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ASSESSMENT OF SEASONAL VARIATION IN RELATION TO PHYSICOCHEMICAL PROPERTIES OF WATER FROM HAND DUG WELLS NEAR SOAKAWAY PITS IN VANDEIKYA, BENUE STATE, NIGERIA

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ABSTRACT

The aim of this study was to assess the effects of seasonal variation in the physicochemical properties of water from six (6) hand dug wells near soakaway pits in Vandeikya Local Government Area of Benue State. Results showed that, pH values ranged from 7.85 to 9.32 in wet season and 8.10 to 8.90 in dry season while colour was between 42.5 to 360 TCU in wet season and 0.00 to 40.00 TCU in dry season. Turbidity was 7.11 - 38.8 NTU (wet season) and 2.79 - 11.71 NTU (dry season)while conductivity was 10.46-155.20 µs/cm (wet season) and 11.50-160.50 µs/cm (dry season). Total dissolved solidwas higher in dry season (5.83-80.75 Mg/L) than in wet season (5.25 to 77.60 Mg/L). Hardness was also higher in dry season (25.00-120.00 Mg/L/$CaCO_3$) than in wet season (5.00- 95.10 Mg/L/$CaCO_3$). The highest amounts of chloride (130.10 Mg/L), nitrate (46.00Mg/L) and sulphate (5.00 Mg/L) were obtained in the wet season while fluoride concentration was highest in dry season (0.65 Mg/L). Statistically, the two seasons showed no variation in pH of well water ($P>0.05$) whereas other physicochemical parameters were significantly different ($P < 0.05$) in both wet and dry seasons. There was a very strong correlation between turbidity of water and colour change such thatin wet season the values for both colour and turbidity of hand dung well were above the allowable WHO range of 15 TCU and 5 NTU respectively. Thus, there was an indication of water pollution that was tied to seasonal fluctuations but not the nearness to soakaway pits. This information is useful in safety of drinkable water in the study area.

Key words: Pollution, Physicochemical parameters, Seasonal variation, Well water,

1 INTRODUCTION

Water plays an important role in human life. It is necessary for industry, agriculture and human existence. The healthy water ecosystem is depended on the physico-chemical and microbiological characteristics. Due to increase in industrialization, urbanization, agriculture activity and various human activities has increased the pollution of surface water and ground water. Use of ground water for human being depends upon ambient water quality. Ground water plays important role in human life (Sohonou *et al*., 2017).

Chemical contaminants occur in drinking water throughout the world which could possibly threaten human health. Determining the health effects of these contaminants is difficult, especially researching and learning how different chemicals react in the body to damage cells and cause illness. Toxic doses of chemicals cause either acute or chronic health effect. An acute effect usually follows a large dose of chemicals, almost immediately. Example of acute health effects are nausea, typhoid fever, Hepatitis B, lungs irritation, skin rash, vomiting, dizziness and even death(Vijay *et al*.,2017). Most rural dwellers depend on Hand dug well water as the only available water source. The qualities of this well water generally are not guaranteed and at times pose health problems to consumers who rely on them as a drinking source. This study aims at assessing the seasonal variation in physicochemical properties of hand dug wells near soakaway pits in Vandeikya Local Government Area of Benue state.

The chemical characteristics of natural waters are a reflection of the soils and rocks with which the water has been in contact. Contaminants may include inorganic and organic substances. Some inorganic minerals dissolve quickly and change the composition of water rapidly,

while other minerals, such as silicates, dissolve slower and have less conspicuous effects on the water composition. Organic compounds are derived from living organism as well as industrial sources. Once the Water of good drinking quality is contaminated, its quality cannot be of importance to human physiology (Ogunbode *et al.,* 2016). Despite the fact that water is one of the key elements of life due to its indispensable role in maintenance of life on earth human beings continue to pollute water sources resulting in provoking water related illnesses. So there is the need to identify the pollutant sources in order to manage associated risks (WHO, 2OO8).

Human activities are constantly adding industrial, domestic and agricultural wastes to ground water reservoirs at alarming rate. Thus both the quantity and quality of water are affected by an increase in anthropogenic activities and any pollution either physical or chemical causes changes to the quality of the receiving water body and about 80% of all the diseases in human beings are caused by water (WHO,2008).Information on the potential sources of water pollution of hand dug wells near soakawaypits in some communities in Vandeikya Local Government Area of Benue State will provide health experts or other concerned agencies with base line values which could be helpful in the implementation of programmes that could help in ameliorating water related diseases in such communities. An adequate supply of safe and potable water would assist in preventing the spread of gastrointestinal diseases, supports domestic and personal hygiene, and improve the standard of living in Vandeikya local Government Area.Moreover, this kind of study is imperative as there has not been any major record on this aspect of research in the area.The aim of the study was to assess the seasonal variation in the physicochemical properties of water from six (6) hand dug wells near soakaway pits in Vandeikya Local Government Area of Benue State.

2 MATERIALS AND METHODS

Study Area

Vandeikya Local Government Area was created on the 28th August, 1976.The local Government is between 8045", and 9004", East and between longitude 7003", and 6033", North. The local Government is bounded in the East by Kwande local Government in the south by Cross River, South-West by Konshisha local Government and in the North-East by Ushongo local Government. Vandeikya local Government covers an area of about 307.5 square kilometers. She has a population of 390,000 inhabitants with a population density of 198 persons per square kilometres. Its headquarter is Vandeikya. The local Government derives its name from a rock that has always been occupied by monkeys.The Local Government has twelve districts, out of which six were selected for sampling.

Source of Raw Materials

Water samples for analysis was collected from six (6) hand dug wells in Vandeikya local government Area of Benue state.

Water Collection

Water samples were collected according to standard procedures by (APHA. 2000) from six (6) different hand-dug wells; clean plastic container was tied to a synthetic rope down the well. New 75 Cl bottles were used to collect the samples for analysis.

Determination of Physicochemical Parameters

Determination of Temperature: The surface water temperature was determined in situ on the field with the aid of a portable digital thermometer (HANNA Model). The thermometer was lowered into the water sample collected at the designated sites and the value of the determined temperature was recorded. The mean values of three of these readings were calculated and recorded (Akaahanet al., 2016).

Determination of Colour

The colour of the water was determined photo electrically using the Palintest Photometer. The sample was filtered to remove suspended solids before analysis to determine the 'true colour' due to dissolved matter. The colour of water was expressed using the platinum/cobalt colour scale (Pt/Co scale). Each unit was equivalent to the colour produced by 1 mg/l platinum in the form of chloroplatinic acid in the presence of 2 mg/l cobaltous chloride hexahydrate. These units are identical with 'Hazen' units, which have been traditionally used to express results from the visual estimation of water colour.

Determination of Turbidity

The turbidity of the water was determined photo electrically using the Palintest Photometer. In many samples both colour and turbidity were present. In order to separate the effect of turbidity and colour, the sample was compared against a filtered portion of the same water. The Palintest method has been calibrated against the widely recognised formazin turbidity solutions. Turbidity is expressed in terms of Formazin Turbidity Units (FTU). These units are broadly equivalent to Jackson Turbidity Units (JTU) and Nephelometric Turbidity Units (NTU).

Determination of pH

Palintest pH methods use standard pH indicators in tablet form. Different indicators are used to cover different ranges. Each tablet contains the precise amount of indicator needed for the test. All Palintest pH tablets contain a dechlorinating agent so that the test can be carried out in water containing chlorine or other disinfectant residuals. This was carried out by filling test tube with sample to the 10 ml mark, adding one pH indicator tablet, crushing and mixing to dissolve followed by selecting the appropriate Phot number on the Photometer and reading taken.

Determination of Conductivity and Total Dissolved Solids (TDS)

The conductivity was determined using Palintest conductivity meter. The meter was placed inside the bottled water and the reading for conductivity was taken. To obtain the value for total dissolved solids, the mode was pressed again and that gave the value of TDS.

Determination of Hardness

The PalintestHardicol test is based on a unique colorimetric method. The reagents are provided in tablet form and the test is carried out simply by adding the appropriate tablets to a sample of the water. Under the controlled conditions of the test calcium and magnesium ions react with Hardicol indicator to produce a purple coloration. The intensity of the colour is proportional to the total hardness of the water and is measured using a Palintest Photometer. The Total Hardness result was displayed as mg/l CaCO3.

Determination of Nitrate

The Nitratest Tube was filled with sample to the 20 ml mark, followed by adding one level spoonful of Nitratest Powder and one Nitratest tablet. Without crushing the tablet replacing screw cap and shaking tube well for one minute and allowing tube to stand for about one minute then gently inverting three or four times to aid flocculation then allowing tube to stand for two minutes or longer to ensure complete settlement. This was followed by removing screw cap and wipe around the top of the tube with a clean tissue and carefully decanting the clear solution into a round test tube, filling to the 10 ml mark and adding one Nitricol tablet, crushing and mixing to dissolve, allowing standing for 10 minutes to allow full colour development then selecting Phot 63 for taking the reading and result expressed as mg/l NO3..

Determination of Fluoride

Test tube was filled with sample to the 10 ml mark, one Fluoride No 1 tablet added, crushed and mixed to dissolve then one Fluoride No 2 tablet added, crushed, mixed to dissolve and was allowed to stand for five minutes to allow full colour development. Phot 14 on Photometer was selected and Photometer reading taken in usual manner. The result was displayed as mg/l F.

Determination of Chloride

The test tube was filled to the 10 ml mark and using Phot 46, the Chloride content was measured. Approximately 1 ml of sample was measured into the test tube and made up to the 10ml mark with deionized water. Acidified tablet was added, crushed and mixed then chloridol tablet added and allowed to stand for 2 minutes in order to dissolve and settle. Blank sample was used and the reading taken as Mg/L.

Determination of Sulphate

The degree of turbidity is proportional to the sulphate concentration and is measured using a Palintest Photometer. This was carried out by filling the test tube with sample to the 10 ml mark, adding one Sulphate Turb tablet, crushing and mixing to dissolve (A cloudy solution indicates the presence of sulphate), allowed to stand for five minutes then mixing again to ensure uniformity, selecting Phot 32 on Photometer and reading taken. The result is displayed as mg/l SO4.

Statistical Analysis

Data collected were analysed using Minitab Software, version 16.0. Tools used included Descriptive and Inferential Statistics such as T-Test, Chi Square and Mann – Whitney Test. Confidence Limit used was set at 95% confidence limit.

3 RESULTS

The physicochemical parameters of the hand dug wells in Wet and Dry seasons are shown in Table 1 and 2 respectively. The temperatures ranged from 26.9 ± 0.07 to 29.2 ± 0.10 and from 28.0 ± 0.00 to 29.4 ± 0.15 in Wet and Dry Season respectively, pH values ranged from 7.85 to 9.32 and 8.10 to 8.90 in Wet and dry season respectively; colour from 42.5 to 360TCU and 0.00 to 40.00 TCU in Wet and Dry Season respectively; turbidity values ranged from7.11 to 38.8NTU and 2.79 to 11.71 NTU in Wet and Dry season respectively; conductivity values ranged from 10.46 to 155.20µs/cm and 11.50 to 160.50µs/cm in Wet and Dry season respectively; Total Dissolved solids ranged from 5.25 to 77.60 Mg/L and 5.83 to 80.75 Mg/L in wet and dry season respectively; Hardness ranged from 5.00 to 95.10 Mg/L/$CaCO_3$ and 25.00 to 120.00 Mg/L/$CaCO_3$ in wet and dry Season respectively; Chloride values ranged 0.00 to 130.10 Mg/L and 2.00 to 125.00 Mg/L in wet and dry season respectively; Nitrate values ranged from 1.72 to 46.00Mg/L and 1.14 to 17.80Mg/L in wet and dry season respectively; Sulphate values ranged from 1.00 to 5.00Mg/L and 0.00 to 4.00mg/L in wet and dry season respectively; Fluoride values ranged from 0.11 to 0.30Mg/L and 0.00 to 0.65Mg/L in wet and dry Season respectively.

The pollution levels in physicochemical parameters in wet and dry season are shown in Table 3 and Table 4 respectively. The results indicate that apart from pH that there was no significant difference ($P > 0.05$) in the values in both wet and dry season, all the other physicochemical parameters were significantly different ($P < 0.05$) in both wet and dry season. The statistical analysis result in Table 5 indicates that there was no significant difference ($P > 0.05$) between the temperatures in wet Season and dry season.

Table 1: Mean Values of Physicochemical parameters during wet season

Parameters/ sample	W_0R_0	W_1	W_2	W_3	W_4	W_5	W_6	WHO limit
Temperature (^{0}c)	28.0	29.2	26.9	28.7	28.7	29.1	28.6	Ambient
pH	7.04	9.32	8.87	8.57	8.38	7.85	7.92	6.5-8.5
Colour (TCU)	10.0	290	360	42.5	145	50	85	15
Turbidity (NTU)	0.25	34.8	38.8	8.0	27.5	7.11	8.71	5
Conductivity µs/cm	26.00	58.5	126.0	155.2	10.46	52.5	63.4	1000
TDS (mg/L)	13.00	29.4	63.1	77.6	5.25	26.4	31.6	500
Hardness (mg/l($CaCO_3$)	30.00	25.1	55.1	95.1	5.0	40.1	40.1	150
Chloride (mg/L)	32.00	130.1	7.0	19.1	1.0	0.0	9.0	250
Nitrate (mg/L)	3.00	46.0	34.1	3.40	1.72	38.8	3.20	50
Sulphate (mg/L)	2.00	3.0	5.0	4.1	5.0	1.0	5.0	100
Fluoride (mg/L)	0.19	0.30	0.23	0.30	0.16	0.11	0.28	1.5

Table 2: Mean Values of Physicochemical parameters in Dry season.

Parameters	W_0	W_1	W_2	W_3	W_4	W_5	W_6	WHO limit
Temperature (^{0}C)	28.0	29.0	28.3	28.7	28.8	29.4	28.0	Ambient
pH	7.04	8.90	8.40	8.50	8.60	8.10	8.10	6.5-8.5
Colour (TCU)	10.0	5.00	30.00	5.00	0.00	40.00	0.00	15
Turbidity (NTU)	0.25	4.80	6.62	4.43	3.85	11.71	2.79	5
Conductivity µs/cm	26.00	35.0	160.5	92.0	11.50	43.20	58.50	1000
TDS (mg/L)	13.00	17.65	80.75	46.0	5.83	21.60	29.05	500
Hardness (mg/l)	30.00	45.00	120.00	80.00	45.00	25.00	25.00	150
Chloride (mg/L)	32.00	14.00	34.00	2.00	54.00	150.00	125.00	250
Nitrate (mg/L)	3.00	2.08	2.60	1.14	1.30	17.8	1.92	50
Sulphate (mg/L)	2.00	0.00	4.00	2.00	3.00	2.00	0.00	100
Fluoride (mg/L)	0.19	0.10	0.21	0.15	0.00	0.01	0.65	1.5

Table 3: Pollution Levels in Physicochemical Parameters in Wet Season

Parameter	X^2	P- Value	Inference
Temperature (^{o}C)	22.95	0.028	P < 0.05
pH	3.61	0.989	P > 0.05
Colour (TCU)	1296.08	0.000	P < 0.05
Turbidity (NTU)	130.123	0.000	P < 0.05
Conductivity(µs/cm)	379.928	0.000	P < 0.05
TDS (Mg/L)	189.836	0.000	P < 0.05
Hardness (mg/L/$CaCo_{3)}$	213.284	0.000	P < 0.05
Chloride (Mg/L)	880.498	0.000	P < 0.05
Nitrate (Mg/L)	221.288	0.000	P < 0.05

Table 4: Pollution Levels in Physicochemical Parameters in Dry Season

Parameters	X^2	P – Value	Inference
Temperature (oC)	0.08	0.000	P <0.05
pH	0.327	1.000	P > 0.05
Colour (TCU)	227.647	0.000	P <0.05
Turbidity (NTU)	24.610	0.017	P < 0.05
Conductivity(µs/cm)	467.517	0.000	P < 0.05
TDS (Mg/L)	235.766	0.000	P < 0.05
Hardness (mg/L/$CaCo_{3)}$	262.254	0.000	P < 0.05

Table 5: Comparison of Mean Temperature in Wet and Dry Season

Season	N	Mean ±S.E Mean
Dry	7	28.600 ±0.20
Wet	7	28.457 ±0.30

T = 0.40, P =0.699 (P > 0.05)

The Sulphate and Fluoride Content in hand dug Wells in Wet Season is shown in Figure 1. The results indicate that there were significant differences in Sulphate content values and those of Fluoride content levels, with Sulphate content being much higher than those of fluoride. The Nitrate, Sulphate and Fluoride Concentrations in Dry Seasonare shown in Figure 2. The results indicate that there were significant differences (P < 0.05) in the Nitrate, Sulphate and Fluoride Content of all the hand dug wells from the differentvarious districts.

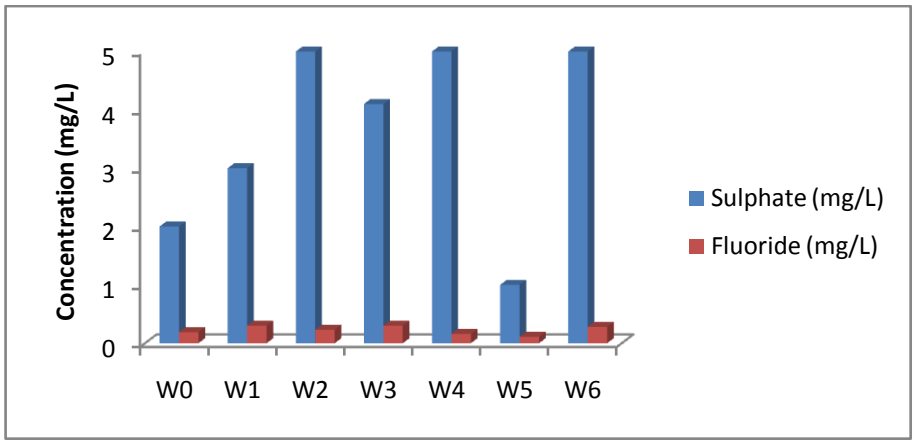

Figure 1: Sulphate and Fluoride Content in Hand dug Wells in Wet Season

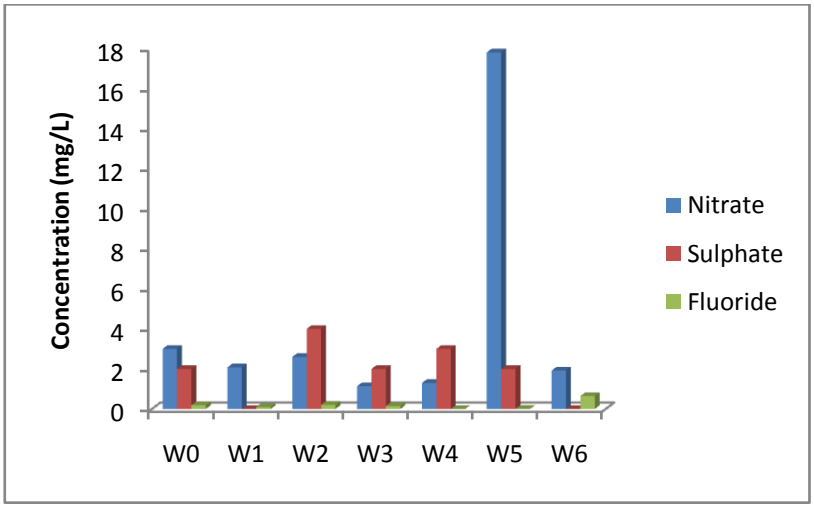

Figure 2: Nitrate, Sulphate and Fluoride Concentrations in Dry Season

4 DISCUSSION

Temperatures ranged from 26.9 ± 0.07 to 29.2°C ± 0.10 and from 28.0 ± 0.00 to 29.4°C ± 0.15 in Wet and Dry Season respectively. However, these values are higher than those obtained by Saidu (2011) for hand dug wells in Minna, Niger State; 25.8 to 27.8°C for both wet and dry season. Water temperature can be affected by many ambient conditions including; sunlight/solar, radiation, heat transfer from the atmosphere, stream confluence and turbidity (Perlman, 2014).The result indicates that there was no significant difference between the temperatures in Wet and Dry season ($P > 0.05$). The pH values ranged from 7.85 to 9.32 and 8.10 to 8.90 in Wet and dry season respectively; the pH for most of the hand dug wells remains relatively within the allowable WHO range of 7.0 – 8.5. Basedon the WHO guidelines, the pH of water samples from Mbayongo, Township and Mbagbera in wet season and from Mbadede, Mbatyough, Mbayongo, Township and Mbagbera in dry season fell within the allowable limit and would not adversely affect its usefor domestic purposes.

Colour values ranged from 42.5 to 360 TCU and 0.00 to 40.00 TCU in Wet and Dry Season respectively while turbidity values ranged from7.11 to 38.8NTU and 2.79 to 11.71 NTU in Wet and Dry season respectively. There was a very strong correlation between Turbidity and colour such that in wet season the values for both colour and turbidity were above the allowable WHO range of 15 TCU and 5 NTU respectively. The rise in colour and turbidity may be attributed to contamination of the water body by erosion resulting to high values of turbidity and colour which may be injurious to health. In the dry season, water samples from Mbajor, Mbatyough, Mbayongo and Mbagbera fell within the WHO allowable range while the hand dug well water samples from Mbadede and Township fell above the allowable limit of 15TCU and 5NTU for colour and turbidity respectively. Turbidity is contributed mainly by suspended sediments which are solid particles of inorganic or biological origin (Manjesh *et al*., 2012).

Conductivity values ranged from 10.46 to 155.20µs/cm and 11.50 to 160.50µs/cm in Wet and Dry season respectively, while Total Dissolved solids ranged from 5.25 to 77.60 Mg/L and 5.83 to 80.75 Mg/L in wet and dry season respectively. These values are all within the WHO allowable limit of 440µs/cm in both seasons. Total dissolved solids ranged from 5.25 to 77.60 Mg/L and 5.83 to 80.75 Mg/L in wet

and dry season respectively. These values are all within the WHO allowable limit of 440µs/cm in both seasons. Hardness of hard water refers to water that has high mineral content e.g. Ca^{++}, mg++. These ions enter water by leaching from minerals within an aquifer (WHO 2006). Hardness ranged from 5.00 to 95.10 Mg/L/CaCO3 and 25.00 to 120.00 Mg/L/CaCO3 in Wet and Dry Season respectively and is below the maximum permissible value of 150 Mg/L/CaCO3. The values obtained for conductivity, Total Dissolved Solids and Hardness are much lower than those obtained by Saidu, (2011) for selected hand dug wells in Minna, Niger State, which were, 344 to 1191 µs/cm for both seasons and 210 -738 mg/l for Conductivity and Total Dissolved Solids respectively and 112 to 444mg/l for hardness. The differences could be attributed to differences in the areas of study for the selected wells (Benue and Niger States) as well as the activities around such wells.

Chloride values ranged from, 0.00 to 130.10 Mg/L and 2.00 to 150.00 Mg/L in wet and Dry season respectively while Nitrate values ranged from 1.72 to 46.00 Mg/L and 1.14 to 17.80 Mg/L in wet and Dry season respectively. These values are within the maximum permissible value of 250 Mg/L and 50 Mg/L for Chloride and Nitrate respectively. Sulphate values ranged from 1.00 to 5.00 Mg/L and 0.00 to 4.00 Mg/L in Wet and Dry season respectively. Fluoride values ranged from 0.11 to 0.30 Mg/L and 0.00 to 0.65 Mg/L in Wet and Dry Season respectively. These values for both seasons are all within the maximum permissible value of 15.0 Mg/L. Fluoride in drinking water reduces dental decays. However, over 20 mg/l of fluoride can result in nausea, diarrhea, abdominal pains, headache and dizziness. Some long term effects is that it may give rise to mild dental fluorosis (Craun et al, 2003). Also it can have adverse effect on tooth enamel and may give rise to mild dental fluorosis at concentrations between 0.9 – 1.2 Mg/L depending on intake (WHO 2006).

The pollution levels in physicochemical parameters in Wet and Dry season are shown in Table 3 and Table 4 respectively. The results indicates that apart from pH there was no significant difference ($P > 0.05$) in the values for both Wet and Dry season, all the other physicochemical parameters were significantly different ($P < 0.05$) for the two seasons.The Sulphate and Fluoride Content of hand dug Well Waters in Wet Season is shown in Figure 1. The results indicate that there were significant differences in Sulphate content values and those of Fluoride content levels, with sulphate content being much higher than those of fluoride.The Nitrate, Sulphate and Fluoride Concentrations in Dry Seasonis shown in Figure 2. The results indicate that there were significant differences ($P < 0.05$) in the Nitrate, Sulphate and Fluoride Content of all the well waters from the different waters from the various districts.The Seasonal Variation in Physicochemical Parameters is as shown in Table 5. The results indicate that there were no significant differences($P > 0.05$) among the hand dug well water samples in Temperature, pH, Conductivity, Total Dissolved solids, Hardness, Chloride and Fluoride Content of the well waters. However, significant differences existed among the water samples for Colour, Turbidity, Nitrate and Fluoride Content.

5 Conclusion

Based on the results from physicochemical parameters, especially colour and turbidity, values for the hand dug well water samples were above the maximum permissible value of 15 TCUand 5NTU for colour and turbidity respectively as recommended by WHO (2008) for potable water and this may compel the people in looking for other alternative sources of water which may be microbiologically unfit for human consumption.

6 Recommendation

Water from hand dug Wells must be treated before use either by boiling and filtration or by chemical sterilization or by combination of both.The containers used for collection of water should be kept in clean conditions to avoid introduction of contaminants. The Community needs to be educated both on activities around the hand dug wells and on safe handling of water obtained from the hand dug wells.

REFERENCES

Akaahan,T.J.A, Eneji, I.S, Azua, E.T(2016).The relationship between surface water temperature and Dissolved Oxygen in River Benue at Makurdi. *European Journal of Basic and Applied Sciences*.3(1);2059-3058.

APHA (2000).American Public Health Association. Standard Procedures recommended on drinking water quality.

Nigerian Industrial Standard (2007).Nigerian Standard f or Drinking Water Quality.

Ogunbode, T.O.Akintunde, E.A.; Akinola, O.T. (2016).Assessment of Underground Water Quality And Pollution Sources Apportionment In A Growing Urban Centre In Osun State South Western Nigeria,*European Journal Of Geography*. 7(3):71-85.

Palintest Water Analysis technologies (2017).A HALMA COMPANY USA.

Sohonou, M. Vissin, E. W. Sintondji, L. O. Houssou, C. S, Agbossou, K. E. Edorh, A. P. (2017).P*hysico-Chemical And Microbiological Qualities Of Water From Wells, Drillings And Tanks Used As Drinking Water In The Municipality Of Allada (Benin, West Africa).European Scientific Journal .13(15) 1857 – 7881.*

Vijay, K.B. Arup, G. And Krishna, K. (2017). Evaluation of Physico Chemical Parameters And Minerals Status Of Different Water Sources At High Altitude.*Peertechz Journal of Environmental Science and Toxicology*.2(1): 010-018.

WHO (2008). World Health Organization: International water Quality Standards.