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Physicochemical Parameters And Heavy Metal Analyses Of Water Samples From Hand Dug Wells In Gambari, Ogbomoso, Oyo State.

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Abstract: *Some physicochemical characteristics and heavy metal levels in water samples obtained from twenty hand dug wells in Gambari, Ogbomoso, Oyo state, Nigeria were analysed in order to investigate and assess the drinking water quality. Conventional analytical methods were employed for the determination of the physicochemical parameters while heavy metals in the water samples were analysed using Atomic Absorption Spectrophotometer. The results of physicochemical parameters in the water analysed showed various ranges as follows: pH (5.57 -7.1, mean; 6.454), conductivity (225.67-1353µscm^{-1}, mean; 498.45 µscm^{-1}), Alkalinity (0.43-4.73 mg/L, mean; 1.27 mg/L), Total hardness (30.33-86.33 mg/L, mean; 44.92 mg/L), Dissolved oxygen (0.73-7.5 mg/L, mean; 4.39 mg/L), Nitrates (0.00-5.0 mg/L, mean; 0.41 mg/L) and Sulphate (0.00-6.33 mg/L, mean; 0.34 mg/L). Also, from the results of the heavy metals analysed, high concentrations were recorded in certain wells especially in sample collected from GASP. The results indicated that the drinking water quality is becoming deteriorated because most of the water samples were found to be at minimum satisfactory level except for GASP (located within a cassava processing and milling industry) found to be at unsatisfactory level because ninety five percent of the parameters tested were found to be at high levels in concentration*

I. Introduction

Much of the current concern with regards to environmental quality is focused on water because of its importance in maintaining the human health and health of the ecosystem (Mahananda*et al.,* 2010). Although water is the most common and important chemical compound on earth, only 2.6% of the global water is freshwater and consequently available as potential drinking water. Availability of sufficient volume of drinking water continues to present major problems worldwide to public health (Postel, 1997). The importance of water is underscored by the fact that many great civilizations in the past sprang up along or near water bodies (Karikari and Ansa-Asare, 2004). In most industrialized countries, drinking water is ranked as food, and high standards are set for its quality and safety (Ölmez and Kretzschmar, 2009). Pollution of water bodies are usually caused by chemical and microbial contaminants which leads to waterborne infections and diseases (USEPA, 1991). Therefore guidelines and legislation has stated that water suitable for drinking should contain some parameters including microorganisms only in low amounts that the risk for acquiring waterborne infections is below an acceptable limit (Zhao *et al.,* 2009). Also, Rapid urbanization of rural areas, industrialization and population growth have been the major causes of stress on the environment leading to problems like human health problems, eutrophication and fish death, coral reef destruction, biodiversity loss, ozone layer depletion and climatic changes (Sadiq, 2002; Bay *et al.*, 2003). Improper disposal of industrial effluents which is most common in major African urban and rural centres has led to heavy contamination of the available fresh water resources reducing the volume of safe agriculture, domestic, irrigation and drinking water.

The study area; Gambari, Ogbomosho is one of the towns around Ogbomoso, Oyo state, Nigeria. Ogbomoso is one of the largest Nigerian cities having a population approximately 645,000 as of 1991 (Chernow*et al.,* 1997) and estimated at 861,300 in 2007 (Encarta, 2009) and it is a commercial centre situated in an agricultural region producing yams, cassava, maize, and tobacco (Chernow*et al.,* 1997). The major occupation of people in Gambariis agriculture with production of cassava products as one of the major products produced, since water is required in virtually all processing in agriculture, from the planting stage to harvesting and even to the stage of processing into edible forms (Omonona and Akinpelu, 2010), there is a need for a critical research on what the effects of usage of water for agricultural practices and its effluent disposal could have on the availability of quality water for the people. Therefore this study was carried out to investigate the impacts of selected pollution sources on the quality of water in hand dug wells in Gambari, Ogbomoso.

II. Materials And Methods Selection Of Sampling Sites

A short term survey was carried out at Gambari, Ogbomoso in order to locate the important sources of pollution. Twenty hand dug wells were randomly selected based on their accessibility and proximity or closeness to pollution sources. The major pollution sources considered are; cassava mill industry, drainage, dumpsite site, poultry farm, bathroom and toilet and automobile exhaust. The wells that were sampled are major source of water for domestic use of the people of the town as majority of them are also located within a living vicinity, also water from these wells are used for commercial purposes most especially in preparation of some street vended foods and in food canteens. The locations of the groundwater points were obtained with a hand held Global Positioning System (GPS).

III. Collection Of Water Samples

The water samples were collected very early in the morning. All the samples were collected in plastic bottles which were properly washed with iron free detergent, rinsed with 5% potassium nitrate, subsequently with demineralized water and air dried. Water samples, in the hand dug wells were obtained using same material that is used to fetch water from each well. This is usually a rubber container made from motorbike or car wheel tube, attached to a long chord. Using this, about four liters (4 L) bulk sample was collected in a large plastic bowl, after a thorough agitation of the water in the well; so as to derive a homogeneous and good representative sample. Two liters (2 L) was subsequently taken from the bulk sample and stored in well labeled, cleaned plastic bottles for laboratory analyses. Separate water samples were however collected for dissolved oxygen (DO) and Biochemical oxygen demand (BOD) in clean reagent bottles. The dissolved oxygen was fixed on the field and the bottled lids were replaced to preserve the absolute oxygen content in the water samples and minimize oxygen contamination and the escape of dissolved gases.

IV. Analytical Methods

After the sampling, the samples were immediately transferred to the laboratory and were store in cold room (4 ^{0}C). The analysis was started without delay in laboratory based on the priority to analyze parameters as prescribed by APHA (1998) methods. Various physicochemical parameters examined in the groundwater samples include, temperature which was measured at the sampling site using a standardized mercury in glass centigrade thermometer as described by Ademoroti (1996), other parameters analyzed for are electrical conductivity (EC), Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), potential hydrogen (pH), NO_3^-, PO_4^{2-}, SO_4^{2-}, lead (Pb), iron (Fe), zinc (Zn), and copper (Cu), chromium, cyanide.

The potential hydrogen (pH) was obtained using a pH meter calibrated with buffer pH 4.7 and 7.0. A calibrated turbidimeter was used to measure the turbidity of the water samples while the electrical conductivity was obtained in conductivity meter using Potassium Chloride (KCl) standard. The colour was determined using a Lovibond comparator disc. The alkalinity was determined by titrimetric method using phenolphthalein indicator solution and titrating with 0.02M HCl.. The dissolved oxygen was determined using a calibrated dissolved oxygen meter with the DO probe and temperature sensors immersed in the sample. The Biological Oxygen Demand (BOD) was determined after incubation for five days, where consumption period of 5 days could not be adhered to, the BOD_n value after n days can be converted to BOD_5 value by multiplying with the conversion factors.

Determination of chloride was done using argentiometric method and determination of nitrate by colorimetry (brucine method). Determination of sulphate and phosphate were done using turbidimetric method and colorimetric method respectively. The sample was prepared for cyanide determination using alkaline picrate. The heavy metals were analysed using Atomic Absorption Spectrophotometric (AAS) method. This method resembles flame photometry, the sample aspirated into a flame where it becomes atomized. A light beam is directed through the flame into a monochromator and then onto a detector that measures the intensity of the light absorbed. AAS is more sensitive in that it depends upon the presence of free unexcited atoms. The amount of light intensity absorbed in the flame is proportional to the concentration of the element in the sample.

V. Results And Discussion

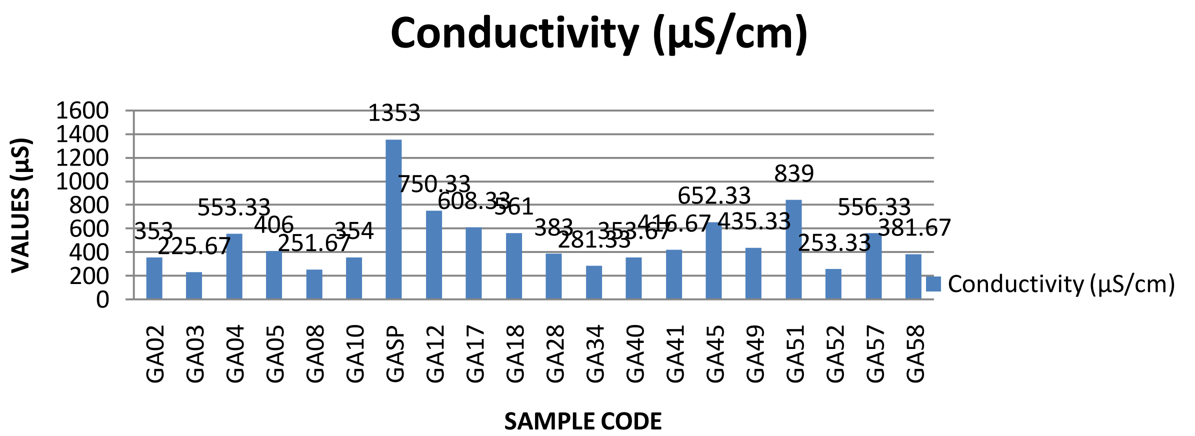


Fig .2 Conductivity of water from selected hand dug wells in...

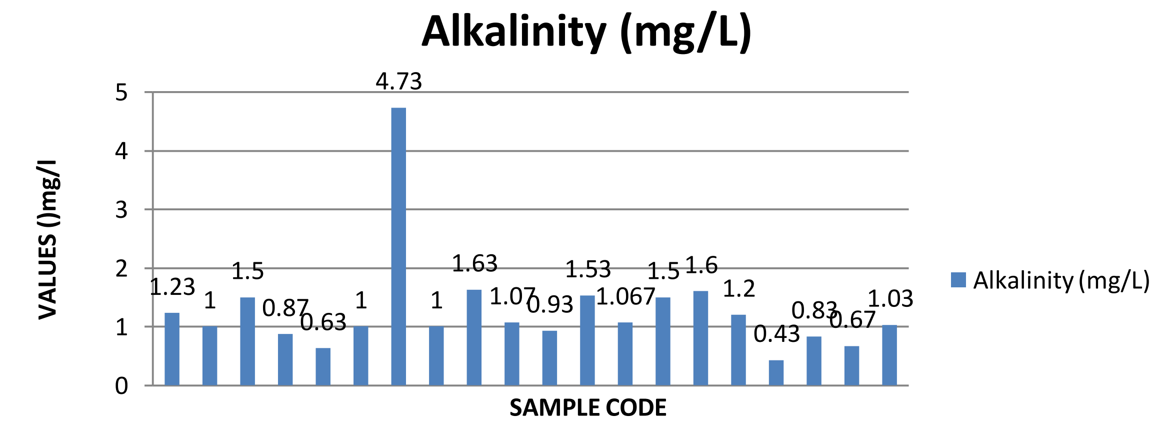


Fig 4.2 Alkalinity of water from selected hand dug wells in...

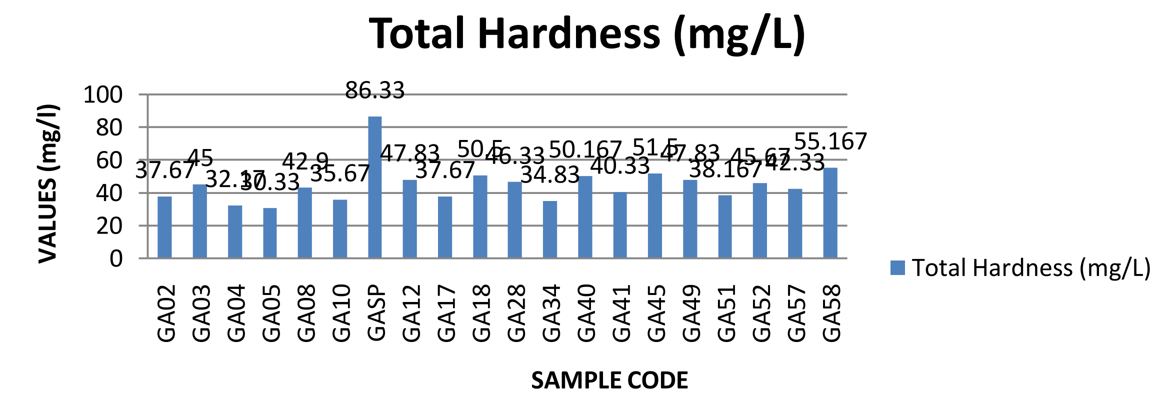


Fig .3 Total hardness of water from selected hand dug wells in...

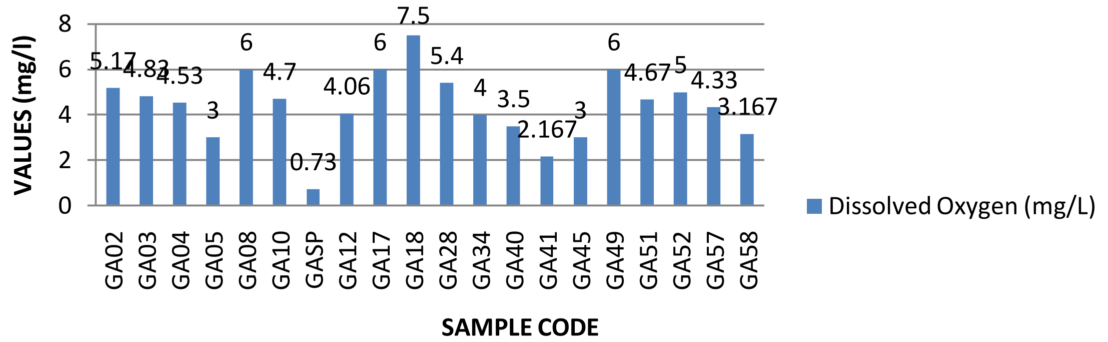


Fig .4 Dissolved oxygen of water from selected hand dug...

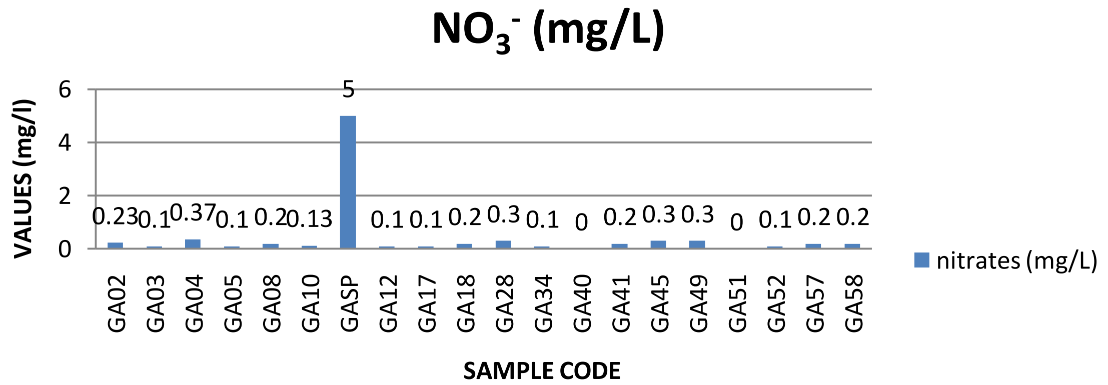
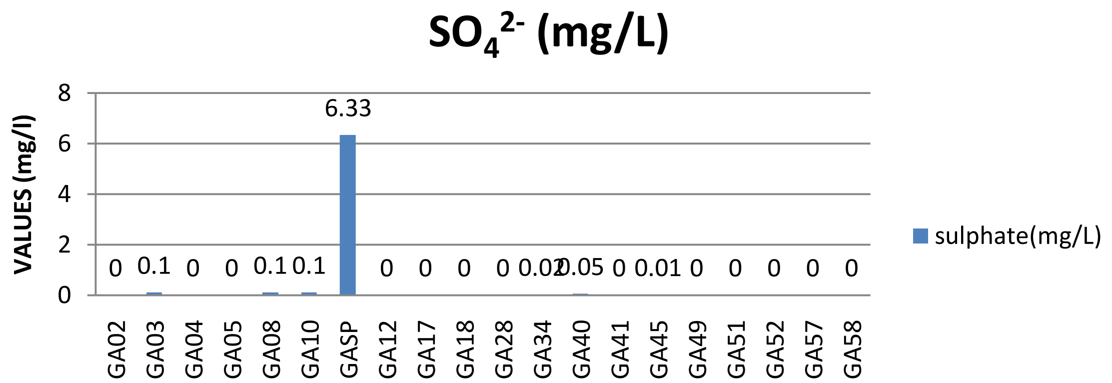


Fig .5 Concentration of nitrate in selected hand dug wells in...



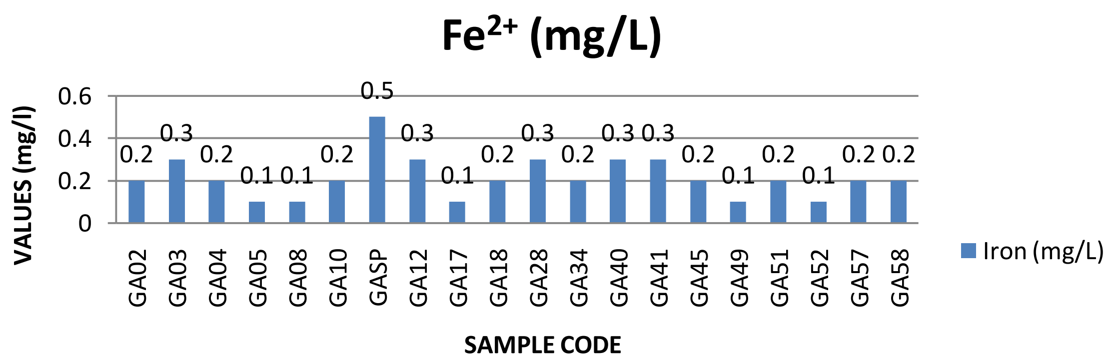


Fig .7 Concentration of Iron in selected hand dug wells in...

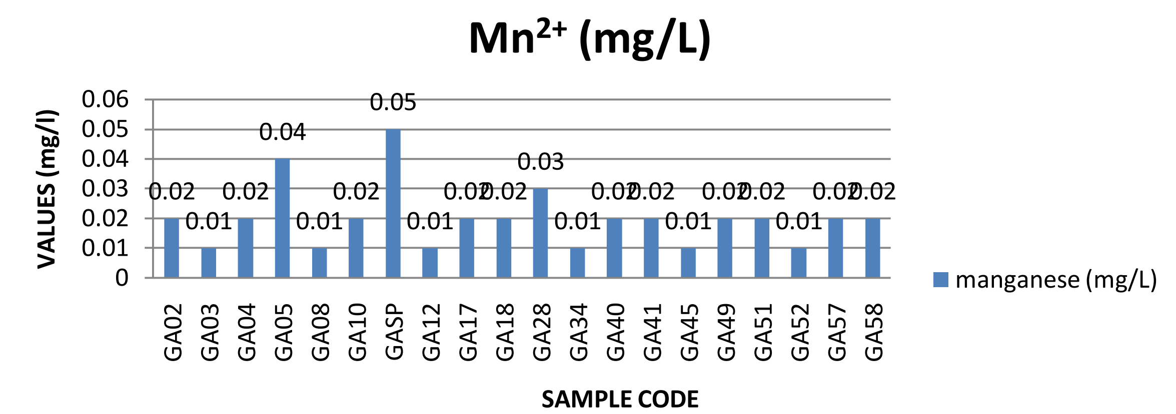


Fig .8 Concentration of Manganese in selected hand dug wells…

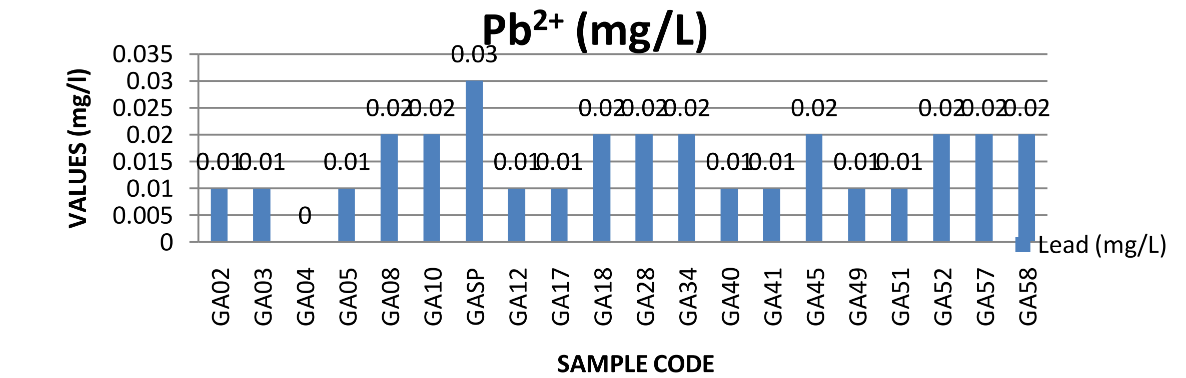


Fig .9 Concentration of Lead in selected hand dug wells in…

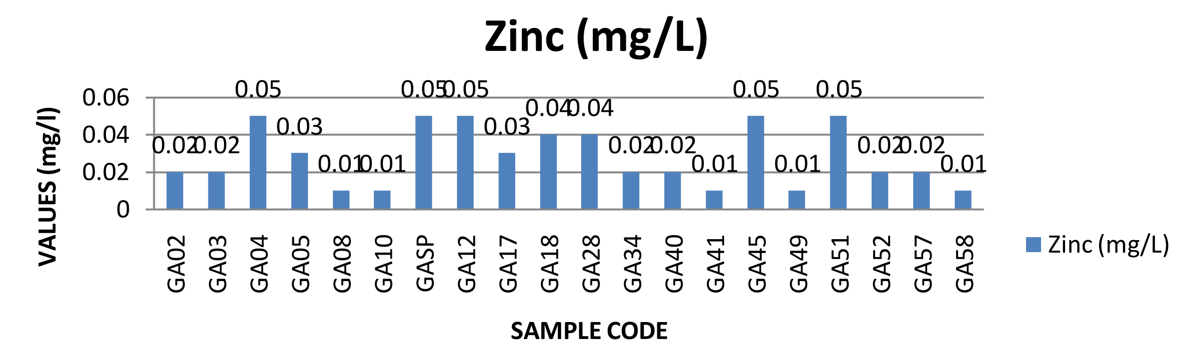


Fig .10 Concentration of Zinc in selected hand dug wells in…

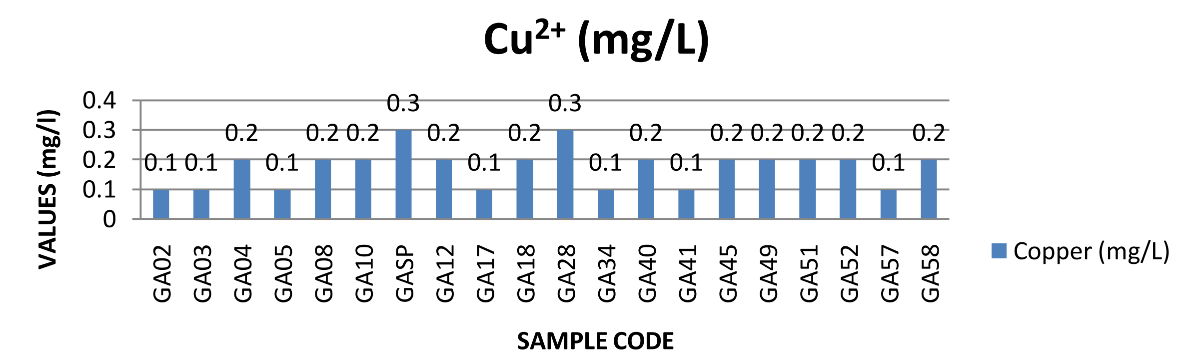


Fig .11 Concentration of Copper in selected hand dug well in…

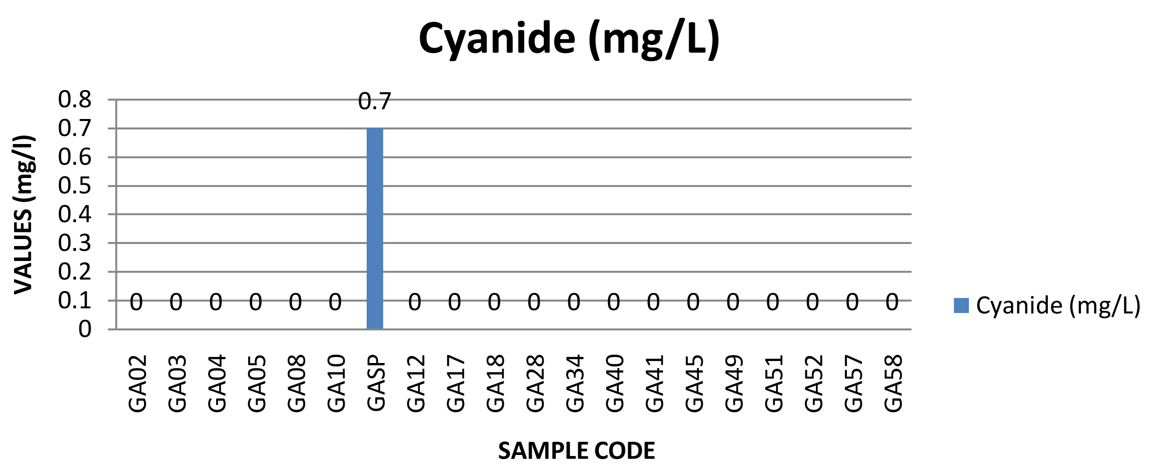


Fig .12 Concentration of Cyanide in selected hand dug well in…

VI. Discussion

pH of a water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity (Fakayode, 2005). The pH of the samples was between 5.57 (from GA02) and 7.1 (from GASP). Eight (8) of the samples that is 40% have pH values below 6.5-8.5 which is the permissible limit of the World Health Organization and they are slightly acidic while the remaining 60% are within the admissible limit that can be regarded as neutral and unpolluted. The mean value for the potential hydrogen concentration in all the samples analysed is 6.454; slightly below the WHO standard.

Electrical conductivity is a measure of water's ability to conduct an electric current and it is related to the amount of dissolved minerals in the water, but it does not give an indication of which element is present but higher value of conductivity is a good indicator of the presence of contaminants such as sodium, potassium, chloride or sulphate (Orebiyi*et al.,* 2010). Conductivity is a good and rapid method to measure the total dissolved ions and is directly related to the total solids in the water sample (Singh *et al.,* 2010). The higher the value of dissolved solids, the greater the amount of ions in water (Bhatt *et al.,* 1999). Analysis of the results show that 50% 0f the samples have conductivity values above 400 µS/cm which is the WHO standard (2008). The range of conductivity of the samples was from 225.67 µS/cm – 1353 µS/cm, with the minimum (225.67 µS/cm) obtained from GA03 and maximum value (1353 µS/cm) obtained from GASP. High values of conductivity were recorded from GA51, GA12, GA45 and GA17. This indicates a high level of dissolved solids and subsequently impurities in the water which can render the water unfit for drinking.

Alkalinity of water is a measure of weak acid present in it and of the cations balanced against them (Sverdrup *et al.,* 1942).total alkalinity of water is due to the presence of mineral salt in it. It is primarily caused by the carbonate and bicarbonate ions (Singh *et al.,* 2010). The total alkalinity recorded from the samples ranged from 0.43mg/l (GA51) to 4.73mg/l (GASP), it has a mean of 1.27235mg/l. there is only a little variation in the concentration of alkalinity across the samples analysed except for a sharp increase recorded at 4.73mg/l in GASP showing a higher level of pollution in GASP compared to the other samples.

Total hardness is the parameter of water quality used to describe the effect of dissolved minerals (mostly Ca and Mg), determining suitability of water for domestic, industrial and drinking purposes and attributed to presence of bicarbonates, sulphates, chloride and nitrates of calcium and magnesium(Taylor, 1949). Its values from the samples analysed varied from 30.33mg/l to 86.33mg/l with a mean value of 44.91955mg/l. the minimum value was recorded in GA05 while the maximum value was recorded in GASP. The high values of total hardness recorded in GASP and some others such as GA58, GA45, GA41 and GA18 which are slightly higher than the rest may be due to discharge of sewage from nearby market place, use of soaps and detergents in washing and bathing by people and from domestic effluents.

Dissolved Oxygen is susceptible to slight environmental changes, it is related to the temperature and biological activities in the water (Chapman and Kimstach, 1992). Oxygen depletion often results during times of high community respiration. And hence DO has been extensively used as a parameter delineating water quality and to evaluate the degree of freshness of a river (Fakayode, 2005). It is also an important limnological parameter indicating level of water quality and organic pollution in the water body (Wetzel and Likens, 2006). It was recorded that maximum dissolved oxygen concentration of 7.5mg/l was obtained at GA18 while 0.73mg/l obtained from GASP was the minimum value recorded. The very low concentration of dissolved oxygen obtained from samples collected from GASP indicates a high level of leachate pollution and heavy pollution from effluents from cassava processing industry located just beside the well (GASP).

The presence of nitrate in water indicates the presence of fully oxidized organic matter (Mwegoha and Kihampa, 2010). The highest concentration of NO_3^- was obtained at GASP with a value of 5mg/l. minimum concentration that was below detection level (0mg/l) were recorded at GA40 and GA51. Slight differences in concentration were noted in most of the sample. A sharp increase in concentration recorded at GASP indicates a high level of pollution from wastewater rich in nitrate. Presence of nitrate is attributed mainly to anthropogenic activities such as runoff water from agricultural lands, discharge of household and municipal sewage from the market place and other effluents containing nitrogen sources (Singh *et al.*, 2010).

High concentration of sulphate in drinking water can have a laxative effect when combined with Calcium and Magnesium, the two most common constituents of hardness (Lennetech, 2011). Also, high sulphate concentration can cause gastro intestinal irritation (Bhatia, 2000). People unaccustomed to drinking water with elevated level of sulphate can experience diarrhea and dehydration. It can also give a bitter taste to water making it unpleasant to drink (MDH, 2010). In this study, the sulphate content concentration was recorded to vary from below detection level (0mg/l) to 6.33mg/l. 65% of the samples analysed have results at 0.00mg/l and 15% have results varying between 0.01mg/l and 0.05mg/l. Also, 15% of the samples have results at 0.1mg/l and a very high and significant increase was recorded in GASP having concentration at 6.33mg/l. this result indicates a very high level of pollution received by the well (GASP) compared to the others.

Iron is the fourth most abundant element by mass in the earth's crust. In water, it occurs mainly in ferrous or ferric state (Ghulman*et al.*, 2008). It is an essential and non-conservative trace element found in significant concentration in drinking water because of its abundance in the earth's crust. Usually, iron occurring in ground water is in the form of ferric hydroxide, in concentration less than 500 µg/L (Oyeku and Eludoyin, 2010). The shortage of iron causes disease called "anemia'' and prolonged consumption of drinking water with high concentration of iron may lead to liver disease called as haermosiderosis (Rajappa*et al.*, 2010; Bhaskar*et al.*, 2010). In this study, iron content varied from 0.1mg/l (GA05, GA08, GA17, GA49, GA52) to 0.5mg/l (GASP). Low iron concentration was recorded in 70% of the samples while the remaining 30% recorded values high for concentration of the iron content. Although, iron is an important dietary requirement in humans needed by hemoglobin and good for several other functions, when high concentrations of iron are absorbed, iron is stored in the pancreas, the liver, the spleen and the heart. This may damage those vital organs. The presence of excess iron in water imparts the taste and it also promotes growth of iron bacteria that hasten rusting process of all the ferrous metals that come in contact with the water (Chukwu*et al.*, 2008).

The concentration of manganese ranged from 0.01mg/l (present in 30% of the samples) to 0.05mg/l (GASP). 95% of the samples studied have values below the permissible levels for Manganese while the value recoded for sample collected from GASP was higher compared to the values from others. Excess manganese can interfere with absorption of dietary iron which can result in iron deficiency anemia, it also increase bacterial growth in water and excessive manganese intake can also cause hypertension inpatients older than 40.

Lead is the most significant of all the heavy metals because it is toxic, very common (Gregoriadou*et al.*, 2001) and harmful even in small amounts. Lead enters the human body in many ways. It can be inhaled in dust from lead paints, or waste gases from leaded gasoline. It is found in trace amounts in various foods, notably in fish, which are heavily subjected to industrial pollution. Some old homes may have lead water pipes, which can then contaminate drinking water. Most of the lead we take is removed from our bodies in urine; however, as exposure to lead is cumulative over time, there is still risk of buildup, particularly in children. Studies on lead are numerous because of its hazardous effects. High concentration of lead in the body can cause death or permanent damage to the central nervous system, the brain, and kidneys (Hanaa*et al.*, 2000). In this study, maximum level of lead concentration (0.03mg/l) was found in water sampled from GASP and a minimum concentration obtained was below detection level (0mg/l) from water sampled from GA04.the concentration of lead obtained from 95% of the samples are at low level of contamination while the concentration obtained from GASP was found to be slightly higher compared to the rest indicating the highest level of lead contamination.

Zinc is one of the important trace elements that play a vital role in the physiological and metabolic process of many organisms. Nevertheless, higher concentrations of zinc can be toxic to the organism (Rajkovic*et al.*, 2008). It plays an important role in protein synthesis and is a metal which shows fairly low concentration in surface water due to its restricted mobility from the place of rock weathering or from the natural sources (Rajappa*et al.*, 2010). In this study, a minimum of 0.01mg/l was recorded from five samples: GA08, GA10, GA41, GA49, and GA58 and maximum concentration of 0.05mg/l also recorded from five samples GA04,GASP,GA12, GA45, and GA51. This indicates that the concentration of zinc in the samples is both at highest and lowest at 23% while the concentration recorded from the remaining 50% ranged from 0.02mg/l to 0.04mg/l.Contamination of drinking water with high level of copper may lead to chronic anemia (Acharya*et al.*, 2008). Copper in excess could impart a bitter taste to water and promotes the corrosion of galvanized iron and steel fittings (Chukwu*et al.*, 2008). The concentration of copper detected in all the samples in this study is above the permissible limits of the WHO. The range was from 0.1mg/l (found in 35% of the samples) to 0.3mg/l (found in 15% of the samples). 50% of the samples have of concentration of 0.02mg/l, this indicates that a variation of 0.1mg/l exists within the level of pollution obtained from the samples. GASP and GA28 showed the highest concentration indicating that they have the highest level of pollution from copperIn this study, the concentration of cyanide obtained ranged from 0.00mg/l (found in 95% of the samples) to 0.7mg/l. Cyanide was only present in water samples collected from GASP, which is located within the cassava processing and milling local industry and is subjected to heavy pollution from cassava waste water effluent. The concentration of cyanide found is ascertained to be far beyond the required limit, therefore it is advised that the well should not be used for both domestic purpose and drinking purposes as cyanide is acutely toxic to humans, relatively low concentrations of cyanide can be toxic to people. It causes hypoxia, and lactate acidosis which can result in respiratory arrest. Cyanide poisoning also affects organs and systems in the body including heart.

VII. Conclusion

The aim of evaluating the quality of water from hand dug wells in Gambari, Ogbomoso was achieved by analyzing the physical and chemical parameters including the concentrations of certain heavy metals in the water samples collected from various locations within the community. From the results of the analysis, most of the parameters were not found averagely to deviate from the standard or found to be present in high concentrations except for conductivity, pH and concentration of copper. Also, most of the water samples were found to be at least at minimal satisfactory level except for GASP (located within a cassava processing and milling industry) that has ninety five percent (95%) of the parameters tested to be at unsatisfactory level. Therefore, it is advised that water from GASP should not be used at all because it is dangerous to use the water for domestic purpose and even for irrigation

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