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Treatment Requirements of Well Water in Gwallameji, Bauchi, Nigeria

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ABSTRACT---- ***This paper reports the result of the investigation made to find out the quality of well water available to the Gwallameji community for domestic/household use. Tests were carried out for the presence or otherwise of Colour, Odour, Temp., Turbidity, pH, Chloride, Fluoride, Nitrate, Iron, Lead, Cadmium, Zinc, Copper, Aluminum, Taste, Faecal coliform and other contaminants and recommendations were made based on the findings from the tests.***

Keywords--- Well, Watertrearment, Quality, Contaminant and Purification

1. INTRODUCTION

There is a popular saying that water is life[1]. This is true because all living organisms need water to live and continued to be alive. According to [2][3] water is indispensable for survival and growth of any living organism. Despite the importance of water to human survival and continued existence, not just any water is useful and beneficial to man. Water appropriate for domestic must be pure, that is, among other qualities it must be clean, colourless, odourless, and neutral in acidity and alkalinity. Gwallameji is a community in Bauchi, Nigeria where a Federal Polytechnic is located and a greater percentage of the Polytechnic students reside there, because there were no enough accommodation for the students in the hostel and the proximity of the community to the campus. Calls made to successive government regimes in the state to extend pipe borne water supply to Yelwa, RafinZurfi and Gwallameji were to no avail. The water installation in the Polytechnic has been the source of drinking water for the community while Wells provided by individuals landlord are the main source of water available to the within Gwallameji community. However the Polytechnic water supply infrastructure as become overstretched by the increase in population of the community. This increase in population was as a result of the influx of people into the Yelewa, RafinZurfi and Gwallameji from more riot/violence prone area of Bauchi, even those that fled from the troubled Borno and Yobe states to Bauchi prefer to settle in the less volatile / flash part of Bauchi town.As a result of the upcoming drinking water insufficiency those that cannot afford the sachet cost water have no alternative for drinking water than the wells. It is therefore necessary to assess the quality of the water from these wells, to ascertain its quality and the fitness for all domestic uses, purposely to identify the need or otherwise of treatment as well as the level of treatment necessary to make the water from these wells completely potable.

2. WATER

2.1. Source of Water

The various sources from which water can be obtained raw can be broadly classified into Surface sources, Underground sources.

Surface sources, these include Pond and lake, Stream and river, Ocean and all water that flows over the surface of the earth, and is thus directly available for water supplies [4],

Underground sources, The water, which gets stored below the ground surface throughpercolation, is known as underground water. This water is generally purer the surface water, because it undergoes naturally filtration during the percolation through the soil pores. Thesewaters are less likely to be contaminated by bacteria through unhygienic practices, and it may contain dissolved salt and mineral [5]. The underground water is harvested through sinking of wells and boreholes.

2.2. Chemical and Physical Properties of Water

Water is a transparent, tasteless, odourless liquid. Colour of water and ice are intrinsically very light blue, although water appears colourless in small quantity. Ice also appears colourless and water vapour is essentially invisible as a gas. Water is liquid under standard/ambient temperature and pressure. Pure water has a low electrical conductivity, but this increase significantly upon addition of a small amount of ionic material such as Sodium Chloride. Water also has high adhesion properties because of its polar nature [6]. So many materials are soluble in water.

2.3. Assessment of Water Quality

Assessmentof water quality is basically an examination of its physical and chemicals status as well as micro-organisms which the water contains, this is because in some cases, chemicals and pathogens in water may cause disease and death, therefore, the investigation of the quality is necessary. Contaminants can be microbiological, metal or mineral salt. The factors that determine the quality or fitness of water for domestic use include:

The pH is a phenomenon that depicts the degree of acidity or alkalinity in water, when the pH is less than 7.0 on the pH scale, it is acidic, when the pH value is greater than 7.0 the water is basic or alkaline, but if the pH is 7.0 it indicate that the water is neutral. pH higher than 8.0, causes a progressive decrease in the efficiency of chlorine disinfections process as well as coagulation process.

Temperature is the degree of coldness or hotness of an object. Cool water is generally more palatable, very low temperature decrease the efficiency of treatment process such as disinfections, while high temperature enhance the growth of micro-organism. Taste, colour and corrosion problem may be increase.

Turbidity is a physical characteristic of water and is an expression of the optical properties that causes light to be scattered and absorbed by particles and molecules rather than transmitted in straight lines through a water sample, it is caused by suspended impurities that interfere with the clarity of the water. These impurities may include clay, silt, finely divided inorganic and organic matter, soluble coloured organic compound, and plankton.

Odour is a chemical dissolve in air, generally at a very low concentration, also called smells, which can refer to both pleasant and unpleasant odours.

Colour The colour of water is a subject of both scientific study and popular misconception. While relatively small quantities of water are observed by human to be colourless, pure water has a slight blue colour; it becomes a deeper blue as the thickness of the observed sample increases.

Nitrate is an inorganic compound that can be a natural or manmade contaminant in drinking water. Nitrates (NO_3) and (NO_2) can cause methemoglobinemia “blue-baby” disease; high nitrate levels can also indicate the presence of other pollutants, such as bacteria or pesticides as theses pollutant may follow the same path as the nitrate into the water supply.

Copper is a metal found in natural deposit such as ores containing other element. People who drink water containing copper in excess of standard limit may with time, experience gastrointestinal distress and further or continuous exposure may lead to liver or kidney damage.

Zinc is especially important during pregnancy, for the growing foetus whose cells are rapidly dividing, zinc also help to avoid congenital abnormalities and pre-term delivery. Zinc is vital in activating growth – height, weight and bone development – infants, children and teenagers.

Cadmium is a heavy metal used as a stabilizer for P.V.C, it is also used in coating and pigments in plastic and paint. This heavy metal is generally used because it is found to be corrosion resistant. With the exception of its use in nickel – cadmium batteries, the use of cadmium is generally thought to be decreasing in all other consumer product due to its high toxicity and carcinogenicity and the associated health and environmental concern.

Lead is part of our world today. It is found in the air, soil, dust and the paint of some building built, before 1978. Being exposed to too much lead can causes serious health problems. Lead is never a normal part of your body.

It is very important that water to be used by man be investigated for chemical and microbial / microbiological contents. Due to rapid growth in population, the government find it difficult to pipe water from Water Board’s water treatment plants to Gwallameji. Therefore, attention for water needed for domestic use has been on the ground water through sinking of wells. Incidentally, some of these wells are exposed to various pathogens and other pollutants that can be responsible for health complications such as accumulation of metals, mineral salts, diarrhoea and typhoid fever. [1] Estimated the death from water caused diseases at 3.3millon per year. [7] Added that death from water borne disease in Nigeria is not restricted to children alone as there are reported cases of epidemic of cholera and diarrhoea killing both children and adults due to drinking unhygienic water.

Uncontaminated ground water is naturally clean, odourless, and tasteless [7]. However, dissolved mineral salts, sewage and other unhealthy practices within the community can contaminate the ground water in an environment. If human beings used the contaminated water without treatment, the people may be infested by water borne diseases, which may reach epidemic stage. Water that looks drinkable can contain harmful element, which could cause illness and death if ingested [6]. Therefore, if adequate attention is not giving to water treatment for purification before used, the water may change from being life to killer number one, and a medium for transmitting infections and diseases [8].

3. PURPOSE OF THE STUDY

The purpose of this study is to investigate the quality of well water that is available for day to day domestic use in Gwallameji. In an attempt to achieve this, the following objectives were pursued:

i. Assessing the physical, chemical and microbial quality of drinking water available in Gwallameji

ii. Identify the chemical and microbial parameters where each well fails the WHO standards for portable water

iii. Identify the need for treatment needs and Recommend type of purification necessary to be done on the water to make it completely potable the.

4. RESEARCH QUESTIONS

i. What is the quality of drinking water available in Gwallameji?

ii. What arethe parameters in the well water that fails the WHO standards?

iii. What are the treatments required of the well water to make it potable?

5. METHODOLOGY

The area was zoned into three; two well were selected randomly from each zone. Samples were collected from the selected six wells; the samples were taken for analysis in the laboratory. Physical observation was carried out to seehow clean the surrounding of the source of the water was, in addition, 81 people were interviewed to find out what they use the water from the wells for. A properly washed/rinsed fetcher/container was dipped into the shallow well, the water agitated before sample was taken from the water inside the well. Clean plastic bottles were properly rinsed with distilled water and thereafter with the sample water, the sample water was poured into the plastic bottles and acidified by adding few drop of diluted Nitric acid which is to keep the ions in the water sample active, as the samples were transported to the laboratory for analysis. Tests were carried out for the presence or otherwise of the following: taste, Colour, Odour, Temp., Turbidity, pH, Chloride, Fluoride, Nitrate, Iron, Lead, Cadmium, Zinc, Copper, Aluminium, Taste, Faecal coliform and some others.

Appearance, Taste, and Odour tests: This was carried out by physical examination.

Iron test: The reagent: Iron phenathroline table equipment: bottle cell 25ml (2) Dr/2010

Equipments: Portable digital spectrophotometer washed bottle, razor blade cork to cover the bottle cell.

5.1 Lead test

Equipments: distilled water sample, Atomic absorption spectrophotometer (AAS).

Procedure: the method used for the test was AAS, in which a small tube of 4mm in diameter was dipped into water sample and the tube was connected with AAS the water flows through the tube to the AAS. Machine when it is on and the result appear in digital form.

5.2 Feacalcoliform test

Apparatus: conical flask/media bottle, beaker test tube, rag, pipette (sterile syringe) Durham tube, lactose broth, incubator, autoclave, hot air oven Bunsen burner (spirit lamp), distilled water, cotton wool and weighing balance.

Procedure

- Cleaning/sterilization of apparatus or equipment by soaking the pipette conical flask, test tube, Durham tube and beaker in soapy water for 24hrs and the equipment were properly rinsed for several times with tap water and finally rinsed with distilled water.
- All the above glasswarewas sterilized in a hot air oven at temperature of 160^0C for 30 min.
- 10grams of lactose powder was weighted, one litre of distilled water was poured in a conical flask and it was sterilized using autoclave at 15 pounds per square inch for 15 minute and then the temperature was allowed to go down before removing it from the autoclave, sterilized pipette was use to dispense 10ml each of lactose broth into the test tube.
- Test tubes were set for each sample and labelled accordingly. After incubation, Durham's tube was inserted into test tube the cotton wool allows flows for oxygen but trapped contamination. The set of each sample were incubated at a temperature of 37^0c for 48hours and then observations were made.

Fluoride test: Reagent used: Spadns reagent solutions, equipment, potable digital spectrophotometer, 2 cell bottle 10ml wash bottle, and cork.

Procedure: The digital spectrophotometer was switched on and the stored program for fluoride was entered, the two bottle cell were filled with distilled water and other was filled with sample water, 2ml of spadns reagent was poured into each cell bottle and was mixed. The cell bottle containing distilled water was placed in the cell holder and close to the light shed to zero the reading, it was removed and the prepared sample was placed into the cell holder close to the light shed to display the reading at the sample.

5.3 Chloride test

Reagent used: acid of $AgNo_3$ solution, methyl orange indicator.

Equipment used: conical flask, burette cylinder, and wash bottle.

Procedure: A clean burette was rinsed with quantity of 0.020 of $AgNo_3$ and filled to the zero mark. The conical flask was rinsed with distilled water and 50ml of water sample was poured into it. Two drops of potassium dichromate was added and titrated with $AgNo_3$. The end point was achieved when the colour changed from yellow to reddish brick.

5.4 Nitrate test

Reagent:nitrocol table, nitrates powder, nitrates tablet.

Equipment:waptech 7100 photometer, nitrate tube 20ml round test tube 10ml (2)

***Procedure**:* The nitrate tube was filled to 20ml of sample. One level spoon of nitrate powder and nitrate tablet was added to the sample and it was properly shake for one minute. The tube was allowed to stand for one minute and was gently inverted three times to aid flocculation; it was allowed to stand for two minutes to ensure complete settlement. The screen cap was removed and the top of the tube was wiped with a clean tissue. The clean solution was decanted into a round test tube and one nitricol tablet was added, crushed and was mixed to dissolve. It was allowed for 10 minute to allow full colour development. The reading was taken on the photometer.

6. RESULT

6.1 Analysis and discussion of water test result

Series of observation and analysis of the specimens were made. It was observed that the people depend largely on water supply from wells and borehole. Most of the wells are not covered. From interview, it was found that the people used the water from these wells for Washing clothes, Cooking, Washing of dishes, Bathing, and Drinking. It is worthy of note that only 12 (14.81%) of the 81 people interviewed drink from these wells, this shows that the water is not portable and is not good for drinking. others either buy sachet water or fetch from the school for drinking, the non drinking of the water may have been the reason why health crisis has not been recorded in the community.

Table 1use made of water from the wells

Response	Washing clothes	Cooking	Washing of dishes	Bathing	Drinking
Frequency	26	31	26	26	12

6.2 Physical, Chemical/Geo-chemical and Bacteriological analysis result

Table 2 showing the results of laboratory analysis of water samples

S/N	Parameter	Well A	Well B	Well C	Well D	Well E	Well F	NSDWQ/WHO Max Acceptability
1	Colour	10	20	15	10	30	25	25Ho
2	Odour	Unobj	Unobj	Unobj	Unobj	Unobj	Unobj	Unobjectionable
3	Temp.	26.9	26.9	26.9	26.9	26.9	26.9	Ambient
4	Turbidity	3.7	6.2*	2.5	4.4	3.7	3.9	5NTU
5	pH	6.71	6.58	7.03	7.62	6.67	5.5*	6.5-8.5
6	Chloride	105.64	100.7	158.1	207	119.8	185.7	250mg/L
7	Fluoride	0.26	0.06	0.41	0.17	0.20	0.31	1.5 mg/L
8	Nitrate	0.12	0.70*	0.01	0.97*	0.04	0.72*	0.50 mg/L
9	Iron	0.32*	0.37*	0.19	0.23	0.56*	0.76*	0.3 mg/L
10	Lead	0	0	0	0	0	0	0.01 mg/L
11	Cadmium	0.016*	0.012*	0.014*	0.012*	0.012*	0.014*	0.003 mg/L
12	Zinc	0.07	0.05	0.03	0.03	0.05	0.04	3 mg/L
13	Copper	BDL	BDL	BDL	BDL	BDL	BDL	1 mg/L
14	Aluminum	0	0	0	0	0	0	0.02 mg/L
15	Taste	Unobj	Unobj	Unobj	Unobj	Unobj	Unobj	Unobjectionable
16	Faecal coliform	0	0	0	0	0	0	0

* The parameters in the well that fails the WHO standards

KEYS

Para = Parameters
Unobj = Unobjectionable
BDL =Below detective level
ND = None detective

A = Havannahludge well
B = Chaba villa well
C = Pentagon suit well
NTU = Nephelometric Turbidity Unit

E = Bima complex well
F = Steel complex well
D = Rockveiw palace well

6.3 Discussion of physical analysis of well water

pH value : pH is a phenomenon that describe the degree of acidity or alkalinity in water, when the pH is less than 7.0 on the pH scale, it is acidic, when the pH value is greater than 7, it indicates that the water is basic or alkaline, but if the pH is 7, it indicate that the water is neutral. A pH higher than 8.0, causes a progressives decrease in the efficiency of chlorine disinfections process as well as coagulation process. The result of the analysis show that the pH is in the acceptable limit of the W.H.O standard.

Temperature: Cool water is generally more palatable, very low temperature decrease the efficiency of treatment process such as disinfections. Although high temperature enhances the growth of micro-organism taste, colour, odour and corrosion problem may be increased. From the analysis result, all temperature value were 26.9^{o}c which show that water in the study area is generally cool.

Turbidity: High level of turbidity in water can protect micro-organism from the effect of disinfectant and can stimulate the growth of bacteria. Turbidity must be preferable below 1.0 NTU, so that the disinfections can be effective. The result obtained show that well A,C,D have low turbidity value that complied with W.H.O guideline, but well B & E are above the W.H.O standard of drinking water.

Colour: The colours from the wells are a bit clear by sight. From the results obtained it is clearly seen that well A,B,C,D falls within the W.H.O limit level for drinking water but well E colour exceeds the permissible level of 25 hazen. As such, this colour should be removed through water treatment by the process of coagulation, flocculation, sedimentation and filtration.

6.4 Discussion of Chemical/Geo-Chemical Analysis Chloride

The sources of chloride include domestic waste, agricultural, activities and mineral deposits. High concentration of chloride gives an undesirable taste of water. From the result obtained well A has a value of 105.64, well B has a value of 100.7, well C has a value of 158.1, well D has a value of 207, well E has a value of 129.8 while well F has a value of 185.7 all the samples obtained from the wells falls within the W.H.O standard for drinking water. The W.H.O maximum permissible level is 250mg/L.

Fluoride: The W.H.O limit for fluoride is 1.5mg/L and the result in the table shows that well A has a value of 0.25, well B has a value of 0.06, well C has a value of 0.41, well D has a value of 0.17, well E has a value of 0.20 and well F has a value of 0.31 this shows that fluoride is in low concentration in the wells.

Nitrate: Nitrate is a highly oxidized form of nitrogen compound it commonly finds its way into water from fertilizers normally applied on land during cultivation and sewage effluents. Nitrate however serves as nutrients to plants such as algae. The result obtained from the table shows that well A has a value of 0.12, well B has a value of 0.70, well C has a value of 0.01, well D has a value of 0.97, well E has a value of 0.04 and well F has a value of 0.72. Three wells B,D & F fell within the W.H.O standard for drinking water while well A, C, & E fell below the standard, so there are presence of nitrate in high concentration level which do harm life.

Iron: The W.H.O accepted standard for Iron in water is 0.3mg/L when solid minerals that contained bicarbonate dissolves in water, iron may be present. Oxidized iron gives a bitter taste, the result obtained shows that well A has a value of 0.32, well B has a value of 0.37, well C has a value of 0.19, well D has a value of 0.23, well E has a value of 0.56 and well F has a value of 0.70. It therefore shows that iron in the well C and D falls bellow WHO standard of drinking water. Well A B E,F iron content was above the WHO allowable drinking for water.

Lead: The WHO limit for lead is 0.01mg/L and the result obtained shows that there is absence of lead in water which is suitable for drinking and for domestic use.

Cadmium: The WHO limit for cadmium is 0.003mg/L and from the results obtained, all the water analysed contained higher concentration than the WHO limit.

Zinc: The WHO for zinc is 3mg/l but from the result obtained well A has a value of 0.07, well B has a value of 0.05, well C has a value of 0.03, well D has a value of 0.03, well E has a value 0.05, while well F has a value of 0.04, the level of zinc in water falls within the WHO standard which is suitable for drinking and domestic uses.

Copper: The WHO limit for copper is 1mg/L, from the result obtained, it shows that the parameter in the water is below detective level (BDL)

Aluminium: The WHO limit for aluminium is 0.02mg/L but from the result obtained, it shows that there are zero (0) level of aluminium in the well water.

7. DISCUSSION OF BACTERIOLOGICAL ANALYSIS

The result shows that the well water sources are not contaminated, the result shows that faecal coliform of the water is zero(0), this falls within the WHO limit.

Areas Where Treatment Is Required In the Wells

S/N	Parameter	Well A	Well B	Well C	Well D	Well E	Well F	NSDWQ/WHO Max Acceptability
4	Turbidity		6.2*					5NTU
5	pH						5.5*	6.5-8.5
8	Nitrate		0.70*		0.97*		0.72*	0.50 mg/L
9	Iron	0.32*	0.37*			0.56*	0.76*	0.3 mg/L
11	Cadmium	0.016*	0.012*	0.014*	0.012*	0.012*	0.014*	0.003 mg/L

* The parameters that that fails the WHO standards in respective well

Recommended household treatment for well water

The local low income earners may not be able to afford a costly treatment, however they can help themselves when the case finally occur and the government has not yielded to their call for provision of portable water. At the household level an economical and simple mini treatment can be employed, these include:

Turbiditycan be removed through any of Conventional Filtration. This consists of adding coagulant chemicals, flash mixing (a millisecond blending), resulting in coagulation/flocculation (forming solid particles), sedimentation (the settling of a loathing material), and filtration.

Nitratecan be successfully removed from water using treatment processes such as ion exchange, distillation, and reverse osmosis.

Iron is most commonly removed with water softener. A water softener is actually designed to remove hardness minerals like calcium and magnesium. Iron can be removed in small quantities by a sediment carbon filter, or water softener.

Cadmium, all the well failed in Cadmiumrequirement can be handed withthefollowing treatment systems to reduce cadmium levels: coagulation/filtration, distillation, ion exchange, reverse osmosis

8. RECOMMENDATION AND CONCLUSION

The result shows that water from all the wells was completely freefrom lead, copper and aluminium contamination. pH, temperature fluoride, zinc, contents in the wells were within the acceptable limit,while turbidity of wells B and E; Nitrate in wells B, C, D and E; iron in wells A, B, E and F as well as cadmium in all the wells were found to be above limits that is safe for water to be used for domestic purposes. Though hitherto the bore holes in the Polytechnic has been the major source of drinking water, but the water provision facility is getting overstretched which may lead to people considering drinking from the wells, hence, the water has to be treated to remove contaminating impurities so that people that drink from the wells shall be saved from water borne health implications of contaminated water, that to avoid reduced productivity, that is, little or no loss of man-hour. Government shall spend less in drug subsidy if any; congestion of patients in the hospital shall be reduced leading to a reduction in pressure on the health workers and facilities.

Therefore, there is the need to treat the water from the wells according to there deficiencies mentioned above, most especially in reduction of excess of Nitrate, Iron and Cadmium. It is worth of note that no one among the sampled wells has a clean slate.

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