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Dry Season Analysis of the Physicochemical, Heavy Metal and Microbial Analysis of Usumang Stream in Abiriba, Ohafia L.G.A, Abia State, Nigeria

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ABSTRACT

Dry season analysis of the Usumang stream at Amogudu Abiriba in Ohafia Local Government Area, Abia State, Nigeria was investigated at six stations which were Isi Usumang Amogudu I, Usumang 2, Isiafara Orunta Usumang Amogudu I, Isiafara Orunta Usumang Amogudu 2, Usumang Amamba, and Akapo. The stream was homogenous in terms of concentrations of parameters with mean values of temperature (27.9), pH (6.9), total hardness (25mgL^{-1}), Turbidity (6.3), Electrical conducting (96us/ca) TDS (60.7 mgl^{-1}), TSS (4.6 mgl^{-1}), Zinc (0.1 mgL^{-1}), total Alkalinity (16.6 mgL^{-1}), Iron (0.1 mg^{-1}) DO (20 mgl^{-1}), COD (10.8 mgl^{-1}), BOD (23.0 mgl^{-1}), sulphate (0.4 mgL^{-1}), Arsenic (0.0 mgl^{-1}). The results of the physical and chemical parameters analyzed were found to be within the permissible limits of the WHO, EPA and Nigerian standard for drinking water. The results of microbial analysis however, showed that none of the samples complied with bacteriological standards as total heterotrophic count exceeded 1.0x10^{6}. Total coliform count for some of the samples were within the range of WHO and EPA maximum contamination level for coliform bacterial in drinking water except Isiafara Orunta Usumang Amogudu I and Akapo which had (4x10^{6} and 2 x 10^{6}) respectively. Total fungal count (TFC) was very high in Isiafara Orunta Usumang Amogudu I and Isi Usumang Amogudu I. Bacterial and fungal isolates isolate types were identified as Staphylococcus spp, Pseudomonas spp, Adiromobacterspp, Bacillus spp, Shigellaspp, Klebsiellaspp, Escherichia coli, Escherichia Coli, Actinomycesspp, Streptococcus spp, Enterobacterspp. In general the water from the stream will need to be boiled or treated before drinking especially during the dry season.

Keywords: Physco-chemical, Bacteriological, and water analysis, pollution, purification

INTRODUCTION

The Usumang stream in Abirba, Ohafia Local Government Area of Abia State, Nigeria is important because of the increasing population of the community due to the sitting of the Abia State School of Midwifery, the Abriba General hospital and the State Library as well as a number of Government and privately owned secondary and primary school. Source of water for drinking and other applications is therefore a very important challenge and hence the need to assess the potabilty of available water sources.

Water is the most abundant compound on earth's surface, covering 70 percent of the planet existing in liquid, solids and gaseous states in nature. It is in dynamic equilibrium between the liquid and gas states at standard temperature and pressure (Clark, 2012). At room temperature, it is a tasteless and odorless liquid, nearly colorless with a hint of blue. Many substances dissolve in water and it is commonly referred to as the universal solvent which makes water in nature and in use rarely pure and its properties may vary from those of the

pure substance (Ainger, 2002). Water is the only common substance found naturally in all three common states of matter and it is essential for all life on earth, Water makes up 55% to 78% of the human body (Brawn, 2006, Neil, 2009).Substances that dissolve in water are called hydrophilic substances and those that do not dissolve easily are called hydrophobic materials based on their polarity as water is a polar substance. Debenedetti, 2003, Non polar molecules stay together in water because it is energetically more favorable for the water molecules to hydrogen bond to each other than to engage in Vander Waals interactions with non-polar molecules Smith, 2004).

Action of water on rock over long periods of time typically leads to weathering and water erosion physical processes that convert solid rocks and minerals into soil and sediment, but under some conditions chemical reactions with water occur as well, resulting in metasomatism or mineral hydration, a type of chemical alteration of a rock which produces clay minerals in nature and also occurs when Portland cement hardens (Castree, 2008).

Historically, the first decomposition of water into hydrogen and oxygen by electrolysis was done in 1800 by English Chemist, William Nicholson. In 1805, Joseph Louis Gay-Lusaac and Alexander Von Humboldt showed that water is composed of two parts hydrogen and one part oxygen. Gilbert Newton Lewis isolated the first sample of pure heavy water in 1933 and the properties of water have historically been used to define various temperature scales, notably, the Kelvin, Celsius, Rankine and Fahrenheit scales were or currently are defined by the freezing and boiling points of water, while the triple point of water is a more commonly used standard point today (Sacco 2000

The accepted IUPAC name of water is oxidant or simply water, or its equivalent in different languages although there is other systematic name of water is hydrogen oxide (Cardler 2001). The general properties of water are shown in Table 1.

Table 1. Properties of Water

Molecular Formula	*H_20*
Molar mass	18.01528 (33) g/mol
Appearance	White solid or almost colorless, transparent, with a slight hint of blue, crystalline solid or liquid
Odor	Odorless
Density	999.9720 kg/m^3
Melting Point	0.00^{0}C (32.00^{0}F; 273.15k)
Boiling Point	100^{0}C (212 ^{0}F; 373K)
Solubility	Soluble In Haloalkanes C_8H_6 Higher Alkanes Ethers, CFC, Phenyls, Cycloalkanes, alcohols, carboxylates
Acidity (pKa)	15.74
Basicity (pK_b)	15.74
Thermal Conductivity	0.58w/m.k
Viscosity	1cp (20^{0}C0
Crystal Structure	Hexagonal
Molecular Shape	Bent

Water for domestic and industrial applications are sourced from surface water which can easily be polluted by human activities (Young, 2001), River flood water, ground water (Marios, 2002) and seas and ocean water, (Castree, 2006).

MATERIALS AND METHODS

Samples Collection

Water sample were collected in 1 litre plastic container from 6 station of Usumang stream and where taken for analysis for determination of certain parameters.

A Sample Presentation and Storage

Due to the nature of the parameters to be analyzed, the samples were kept in a cool and dry container so as to maintain the temperature and other conditions necessary to keep the physical and chemical properties intact. It is necessary to avoid keeping the samples for too long in order to overcome some problems associated with sample over storage. E.g. when samples are stored for long, there are chances of precipitation of some metal while some undergo oxidation reduction to form insoluble compounds like Fe^{2+} changing to Iron (II) hydroxide Fe $(OH)_3$.

Laboratory Analysis of Water Samples

The analysis of samples was carried at Golden year's limited laboratory. Twenty five parameters were analyzed, these includes:

$_p$H, temperature ^{0}C, electric conductivity, µs/cm, total dissolved solids, mg/L, total suspended solids, mg/l, Turbidity NTU, dissolved oxygen mg/L, odor, alkalinity, bicarbonate mg/L carbonate mg/l, hardness, $CaC0_3$ mg/L, biological oxygen demand, chemical oxygen demand with metals.

Procedure for Analysis

The pH measurements were carried out by means of a Win Lab pH meter according to ALPHA 4500 H^+ which was calibrated in the laboratory. Calibration was checked by measuring standard buffer solutions.

Alkalinity was determined by the titrimetric method ALPHA 23220-B (API-RP45). Total hardness was determined by ALPHA 2340-C method with EDTA

The concentrations the metals in mg/l of all the metals analyzed in the collected samples were determined using the ALPHA 3030-E (after nitric acid digestion) by means of an Atomic Absorption Spectrophotometer (Biotech Engineering Ltd. AA-8390). Specific metal standards in the linear range of the metal were used to calibrate the equipment. The metals were analyzed by direct air-acetylene flame method (APHA 3111-B). The concentrated and digested samples were then aspirated and the actual concentrations were obtained by referring to the calibration graph and necessary calculations.

Turbidity was measured using the Nephelometric Method (APHA - 214A) Turbidimetre. Total dissolved solids (TDS) was measured according to ALPHA=209C method using a Hach TDS metre and compensations were made for metals ions such as iron which precipitate as hydroxide prior to pH 4.3 and are measured as acid.

Conductivity was measured with a HACH/CAMLAB conductivity meter according to ALPHA-145 and ALPHA-209C.

Dissolved Oxygen (DO) determinations made in laboratory further away from source are usually not correct. The best results are obtained when dissolved oxygen is determined on location. Out of various methods, a modified method (APHA-422Bwas used for the determination.

The Total suspended solids (TDS) were measured by a gravimetric method according to ALPHA-209D. A well-mixed sample is filtered through a weighed standard glass fiber filter and the residual retained on the filter is dried to a constant weight at 103 to 105°C, the increase in weight of the filter represents the total suspended solids.

Precautions were taken to avoid prolonged filtration times resulting from filter clogging map which produce high results owing to increased colloidal materials captured on the clogged filter. For samples high in dissolved solids, thoroughly wash the filter to ensure removal of dissolved material.

Biochemical Oxygen Demand (B) was measured by a 5 day method (APHA-508)

The method consists of filling with sample to overflowing an airtight bottle of the specified size and incubating it at the specified temperature for 5 days. Dissolved oxygen is measured initially and after incubation and the BOD is computed from the difference between initial and final DO.

Samples for BOD analysis may degrade significantly during storage between collection and analysis, resulting in low BOD values. Minimize reduction of BOD by analyzing samples promptly or by cooling it to near freezing temperature during storage. However, even at low temperature, keep holding time to a minimum. Warm up chilled samples to 20^0C before analysis.

Chemical Oxygen Demand (COD) was measured by Dichromate Method (Reflux) (APHA-422B).Here a sample was refluxed in strongly acid solution with a known excess of Potassium dichromate ($K_2Cr_2O_7$). After digestion, the remaining unreduced ($K_2Cr_2O_7$) is titrated with Ferrous Ammonium Sulphate to determine the amount of $K_2Cr_2O_7$ consumed and the oxidizable organic matter is calculated in terms of oxygen equivalent. Volatile straight-chain aliphatic compounds are not oxidized to any appreciable extent. This is partly due to the presence of volatile organic in the vapor space which does not come in contact with the oxidizing liquid. When silver sulphate Ag_2SO_4)

ALPHA-427C, AP1 – RP 45 and the Ascorbic Acid Method'(ASTM-D515, APHA-425 C, AP1-RP45) were used for the measurement of Sulphate, Carbonate/bicarbonate and total phosphate respectively while an electro titrimetric method was used in the determination of pH with a pH meter.

Microbiological Analysis

The microbiological analysis of Usumang stream from the six stations was analyzed using standard methods**.** Total heterotrophic bacterial counts, total coliform count and total fungal count were determined using the method of Cappuccino and Sherman (1996). Total heterotrophic counts were detected by serial dilution method on nutrient agar while total coliforms were done using MacConkey agar. Total fungal counts were carried out using Sabauraud Dextrose agar (SDA). All the agar used were weighed and autoclaved according to the manufacturers specifications. The water samples were incubated at 37^0C and 44.5^0C respectively for 48hrs for these counts. They were also identified using Gram stain reaction,

and biochemical tests such as catalase, oxidase and sugar fermentation tests according to the method of Okereke and Kanu (2006).

RESULT AND DISCUSSION

Results

Results of the various physicochemical parameters of Usumang Stream at the six stations at Amagoudu Abiriba in Ohafia Government Area, Nigeria is shown in Table 2.

Table 2. Results of the physicochemical Analysis of Usumang Stream

Parameters	*Isi Usumang Amogudu 1*	*Usumang 2*	*Isiafara Orunta Usumang Amogudu 1*	*Isiafara Orunta Usumang Amogudu 2*	*Usumang Amamba*	*Akapo*	*Mean*
pH	7.14	7.08	6.98	6.81	6.70	6.79	6.9
Temp, ^{0}C	27.7	27.6	28.2	28.1	28.0	27.9	27.9
Electrical conductivity µs/cm	19.13	22.8	49.00	97.00	182.0	206.0	96
Total dissolved solids	10.14	12.12	32.00	59.00,	118.0	133.0	60.7
Total suspended Solids, mg/L	< 1.00	< 1.00	6.35	9.53	7.27	2.23	4.6
Turbidity, NTU	<0.01	<0.01	9.52	14.3	10.9	3.35	6.3
Acidity mg/L	3.02	3.14	6.00	6.09	7.06	6.07	5.2
Bicarbonate, mg/L	4.14	5.11	28.17	28.03	26.18	26.84	20
Alkalinity, mg/L	4.56	5.27	23.09	22.98	21.46	22.00	16.6
Carbonate, mg/L	<0.01	<0.01, mg/L	18.00	16.0	15.98	16.02	11.0
Hardness, $CaCo_3$, mg/L	2.00	2.20	16.00	36.00	28.00	68.00	25.3
Dissolved oxygen, mg/L	5.52	5.63	12.67	9.57	10.16	10.09	10
Biological oxygen demand, mg/L	0.05	0.05	6.99	2.99	4.44	3.38	3.00
Chemical oxygen demand, mg/L	0.10	0.10	19.87	12.87	16.76	15.00	10.8

The results of the metallic analysis of Usumang stream from the six locations in Abriba, Ohafia LGA, Abia State, Nigeria is shown in Table 3

Table 3. Results of Metallic Analysis of Usumang Six Water Samples at Amogudu Abiriba in Ohafia LGA, Abia State, Nigeria

Parameters	*Isi Usumang Amogudu 1*	*Usumang 2*	*Isiafara Orunta Usumang Amagudu 1*	*Isiafara Orunta Usumang Amogudu 2*	*Usumang Amamba*	*Akapo*	*Mean*
Phosphate, mg/L	-	-	0.013	0.030	0.016	0.072	0.0
Sulphate, mg/L	0.78	0.98	0.098	0.115	0.101	0.103	0.4
Iron, mg/L	BDL	BDL	0.089	0.081	0.061	0.041	0.1
Cadmium, mg/L	-	-	0.011	<0.001	<0.001	<0.001	0.0
Zinc, mg/L	-	BDL	0.101	0.111	0.114	0.122	0.1
Lead, mg/L	BDL	BDL	0.002	<0.001	<0.001	<0.001	0.0
Nicked, mg/L	BDL	BDL	<0.001	<0.001	<0.001	<0.001	0.0
Mercury, mg/L	BDL	BDL	<0.001	<0.001	<0.001	<0.001	0.0
platinum, mg/L	BDL	BDL	<0.001	<0.001	<0.001	<0.001	0.0
Palladium, mg/L	BDL	BDL	<0.001	0.001	<0.001	<0.001	0.0
Arsenic, mg/L	BDL	BDL	<0.001	<0.001	<0.001	<0.001	0.0

Note: BDL: Below Detection Limit (<0.001mg/L)

Results of the microbiological analysis of o Usumang stream is described in Table 4.

Table 4. Results of the Microbiological Analysis of Usumang Stream in Amogudu Abriba, Ohafia LGA, Abia State, Nigeria

Source	*NA Total Heterotrophic Count*	*Total Faecal Coliform Count on Maccouley Agar (MAC Coliforms)*	*Total Fungi Count*
Isi Usumang Amogoudu I	$6.5x10^6$cfu/ml	-	$2x10^5$cfu/ml
Usumang 2	$9.2x10^6$cfu/ml	-	$1x10^5$cfu/ml
Isiafara Orunta Usuusumang Amogudu 1	$18x10^6$	$4x10^6$	2×10^2
Isiafara Orunta Usumang Amogudu 2	2.5×10^6	0	0
Usumang	12×10^6	0	0
Akapo	$30x10^6$	$2x10^6$	$1x10^2$

Table 5. Bacteria Isolated From UsumangSream at the Various Sampling Points

Isi Usumang 1	Adiromobacter Spp, Escherichia Coli, Actinomyces Spp, Bacillus Spp, Staphylococeus Spp, pseudomonas Spp
Usumang 2	Escherichia Coli, Staphylococcus Spp, Psuedomonas
Isiafara Orunta Usumang Amogudu 1	Streptococcus Spp, Enterobacter Spp; Bacillus Spp.
Isiafara Orunta Usumang Amogudu 2	Bacillus Spp, Shigella Spp, Klebsiella Spp
Usumang Amamba	Pseudomonas Spp, Staphylococcus spp
Akapo	Shigella Spp, Enterobacter Spp, Pseudomonas Spp

Table 6. Fungal Organisms Isolated from Usumang Stream at the Various Sampling

Isi Usumang Amaogudu 1	CadidaSpp, MucorSpp, Aspergillus Spp, PenicllinSpp
Usumang 2	Candida Spp, mucorSpp, fusariumspp
Isiafara Orunta Usumang Amogudu 1	Candida spp, phycomycesspp
Isiafara Orunta Usumang Amogudu 2	Aspergillus spp, penicilliumspp
Usumang Amamba	Phycomycesspp, cadidaspp
Akapo	Penicilliumspp

The result of physical, chemical and microbial parameters of Usumang stream showed that the concentrations of the various parameters were evenly distributed round the stream. In this part of world, this physical water quality parameter is the most looked out for by water user in describing and certifying a water sample with good drinking quality. The results for appearance shows that all the water samples are colorless hence making it good with W.H.O standard.

DISCUSSIONS

$_{p}$h

The pH lower than 4 will produce sour taste and higher above 8.5 bitter taste. Dissolved gases such as carbon (iv) oxide hydrogen sulphide and ammonia also affect the $_{p}$H of water.

The samples analyzed have a $_{p}$H range of 6.7 – 7.14 thus all the water samples measured $_{p}$H valves within the W.H.O and EPA (2011) limit of 6.5 – 9.2. The $_{p}$H of the sample therefore is suitable for drinking within W.H.O and EPA limits.

Temperature

In the stream water, the temperature were found to be 27.9 and this value was within the limit of WHO and this value was fell within the acceptable limit of value. Temperature is very important because of its influence on water chemistry Barnes (2007).

Electrical Conductivity

The conductivity of the stream was 96 us/cm and is not within the W.H.O allowable limit which is N/A. The conductivity of the stream was found to be high. The value of the conductivity correlates with its hardness. The more the hardness the higher the conductivity (Hong, 2000).

Total Dissolved Solid (Tds)

In the stream water were found to be < 1.00 – 9.53 and this value was within the FEPA standards for water used in baking, brewing, carbonate beverage, dairy, sugar manufacturing dissolved solid include dissolved salts in natural waters are increased by many of man's activities, irrigation of land discharge of oil field and other brines, diversion of streams, the low level of TDS in Usumang stream may be because activities capable of increasing TDS are absent in and around the stream Mason, (2006).

Turbidity

There is a correlation between the turbidity of a water body and its alkalinity. The work Mann, (2007) shows that when high amounts of light passes through water from top to bottom, the resultant photosynthetic rate causes low alkalinity. This explains the reason for low alkalinity of the shallow Usumang stream water. The presence of topminnows (Little fishes) at the water source proves that the water can support the growth and existence of fish.

Total Hardness

Table 7. Description of Total Hardness

ppm $CaC0_3$	*Degree of Hardness*
0-50	Very soft
51-100	Soft
101-200	Medium hard
201-300	Fairly hard
301-450	Hard
Over 451	Very Hard

Note: above common terms are generally used to describe hardness.

The total hardness mean value of the stream locations was $25mg^{1-1}$ and it was within the allowable W.H.O Range. This shows that the water is a soft water body ideal for laundry since soap will latter well. Hardness in itself a does not play a role in controlling specification of metals in water, but it does influence metal toxicity through antagonistic mechanisms, (Marque, 2003).

Dissolved Oxygen (Do)

Oxygen is measured in its dissolved form as dissolved oxygen (DO) if more oxygen is consumed than is produced, dissolved oxygen levels decline and some sensitive animals may move away, weaken or die. The result for DO for all the samples was 10.mg/L ranges from

5.52mg/L – 12.67 mg/L against the W.H.O limits valve of 70 mg/L hence making it satisfactory. Oxygen levels that remain below 1.2mg/L for few hours can result in large fish kills, (Herden*et al,* 2006).

Sulphate

Sulphate in water containing calcium forms, hard scale in steam boilers. In large amount, sulphate in combination with other constituents gives a bitter taste to water and also act as purgative in humans. The level of sulphate were generally low, ranging from 0-1-0.78$^{mg/L}$. according to W.H.O concentration above 250mg/L may have laxative effect (Andrea, 2006).

Metallic Analysis

The iron concentrations was 0.1 and was not within the tolerable limits for water used in carbonate beverage, brewing confectionary and during products and it was not also within the acceptable limits for W.H.O. which is 1.00 significant levels in domestic water supply systems stain laundry and porcelain. The presence of a tolerable level of iron in the stream may be as a result of soil distributing activity that can often stir up iron deposits and in turn the deposits found their way to the water body (Boehler 2007).

Zinc

The concentration of zinc fell within the acceptable limits of W.H.O for drinking water. The Usumang stream is a soft water body and this fact is supported by the low level of zinc in the water body, (Prasad, 2003).

The other metals especially the heavy metals were below detection levels and so insignificant and pose no danger by the use of the stream

Microbial Analysis

Heterotrophic count measures a range of bacteria that are naturally present in environment, the total hetetrophic count for all the water samples were generally high exceeding the limit of 1.0x10^{6}cfu/ml which is the standard limit of heterotrophic count is indicative of the presence of high organic and dissolved salts in the water and the primary source of these bacterial in water and animal and human waste (cappuccino 1996).

Accordingly, the total coliform count for all the water samples were zero (0) and these fell within the range of environmental protection agency maximum contamination level for coliform bacteria in drinking water except Isiafara Orunta Usuman Amogudu I and Akapo (3x10^6, 2 x10^6) respectively. The high coliform count obtained in the samples may be an indication that the water sources are faecally contaminated (Okereke, 2006).

Total fungal count was 0 in Isiafara Orunta Usumang Amogudu 2 and Usumang Amamba. Isiafara Orunta Usuman Amogudu 1 has the highest total fungal count of 2x10^2 cfulml, Akapo has 1x10^{2}cfu/ml which is the standard limit of total fungal count for drinking water (Kanu, 2006).

CONCLUSION

Environmental consciousness should be advocated in the community to help them see the need to appreciate, conserve and preserve the natural environment which include their stream. The stream should be treated if for use for portable uses.

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