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Physicochemical Quality of Selected Borehole Water in Nembe Local Government Area, Bayelsa State

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Abstract

This study was carried out to assess portability in relation to physiochemical quality characteristics of borehole water in Nembe Local Government Area of Bayelsa State. A cross-sectional study design was employed for the study which involves the collection and analysis of data from a population or a representative subset at a defined time.In this regard, a detailed physical and chemical analysis of public borehole water samples was carried out in five randomly selected communities (Ogbolomabiri, Bassambiri, Igopiri, Otatubu and Etieama) in the study area. A number of parameters such as pH, colour, turbidity, conductivity, total suspended solids (TSS), total dissolved solids (TDS), and chemical properties such as dissolved oxygen, biological oxygen demand, chlorides, total hardness, copper and iron were analyzed for each water sample collected during the study.The analysis was done using descriptive statistics method with the aid of SPSS. The obtained values of each parameter i.e. pH ranges from 4.65 ± 0.4 to 6.86 ±0.61, TDS ranges from 38.3 ± 3.05 to 543.6 ± 3.5 (NTU), Turbidity ranges from5.7 ± 1.52 to 42.6 ± 2.51(mg/l), TSS ranges from 1.10 ± 0.37 to 37.3 ± 2.5(mg/l), EC ranges from 55.0 ± 2.64 to 829.3 ± 2.5(µs/cm), Colour ranges from 8.3 ± 2.5 to 341.0 ± 4.00(Pt-Co), Cl- ranges from 15.67 ±1.52 to 241.0 ±3.00(mg/l), DO ranges from 4.8 ±0.30 to 7.06 ±1.10(mg/l), BOD ranges from 1.57 ±1.02 to 2.66 ±0.40(mg/l) andTotal hardness ranges from5.6 ±1.62 to 179.7 ±2.51(mg/l)were compared with the standard values set by the World Health Organization (WHO). The values of each parameter were found to be within the safe limits set by the WHO except for water samples in Otatubu borehole whose colour was brown, colour units341.0 ± 4.00(Pt-Co) and turbidity unit 42.6 ± 2.51(mg/l), exceeded the WHO recommended limit for drinking water hence water from that borehole is not safe for drinking while that of iron and copper showed insignificant result of <0.001(mg/l) each. Overall, the water from the other locations was found to be safe as drinking water. However, it is advisable further investigation should be carried out to determine the concentration of other potential water contaminations such as microbial and radiological materials for a longer period of time, including human body fluids, in order to assess the overall water quality of the Local Government Area investigated.

Keywords: Physiochemical, Water, Hygiene, Contamination, Quality

Introduction

Access to safe and hygienic drinking water is a fundamental human and a critical determinant of public health. In Nembe local government area located in Bayelsa state, borehole water sources have become primary water supply option for a significant portion of the population. Borehole are often relied upon to mitigate issues related to inadequate access to potable water from a centralized water treatment facilities and natural sources seen as rivers or well.

The physicochemical quality of water from borehole is of paramount importance as it directly impacts the healthiness and well-being of general public who depend on it. Several factors may affect the physicochemical properties of borehole water, including geological characteristics, land use patterns and potential sources of contamination in the vicinity such as defecating in nearby bushes or rivers, proximity of borehole from latrines, the effects of oil exploration and exploitation, oil bunkering and oil spill coupled with the direct sewage contamination of natural water bodies due to the cultural habit of defecating inside rivers.

However, the quality of borehole water in Nembe Local Government Area has not been comprehensively studied and

documented in recent years. Rapid urbanization, industrial activities and agricultural practices in the area may introduce various pollutants into the groundwater, potentially endangering the safety of this vital water source.
In Nembe Local Government Area, concerns have arisen as regard the physicochemical quality of borehole water which serves as a primary source of drinking water for a significant portion of the population. It is against this background that the researcher have designed this study to determine the physicochemical quality of selected borehole water with the view to address several pressing issues and challenges related to the quality of borehole water in Nembe Local Government Area (LGA). With the view to ascertain the following objectives: to ascertain the physical quality of borehole water in Nembe Local Government Area, Bayelsa State.To find out the chemical quality of borehole water in Nembe Local Government Area, Bayelsa State**.** To compare the physicochemical quality of borehole water from sampled communities in Nembe Local Government Area, Bayelsa State with the World Health Organisation's (WHO) recommended standard.

Materials and Methods

A cross-sectional study design was employed for the study which involves the collection and analysis of data from a population or a representative subset at a defined time. The total number of five (5) boreholes were randomly selected from(5) different communities or zones within Nembe LGA for the research, which are zone 1: Ogbolomabiri (Nembe city), zone 2:Bassambiri (Opu Nembe), zone 3: Igopiri, zone 4: Otatubu, and zone 5: Etieama. Borehole water sample were collected three times at each sampling points in each of the zones. Simple random sampling technique was adopted to select borehole water samples from different borehole water sources that serve most indigenes of the communities. Sterile plastic bottles were used to collect water samples. The collection process for borehole water involved turning on the tap and allowing the tap water to run for at least 1-2 minutes before collecting samples, sealing and labelling the bottles, and then the samples were place in an iced cooler before transporting to the laboratory for analysis within 24hours from the time of sample collection. The borehole water samples were collected at five different sampling points which are zone 1,2,3,4 and 5 as specified earlier. Three water samples were collected at each sampling points and the mean values of the parameters at the five sampling points were determined and used for data computation. The physical parameters were analysed at the point of collection of borehole water samples while the chemical parameters were analysed in a standard laboratory called Analytical Concept Ltd in Port Harcourt, Rivers State. The parameters that were analysed are physical parameters (pH, Turbidity, Total Dissolved Solids, Total suspended solids, Electrical conductivity and Colour), chemicals parameters (Chloride, Copper, Iron, Dissolved Oxygen, Biochemical Oxygen Demand and Total Hardness). The analytical method were pH, EC and TDS (Electrometric Method) -RoHS-3508 Multi-Parameter Tester, Colour(Colorimetric Method)-HACH DR890 Colorimeter (USA), Turbidity (Absorptometric Method) - HACH DR890 Colorimeter (USA), Total Hardness (Titration Method), Dissolved Oxygen (DO) (Titration Method),, Chloride (Argentometric Titration Method), Total suspended solids (Gravimetric after Filtration Method), Biochemical Oxygen Demand (BOD) (Incubation Method), then Iron and Copper - GBC 908PBMT Atomic Adsorption Spectrophotometer AAS (Australia). The collected data for the study was cross tabulated in an excel worksheet and was analysed using Statistical Package for Social Sciences (SPSS, version 20.0). The analysis was done using descriptive statistics and the results were displayed in frequency tables and charts. P-value less than 0.05 were considered statistically significant.

Result

Mean pH of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The mean pH of some selected borehole water samples in five (5) different communities in Nembe LGA of Bayelsa State was analysed. The results for the pH ranged from 4.6-6.8 (Table 1) The results showed that the highest mean pH was observed in water samples collected from Etieama community with a mean pH of 6.89, while the least mean pH was observed in samples collected from Ogbolomabiri community 4.6. Whereas the water samples collected from Igopiri, Otatubuand Bassambiri communities showed acidic mean pH value of 6.70, 6.58 and 5.29 respectively, which was below the WHO limit of 6-7 for drinking water. The results showed no significant differences in pH between water samples collected from Ogbolomabiri and Bassambiri respectively. Also, there were no significant differences in pH between water samples collected from Otatubu, Igopiri and Etieama communities at p=0.05. The result is as shown in Table 1 below.

Mean turbidity of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The turbidity values of the borehole water samples varied between 0.00 NTU and 42.6 NTU (Table 1). The recorded turbidity values show that all water sample exception of Ogbolomabiri water sample had turbidity values higher than the WHO limit for drinking water (5NTU). Water samples from Otatubu recorded the highest turbidity value of 42.67 NTU, followed by water samples from Igopiri community with a turbidity of 9.6NTU. Water samples from Ogbolomabiri community had a turbidity of 0.00NTU. There were no significant differences in turbidity between water samples from Igopiri and Bassambiri communities.

Table 1: Showing LSD of the Physical Parameters of Borehole Water Analysed from Different Communities in Nembe LGA of Bayelsa State

Parameter / Communities	pH	Total Dissolved Solids TDS (NTU)	Turbidity (mg/l)	Total Suspended Solids TSS (mg/l)	Elect. Conductivity EC (µs/cm)	Colour (Pt-Co)
Ogbolomabiri	4.65 ± 0.4^{a}	45.3 ± 2.08^{b}	0.00 ± 0.00^{a}	2.3 ± 1.5^{ab}	65.0 ± 7.93^{a}	8.3 ± 2.5^{a}
Igopiri	6.70 ± 0.66^{c}	389.3 ± 4.01^{c}	9.7 ± 2.50^{c}	5.8 ± 1.52^{c}	573.0 ± 27.7^{b}	97.8 ± 2.51^{d}
Otatubu	6.58 ± 0.63^{bc}	543.6 ± 3.5^{a}	42.6 ± 2.51^{d}	37.3 ± 2.51^{d}	829.3 ± 2.51^{d}	341.0 ± 4.00^{e}
Etieama	6.86 ± 0.61^{c}	436.7 ± 3.51^{d}	5.7 ± 1.52^{b}	4.6 ± 1.53^{bc}	655.3 ± 4.50^{c}	54.0 ± 3.00^{c}
Bassambiri	5.29 ± 1.10^{ab}	38.3 ± 3.05^{e}	7.8 ± 1.53^{bc}	1.10 ± 0.37^{a}	55.0 ± 2.64^{a}	37.6 ± 2.6^{b}
W.H.O	6.5-8.5	500	5	500	750	5

Mean total dissolved solids of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The mean total dissolved solids (TDS) obtained from all the borehole water samples varied from 38.30 mg/L to 543 mg/L (Table 1). All the measured borehole water samples recorded TDS concentration values within the permissible limit of WHO (500mg/L) for drinking water, except for borehole water samples from Otatubu (543.67mg/L) which exceeded the WHO limit of TDS for drinking water. The results showed significant differences in TDS in all the water samples from the different communities analysed at p=0.05. The result is as shown in Table 1 above.

Mean total suspended solids of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The concentration of Total Suspended Solids (TDS) obtained from all the borehole water samples. All the measured borehole water samples recorded TSS concentration values within the permissible limit of WHO (500mg/L) for drinking water. The highest mean TSS was 37.3 mg/L from water samples collected at Otatubu community, followed by water samples from Igopiri, while the least mean TDS concentration of 1.1mg/L was recorded for water samples from Bassambiri community. The result showed significant differences in TSS between water samples collected from Otatubu and all other locations; meanwhile, there were no significant differences in TSS between water samples from Bassambiri and Ogbolomabiri and between Etieama and Igopiri communities respectively at p=0.05.

Mean electrical conductivity of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

Electrical conductivity value for all the sampling sites varied from 55 to 829µS/cm (Table 1). The measured EC value indicates that all examined water samples had values which were within the permissible limit of WHO 750µS/cm for drinking water except for water samples collected from Otatubu borehole. The highest EC value of 829.3 µS/cm was recorded in water samples collected from Otatubu borehole, followed by water samples collected from Etieama (655.3 µS/cm) while the lowest EC values were observed in water samples collected from Ogbolomabiri (65 µs/cm) and Bassambiri (55.0 µs/cm) respectively. The results showed no significant differences in EC between water samples from Ogbolomabiri and Bassambiri but there was a significant differences in the water samples from Otatubu, Igopiri and Etieama communities analysed at p=0.05. The result is as shown in Table 1 above.

Mean colour of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The water samples from all the locations were clear and with no observable colour except for water samples collected from Otatubu. The laboratory analysis showed that the water samples from Otatubu recorded the highest colour value of 341 ^{0}H, followed by water samples from Igopiri (97 ^{0}H) and Etieama (54 ^{0}H). The least recorded colour value was found in water samples from Ogbolomabiri borehole with a value of 8.3 ^{0}H. The results are as shown in Table 1 above. The values for the colours obtained where above the WHO standard of colour for drinking water which is 5 ^{0}H. There was significant differences in colour from all the water samples analysed from the communities at p=0.05. The result is as shown in Table 1 above

Mean chloride concentration of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State.

The concentration of chloride ion in the borehole water samples varied between 15.8mg/L and 241mg/L respectively (Table 2). Chloride ion level that was recorded in all water samples analysed were within permissible limit of W.H.O for drinking water, 250mg/L. The highest Chloride Ion was observed in borehole water from Otatubu (241mg/L), followed by water samples from Etieama (192.7 mg/L) and Igopiri with a chloride concentration of 171mg/L while the lowest chloride content was observed in water samples from Bassambiri 15.6 mg/L. The result showed significant differences in chloride between all the communities sampled at p=0.05.

Table 2: Showing LSD of Chemical Parameters of Borehole Water Analysed from Different Communities in Nembe LGA of Bayelsa State

Parameters / Communities	Chlorides Cl (mg/l)	Dissolved Oxygen DO (mg/l)	Biochemical Oxygen Demand, BOD (mg/l)	Total Hardness (mg/l)	Copper Cu (mg/l)	Iron, Fe (mg/l)
Ogbolomabiri	21.0 ± 2.00^b	4.8 ±0.30^a	2.09 ±1.10^a	7.67 ±1.52^a	<0.001	<0.001
Igopiri	171.67 ±2.51^c	7.06 ±1.10^b	2.50 ±0.88^a	140.33 ±2.50^b	<0.001	<0.001
Otatubu	241.0 ±3.00^e	5.50 ±0.87^{ab}	1.57 ±1.02^a	179.7 ±2.51^d	<0.001	<0.001
Etieama	192.6 ±2.51^d	5.63 ±0.41^{ab}	1.9 ±0.30^a	158.3 ±3.51^c	<0.001	<0.001
Bassambiri	15.67 ±1.52^a	5.90 ±1.51^{ab}	2.66 ±0.40^a	5.6 ±1.62^a	<0.001	<0.001
W.H.O	250	5.0-7.0	5	300	2	0.3

Mean dissolved oxygen (DO) of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The mean Dissolved Oxygen (DO) of some selected borehole water samples in different communities in Bayelsa State was analysed. The results obtained are presented in Table 2 above. The results obtained from the laboratory showed that the DO of water samples from Igopiri was higher (7.06mg/L) than the water samples obtained from all the other communities. The results showed no significant difference in DO between the water samples obtained from all the communities sampled. The values for the DO in this study were within the W.H.O range for drinking water (5-7mg/L).

Mean biological oxygen demand (BOD) of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The mean Biological Oxygen Demand (BOD) of some selected borehole water samples in different communities in Bayelsa State was analysed. The result is shown in Table 2 above. The results obtained showed that the BOD in all the

sampled communities is within the permissible range of BOD for drinking water (less than 5mg/L). The result showed no significant difference in BOD between all the communities sampled at p=0.05.

Mean total hardness of borehole water samples analysed from different communities in Nembe LGA of Bayelsa State

The values of total hardness concentrations recorded from the borehole water samples ranges from 75.6 mg/L and 179.7mg/L (Table 2). These amounts of total hardness concentrations are within the maximum allowable limit of WHO for drinking water 300mg/L. The results showed significant differences in water sampled between Igopiri, Otatubu and Etieama and whereas there were no significant differences in total hardness between Bassambiri and Ogbolomabiri communities at p=0.05.

Conclusion

The goal of this study was to assess the level of physicochemical parameters of water samples from boreholes in different communities of Bayelsa State. The results showed that the concentrations of most physicochemical parameters of the water samples, such as, pH, total hardness, total suspended solids, total dissolved solids, chloride, BOD and DO were within the permissible limit of the World Health Organization (WHO) for drinking water with the exceptions of some physiochemical parameters such as turbidity, colour, electrical conductivity in Otatubu borehole water samples which were above the WHO permissible limit for drinking water. Although some of the chemical parameters fell below the approved standards, they were judged to be acceptable since they were not above the required maximum permissible limits which could have been more risky and dangerous to health. Conclusively, a water sample from the borehole in Otatubu community is not suitable for drinking.

Recommendations

Although, most of the analysed physiochemical parameters in some of the communities were within the range of WHO standard for drinking water, it is essential that the boreholes be clean and hygienic so as to promote safety of water for drinking. Generally, the water qualities offour borehole water samples analysed from the communities are within WHO drinking water standard with the exception of some physicochemical parameters in Otatubu community borehole water sample analysed. It is recommended to check the quality of the water sources regularly in the study area.This assessment of some physicochemical quality of borehole water in the study area is necessary but not enough to determine its overall suitability for drinking purpose. Hence, further research can be done to assess other biologicaland radiological parameters to confirm the overall suitability of the borehole water for drinking purpose.

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