Effect of Distance of Sanitary Pits on the Physicochemical Properties of Hand Dug Well Water Samples Consumed by People Living in Akwuke Community, Enugu South Local Government Area of Enugu State

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Abstract

Studies were carried out to evaluate the effect of distance of sanitary pits on the physicochemical properties of hand-dug well water samples consumed by people living in Akwuke community, Enugu South Local Government Area of Enugu State, using standard analytical procedures and instrumentation. The mean range of pH, turbidity, electrical conductivity, total dissolved solids, nitrate and sulphate in the well water samples at the determined sampling distances of 3, 6 and 10 m from the sanitary pits were 5.9 - 7.24, 1.92 - 6.63 NTU, 122.03 - 303.91 μs/cm, 100.00 - 261.90 mg/L, 1.21 - 4.68 mg/L and 28.89 - 49/61 mg/L respectively. The investigated mean physicochemical parameters of the well water samples were generally observed to increase with decrease in the distance of the well water samples from the sanitary pits. The levels of the determined physicochemical parameter of the well water samples at sampling distances of 3, 6, and 10 m respectively from the sanitary pits were statistically significant. The mean pH values of the well water samples at sampling distances of 3 and 6 m respectively from the sanitary pits were below the WHO recommended threshold limits for safe drinking water. Additionally, the mean values of turbidity and total dissolved solids of the well water samples at a sampling distance of 3 m from the sanitary pits were above the WHO permissible limits. The pH, turbidity and total dissolved solids are

some of the most important parameters used in assessing the quality of any water source, therefore, the poor physicochemical properties of well water samples at a sampling distance of 3 m from the sanitary pits could put at severe health risk consumption of this water over a prolonged time. Siting well water at a reasonable far distance (above 10 m) for sanitary pits especially in communities with severe water scarcity would definitely help guarantee access to safe drinking water by rural as well as urban dwellers in Nigeria.

Keywords

Physicochemical Parameters, Well Water, Sanitary Pits and Faecal Contamination

1. Introduction

The availability of good quality water is an indispensable feature for preventing diseases and improving the quality of life and it is goal six of the sustainable development goals (SDGs) [1]. A reliable supply of clean wholesome water is highly essential in a bid to promoting healthy living amongst the inhabitants of any defined geological region [2].

Ground water is an important source of drinking water for humans, it contains a larger percentage of the available fresh water resources and it is an important reserve of good water quality [3].

According to Black M. [4], about 300 million people in sub-Saharah Africa do not have access to the safe water supply. This is mainly due to the inefficiency of public water supply authorities in the region. With the demand for safe water increasingly outweighing supply, many individuals are forced to place greater demands on well water especially in states like Enugu with huge water scarcity. Well water, which is ground water, provides over 80% of the drinking water needs for the sub-Saharan population [5].

In terms of access to sources of water in Nigeria, it has been shown that 48% of the total population depends on surface water for domestic use, 57% depends on hand-dug wells, 20% rain water, while 14% have access to pipe borne water [6]. However, ground water sources especially hand-dug wells are unduely observed to be vulnerable to pollution, which may degrade their quality [7].

According to Agatemor C. and Agatemor U.M [8], most well water sources are sited indiscriminately without knowledge of the hydrogeology of the site, and moreover, some of the well water is sited proximally to refuse and dump sites, underground sewage tanks and pit latrines. These practices according to Agatemor C. and Agatemor U.M [8] can profoundly affect the microbiological and physicochemical characteristic of the well water.

According to Salaudeen I. *et al* [6], in rural Africa, the microbial and nonmicrobial quality of ground water is threatened due to the pit latrines as well as siting of wells and boreholes in proximity to septic tanks, solid wastes dumpsites

and other diverse sources of pollution.

Consequently, water related diseases continue to be one of the major health challenges all over Africa.

According to Macler B.A. and Markle J.C. [9], a significant fraction of all water borne disease outbreaks is associated with ground water.

One of the most effective ways to communicate information on water quality trends is with indices. The water quality index (WQI) is commonly used for the detection and evaluation of water pollution and may be defined as a rating reflecting the composite influence of different quality parameters on the overall quality of water [10]. The indices are broadly characterized into two parts: the physicochemical and biological (bacteriology) indices. America Public Health Association (1998) [11] stated that the physicochemical indices are based on the various physicochemical qualities in water and are vital for water quality monitoring.

A number of scientific procedures and tools have been developed to assess the water contaminants and these procedures include parameters such as pH, turbidity, alkalinity, electrical conductivity, total dissolved solids, sulphates, and nitrates among others [12].

Dissmeyer G.E. [13] observed that these physicochemical parameters could affect the drinking water quality if their values are in higher concentrations than the safe limits set by the World Health Organization and other regulatory bodies.

According to World Health Organization (2008) [14] report on guidelines for drinking water, safe drinking water as defined by the guidelines does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages. The information concerning water quality will provide useful information for policymakers to formulate management strategy for the control and abatement of water pollution and such reliable data can only be gotten through monitoring.

According to Adah P.D. and Abok G. [15], water quality monitoring is a parameter used especially in the sub-Sahara African countries like Nigeria to safeguard the public health, to protect the water resources and fundamental tool necessary for the management of fresh water that is the main sources of drinking water in the rural and some urban areas.

This monitoring is used for identifying problems and formulating measures to minimize deterioration of water quality. The physicochemical parameters of water essentially explain the suitability of that water body for drinking, agricultural and recreational purposes. The residents in the Akwuke community rely on well water to serve their domestic needs, with the well water poorly and indiscriminately sited around the community. For this reason, research was conducted to evaluate the effect of distance of sanitary pits on the physicochemical properties of hand-dug well water consumed by people living in Akwuke community, Enugu South Local Government Area of Enugu State.

2. Materials and Methods

Sample Collection

Ten (10) water samples were each collected from hand dug wells at sampling distance of 3, 6, and 10 m respectively from the sanitary pits located randomly within the Akwuke Community.

Therefore, a total of thirty (30) well water samples were randomly collected between the months of November and December, 2020. The water samples were collected in clean, pre-sterilized, well labelled plastic containers. The sample containers were tightly covered and taken to the laboratory where they were stored in desiccators prior to analysis.

3. Methodology

The pH, total dissolved solids (TDS), turbidity and electrical conductivity were measured in-situ in the well water samples with the aid of Horiba-Vio multimeter [16]. The spectrophotometric screening methods were used for the analysis of the concentration of nitrate [11].

Turbidimetric titration method was used to analyze the concentration of sulphate [11].

4. Statistical Analysis

All the analysis were carried out in triplicate and the data expressed in mean and standard deviation and subjected to one way analysis of variance (ANOVA) at 5% confidence level using SPSS 22.0.

5. Results and Discussion

The result of Table 1 shows that the pH values of the well water samples decreased with increase in the sampling distance from the sanitary pits. This result therefore indicates that the well water samples tend to become acidic as its distance from the sanitary pits was reduced.

The mean pH values of well water samples at sampling distances of 3 and 6 m respectively from the sanitary were below the WHO recommended threshold limits for safe drinking water.

The pH values of the well water samples at the determined sampling distances from the sanitary pits were statistically significant.

The pH values of the well water samples show that the closeness of the well water samples at distances of 3 and 6 m respectively from the sanitary pits could have had increased the levels of biological and nonbiological water contamination of its aquifers through leachates from the sanitary pits but which also may include other non-investigated anthropogenic activities going on the in studied environment. According to [17], low pH values could contribute to high electrical conductivity and total dissolved solids of water, as low pH waters reportedly increase the tendency of the water to dissolved minerals and metals.

Table 1. Mean levels of the physicochemical parameters of the well water samples at sampling distances of 3, 6 and 10 m respectively from the sanitary pits.

| Parameter | Mean physicochemical parameters at determined sampling distances from the sanitary pits | | | | [13] Permissible limits |
	3 m	6 m	10 m	F test p value	
pH	5.90 ± 0.12	6.31 ± 0.11	0.03	6.5 ± 8.5	6.5 ± 8.5
Turbidity (NTU)	6.634 ± 0.41	6.634 ± 0.22	1.92 ± 0.16	0.01	5
Electrical conductivity (μS/cm)	303.91 ± 10.62	211.42 ± 17.61	122.03 ± 3.64	0.02	1000
Total dissolved solids (mg/L)	261.90 ± 17.20	185.95 ± 4.62	100.06 ± 2.13	0.02	250
Nitrate (mg/L)	4.68 ± 0.37	2.29 ± 0.15	1.21 ± 0.11	0.02	50
Sulphate (mg/L)	49.61 ± 2.02	38.77 ± 2.10	28.89 ± 0.81	0.01	250

pH: **Table 1** shows that the mean pH of the hand-dug well water samples at sampling distances of 3, 6, and 10 m from the sanitary pits were 5.90 ± 0.02, 6.31 ± 0.16 and 7.24 ± 0.11 respectively.

The low pH values of well water samples at sampling distances of 3 and 6 m respectively from the sanitary pits, therefore, indicated that the water samples could be slightly acidic.

Asamoah D.N. and Amorin R. [18] stated that continuous consumption of water with pH below the acceptable is capable of causing acidosis.

Ojekunle Z.O. *et al.* [19] reported a mean pH range of 5.88 - 6.26, between wet and dry seasons in underground water within the industrial areas in Ogun State, which compared very well with the mean pH values obtained in the studied water samples at sampling distances of 3 and 6 m respectively from sanitary pits.

5.1. Electrical Conductivity

Electrical conductivity measures the degree of ions in water, which greatly affects taste and thus has a significant impact on the user's acceptance of the water.

Table 1 shows that the mean values of electrical conductivity of the well water samples at sampling distances of 3, 6 and 10 m from the sanitary were 303.91 ± 10.62, 211.42 ± 17.61 and 122.03 ± 3.64 μS/cm respectively.

As was observed for the values of pH of the well water samples, the mean values of electrical conductivity of the well water samples decreased with increase in sampling distance from the sanitary pits.

The mean values of electrical conductivity of the water samples at sampling distances of 3, 6 and 10 m respectively from the sanitary pits were statistically significant and equally within the WHO recommended threshold limits for safe drinking water.

[8] reported a higher mean value of 355.30 ± 20.67 μS/cm for well water samples in Ekpoma city, Edo State than what this study obtained as electrical conductivity values in well water samples at the investigated sampling distances

from the sanitary pits. According to [20], electrical conductivity does not have a direct implication on human health.

Total dissolved solid (TDS).

Total dissolved solid are measures of the general nature of water quality [21]. The total dissolved solid is the total of cations and anion in water including carbonate, calcium, magnesium, sodium, organic ions and other ions.

Total dissolved solids affect the taste of drinking water if present at levels above the WHO recommended level [22].

Table 1 shows that the mean values of total dissolved solids in the well water samples at sampling distances of 3, 6 and 10 m from the sanitary pits were 261.90 ± 17.24, 185 ± 4.62 and 100.06 ± 1.13 mg/L respectively.

The well water samples had mean values of TDS within WHO recommended permissible limits at the investigated sampling distances of 6 and 10 m respectively.

The mean value of TDS in the well water samples at a sampling distance of 3 m from the sanitary pits was above the WHO recommended threshold limits for safe drinking water and therefore negates the use of the well water for drinking and other domestic water uses.

Adesakin T.A. *et al.* [22] reported a lower mean range of values of 139.43 - 148.75 mg/L for TDS between wet and dry season in well water samples in Samaru Community, Zaria, Kaduna State than what was gotten for TDS in the studied well water samples at sampling distances of 3 and 6 m respectively from the sanitary pits.

The mean values of TDS in the well water samples at sampling distances of 3, 6 and 10 m respectively from the sanitary pits were statistically significant.

5.2. Turbidity

Table 1 shows that the mean values of turbidity of the well water samples at sampling distances of 3, 6 and 10 m from sanitary pits were 6.63 ± 0.41, 3.04 ± 0.22 and 1.92 ± 0.16 NTU respectively.

The turbidity values of the well water samples decreased as the distance of the well water from the sanitary pits increased. Of the three investigated sampling distances of the well water samples from the sanitary pits, only well water samples at 3 m distance from the sanitary pits was above the WHO recommended threshold limits for safe drinking water.

This, therefore, indicates that the proximity of well water samples at 3 m distance from the sanitary pits significantly contributed to the less clarity of the water samples due to the filtration of particulate materials from the pits into the acquifier of the water samples making it cloudy and turbid and hence unhealthy for consumption purposes. The turbidity values of the well water samples at the investigated sampling distance from the sanitary pits were statistically significant.

Atiku S. *et al.* [23] reported a higher mean value of 3.43 NTU for turbidity in well water samples in industrial district, Jabi, Abuja than what was obtained for

the turbidity of the studied well water samples at sampling distances of 3 and 6 m respectively from the sanitary pits.

5.3. Nitrate

Table 1 shows that the mean values of nitrate in the well water samples at sampling distances of 3, 6 and 10 m from the sanitary pits were, 4.68 ± 0.37, 2.29 ± 0.15 and 1.21 ± 0.11 mg/L respectively. The mean levels of nitrate in the well water samples at the investigated sampling distances from the sanitary pits were within WHO recommended threshold limits for safe drinking water. The levels of nitrate in the water samples at the determined sampling distances from the sanitary pits were statistically significant.

According to Adesakin T.A. *et al.* [22] agricultural use of organic and chemical fertilizers has been the major cause of water pollution with nitrates.

Adesakin T.A. *et al.* [22] reported a lower mean value of 1.87 ± 0.62 mg/L for nitrate in well water samples in Samaru community, Zaria, Kaduna State than what was gotten for nitrate in the studied well water samples at sampling distances of 3 and 6 m respectively from the sanitary pits.

According to Nwachukwu E. and Ume C. [10], lifetime exposure to nitrate at levels above the maximum acceptable limits could cause such problems as diuresis, increased starch deposits and haemorrhaging of the spleen.

5.4. Sulphate

Table 1 shows that mean levels of sulphate in the well water samples at sampling distances of 3, 6 and 10 m from the sanitary pits were 49.61 ± 2.02, 38.77 ± 2.10 and 28.89 ± 0.89 mg/L respectively. The mean levels of sulphate in the well water samples at the investigated sampling distances from the sanitary pits were statistically significant and within the WHO recommended threshold limits.

Olabaniyi S.B. and Onoyemi S.B. [24] stated that sulphates naturally occur in ground water by dissolution of sulphides such as pyrite from the inter stratified materials by percolating water producing sulphate ions.

Ogoko E.C. [25] reported a mean value of 36.06 mg/L for sulphate in the hand dug well water samples in Lagos Island, Lagos which compared very favourably with what was gotten for nitrates in the studied well water samples at a sampling distance of 6 m from the sanitary pits.

6. Conclusions

The physicochemical properties of the hand-dug well water samples were generally observed to decrease with an increase in distance of the well water samples from the sanitary pits.

The mean pH values of the well water samples at sampling distances of 3 and 6 m respectively from the sanitary pits were below the WHO recommended permissible limits. The mean turbidity and total dissolved solids of the well water samples at a distance of 3 m from the sanitary pits were above the WHO

recommended threshold limits for safe drinking water. The mean values of electrical conductivity, sulphate and nitrate ions in the water samples at the investigated distances of 3, 6 and 10 m respectively from the sanitary pits were within WHO threshold limits.

The pH, turbidity and total dissolved solids values of well water samples at a sampling distance of 3 m from the sanitary pits renders these water samples unfit for any domestic use and therefore, portends a health danger to its continuous consumption by people.

The proximity of the well water samples to the sanitary pits especially at a distance of 3 m could have significantly contributed to the poor physicochemical characteristics of the well water samples owing to the heavy contamination of the acquifer of the shallowly dug well water samples by leachates from the sanitary pits.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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