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Determination Of Heavy Metals In Hand Dug Well Water Near Dumpsite InFadaman Mada Bauchi

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ABSTRACT

In this study, the level of Cadnium, Zinc, Lead, Silver, Nickel, and Chromium was determined in some selected wells near dumpsite in FadamanMada, (Kasuwan Rake) of Bauchi State. Heavy metals Determination was conducted by using Atomic Absorption Spectrophotometer (A.A.S) to know the extent of the concentration of these metals in well water located near the dumpsite. Six (6) water samples were collected from different wells which were analyzed for the above metals. The samples were preserved and digested. The results indicate that there was no trace of Nickel, however Chromium and Zinc were detected and fall within the permissible limits of World Health Organization (WHO) values of 0.05mg/l and 3mg/l. Cadmium, Silver and Lead were found to be above the permissible limits of (WHO) World Health organization values of 0.003mg/l, 0.10mg/l and 0.01mg/l respectively. These levels rendered the water unsafe for consumption due to the established adverse effects.

Keywords: *Heavy metals, Water, Spectrophotometer, Concentration and Samples.*

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INTRODUCTION

Fadaman Mada is located in Bauchi State Nigeria. In most developing countries of the world Solid waste disposal has been a chronic problem particularly in area with high population density. [1]. Human activities on earth give rise to residual materials which are not of immediate use where they arise. These residual materials may be recycled, reclaimed, or reused; otherwise they constitute waste which will ultimately be released to the environment in mobile form or insitu. [2]. The biosphere has the capacity to transform many wastes over time, either into harmless products or into nutrients which can be used again. However, the natural assimilative capacity of the environment can easily be exceeded if waste particularly from man's activities is not controlled. Waste is generated universally and is a direct consequence of all human activities. The disposal of solid waste into the land has been recognized as the major source of Ground water contamination. Waste disposal by land fill has led to pollution of ground water resources under a wide range of conditions around the globe [3].

Waste is defined as unwanted or undesired materials accumulating after the completion of a process [4]. Waste was also characterized as items that are no longer used for any significant function. They are classified as items with hazardous properties. Such hazardous wastes include household dump items, sewage, sludge, waste from manufacturing industries etc. [5]. The United Nations Environmental Programme Define waste as those materials which the initial user has no further use for either purpose of production, transformation or consumption and of which can be disposed off. [6].

Industrial revolution gave birth to the large volume of industrial chemical discharge which has added to the growing load of untreated domestic waste. The disposal of domestic, commercial and industrial garbage in the world is often a problem that continues to grow with human civilization and no method so far is completely safe. Experience has shown that all forms of waste disposal have negative consequence on the environment, public health and social economic. Dumpsite is an old traditional system of waste disposal similar to land fill method of waste Management. Dumpsite are often established in disused quarries, mining or excavated pits away from individual residence areas, designated government agency, cooperate bodies and some individual collect waste routinely into these dumpsite. Here in Nigeria, modern land fill facilities are not found in these dumpsite; consequently sorting out of waste into degradable and no degradable and recyclable precious materials cannot be achieved. Poor management of dumpsite could create a number of adverse environmental impact, including wind-blow litter, attraction of mice and pollutant such as leachate, which can pollute ground water. Land fill gas mostly is compose of methane and carbon dioxide are produce through biodegradation of such waste[7].

Water

Water is the world greatest natural resource, yet most people under value its worth. Diamond, gold and emerald are priced because they are so rare, yet none has the value of water, a chemical compound so common that it is found almost everywhere in the world. Approximately 70% of our body (human beings) is composed of water. Water is so vital that most people will die within 48 hours if they cannot replenish their water reserves. By comparison, most people can survive for a week or more without food. No living organism is less than 50 percent in comparison by water, and some 97 percent of water [8].

Hospital wastes are generated during the diagnosis, treatment or immunization of human beings and animals or in research activities in production or testing of biological analysis. These wastes are mainly in form of disposable syringe, swabs and bandages, body fluid, human excreta etc. This waste is highly infectious and can be a serious threat to human health[9].

Heavy Metals

Heavy metals are referred to as any metallic element that have relatively high density and is toxic or poisonous even at low concentration. Heavy metal is a collective term that applies to the group of metals and metalloids with atomic density greater than $4g/cm^3$ or 5times or greater than water. Their pollution of the environment, even at low levels and the resulting long – term cumulative health effects are among the leading health concerns all over the world [10]. They occur as natural constituents of the earth crust, and are persistent environmental pollutant since they cannot be degradable and destroyed, human activities effect geological and biological distribution of heavy metals through pollution of air, water, and soil. Human are also responsible for altering the chemical forms of heavy metals released to the environment. Such alteration often affect a heavy metal toxicity by allowing bioaccumulation in plant and animal. Heavy metals and chemicals accumulate in living things anytime they are taken up and stored faster than they are broken down[11].

Heavy metals become toxic when they are not metabolized by the body and accumulate in the Soft tissues. Heavy metals may enter the human body through food, water, air, or absorption through the skin when they come in contact with humans in agriculture and in manufacturing, Pharmaceutical, industrial, or residential settings. Heavy metal poisoning could result, for instance, from drinking-water contamination (e.g. lead pipes), high ambient air concentrations near emission sources, or intake via the food chain[12]. Some heavy metals like Ar, Cd and Pb have been reported to have no known bio-importance in human biochemistry and physiology and consumption even at very low concentrations can be toxic [10]. Heavy metals can enter a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater [12].

RESEARCH METHODOLOGY

Equipment and Apparatus

The equipment and apparatus used for the research include Atomic Absorption Spectrophotometer (AAS) (Buck Scientific, United States of America), Conical flask, Stop watch, Funnel, Wattman filter paper and Distilled water

Chemicals and Reagent

The following chemicals and reagents were used during the research analysis;
Hydrochloric Acid (HCL), (Ahmedabad Chemicals)
Nitric Acid (HNO_3)
Hydrogen peroxide (H_2O_2)
All glass and plastic wares used and were thoroughly washed with detergent solution and then rinsed with 5% Nitric acid, distilled water.

Sample Collection and Treatment

Six (6) samples were collected from Fadama Mada from different hand dug well water near dumpsite in a sterilize Polyethylene container, after collection it was taken to laboratory for analysis. The water from hand dug well near dumpsite after collection was treated with nitric acid to avoid precipitation of the heavy metals. The treatment was carried out by adding $10cm^3$ of nitric acid to 1L and stored in a refrigerator till it is needed for the analysis.

Digestion of Sample

Concentration of Cd, Cr, Pb, Zn, Ni and Ag in the digested water sample was estimated using (A.A.S) Atomic Absorption Spectrophotometer. This was carried out by measuring $100cm^3$ of the water sample into a $200cm^3$ volumetric flask and put in a conical flask, $5cm^3$ of concentrated nitric acid was added. The mixture was then slowly heated on a hot plate which was evaporated to about 20ml ensuring that the mixture did not boil. A further $5cm^3$ of concentrated nitric acid was added while heating continues until the solution becomes light colour and clear. Then a further $2cm^3$ of hydrochloric acid was added and heated lightly to dissolve any remaining residue and then few drops of hydrogen peroxide was added in drops to ensure complete digestion has taken place. Lastly the solution was filtered and the filtrate was transferred into a 100cm^3 volumetric flask and made to mark with distilled water, The digested samples obtained were used to determine the concentration of Chromium (Cr), Zinc (Zn), Cadmium Cd, Iron (Fe), Nickel (Ni) and Mercury (Hg) using Atomic Absorption Spectrophotometer (A.A.S).

Statistical Analysis

Data obtained were analyzed using descriptive statistics for the mean and standard deviation. One way ANOVA was used to test the significant differences in the concentration of heavy metals from the six different well water samples at ($p \leq 0.05$). It was observed that zinc and cadmium showed significant difference in their mean concentration, lead, silver and chromium showed no significant difference in their mean concentration whilst nickel was not detected.

Determination of Heavy Metals

The heavy metals (cadmium, nickel, silver, Arsenic and lead), were determined using the Atomic Absorption Spectrophotometer by following the standard procedure of AOAC. The buck scientific spectrophotometer VGP (Variable Giant Pulse) system model 210 was used. The VGP uses a time specific modulation of the Hollow Cathode Lamp (HCL) to produce energy pulse that contains information on both the sample (analyte) absorbance and background (matrix) absorbance. Atomic Absorption Spectrophotometer is based on the ability of an excited atom of an element to absorb energy from wavelength of light of the same frequency as the element. This creates a decrease in the initial signal energy and this difference is proportional to concentration of the element. Each element has its own series of specific wavelength. This wavelength will have specific characteristics for sensitivity, noise and linearity. Sensitivity and noise will determine the limit of detection for that element [13].

Principles and Instrumentation of the AAS

The technique makes use of absorption spectrometry to assess the concentration of the analyte in the sample. It relies therefore on the Beer-Lambarts law. In short, the electrons of the atoms in the atomizer can be promoted to higher orbital for a short amount of time by absorbing a set quantity of energy (I e light of a given wavelength). This amount of energy (or wavelength) is specific to a particular electron transition in a particular element, and in general, each wavelength corresponds to only one element. This gives the technique its selectivity. As the quantity of energy(the power) put into the flame is known, the quantity remaining at the other side (at the detector) can be measured, it is possible from Beer-Lamberts law, to calculate how many of these transitions take place, and thus get a signal that is proportional to the concentration of the element being measured [13]. In atomic absorption, there are two methods of adding thermal energy to a sample. A graphite furnace AAS uses a graphite tube with a strong electric current to heat the sample. In flame AAS; we aspirate a sample into a flame using a nebulizer. The flame is lined up in a beam of light of the appropriate wavelength. The flame (thermal energy) causes the atom to undergo a transition from the ground state to the first transition state. When the atoms make their transitions, they absorb some of the light from the beam (AOAC, 2003) the concentration is proportional to the light absorbed.

RESULT AND DISCUSSION

The determination of the concentration of cadmium (Cd), (Pb) Lead, (Ni) Nickel, (Cr) Chromium, (Ag) Silver and (Zn) Zinc from drinking well water close to dumpsite from different location in Fadama Mada Bauchi, Bauchi State are presented below;

Table 1: Mean concentration of some selected heavy metals (mg/L) in well water samples in FadamaMada (Kasuwan Rake) Bauchi, State.

FadamaMada	Mean concentration of heavy metal in (mg/L)					
	Cd	Ni	Zn	Ag	Pb	Cr
Well A	0.16 ± 0.02[a]	0.00 ± 0.00	0.88 ± 0.03[a]	0.15 ± 0.02	0.07 ± 0.01	0.01 ± 0.00
Well B	0.32 ± 0.01[b]	0.00 ± 0.00	0.06 ± 0.03[b]	0.17 ± 0.02	0.06 ± 0.01	0.01 ± 0.00
Well C	2.25 ± 0.01[c]	0.00 ± 0.00	1.96 ± 0.04[c]	0.21 ± 0.02	0.09 ± 0.01	0.02 ± 0.01
Well D	0.51 ± 0.02[d]	0.00 ± 0.00	0.33± 0.02[d]	0.22 ± 0.03	0.08 ± 0.01	0.01 ± 0.00
Well E	0.41 ± 0.00[e]	0.00 ± 0.00	0.36 ± 0.01[e]	0.28 ± 0.01	0.11 ± 0.01	0.01 ± 0.01
Well F	0.58 ± 0.00[f]	0.00 ± 0.00	0.50 ± 0.01[f]	0.11 ± 0.02	0.4 ± 0.01	0.003± 0.00

Value are mean ± standard deviation (n=3)

Values on the same column with the same letters are significantly the same (p≤0.05) as revealed by one way ANOVA. Values on the same column with different letters are significantly different (p≤0.05) as revealed by the same ANOVA and least significant difference test (p≤0.05).

Maximum Permissible limits of the various element by [14].

Heavy Metals	Permissible Limit (mg/L)
Cd	0.003
Ni	0.02
Zn	3.00
Ag	0.10
Pb	0.01
Cr	0.05

DISCUSSION

The mean concentration of Cadmium (Cd) in the water sample from well A, well B, well C, well E and well F are 0.16 ± 0.02, 0.32 ± 0.01, 2.25 ± 0.01, 0.51 ± 0.02, 0.41 ± 0.00 and 0.58 ± 0.00 mg/L. All samples from A to F where found to be above the permissible limit of (WHO) which is 0.003mg/L. Excess of Cadmium in the water samples may be as a result of the presence of cadmium containing waste substances such as batteries, television set, insecticide rubbers e.t.c Cadmium leads to various health effect such as kidney damage, it also effect the nervous system, causes damage to DNA and the immune system and enhance the development of cancer .it can also cause loss of sense, smell and taste ,shortness of breath, skeletal effect, hypertension and cardiovascular diseases [14]. Food is the main source of daily exposure to Cadmium.

Nikel is considered as one of the most essential trace element to human and animals. The concentration of Nickel was not detected in the well water samples from A to F, the maximum permissible limit for Nickel is 0.02mg/L.

The mean concentration of Zinc in well water samples from A to F are 0.88 ±0.03, 0.06 ± 0.03, 1.96 ± 0.01, 0.33 ± 0.02, 0.36 ± 0.01 and 0.50 ± 0.01mg/L and the permissible limit for Zinc is 3mg/l. All samples were found to be within the acceptable range of 3mg/L.

The mean concentration of Silver (Ag) in well water samples from well A to F are 0.15 ± 0.02, 0.17 ± 0.02, 0.21 ± 0.02, 0.22 ±0.03, 0.28 ± 0.01 and 0.11 ± 0.02 mg/LThe permissible limit for silver by (W.H.O) was found to be 0.1mg/L Therefore the concentration of Silver in the samples were found to be above the maximum permissible limit of (W.H.O). This may be as a result of Silver containing materials found in the waste.

The mean concentration of Lead (Pb) in the well water samples from well A to F are 0.07 ± 0.01, 0.06 ± 0.01, 0.09 ±0.01, 0.08 ± 0.01, 0.11 ± 0.01 and 0.4 ±0.01mg/L all concentration were found to be above the permissible limits of (W.H.O) which is 0.01 mg/L. Comparing with (John *et al*, 2013) it showed that the concentration of Lead (Pb) in both wet and dry season were above the permissible limit of (W.H.O).This can be as a result of lead containing materials in the waste close to the water area. Lead is a well-known poison and is one of the most significant toxicant of heavy metals and its inorganic form are absorbed by ingestion, food and inhalation, Lead is very toxic and has serious health problems even at low concentration[15].

The mean concentration of Chromium (Cr) from well A to E are 0.01 ± 0.00, 0.01 ± 0.00, 0.02 ± 0.01, 0.01 ± 0.00, ± 0.01 and 0.003 ± 0.00 mg/Lfrom the result above it is considered that all concentration of Chromium from well A to F fall within the acceptable limit of (W .H .O) which is 0.05mg/L.

CONCLUSION

Ground water is one of the major water sources in most village areas. The public use ground water for drinking purpose and the results from the determination of heavy metals in the well samples shows that Cadmium, Lead and Silver were found with high concentration level, which can cause health complication for people drinking from the well and also children are highly at risk drinking such water.

RECOMMENDATIONS

From the above research, contamination by Cadmium, Lead and Silver were observed and pose detrimental effects to human health and the environment. Therefore the following recommendations were made;

I. The environment should be kept clean by having proper disposal of Waste in Fadama'mada area Kasuwa rake.
II. Public awareness program should be considered to inform people of health risk of heavy metal contamination in water.
III. Sustainable technology should be used to improve drinking water quality of in rural area and also law income household.

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