IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 13, Issue 10 Ser. I (October. 2020), PP 04-13
www.iosrjournals.org

Water Quality Assesement Using the Wagtech Palintest Kit a Case Study of Some Selected Communities in Darazo Local Government Area, Bauchi State, Nigeria

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Abstract
This study examined, the quality of water using the wagtech palintest kit, in some selected communities of Darazo Local government area of Bauchi state, Nigeria. Water samples (groundwater) were collected from eight (8) randomly selected locations (communities) across four different wards. Wagtech Palintest Photometer, Atomic Absorption Spectrophotometer, pH meter, Conductivity meter, Turbidimeter, Wagtech Incubators were used to analyze the samples. The results revealed that the mean concentration (mg/L) of the physicochemical parameters were within the Nigerian standard for drinking water quality maximum permissible limits (NSDWQ MPL) except for two locations (Angwan Gabarr and Masallachi Irii). A fair share of household and source water samples tested positive for Escherichia coli, indicating faecal contamination. The water in the selected communities were found to have high levels of Nitrate, which is a disturbing fact. The heavy metal contents are within the maximum permissible limits of the Nigerian standard for drinking water quality. This study shows that from the results of the water quality index analysis, the water quality ranges from poor to very poor.

Keywords: *Wagtech Palintest Kit, Physicochemical parameters, Eschericia coli*

Date of Submission: 20-09-2020 Date of Acceptance: 04-10-2020

I. Introduction

Water is in continuous movement on, above, and below the surface of the earth. As water is recycled through the earth, it picks up many things along its path. Water quality will vary from place to place, with the seasons, and with the various kinds of rock and soil it moves through.For the most part, it is largely natural processes that affect water quality (WHO, 2008). For instance, water moving through underground rocks and soils may pick up natural contaminants, even with no human activity or pollution in the area. In addition to nature's influence, water is also polluted by human activities, such as open defecation, dumping garbage, poor agricultural practices, and chemical spills at industrial sites(Chindo, 2013).

Even though water may be clear, it does not necessarily mean that it is safe for us to drink. It is important for us to judge the safety of water by taking the following three qualities into consideration. Microbiological, Chemical andPhysical parameters(Olowe, 2016).

Safe drinking water should be low in concentrations of toxic chemicals, Clear, Tasteless and colourless (for aesthetic purposes). When considering drinking water quality, microbiological contamination is the main concern in most cases since it is responsible for the majority of illnesses and deaths related to drinking unsafe water

The water quality assessment is the overall process of evaluation of the water quality parameters; physical, chemical and microbial properties of water, usually with respect to its suitability for a particular purpose such as drinking, laundry, cooking etc. Water quality determines the ‘goodness’ of water for particular purposes(Samuel, 2019).

Water quality tests will give information about the health of the waterway. By testing water over a period of time, the changes in the quality of the water can be seen. The use of safe drinking water is an essential prerequisite for good health of society and for maintaining the natural and healthy aquatic ecosystem. The water resources are being severely polluted by sewage, industrial waste and discharge from human activities and it affects the physicochemical and bacteriological quality of water (Molina, 2015).

Rural areas face challenges related to demographic changes, workforce development, capital access, infrastructure, health, land use and environment, and community preservation with the most persistent and disturbing being little or no access to quality and safe water.

Rural population (% of total population) in Nigeria was reported at 51.4 % in 2016, according to the World Bank collection of development indicators, compiled from officially recognized sources. This percentage represents 95,604,260 of the over 150,000,000 population size. Of this, only 11.46% of this large population have access to improved water source. 56.44% of this population have people practice open defecation, a large contributing factor leading to microbial contamination of ground water.

According to Nwandikor and Okolo (2016), unsafe water consumption by rural areas inhabitants, brings about high infant and child mortality, and for those who survive into adulthood: poor health, loss of productivity and shortened life are amongst the problems likely to arise. For such people, infection may be more, and may become life threatening. Infants, the very elderly and those whose health is fragile due to chronic diseases are also more vulnerable to more serious complications(Talabi, 2014).

Water related diseases continue to be one of the major health problems globally due to consumption of contaminated water. The high prevalence of diarrhea among children and infants can be traced to the consumption of unsafe water. The most dangerous form of water pollution occurs when faecal contaminant like Escherichia coli enters the water supply (EPA, 2001). Also, the sanitation which include faecal-oral routes of transmission, in which pathogens are shed in human or animal faces.

Heavy metals demands serious attention in water quality, in that, when water gets contaminated by pollutants containing these metals, it is not removed by any natural means(Uduma, 2014).

II. Materials and Methods

2.1The Study Area

The case study/ study area is some selected communities in Darazo local government area of Bauchi state. The LGA comprises several towns and villages which include Darazo, Konkiyal, Papa, Lanzai, Gabarin, Lago, Yautare, Tauya, Wahu, Gabchiyari and Sade. The population of Darazo LGA is put at 249,946 inhabitants according to the 2006 census (National Population Commission of Nigeria), with the majority of the area's inhabitants being members of the Hausa ethnic group. Darazo LGA sits on a total area of 3,015 square kilometers and witnesses two major seasons each year which are the dry and the rainy seasons. The average temperature of Darazo LGA is 32^0Cwhile the total annual precipitation level of the area is 1190 mm of rainfall (Wikipedia, 2010). Farming is the main economic activity in Darazo LGA with a number of crops grown in the area. The research work was conducted in eight different communities across four wards in the LGA.

2.2 Sampling Sites

Samples were collected for quality monitoring and assessment. At each sample site, latitude and longitude were determined with a GPS coordinate tool. The selected sampling wards and communities are as follows;
Darazo ward: Angwan Gabarr, Masallachi Irii. **Lago ward:** Tasha Primary, Angwan Wakili
Konkiyal ward: Angwan Pada, Angwan Yandure. **Gabarin ward**: Angwan Kapi, Angwan Ba'ayi

2.3 Sample Collection

Water samples from the selected sites were collected in November 2019 in 1.00 dm^3 pre-cleaned, sterilized and capped polyethylene bottles. The samples after collection were immediately placed in dark polythene leathers and processed within six (6) hours of collection to minimize photochemical activity upon action of incident rays of sunlight and possible contamination.

2.4 Physio-chemical Analysis: Drinking water has to meet acceptable standards if it is to be considered safe.The samples were analyzed for major physical and chemical water quality parameters like temperature, pH**,** electrical conductivity (EC), turbidity and nitrate as per the Assessment of Ground Water Quality method described in "Standard methods for the examination of water and wastewater of American Public Health Association (APHA, 1992). The heavy metal content of these water samples were also determined. These include Nickel, Copper, Lead, Chromium and Arsenic. The parameters present in the water sample were calculated by using different statistical methods upon carrying out replicate determinations. The water samples temperatures, pH, electrical conductivity and Turbidity, colour and nitrate were all determined in the laboratory using the wagtech palintest kit. The heavy metals were determined by the standard methods of water and waste water (Nagarajan *et al.,* 1993) using the AA320N Atomic Absorption Spectrophotometer.

2.5 Microbiological Analysis

All the samples for microbiological analysis were collected in sterile containers from the selected sites. At a particular site, water samples were collected from two different points for source and household water quality assessment. The standard collection procedure of Cruickshank (2015) was adopted. Membrane filter technique method was employed for all microbiological analysis. A 100 ml volume of the water sample was filtered through a membrane with pore size (0.45 mm) small enough to retain the indicator bacteria to be counted. The membrane was incubated on the selective differential to allow the bacteria to grow. Colonies were recognized by their colour, morphology and number.

III. Results

The data revealed variations in the different water sources, with respect to the physical, chemical and microbial characteristics. Water quality varies from location to location, albeit, the same water facility. The Location of the eight(8) water sampling sites are presented in Table 1

Table 1: Location of water sampling sites

S/N	SAMPLE SITE	FACILITY TYPE	LOCATION	TIME OF COLLECTION (Hours) Source	Household
1	Angwan Gabarr	Motorized borehole	Lat: 11.00349 Lng: 10.41976	1557	1603
2	Masallachi Irii	Motorized borehole	Lat: 11.00403 Lng: 10.42006	1612	1618
3	Tasha Primary	Hand pump borehole	Lat: 11.18211 Lng: 10.48960	1630	1635
4	Angwan Wakili	Motorized borehole	Lat: 11.18269 Lng: 10.48525	1649	1652
5	Angwan Pada	Hand dug well	Lat: 11.14790 Lng: 10.45850	1707	1710
6	Angwan Yandure	Hand dug well	Lat: 11.14580 Lng: 10.45590	1715	1718
7	Angwan Kapi	Solar borehole	Lat: 11.11213 Lng: 10.43823	1730	1735
8	Angwan Ba'ayi	Motorized borehole	Lat: 11.11013 Lng: 10.43823	1750	1755

*Lat- Latitude
*Lng- Longitude

Table 2: Physical water quality analysis

S/N	Community	Parameters pH	Colour (TCU)	Conductivity (µS/cm)	Turbidity (NTU)
1	Angwan Gabarr	5.63±0.06	0.00±0.00	133.60±0.10	0.10±0.00
2	Masallachi Irii	5.97±0.06	0.00±0.00	110.40±0.01	0.03±0.00
3	Tasha Primary	6.20±0.00	10.00±0.00	130.30±0.01	2.07±0.06
4	Angwan Waklili	6.97±0.06	0.00±0.00	210.00±0.10	0.33±0.06
5	Angwan pada	6.78±0.03	10.00±0.00	470.00±0.10	1.37±0.07
6	Angwan Yandure	6.20±0.00	10.00±0.00	380.00±0.00	2.01±0.01
7	Angwan Kapi	7.40±0.00	5.00±0.00	320.00±0.00	2.30±0.16
8	Angwan Ba'ayi	8.25±0.00	0.00±0.00	550.00±0.00	0.20±0.00

Values are mean± standard deviation (n=3)
*NTU: Nephelometric turbidity unit
*TCU: True colour units
*µS/ cm: microSiemens per centimeter

Table 3: Microbiological water quality analysis

S/N	Location	Parameters (cfu/100 ml) E.coli(Quality control)	E.coli (Source)	Status/Remark	E.coli (Household)	Status/ Remark
1	Angwan Gabarr	0.00±0.00	0.00±0.00	- / SAFE	6.00±0.00	+/UNSAFE
2	Masallachi Irii	0.00±0.00	5.00±0.00	+/UNSAFE	30.00±0.10	+/UNSAFE
3	Tasha Primary	0.00±0.00	0.00±0.00	-/SAFE	12.00±0.00	+/UNSAFE
4	Angwan Waklili	0.00±0.00	0.00±0.00	-/SAFE	62.00±0.00	+/UNSAFE
5	Angwan pada	0.00±0.00	106±0.10	+/UNSAFE	80.00±0.00	+/UNSAFE
6	Angwan Yandure	0.00±0.00	26±0.00	+/UNSAFE	112.00±0.00	+/UNSAFE
7	Angwan Kapi	0.00±0.00	0.00±0.00	-/SAFE	TNTC	+/UNSAFE
8	Angwan Ba'ayi	0.00±0.00	22.00±0.00	+/UNSAFE	82.00±0.00	+/UNSAFE

Values are mean± standard deviation (n=3)
(+)-E.coli present **(-)-E.coli absent**
***TNTC- Too numerous to count**

Table 4: Chemical water quality analysis

S/N	Location	Parameters (mg/dm^3)					
		Arsenic	**Chromium**	**Copper**	**Lead**	**Nickel**	**Nitrate**
1	Angwan Gabarr	0.113±0.004	0.027±0.003	0.061±0.006	0.025±0.002	0.106±0.005	79.00±0.000
2	Masallachi Irii	0.003±0.000	0.094±0.007	0.033±0.01	0.013±0.002	0.033±0.000	62.00±0.000
3	Tasha Primary	0.014±0.000	0.090±0.002	0.068±0.001	0.126±0.009	0.129±0.008	60.00±0.000
4	Angwan Waklili	0.015±0.003	0.003±0.000	0.104±0.000	0.073±0.003	0.019±0.001	45.20±0.000
5	Angwan pada	0.031±0.000	0.052±0.007	0.121±0.007	0.012±0.001	0.082±0.004	156.00±0.000
6	Angwan Yandure	0.013±0.000	0.210±0.010	0.097±0.007	0.184±0.000	0.486±.0001	25.60±0.000
7	Angwan Kapi	0.084±0.005	0.082±0.003	0.087±0.012	0.047±0.004	0.075±0.004	54.00±0.000
8	Angwan Ba'ayi	0.022±0.000	0.111±0.003	0.035±0.001	0.027±0.004	0.060±0.001	63.00±0.000

Values are mean± standard deviation (n=3)

From these results, one cannot infer whether or not the water from different sources are safe for consumption and domestic uses. Consequently, it is compared against a standard. For the purpose of this research work, the Nigerian standard for drinking water (NSDWQ) was employed. Locations whose water quality parameter exceeds the NSDWQ maximum permissible limits are considered a threat to healthy living and sound livelihood in general.

Table 5: Result against NSDWQ standards

S/N	Parameter	Location								NSDWQ MPL
		Angwan Gabarr	**Masallachi Irii**	**Tasha Primary**	**Angwan Waklili**	**Angwan pada**	**Angwan Yandure**	**Angwan Kapi**	**Angwan Ba'ayi**	
1	**pH**	5.63±0.06	5.97±0.06	6.20±0.00	6.97±0.06	6.78±0.03	6.20±0.00	7.40±0.00	8.25±0.00	**6.5-8.5**
2	**Colour**	0.00±0.00	0.00±0.00	10.00±0.00	0.00±0.00	10.00±0.00	10.00±0.00	5.00±0.00	0.00±0.00	**15.00**
3	**Conductivity**	133.60±0.10	110.40±0.01	130.30±0.01	210.00±0.10	470.00±0.10	380.00±0.00	320.00±0.00	550.00±0.00	**1000**
4	**Turbidity**	0.10±0.00	0.03±0.00	2.07±0.06	0.33±0.06	1.37±0.07	2.01±0.01	2.30±0.16	0.20±0.00	**5.00**
5	**Nitrate**	79.00±0.000	62.00±0.000	60.00±0.000	45.20±0.000	156.00±0.000	25.60±0.000	54.00±0.000	63.00±0.000	**50.00**
6	**Arsenic**	0.113±0.004	0.003±0.000	0.014±0.000	0.015±0.003	0.031±0.000	0.013±0.000	0.084±0.005	0.022±0.000	**0.01**
7	**Copper**	0.061±0.006	0.033±0.01	0.068±0.001	0.104±0.000	0.121±0.007	0.097±0.007	0.087±0.012	0.035±0.001	**1.00**
8	**Chromium**	0.027±0.003	0.094±0.007	0.090±0.002	0.003±0.000	0.052±0.007	0.210±0.010	0.082±0.003	0.111±0.003	**0.05**
9	**Nickel**	0.106±0.005	0.033±0.000	0.129±0.008	0.019±0.001	0.082±0.004	0.486±.0001	0.075±0.004	0.060±0.001	**0.02**
10	**Lead**	0.025±0.002	0.013±0.002	0.126±0.009	0.073±0.003	0.012±0.001	0.184±0.000	0.047±0.004	0.027±0.004	**0.01**
11	**E.coli (Source)**	0.00±0.00	5.00±0.00	0.00±0.00	0.00±0.00	106±0.10	26±0.00	0.00±0.00	22.00±0.00	**0.00**
12	**E.coli (Household)**	6.00±0.00	30.00±0.10	12.00±0.00	62.00±0.00	80.00±0.00	112.00±0.00	TNTC	82.00±0.00	**0.00**

Values are mean± standard deviation

*TNTC: Too numerous to count

Chart presentation of results

It is important to compare quantitatively and qualitatively experimental data, this clearly shows and explains the differences in the water quality of different locations.

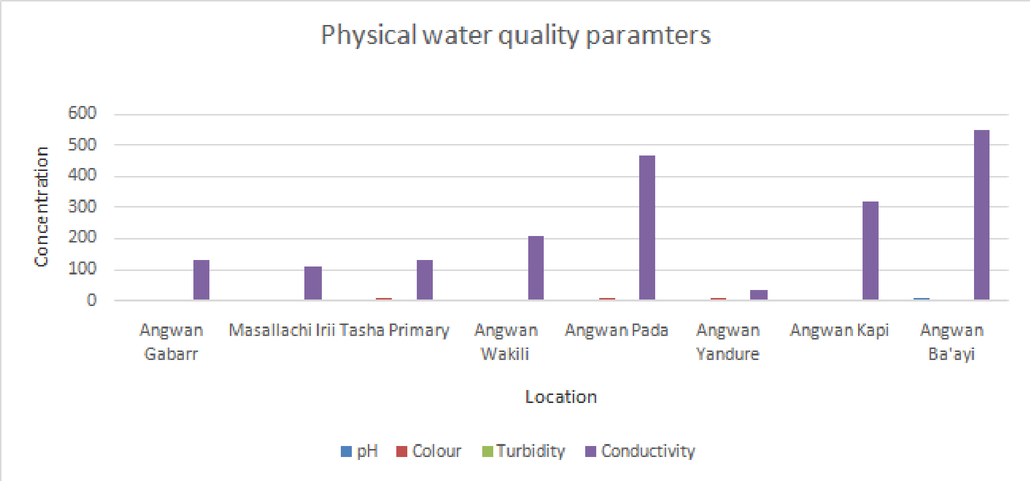

Figure 1: A chart representing the physical water quality parameters

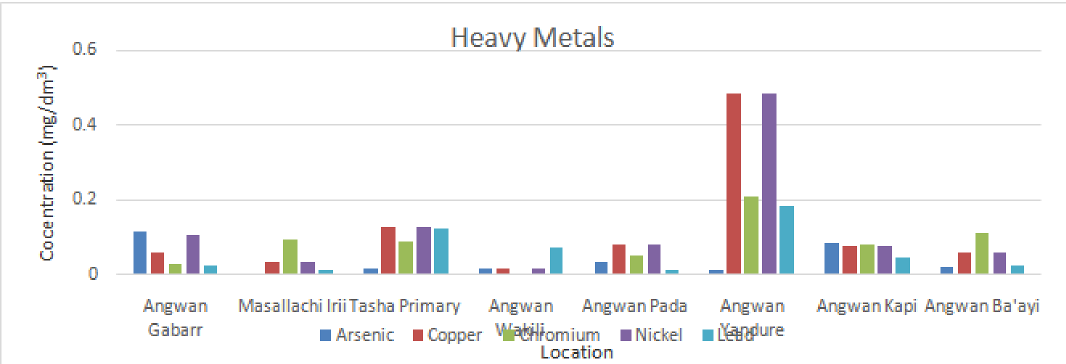

Figure 2: A chart showing the heavy metal content of various water samples

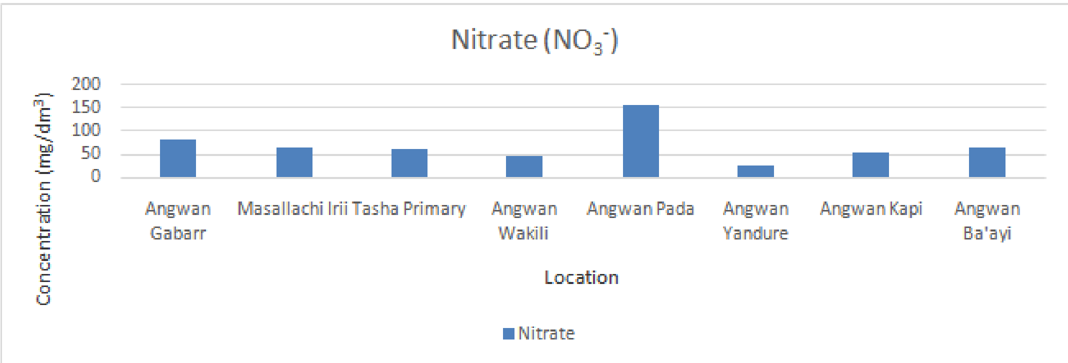

Figure 3: Chart showing nitrate concentration of various water samples

Water Quality Index (WQI) Determination

An effective monitoring tool that provides useful information of water from various sources is the water quality index which often incorporates several water quality parameters to describe the state of the water resources and its potential application for drinking purposes (Samuel *etal*, 2019). Several authors have reported variable weights assigned to a particular water quality parameter. The choice of the weight is usually due to the perceived risk that a specific parameter is likely to have. A maximum number of 5 is usually assigned to water quality parameters with the highest perceived risk in drinking water while 1 was assigned to the least perceived water quality risk parameter (Tyagi, 2013). The values reported for chloride ranges from 1–5. Chloride has a low health risk in drinking water with a World Health Organization (WHO) permissible limit of 250 mg/L (WHO, 2014). The major concern of Cl is that it affects the taste of drinking water when present in relatively high concentrations. There is, however, a consensus on pH as most authors have assigned the weight of 4 to it.

Table 6: The assigned reported weight for water quality parameters in this study

Parameters	Assigned weight				
pH	4	4	4	ND	4
Ca	2	2	2	3	2
Mg	2	2	2	3	2
Cl	3	3	1	5	4
Cr	ND	ND	ND	5	ND
Cu	ND	ND	ND	5	ND
Pb	ND	ND	ND	5	5
NO_3^-	ND	ND	ND	ND	5
Reference	Rao & Nageswarano	Shamar et al	Kawo& Karuppannan	Chourasia	Samuel et al

In this study, ten parameters were used to estimate the WQI of groundwater in the study area. Parameters that are important in water quality assessment such as Cr, Pb and other possible carcinogens were assigned 5 while those like chloride which play insignificant roles in the assessment of water quality were assigned 1 (Kao and Karuppannan, 2018).

Table 7: The relative weight of parameters

Parameter	NSDWQ MPL	Weight (w_i)	Relative weight(W_i)
pH	6.50-8.50	4	0.1053
Colour	15.00	1	0.0263
Turbidity	5.00	2	0.0526
Conductivity	1000	2	0.0526
Nitrate	50.00	4	0.1053
Nickel	0.02	5	0.1316
Copper	1.00	5	0.1316
Lead	0.01	5	0.1316
Chromium	0.05	5	0.1316
Arsenic	0.01	5	0.1316
		$\sum w_i$=38	$\sum W_i$ =1

The relative weight of the parameters was computed using the relationship in Equation (1) below:

$$W_i = \frac{w_i}{\sum w_i} \qquad (1)$$

Wi represents the relative weight of the parameter, wi is the weight of each parameter. The calculated relative weight (Wi) values of each parameter are given in the table below. For each of the parameters, a quality rating scale (qi) was determined using the relationship in Equation (2) below:

$$q_i = \frac{C_i \times 100}{S_i} \qquad (2)$$

Where qi is the quality rating and Ci the concentration (mg/L) of each chemical parameter in each water sample. Si is the NSDWQ drinking water standard for each of the parameter. The sub-index and WQI were computed using the relationship in Equations (3) and (4), respectively

$$SI_i = W_i \times q_i \qquad (3)$$

$$WQI = \sum SI_i \qquad (4)$$

Where SIi is the sub-index of the ith parameter and qi is the rating based on the concentration of the ith parameter. Table 8 below, shows the range of the water quality index specified for drinking water.

Table 8: The water quality classification based on water quality index (WQI) value

WQI Range	Water Quality
< 50	Excellent water
50-100	Good water
100-200	Poor water
200-300	Very poor water
>300	Water unsuitable for drinking purpose

From the calculations, the results for the water quality index for all locations are stated in the table below;

Table 9: The Water Quality index for selected communities in Darazo LGA

Location	Water quality Index (WQI)
Angwan Gabarr	283.83
Masallachi Irii	122.71

Tasha primary	201.02
Angwan Wakili	195.00
Angwan pada	224.57
Angwan Yandure	175.20
Angwan Kapi	122.50
Angwan Ba'ayi	180.05

Going by the results above, the overall water quality of water samples in different locations in Darazo Local government area ranges from poor to very poor.

IV. Discussion

The mean values of the physicochemical and microbiological parameters shown in the tables and charts above are further discussed. This section considers all the parameters evaluated for all locations and assesses the water quality thereof, in comparison to the NSDWQ standards.

pH

The mean pH values of the drinking water samples from different locations ranged from 5.63 to 8.25 all across the different water facility. The mean values of four different water samples (Angwan Ba'ayi, Angwan Kapi, Angwan pada, Angwan wakili) are all well placed within the standard maximum permissible limit (6.5-8.5) set by the NSDWQ and WHO. Water samples from Angwan Gabarr, Masallachi Irii; all within Darazo ward were found to be slightly acidic. The mean pH values of water samples from Angwan Yandure and Tasha primary were also found to be moderately acidic. The low mean pH values observed may be attributed to several factors such as percolating carbon dioxide that produced weak carbonic acid (Napacho and Manyele, 2010), mineral composition as well as differential weathering intensity of the various bed rocks around the study area (Talabi and Ogundana, 2014). The consumption of such acidic water could have adverse effect on health and may also read to corrosion of water pipes as the case maybe. Furthermore, acidic water causes leaching of soil nutrients. Extreme pH values affect the palatability of water. The hydrogen ion concentration (pH) govern the behaviour of several other important parameters of water quality such as ammonia toxicity, chlorine disinfection efficiency and the solubility of metal ions that may be catalyzed by H^+ ions (Chindo *etal.*, 2013) . As a remedy for this shortfall, one can increase pH by soda ash and decrease pH with white vinegar / citric acid (NSDWQ, 2015).

Electrical conductance/conductivity

The mobility of ions in solution has been found to be closely related to its total alkalinity, which in turn increases electrical conductance ability in water. The mean conductivity values of all the different water samples all fall below and within the maximum permissible level of the NSDWQ. The mean conductivity values were found to be higher at two water supply points; Angwan pada and Angwan Ba'ayi with values of 470 and 550 µS/cm respectively. The conductivity was generally low in all the water samples. This conductivity is related to the ionic content of a particular water sample, which in turn is a function of the dissolved (ionizable) solids. This property of water is related to its hardness; the more the dissolved ions such as Ca^{2+}, Mg^{2+} and SO_4^{2-} etc., that are present in water, the more the conductivity. In itself, conductivity is a property of little interest to an analyst, but it is an invaluable indicator of the range of alkalinity and hardness of water (Chindo *et al.,* 2013).

Turbidity

Turbidity is a measure of the degree of clarity and uncloudedness of water. The origin of turbidity may be clay particles, sewage solids, silt and sand washings, organic and biological sludge or some factors. Direct health effects depend on the precise composition of the turbidity causing materials, but there may be other implications (Elisha *et al.*, 2013). As turbidity can be caused by sewage matter in water, there is a risk that pathogenic organisms can be shielded by the turbidity particles, hence escape the action of the disinfectant. Turbidity in water arises from the presence of very finely divided solids which are not filterable by routine methods (Elisha *et al.,* 2013). A turbid water loses acceptance in the eyes of the consumer. The mean turbidity values of all the water samples from different location were found to be well placed within the NSDWQ maximum permissible levels (5 NTUs). Two water samples from hand dug well facility (Angwan pada and Angwan Yandure) and the only solar borehole facility type were found to be slightly turbid. The particles causing the turbidity may also interfere with the water treatment techniques and in the case of the disinfection process, the consequences could be grave (WHO, 2014).

Colour

Natural colour reflects the presence of complex organic molecules derived from vegetable (humic matter) such as peat, leaves, branches and so on. It effects are also increased by the presence of suspended matter. Natural colour might also arise from the presence of colloidal iron/manganese but organic matter is the major contributing factor (EPA, 2001). All water samples were well placed within the NSDWQ maximum permissible levels (15 TCU). High colour levels of about ten true colour units (10 TCU) were observed in water samples from the hand dug well facility (Angwan pada and Angwan Yandure) and hand pump borehole (Tasha primary). Objections to high colour contents in water are generally on aesthetic grounds rather than on the basis of a potential health hazard. The 1998 EU drinking water directive in contrast to its 1980 directive, does not set a quantitative standard for colour, effectively leaving the matter to the reaction of consumers. Treatment for colour in water and possible remedy includes filtration, ozonization, distillation, reverse osmosis etc.

Nitrate

Nitrate in soils may be from soluble nitrate compounds or from runoff inorganic fertilizers that may leach into ground water deposits (WHO, 2006). Bacterial oxidation and fixing of nitrogen by plants can also produce nitrate. Water samples from Angwan wakili, Angwan Yandure and Angwan Kapi, all fall within the NSDWQ maximum permissible levels (50 mg/L), hence show safe levels of nitrate. Water samples from Masallachi Irii, Tasha primary and Angwan Ba'ayi were slightly above the desirable limits. The only water source with extremely high concentration of nitrate is Angwan pada in konkiyal ward. This is very calamitous upon consumption especially in infants, where high level of nitrate induces the "blue baby" syndrome (Methaemoglobinaemia). This is a health hazard caused by conversion of nitrate to nitrate and subsequent reaction with blood haemoglobin (EPA, 2001). Possible treatment/ preventive measure include ion exchange and reverse osmosis.

Arsenic

Arsenic is one, amongst five toxic heavy metals classified as possible carcinogens (cancer inducing substances) as informed by the world health organization. It is very widely distributed throughout the earth's crust, according to the WHO guidelines which states that "it is introduced into water through the dissolution of minerals and ores from industrial effluents and from atmospheric deposition. All water samples showed considerable permissible levels of Arsenic in them (~0.01 mg/L) excluding Angwan Gabarr and Angwan Kapi with 0.084 and 0.131 mg/L of Arsenic, respectively. It should be noted that not all compound forms of Arsenic are toxic to humans. High intake of Arsenic in Arsenate and Arsenite form are harmful whereas Arsenosugars helps in carbohydrate metabolism in the body. Adsorption and solution pH commonly controls the mobility of Arsenic in the aqueous environment (EPA, 2001).

Copper

Copper is present naturally within Iron deposits but more often, its presence in water is due to attack on copper pipes. Rarely, its occurrence may be to its use as an algaecide (EPA, 2001). A copper level above 2 mg/L in drinking water causes adverse effects, 1 mg/L in stringent cases. In this work, all water samples were well placed within the NSDWQ maximum permissible levels of 1 mg/L. High levels of copper in drinking water causes Anaemia, digestive disturbances, liver and kidney damages etc. (NSDWQ, 2015). Staining of laundry and sanitary occurs at copper concentration above 1 mg/L. At levels above 2.5 mg/L, copper imparts an undesirable bitter taste to water and its colour (WHO, 2008).

Chromium

Chromium is widely distributed in the earths crust. Soils and rocks may contain small amounts of chromium. Chromium arises in water bodies/deposits from discharges from electro plaiting, tanning, textile, paint and dyeing plants. The element is an essential dietary requirement in limited amounts and a deficiency can lead to disruption of glucose metabolism. However, at high concentrations, it is considered carcinogenic (EPA, 2001). In this work, all water samples were found to have chromium concentration greater than the NSDWQ permissible limit with the exception of Angwan Gabarr, Angwan Wakili and Angwan pada. Geological treatment for water with high levels of chromium includes Reverse osmosis and distillation.

Nickel

The principal sources of nickel are minerals and industrial wastes. This is another heavy metal which is among the class of possible carcinogens as far as humans are concerned. It also has harmful effects on aquatic life and is toxic to plant life too (EPA, 2001). In this work, all water samples were found to have high levels of nickel with exception of Angwan wakili. Now, this is dangerous because, the inhabitants of these areas are exposed to the possibility of having cancer.

Lead

The primary source of lead is leaching from ores and effluent discharges. It is a toxic cumulative poison and a possible carcinogen (EPA, 2001). Lead is one of the most commonly determined heavy metal in drinking water source because it accumulates in body tissues and has calamitous effects in raw and finished drinking water. Particular attention is paid to this element and hence stricter limits and permissible levels of ~0.01 mg/L (NSDWQ, 2015). All water samples were within the NSDWQ maximum permissible levels with exception to Tasha primary and Angwan Yandure. Lead is very toxic to human health as it causes damaging effects such as mental retardation, hearing loss, hypertension, kidney and neurological disorders etc. Possible treatment for lead in drinking water includes Reverse osmosis, use of activated carbon and distillation.

Escherichia coli (E.coli)

Faecal coliforms originate in human and animal waste. Presence of thermotolerant E.coli is the indicator organism of water contamination. The risks to consumers of infection from drinking polluted water will vary very widely from instance to instance because the number of pathogenic organisms in contaminated waters will show great variations (EPA, 2001). The presence or absence of E.coli is a true test to ascertain water quality. In this work, E.coli was tested for both source and household water samples. For the Source water samples, Masallachi Irii, Angwan pada, Angwan Yandure and Angwan Ba'ayi all tested positive for E.coli. All other water samples tested negative. It is worth mentioning that all water samples from hand dug wells tested positive, hence, usage should be stopped or water treated before consumption. All Household water samples tested positive to E.coli tests. This goes further to show the absence of hygiene and poor treatment of water. Possible treatment for these water samples include chlorination, iodination etc. (NSDWQ, 2015). The Quality control sample tested negative for E.coli at all times.

V. Conclusion

Based on the above findings, it is obvious that most of the water samples were contaminated with E.coli. The results from the water quality index analysis shows that the quality of water in these communities ranges from poor to very poor. The health of people living in Darazo, especially children are at risk due to consumption of this water, because water from these boreholes and wells are used for drinking, cooking and other domestic purposes. It is recommended to adopt some kind of inexpensive method of treatment of the water samples to reduce the levels of faecal contamination and some heavy metals consumed by people residing in the affected areas.It may be recommended that simple, acceptable, low-cost interventions at the point-of-use (household) level that are capable of improving the microbial quality of drinking water and reduce the attendant risks may be established.

Conflict of Interests: Nil

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