LEVEL OF pH IN DRINKING WATER OF AN OIL AND GAS PRODUCING COMMUNITY AND PERCEIVED BIOLOGICAL AND HEALTH IMPLICATIONS

Dirisu, Chimezie G.
Dept. of Biology Education
Federal College of Education
(Technical) Omoku, **NIGERIA**

Mafiana, M. O.
Dept. of Biology Education, Federal
College of Education (Technical)
Omoku, **NIGERIA**

Dirisu, G. B.
Dept. of Physics Education,
Federal College of Education
(Technical) Omoku, **NIGERIA**

Amodu, R.
Dept. of Physics Education, Federal College of Education
(Technical) Omoku, **NIGERIA**

ABSTRACT

pH level of drinking water supply in Omoku, an oil and gas producing community and headquarter of Ogba/Egbema/Ndoni local Government area (ONELGA) of Rivers state, Nigeria was ascertained using standard method. Result shows that pH ranged from4.74±0.49 in private borehole to 6.40±0.42 in rain water. The order of decreasing pH level was private borehole<public borehole<Stream water<Well water<Rain water. Although all water sample fall within the acidic range, borehole water was more acidic than stream. The result of the study showed that the five water samples did not exceed the specific standard of W.H.O for a safe drinking water quality. Analysis of variance indicated lack of significant difference between the various drinking water samples studied (p>0.05).Chi square statistic indicated significant negative correlations of positive and negatively responses on the perceived causal factors and impacts of low water pH (p<0.05).The observed pH values of Omoku community's drinking water is an indicator of potential health risk and loss of biodivserssity due to acidification of soil and aquatic habitats. Water supply therefore should be treated before distributing for human consumption to ascertain quality supply

Keywords: pH, water, acidity, biological, health.

INTRODUCTION

The concept of the acidity or alkalinity of either water or any solution is based on the pH scale, which ranges from 0-14 (Corington et al, 2001; WRN, 2016). pH is an acronym which stand for *potential of hydrogen*, is simply a measure of the concentration of hydrogen ions [H^+] in water. The chemists define pH as the negative logarithm of hydrogen ion [H^+] concentration (mol/L) in an aqueous solution and given by the equation:

$$pH = -Log\,10\,[H+]$$

pH affects most biochemical processes in water such as enzyme activity and solubilization and uptake of certain ions such as ammonia. pH limits biodiversity distribution in aquatic habitat. Different species thrive within different ranges of pH with the optima for most aquatic organisms falling between pH 6.5-8.5 (W.H.O. 2004). In view of the increasing human activities releasing acidifying pollutants into the atmosphere and water bodies and the inherent food insecurity and increased morbidity, the study was undertaken to determine the pH of various drinking water of Omoku, an oil –rich community in Rivers State, Nigeria as well as ascertain the extent of impact on man and his resources.

LITERATURE REVIEW
The Concept of Water pH and Biological Functions

pH represent the hydrogen ion activity not concentration of a solution (AWWA, 2005), and is an indication of whether water or any solution is acidic or alkaline and the intensity. pH value is a good indicator of whether water is hard or soft. Pure water has a pH of 7., thus pH below 7 is considered acidic and pH above 7 is alkaline. Surface water has pH range from 6.5 to 8.5, while pH of ground water is between 6 to 8.5. Alkalinity is defined as the capacity of water to resist pH changes that would tend to make the water more acidic. pH also determines whether water is corrosive or toxic, thus pH measurement is needed to determine the corrosiveness of the water. pH affects most chemical and biological processes in water and it is one of the most important environmental factors limiting the distribution of species in aquatic habitats. Even small changes in pH can shift community composition in water, because pH alters the chemical state of many pollutants such as copper and ammonia, changing the solubility, transport, or availability. This can increase exposure to toxicity of metals and nutrient to aquatic plant and animals. Though, the ideal pH level of drinking water should be between 6-8.5, living organisms are able to maintain constant pH equilibrium and will not be affected by water consumption. The pH scale is shown in figure 2.

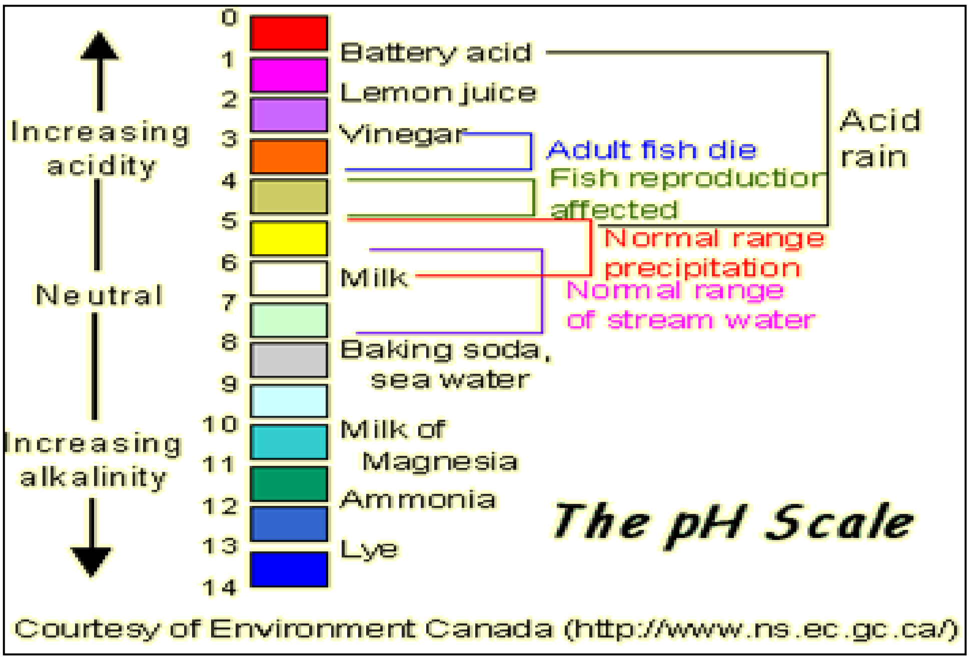

Figure 1. The pH scale (redrawn from http://www.water-research.net/index.php/ph-in-the-environment

Different organisms flourish within different pH ranges with the optima for most aquatic organisms falling between pH 6.5-8 (W.H.O 2004). The stipulated standard is between 6.5 to 9. Fluctuations in pH or sustained pH outside this range reduces biologic diversity in water because it causes physiological stresses to many species, resulting in decrease reproduction and growth as well as disease or death.

High pH in Water

A water body is said to have a high pH if the pH is >9.0 for prolonged periods of time or with high frequency. An increase in water temperature, decreases solubility of oxygen and increases the dissolution of basic salts such as bicarbonates in water, making water more alkaline. A pH > 8.5 could indicate that the water is hard. Although hard water does not cause health problems, it causes aesthetic problems such as imparting an alkali taste to the water, formation of scale on dishes, cooking utensils, and laundry basins, inability of soaps and detergents to lather, and the formation of insoluble precipitates on clothing [WRN, 2016). High pH is less common than low pH. High water pH means that the water is alkaline and the effect of such water include decreased reproduction, reduction in biodiversity, retarded growth and damage to body organs such as olfactory organs, eyes. High pH also raises the toxicity of other substances such as ammonia and hydrogen sulphide (Svobodova et al, 1993; Uber, 2002; Lentech, 2016).

Low pH in Water

Low pH of a water body means that the pH generally <6 or 6.5 depending on the system. The decomposition of organic matter within a body of water, releases carbon dioxide, which combines with water to form carbonic acid. Also, the presence of some metals such as aluminum, copper and zinc as well as acidifying substances in the earth such as calcium oxide and sodium carbonates creates low water pH water passes over them. Although carbonic acid is a weak acid, large amounts of it will drop the pH. Photoelectric reactions lead to the formation of acidic oxides such as SO_2 and NO_x, which readily dissolve in water to make it acidic. Chemical pollution also reduces water pH. .Biological effects of low pH include damage to gill, formation of mucus on gills, retarded growth, problem with ion regulation, reproductive failure leading to reduction in species number of species as well as replacement of acid sensitive species with acid tolerant species (USEPA, 2003; Lemtec, 2016; WRN, 2016)

METHODOLOGY
Study Area

Omoku is located within the latitudes of 5.3500 and longitude of 6.6500, respectively the altitude of 139m. It is the capital of Ogba/Egbema/Ndoni Local Government Area of Rivers State and covers an area of 920km^2 in the northern part of the Niger Delta region of the state. It is bordered on the west by the Orashi River and on the East by the Sombreiro Rivers (Ellah, 1995). Omoku constitutes one of the coastal and estuarine settlements in Rivers State and is characterized by community creeks, flood plan, mangrove swamps and other coastal features. Figure one shows map of the study area.

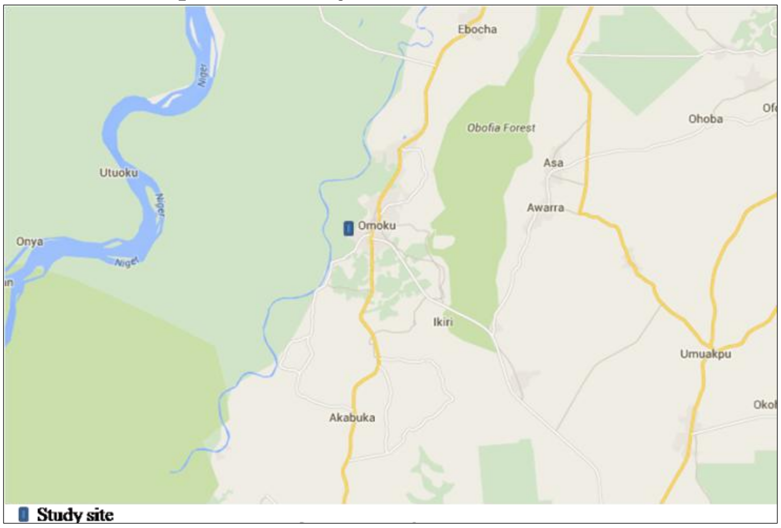

Figure 2. Google Map showing Study Area
Source: http://www.viewphotos.org/nigeria/coordicnates-of-Omoku-94.html

Site Description

The sampling sites are shown in table 1

Table 1. Sampling sites

Site	Location	Water sample type
SS1	Obosi quarter	River (Onosi-Obosi) water
SS2	Palace road	Well water
SS3	Church road	Private borehole water
SS4	EremaStreet water board	public borehole water
SS5	Elder Mark Street	Rainwater

Source: Field sample (this study)

Sample Collection

Samples were collected from four different areas in Omoku namely, stream water was collected from. Sample were collected using a clean polythene bottles, all bottles were washed with detergents, rinsed with deionized water and finally with water sample prior to collection a total of 4 bottles were used for the analysis.

pH Determination

pH of water samples were measured using a multi-meter pH meter after calibration of instrument (APHA, 2005). Readings were taken in duplicates.

Survey

Perceived causes and impacts of low water pH (acidity) was studied by administering a structured questionnaire, which was randomly distributed to one hundred and twenty respondents from the study area.

Statistical Analysis

Mean of measured pH from the pH meter was computed. One way-analysis of variance was used to ascertain whether there was significant difference between the pH of the tested water Frequency of responses were computed. Positive and negative responses were pooled and correlated using Pearson's correlation coefficient. Chi square statistics was used to test whether there existed significant differences in the responses from the survey study. All analyses were done using Microsoft excel and SPSS software, version 18.

RESULTS

Community water pH

The result of pH analysis of the community sources of drinking water is shown in figure 2. Stream had mean pH of 5.54$\pm$0.035, well water (6.06$\pm$0.21), private borehole 4.74$\pm$0.49, public borehole (5.06$\pm$0.20) and rain water (6.40$\pm$0.42). These pH values are all within acidic range and below the specified W.H.O standard of from 6.5 to 8.5.

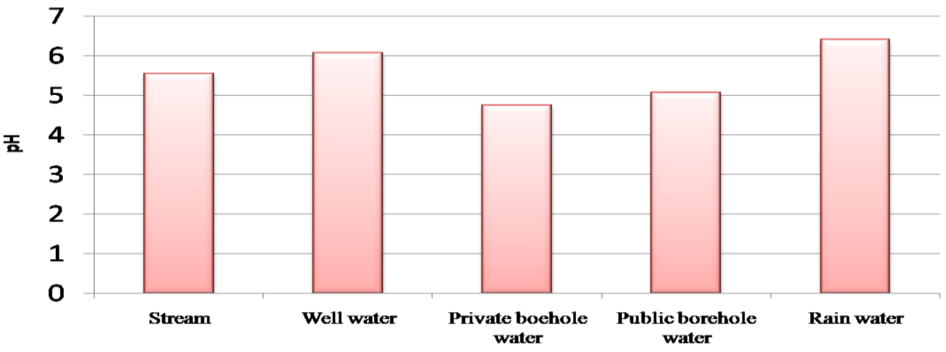

Figure 3. pH of community drinking water

Perceived Causes of Perceived Acidity in Community Drinking Water

Table 2. Perceived causal factor of observed low water pH

Item	Statement	Positive responses	Rank	Negative responses	Rank	Chi-square	df	Asymp. Sig.
1	Water treatment with chlorine	98	2nd	22	5th	.000	3	1.000
2	Oil pipeline explosion	89	4th	31	4th	.000	3	1.000
3	Solid waste incineration	54	6th	66	2nd	.000	3	1.000
4	Gas flaring	107	1st	13	7th	.000	3	1.000
5	In put of agrocheimcals on farms	98	2nd	22	5th	.000	3	1.000
6	Deforestation	50	7th	70	1st	.000	3	1.000
7	Transport of petroleum products	88	5th	32	3rd	.000	3	1.000

The result of a survey as to what contributes or caused the low water pH observed is shown in table 2. There was significantly negative correlation between positive and negative responses (r=-1.000; p<0.05) and chi square was also significant (p<0.05). This implies that positive responses outweighed negative responses (as also indicated by 70% >30% responses respectively). In the cases of positive responses, gas flaring ranked first, followed by water treatment with chlorines, and then, run-offs of agrochemicals from farms. Deforestation contributed least to water acidity (7^{th}). The contributions to water acidity from all causal factors were not significantly different (p>0.05).

Perceived impacts of low pH of community water

Table 3. Responses on perceived impact biological and health impacts of low water pH

Item	Statement	Positive responses	Rank	Negative Responses	Rank	Chi-square	df	Asymp. Sig.
8	Makes soil acidic as it percolates the soil	116	1st	4	7th	.000	3	1.000
9	Water unsafe for drinking-causing sickness	97	6th	23	2nd	.000	3	1.000
10	Leads to death of fishes	100	4th	20	3rd	.000	3	1.000
11	Acidic water cause death of useful soil organisms	101	3rd	19	5th	.000	3	1.000
12	Irritates skin when used for bathing	84	7th	36	1st	.000	3	1.000
13	Acidic soil water reduces crop yield	107	2nd	13	6th	.000	3	1.000
14	Spoils roofing sheets, leading to loss of money	100	4th	20	4th	.000	3	1.000
	%	86		14				

Result in table 3 indicates 86 % of positive responses against 14% negative responses. The result of a survey as to the extent to which water pH impacted on living organisms and man's health reveal that gastro-intestinal sickness and skin irritation of consumers were among the impacts. Other impacts included acidification of soil, leading to leaching of soluble nutrients, death of useful microorganisms and death of fishes in case of aquatic systems. There was significantly negative correlation between positive and negative responses ($r=-1.000$; $p<0.05$) and chi square was also significant ($p<0.05$). This implies that positive responses equally outweighed negative responses (as also indicated by 86% >14% responses respectively). In the cases of positive responses, soil acidification ranked 1st, followed by reduction in crop yield (2nd) and that water was unsafe for human drinking (3rd). Skin irritation was among the last impacts (7th). The contributions of low water pH to negative impacts were not significantly different ($p>0.05$).

DISCUSSION

Water pH of Community Drinking Water

Result (figure 2) shows that the mean pH of ground water-borehole and well water. pH of borehole water is lower than other sources, with private borehole water having mean pH of 4.74 and public borehole water having a pH of approximately 5.1. These values are lower than the standard specified by W.H.O. This implies a higher acidity level which is not safe for human consumption but can be used for other domestic activities.This result is similar to that reported of borehole waters in Maiduguri with pH ranging from 6.1-7.9 (Kolo et al, 2009; and mean pH of 6.75 in Benin borehole waters (Akpoteva et al, 2011) all of which are within the safe limit. Well water has a mean pH of 6.06, which is higher than the borehole and also below the specified guideline of world health organization. Tap water used for drinking purposes in the United States of America has equally revealed the presence of chemical contaminants including lead and chlorinated compounds used for water treatment. (Oslon, 2003; McIntyre, 2011). These substance no doubt, by their nature would make the water acidic. In the Philipines, GreenPeace (2007) also reported the qualities of ground water, which proved to harbour some level of chemicals from industrial effluents.

Surface water mean pH was 5.54 ± 0.035. This value is lower than that of well water but higher than borehole water pH. It was also below the stipulated standard. pH of River water ranging from 6.5 to 7.10 had also been reported in Sombreiro river (Iyama et al, 2014). Surface water pH of 6-8 is tolerated by fishes. Water pH also has a significant influence on the toxic action of a number of other substances (e.g. ammonia, hydrogen sulphide, cyanides, and heavy metals) on fish. Acid rain (pH<5.6) for example, tend to mobilize and leach metals such as aluminum into ground water and to streams resulting in higher concentration of metals in stream combine with low pH (Likens, 2010).

Rain water's pH was 6.40 ± 0.42. This is lower than pH ranges of 5.0 to 5.4 reported by Ezenwanji et al (2013). This value was higher than all three types of drinking water but still below the stipulated standard. Dissolution of acidic gases released into the atmosphere by industries and particularly oil and gas industry and others acidify rain water the more. Gas flaring has been attributed as a major offender and impacts negatively on rainwater quality (Dirisi, 2006; Akpo Lawan, 2010; Edem, 2011; Olowoyo, 2011; Ezenwaji et al, 2013; Ite and Ubok, 2013 Anefiok et al, 2013; Health impacts of water with low pH has been confirmed by W.H.O/UNICEF (2005), Rogers (2013), WRN (2016). Acidic water has metallic taste, corrodes materials and lead to damage to valuable products (USEPA, 2013).

CONCLUSION

This study investigated the pH level of drinking water supply in Omoku, Nigeria. From the data collected and analyzed the study reveals that the water was slightly acidic (low pH) with private borehole water having the least pH. Since low pH implies the presence of elements or contaminants, it is hereby recommended that the water be treated to some extent to bring up the pH to the specified level, considering the fact that acidity in drinking water can affect man's health. More so, surface water use should be in a sustainable and environmentally-friendly manner on order to protect aquatic lives.

ACKNOWLEDGEMENT

The authors will like to appreciate Miss Ukazu Happiness for collecting the water samples used for the study..

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