Ibadan Nigeria.

Algal Species Associated with Hand - dug Water

Table 4 showed algal species identified from the three Wells' water. A total of 430 org/L algae were identified belonging to 13 genera consisting of Cyanophyta (51.1%), Chlorophyta (16.2%) and Bacillariophyta (32.7%). The greater diversity in Site A, may be due to its age (about 76 years). Older Wells are usually corroded and located at the center of homestead and surrounded by many potential contamination sources (Ayantobo *et al*., 2013). The dominant group, cyanophyta also known as Cyanobacteria, blue-greens, blue-green algae, myxophyceaens, cyanophyceans, cyanobacteria, cyanoprokaryotes, etc (Chorus and Bartram, 1999) occurred in good numbers in all sites. They are often the first plants to colonize bare areas of rock and soil and flourish in water environments where no other microalgae can exist (Anago *et al.*, 2013). The genera *Oscillatoria* was the overall dominant species, it constituted 33.4% of the total count of algae during the study. The mean number of *Oscillatoria* found from Site C (71org/L) equals the count from Site B and Site A combined. Likewise, *Phormidium sp.* and Anabaena *sp* were higher in number in site C. Perhaps the concrete lining in site C provides much more stable substrate for the algae. The three genera are known to affect the taste, smell of water and toxigenic however, the water in Site C is potable and no incidences of diseases had been reported by the users.

Table 4: Algal Species Composition, Distribution and Abundance from Hand - dug Wells Water

Species Composition	Mean Number of Occurrence (org/L) A	B	C	Mean Total	Characteristics and Ecological Importance Chorus and Bartram, (1999); Gatz, (2020)
Cyanophyta (Blue green algae)					
Oscillatoria sp.	42	30	71	144	Known to produce neurotoxins anatoxins and hepatotoxins
Phormidium sp.	13	14	28	55	Known toxicity, affect tastes, causes odours and smells
Anabaena sp.	19	02	01	22	Capable of producing lethal toxins (anatoxin-a), Blooms, known toxicity, affect tastes, causes odours and smells, causes dermatitis
Chlorophyta (Green algae)					
Dictyosphaerium sp.	11	15	06	32	Sometimes the dominating phytoplankton community in water bodies
Chlorella vulgaris	15	04	00	19	One of the first algae grown as a possible food additive
Zygnema sp.	08	00	02	10	Produce large amounts of biomass in shallow freshwater habitats
Lyngbya sp.	03	00	06	09	Known to release toxins (debromoaplysiatoxin, aplysiatoxin and Lyngbya toxin) into the water.
Bacillariophyta (Diatoms)					
Cocconeis sp.	13	01	00	14	No known harm
Navicula sp.	23	30	68	121	Secretes mucilage Clog filters at water treatment plants
Pinnularia sp.	02	00	00	02	Largest among freshwater diatoms
Nitzschia sp.	01	00	00	01	Several taxa are indicative of nutrient enrichment (eutrophication)
Gomphonema sp.	01	00	00	01	Occur in a wide range of mostly fresh waters including those enriched with sewage.
Fragillaria sp.	01	00	00	01	Fresh water Blooms, filter clogging, affects taste and odour
Mean Total number	152	96	182	430	

Chlorophyta (Green algae) was the least abundant (16.2%) of the three classes. *Dictyosphaerium sp.* had the highest mean number (15org/L) in site B. *Chlorella vulgaris Zygnema sp.* and *Lyngbya sp.* were all less than 5% of the total algal counts. The three wells are deep enough to prevent light adequately reaching the water, light intensity is a growth requirement for the green algae (Chukwu, 2007).

Bacillariophyta (Diatoms) are the largest contributors to global primary production are powerful ecological tools to investigate past conditions (fossils) have many industrial and commercial applications. This is the most diverse class even though *Pinnularia sp.* had the mean average count of (15org/L) while *Nitzschia sp. Gomphonema sp.* and *Fragillaria sp.* recorded (1org/L) each all found in site A. *Navicula sp.,* was the second most abundant during the study and constituting 28.1% of the total algal count which was found in all Wells and the only diatom found in site C. *Cocconeis sp.* was recorded in site A (13org/L) and site B (13org/L) respectively.

Site A also had higher mean temperature and nitrate content; conditions known to enhance algal growth (Gatz, 2020). The higher diversity in site A and total number in site C of algal species could also be due to the two wells being older and having wider diameter than site B. Tools used for extraction (unclean buckets and ropes) and conditions around the Wells may have been the sources of the identified algal species.

CONCLUSION

All assessed physicochemical parameters of the water from the study area were below drinking water permissible limits. *Oscillatoria sp* and *Navicula sp.* were the most abundant species. Even though some of the identified species are known to produce toxins*,* affect taste and odour, their presence in the Wells did not seem to have much negative effect on the water quality in the Wells. It is recommended that additional protective structures and sanitary extraction methods and conditions around the Wells should be improved to ensure continuous supply of healthy drinking water.

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