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ASSESSMENT OF SOME SELECTED HEAVY METALS IN DRINKING WATER SAMPLES FROM GANDUN ALBASA, KANO MUNICIPAL LOCAL GOVERNMENT AREA, KANO

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Abstract: **Drinking water samples from boreholes (GDB), tap (GDT) and well (GDW) water from Gandun Albasa, Kano Municipal Local Government, Kano State, were collected, in which the concentration of heavy metals were analyzed/determined with the aid of standard analytical technique (Atomic Absorption Spectrophotometry). The results of the analysis obtained describes the concentration of Co which was found to be 0.0056 mg/L in GDB, 0.041 mg/L in GDT and 0.06 mg/L in GDW samples. The concentration of Cu is found to be 0.123 mg/L in GDB, 0.091 mg/L in GDT and 0.077 mg/L samples. Nickel concentration was found to be 0.074 mg/L in GDB, 0.038 mg/L in GDT and 0.077 mg/L in GDW samples. Pb concentration was not detected in all of the samples. Finally, Zn concentration was found to be 0.042 mg/L in GDB, 0.115 mg/L in GDT and 0.327 mg/L in GDW samples. The concentration of heavy metals analyzes were compared with WHO recommended limits and was found to be below the limits in all of the samples. It's evident based on this work that water samples analyzed from Gandun Albasa, Kano are safe for human consumption.**

Keywords: **Drinking water samples, standard analytical technique, (Atomic Absorption Spectrophotometry), human consumption.**

1. INTRODUCTION

1.1 RESEARCH BACKGROUND

Water is the only substance that exists naturally on earth in all three physical states of matter as gas, liquid, and solid and it is always on the move among them. The earth has oceans of liquid water and Polar Regions covered by solid water. Water is recycling constantly and the constant recycling of water from oceans, to atmosphere, to land surface, and back to the oceans again is known as the water or hydrologic cycle (Shakarishi, 2011).

The quality of drinking water is a powerful environmental determinant of health (WHO, 2010). Water plays an indispensable role in sustenance of life and it is a key pillar of health determinant, since 80% of diseases in developing countries are due to lack of good quality water (Cheesbrough, 2006). Drinking water quality management has been a key pillar of primary prevention for over one and half centuries and it continues to be the foundation for the prevention and control of water borne diseases (WHO, 2010). The functioning of an aquatic ecosystem and its stability to support life forms depend to a great extent on the physicochemical characteristics of its water. Water meant for drinking must therefore meet quality standards. Water quality is essentially determined by its physical and chemical characteristics.

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Contaminated water is a global public health threat placing people at risk of a host of diarrhea and other illness as well as chemical intoxication (Okonko *et al*., 2009). Naturally water contains some types of impurities whose nature and amount vary with source of water. Water contains variety of constituents such as microorganisms, gases, inorganic and organic materials, etc at different concentrations (Sundaram *et al*., 2009; SGS, 2012) which may constitute undesirable pollutant when they are not within the standard limit for drinking water (Nkamare *et al*., 2012). Anthropogenic contamination of the water even at the source is the second issue. For example, water contamination with trace metals can be related to pollution.

Industrial revolution that occurred in 1800 increased the extent of water pollution by human activities. Surface water bodies like rivers, rivulet streams and lakes are the first to receive trace elements generated by various industries and waste producing sources. Lower concentration of heavy metals in ground water indicate the metals accumulated mostly in the surface soil and only a small portion is leached to reach the ground water (Ganeshamurthy *et al*., 2008).

Heavy metals have become of particular interest in recent decades within the framework of environmental investigation. This has without doubt been due to the fact that highly sensitive analytical procedures are available for determining and detecting metal content with high precision. Medical geology is a subfield of geology that studies the effects of chemical in the environment, especially trace elements, on the health of humans and animals. The contribution of the geology is to help isolate environmental aspect that may influence the incidence of disease. Due to the significant important of water to the living organisms (both plants and animals) a lot of studies had been carried out to ascertain the quality of drinking water in different places all over the world, mainly by determination of heavy metals present due to their impact on human health.

World health organization estimates that safe water could prevent 1.4 million of about 5 million death caused by polluted drinking water each year (WHO, 2010).

1.2 STRUCTURE OF WATER

Water is a chemical compound made up of two gases namely: Hydrogen and Oxygen forming the liquid compound, in which two hydrogen atoms are bonded to one oxygen atom, it's molecular formula is written as H_2O and has several names among which are hydrogen monoxide, dihydrogen oxide, hydrohydroxic, hydroxic acid, hydrol, hydric acid, hydrogen hydroxide (HH or HOH) dihydrogen monoxide (DHMO) (Lenntech,2010).

Water molecules have a simple structure: two hydrogen atoms bonded to one oxygen atom (H_2O). This simple structure is responsible for water's unique properties. The bond between each hydrogen atom and oxygen atom results from a pair of electrons shared between the two atoms. In water, the electrons in the shared pair are not shared equally between the hydrogen and oxygen atoms. The oxygen atom has a greater affinity for electrons than those in the hydrogen atom. And the electrons in the O—H bond results in oxygen acquiring a partial negative (-) charge and hydrogen a partial positive charge (+). The H—O—H bond angle is 104.5^0, which means that the molecule has a **bent** shape or **V-shape.** This bent geometry and the accumulation of electrons on the oxygen side of the molecules cause the water molecule to have a negative charge on one side. Molecules with negative regions and positive regions are called Polar molecules, indicating that water molecules are polar molecules (Shakarishi, 2011).

1.3 PROPERTIES OF WATER

Water is a good polar solvent and is often referred to as universal solvent. Substances that dissolved in water include sugar, acid, salts etc. (Wikipedia, 2015). Other properties are shown in the table below.

Table 1.1: Some properties of water

S/N	Properties	Values
1	Boiling point	100^oC
2	Melting/Freezing Point	0^oC
3	Dielectric constant at 20^oC	80.18
4	Heat of ionization	55.71kJ/mol
5	Refractive index at 20^oC	1.3325
6	Ionic dissociation constant	10-4

7	Heat of formation at 18ºC	285.89kJ/mol
8	Heat of vaporization at 100ºC	40.651kJ/mol
9	Molecular weight	18.015g
10	Specific heat at 0ºC	4.179 J/g
11	Max density	0.998
12	Heat of fusion at 0ºC	4.179kJ/mol

(Uduma, 2008)

1.4 IMPORTANCE OF WATER

All Things are Water (Aristotle attributed this teaching to Thales of Miletus, the first known Greek philosopher, scientist and mathematician. Thales lived approximately 624-546 BC).

Water is one of the most vital substances needed to sustain human, animals, and plants life. All plants and animals must have water in order to survive. If there is no water there would be no life on earth. It is part of the physiological process of nutrition and waste removal from cells of all living things. It is one of the controlling factors for biodiversity and the distribution of Earth's varied ecosystems, communities of animals, plants, and bacteria and their interrelated physical and chemical environments. In terrestrial ecosystems, organisms have adapted to large variations in water availability. Water use by organisms in desert ecosystems is vastly different from those in forest ecosystems. A person can live no more 4 to 5 days without water, and we rely on it for drinking, cooking, washing, bathing, growing food, industry, mining, recreation as well as generation of an electric power (Hydroelectric). Like air we breathe, water is also essential to our daily life activities. Water in all three states makes a large contribution to the planet's climate. Water vapor is a greenhouse gas that traps energy radiated from the surface of the planet and helps to keep the planet warm enough to sustain the complex life that has evolved in this environment. Water vapor is responsible for more than half the Earth's greenhouse gas warming. It is the major constituent of the body , in fact water account for about 70-80% of weight of most tissues like muscles, brain, liver, etc. the average water content of all body as a whole is about 61% in a normal adult (Stephen J. Vandas, 2002).

Water is vital both as a solvent in which many of the body's solutes dissolve and as an essential part of many metabolic processes within the body. It is used to break bonds in order to generate smaller molecules like glucose, fatty acids and amino acids to be used as fuels for energy use. Most of the living organisms can survive only for short periods without water. It plays a key role in prevention of diseases; drinking 8 glasses of water per day can decrease the risk of colon cancer by 45% and bladder cancer by 50% (Oporaocha *et al*, 2010).

Water serves as a habitat for thousands of plant and animal species. It serves as a reservoir of air for intake by aquatic plants and animals. It also serves as a food directly or indirectly to living organisms because without water nutrition cannot continue (Awake, 2001).

Water plays an important role in the world economy, as it functions as solvent for a wide variety of chemical substances and facilitates industrial cooling and transportation. It is also needed for tanning, fermenting, brewing, and pharmaceutical preparations.

Water plays an important role during irrigation; irrigation is simply the artificial application of water to the land or soil. It is used to assist the growing of agricultural crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areas and during periods of inadequate rainfall.

The fact that water is basic for existence of human, plants and other animals, inadequate provision of water pollutions caused by solid waste and effluents from various sources such as abattoirs, chemical industries, tanneries, homes and farms etc make it necessary for people to look for alternative sources of water that is clean and pure (Said, 2008).

1.5 SOURCES OF WATER

1.5.1 Rainfall

Rainfall is the main natural source of water otherwise known as the prime source of all water. Rainfall is measured by an instrument known as the **rain gauge.** A part of the rain water sinks into the atmosphere, and some runs off to form streams and rivers which flow ultimately into the sea. Some of the water in the soil is taken up by the plants and is evaporated in turn by the leaves. These events are spoken of as "water cycle" (Park, 1997).

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1.5.2 Surface Water

This type of water is found in streams, lakes, wetlands, ponds, rivers, fresh water, and reservoirs. This is the remnants water after evaporation and seepage. This type of water may contain sand, micro-organism, small amount of ions, decaying organic matter remnants and other impurities. The amount of available surface water depends largely upon rainfall. When rainfall is limited, the supply of surface water will vary considerably between wet dry years (Okedi, 1997). The pollution of this type of water due to animal or human activities is frequent and increasing (Oni, 1997).

Surface water such as river water undergo self-purification naturally such as sedimentation, aeration, dilution, plants and animals lives, however these agencies are not sufficient to make the water safe for consumption.

1.5.3 Underground Water

This kind of water lies under the surface of the land, some of which seeps through the soil on to the non-porous rocks below, where it travels through and fills openings in the rocks. The rocks that store and transmit groundwater are called aquifers. Groundwater must be pumped from an aquifer to the earth's surface for use. Groundwater is the cheapest major source of water for various communities. This type of water depends on both current and historic geology, rainfall and geomorphology/weathering of a location, and it is usually available even during dry season.

Groundwater requires minimal treatment or no treatment at all due to its excellent chemical and microbiological quality. Groundwater is protected from contamination by geological filters that remove pollutants from water as it is percolated through the soil. This type of water is often considered to be fairly safe for consumption as it usually occurs below the surface and not typically in contact with atmosphere, compare to surface water (Quist, 1998).

Hence usable anthropogenic natural factors are affecting the quality as well as quantity of this valuable resource. It has been estimated that once pollution enters the sub-surface environment it may be concealed for many years becoming dispersed over wide areas of ground water aquifer, rendering ground water supplies unsuitable for consumption and other uses (Deshpande and Aher, 2012).

1.6 WATER POLLUTION

The contamination of water is hazardous to humanity both directly and indirectly as water is part of our daily necessity. Water can be polluted by microorganism such as bacteria as well as with chemical elements. Metals contamination is one of the major environmental problems in many countries and those contaminants generally come from various industries like leather, agricultural, textile industries and so on (Ganguli, 2002).

Water pollution is a major in the global context (Yang, 2004). It has been suggested that it is the leading worldwide cause of deaths and diseases. And that it accounts for the deaths of more than 14,000 people daily (World Bank, 1990).

1.7 WATER QUALITY

Water quality refers to the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use. It is most frequently used by reference to a set of standard against which compliance can be assessed. Water has many uses such as for drinking, recreation, fisheries, agriculture and industry. Each of this designated uses has different defined chemical, physical and biological standards necessary to support that use. For example, higher standards are used for water meant for drinking. The guideline value for drinking water quality developed by WHO, forms a reference standard for developing national Standards. The NAFDAC/SON and other health institution standards on drinking water quality are such guidelines. Guideline values have been set for potentially hazardous water constituents and provide a basis for assessing drinking water quality. A guideline value represents a concentration of a constituent that does not result in any significant risk to the health of the consumer over the life time of consumption (WHO, 1999).

The problems associated with chemical constituent of drinking water arise primarily from their ability to cause adverse health effects after prolonged periods of exposure some particular concern are contaminants that have cumulative toxic properties, such as heavy metals, and substances that are carcinogenic (DEWO, 1989). The use of chemical disinfectants in water treatments or construction materials used in water supply system, usually results in the formation of the chemical by-products, some of which are potentially hazardous (IARC, 1990; AWA, 1990). Some of the parameters considered for water quality include odor, turbidity, pH, alkalinity, hardness, conductivity, taste, color, total suspended solids, sulphates, metals such as Ca, Mg, Zn, Pb, Fe etc. (Hammer and Kenneth,1981).

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1.8 HEAVY METALS

Heavy metals are also known as trace elements (Khan, 2011). Heavy metals have several definitions as viewed from different but similar angles. Some of the definitions were proposed based on the atomic number or weight, chemical properties, density or toxicity. Metals are inorganic substances that occur naturally in geological formations. Heavy metals refer to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentration (Lenntech, 2010).Toxic heavy metal is any relatively dense metal or metalloid that is noted for its potential toxicity especially in environmental contexts. Heavy metals have little to do with density but great concern is paid to the chemical properties of the elements (Duribe, 2007). Heavy metals include Arsenic (As), Cadmium (Cd), Lead (Pb), Zinc (Zn), Nickel (Ni), Lithium (Li), Selenium (Se), Vanadium (V), Molybdenum (Mo), Cobalt (Co), Chromium (Cr) and others.

Heavy metals are dangerous because they tend to bio accumulate. Bio accumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical concentration in the environment. Compounds accumulate in living things anytime they are taken up and are stored faster than they are broken down (metabolized) or excreted.

Heavy metals are natural component of the earth's crust. They cannot be regarded nor destroyed. To a small extend they enter our bodies via food, drinking water, air, animal flesh. Some of these heavy elements such as Cu, Se, and Zn are essential for maintaining the metabolism of the human body and are naturally available in our food and water. However, at higher concentrations they can lead to poisoning. Heavy metals poisoning could result from ingestion or inhalation.

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 and ground water.

Natural contamination of heavy metals usually originates from weathering of minerals, rocks and aquatic environment which result in the entry of heavy metals into water bodies. Disposal of industrial effluents, wastes (domestic and industrial), such as sewage sludge and mining effluents are other causes of contamination (Imam, 2012). Usually in unaffected environments the concentration of most of the metals is very low and is mostly determined by the mineralogy and the weathering of that area (Nouri *et al*., 2008).

In today's industrial society there is no escaping exposure to toxic chemicals and metals. Chronic exposure comes from lead in paint and tap water, chemical residue in processed foods, and in personal care products such as cosmetics, shampoo, mouthwash, toothpaste, and soap (Dara, 2006). Heavy metals can cause serious health effects with varied symptoms depending on the nature and quantity of the metal ingested (Adepoju and Alabi, 2005), they produce their toxicity by forming complexes with proteins, in which carboxylic acid (—COOH), amine (—NH_2), and thiol (—SH) groups are involved, These modified biological molecules lose their ability to function properly and result in the malfunction or death of the cells. When metals bind to these groups, they inactivate important enzyme systems or affect protein structure, which is linked to the catalytic properties of enzymes (Momodu and Anyakora, 2010).

1.8.1 Copper

Copper is a chemical element with the symbol **Cu** (from Latin: *cuprum*) it has atomic number of 29, atomic weight of 63.546, melting point of 1,083 °C (1,981 °F), boiling point of 2,567 °C (4,653 °F), and density of 8.96 at 20 °C (68 °F). It is a soft, malleable, and ductile metal with very high thermal and electrical conductivity. A freshly exposed surface of pure copper has a pinkish-orange color. Copper is used as a conductor of heat and electricity, as a building material, and as a constituent of various metal alloys, such as sterling silver used in jewelry, cupronickel used to make marine hardware and coins, and constantan used in strain gauges and thermocouples for temperature measurement.

Copper is one of the few metals that can occur in nature in a directly usable metallic form (native metals). This led to very early human use in several regions, from 8000 BC. Thousands of years later, it was the first metal to be smelted from sulfide ores, 5000 BC; the first metal to be cast into a shape in a mold, 4000 BC; and the first metal to be purposely alloyed with another metal, tin, to create bronze, 3500 BC.

In the Roman era, copper was mined principally on Cyprus, the origin of the name of the metal, from *aes cyprium* (metal of Cyprus), later corrupted to *cuprum* (Latin). *Coper* (Old English) and *copper* were derived from this, the later spelling first used around 1530.

Toxic effect of Copper

Gram quantities of various copper salts have been taken in suicide attempts and produced acute copper toxicity in humans, possibly due to redox cycling and the generation of reactive oxygen species that damage DNA. Corresponding amounts of copper salts (30 mg/kg) are toxic in animals. A minimum dietary value for healthy growth in rabbits has been reported to be at least 3 ppm in the diet. However, higher concentrations of copper (100 ppm, 200 ppm, or 500 ppm) in the diet of rabbits may favorably influence feed conversion efficiency, growth rates, and carcass dressing percentages. Elevated copper levels have also been linked to worsening symptoms of Alzheimer's disease.

1.8.2 Zinc

Zinc is a chemical element with the symbol Zn and atomic number 30. It has Atomic mass of 65.37 g/mol, Electronegativity of 1.6, density of 7.11 $g.cm^{-3}$ at 20°C, melting point of 420 °C, and boiling point of 907 °C. Zinc is a slightly brittle metal at room temperature and has a silvery- greyish appearance when oxidation is removed. It is the first element in group 12 (IIB) of the periodic table.

Toxic effect of Zinc

Although zinc is an essential requirement for good health, excess zinc can be harmful. Excessive absorption of zinc suppresses copper and iron absorption. The free zinc ion in solution is highly toxic to plants, invertebrates, and even vertebrate fish.

1.8.3 Nickel

Nickel (Ni) is lustrous white ferromagnetic metal. It occurs in five isotopic forms ^{58}Ni (67.8%), ^{61}Ni (1.2 %), ^{62}Ni (3.7%), and ^{64} Ni (1.2%). Nickel has melting point of 1555ºC, boiling point of 2837ºC and specific gravity of 8.90g/cm^3 (Morgan and Flint, 1989). Metallic nickel is not affected by water but slowly attacked by dilute Hydrochloric acid. i.e. 2Ni(s) + 2HCl (aq) → $2NiCl_{2\,(aq)} + H_{2\,(g)}$ or sulfuric acid i.e $Ni_{(s)} + H_2SO_4 \rightarrow NiSO_4 + H_{2\,(g)}$ and is readily attacked by Nitric acid i.e $Ni_{\,(s)} + 2HNO_{3(aq)} \rightarrow Ni\,(NO_3)_{2(aq)} + H_{2(g)}$. Nickel usually has two valence electrons but do exist in oxidation state of +1, +3 or +4 (Haudrechyet, 1994).

Toxic effect of nickel

Nickel toxicity is usually low, but elevated levels have been reported to cause sub-lethal effects (Nussey *et al*., 2000). Among the known health-related effects of Ni are skin allergies, lung fibrosis, variable degrees of kidney and cardiovascular system poisoning and stimulation of neoplastic transformation. Nickel sulphide fume and dust is believed to be carcinogenic, and various other Ni compounds may be as well (Kasprzak *et al*., 2003). The toxicity of Ni carbonyls is a function of both the toxicity of the metal as well as the carbonyl's ability to give off highly toxic carbon monoxide gas, being explosive in air (Nussey *et al*., 2000)

1.8.4 Lead

Lead is one of the limited classes of elements that can be described as purely toxic. Many other elements including heavy metals such as chromium, manganese, molybdenum, nickel, and selenium although toxic at high levels are actually required as nutrients at lower levels. This is clearly not the case for the lead. The main environmental source of lead exposure are paints, leaded gasoline, plumbing fixtures, contaminated soil and air, ceramics and lead crystal. Most people are exposed to more than one source of lead. There is no exposure level below which lead appears to be safe (Levander, 1977).

Lead is a serious cumulated body poison (ASTM, 2004). It is not commonly found in natural water. If present it is normally found in trace amount (APHA, 1985). Presence of lead in water may be from industrial mine and smelter discharges or from the dissolution of old lead plumbing materials (APHA, 1985). Other common sources of lead intake are food; air and tobacco smoke (Edward, 1980).

Measurement of lead in water is very important, because lead taken into the body by either brief or prolong exposure can seriously injure health or cause death (Gordon and Russell, 1976).

Toxic effect of lead

Human exposure to lead results to wide range of biological effects depending on the level and duration of exposure. In recent times, deaths arising from lead poisoning have continued to pose a great challenge to health experts. The recent UN report that, more than 400 children in Zamfara State, Northern Nigeria died from complications arising from lead poisoning. Lead poisoning is a medical condition caused by increased levels of metal lead in the body. While poison interferes with a variety of body processes, it is also toxic to many organs and tissue including the heart, bones, intestines, kidneys, as well as reproductive and nervous (Daily Trust,2013).

However, the general belief is that the poison gets into these organs through polluted air, water, soil, food, and consumer products, while the symptoms of the illness manifest themselves in the abdominal pains, he ache, and irritability a among others. In severe cases, lead poisoning could result in coma and subsequent death of the victim (Daily Trust, 2013).

1.8.5 Cobalt

Cobalt is a chemical element with the symbol Co and atomic number 27. Like nickel, cobalt is found in the Earth's crust only in a chemically combined form, save for small deposits found in alloys of natural meteoric iron. The free element, produced by reductive smelting, is a hard, lustrous, silver-gray metal.

Uses of cobalt

Cobalt is used in electroplating for its attractive appearance, hardness, and resistance to oxidation .It is also used as a base primer coat for porcelain enamels. Cobalt is essential to the metabolism of all animals. It is a key constituent of cobalamin, also known as vitamin B 12, the primary biological reservoir of cobalt as an ultra-trace element. Bacteria in the stomachs of ruminant animals convert cobalt salts into vitamin B 12, a compound which can only be produced by bacteria or archaea. A minimal presence of cobalt in soils therefore markedly improves the health of grazing animals, and an uptake of 0.20 mg/kg a day is recommended because they have no other source of vitamin B 12.

1.9 Beneficial Effects of Heavy Metals

In small quantities, certain heavy metals are nutritionally essential for a healthy life. Some of these are referred to as the trace elements (e.g., iron, copper, manganese, and zinc). These elements, or some form of them, are commonly found naturally in foodstuff, in fruits and vegetables, and in commercially available multivitamin products (International Occupational Safety and Health Information Centre, 1999). Diagnostic medical applications include direct injection of gallium during radiological procedures, dosing with chromium in parenteral nutrition mixtures, and the use of lead as a radiation shield around x-ray equipment (Roberts, 1999). Heavy metals are also common in industrial applications such as in the manufacture of pesticides, batteries, alloys, electroplated metal parts, textile dyes, steel, and so forth (International Occupational Safety and Health Information Centre, 1999).

Many of these products are in our homes and actually add to our quality of life when properly used.

1.10 Literature Review

The study of heavy metals and other kinds of metals contamination in drinking water sample has been done by many researchers. It involves types of water like water from the river, tap water, lake, dam, and others. Most of the results have shown that heavy metals exist in these samples of water but the concentrations of their contamination are different and some of the results do not detect the existence of heavy metals in water samples.

Water being one of the most vital elements to life, its pollution has been a common concern globally leading to various studies on the possible contaminants.

A studied carried out in Kano metropolis by (Said, 2008) in water samples, in which heavy metals concentrations were measured, ten samples from borehole, dams and well water were analyzed using Atomic Absorption Spectroscopy (AAS). It was found that zinc level was 5.308± 5.27μgL^{-1}, the cadmium level was found to be 0.382± 0.25μgL^{-1}, and the lead level was 1.561±0.54μgL^{-1}, while the copper level was found to be 1.164±0.43μgL^{-1} and other elements such as Na, Fe most which their mean concentrations were below the WHO threshold limits.

A studied carried out in Agepanu and environs, Edo, Nigeria by (Chinyem, 2010) in which the concentrations of some trace elements such as Cd, Ni, Cu, Zn, Pd and Cr were, determined in the surface and underground water samples. The concentrations of the elements were found to be below the WHO and FMEV safe limits, except Cr which was slightly higher than the safe limit in Afiangbe.

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According to Jimoh and Sholadoye (2011) minerals and trace metals are very essential to the body system in permissible concentration but in excess, they pose threats to human health. Metals in drinking water may occur naturally or may also be as a result of contamination through many sources which include rocks and soil matter dissolution, corrosion of pipes and pumps, agricultural activities (such as use of manure, organic and inorganic fertilizers, herbicides and pesticides), industrial activities (mining, manufacturing and processing industries, fuel leakages etc) (WHO, 2011) and leakages from waste disposal sites (Skeat, 1969; Jimoh and Sholadoye, 2011).

The study about the determination of the total content of Cd, Cu, Pb, Fe, Ni and Co in tap water sample has been done by Farghaly (2013). The result of the study indicate that metal ion concentrations values in tap water at Assiut City was below the recent proposed criteria for water quality and below safety baseline levels of the World, European, American Chemical Standards and the Egyptian Chemical Standard of Ministry of Health. It could be concluded that no effect was observed (approximation 15%) for Zn, Pb and Cu ion concentrations.

Abdurrahman I. Alabdula'aly, (2011) conducted a chemical analysis on heavy metals in groundwater sample, 17 metals were analyzed using Inductively Coupled Plasma Spectrophotometer (ICP). Which include Ba, Ni, Pb, Se, Zn, Be, Cd, Cr, Cu, Fe, Ag, Mn, Al, As, V, Mo and Hg in their well water used for drinking purposes in Riyadh region in the Kingdom of Saudi Arabia. The results indicated the presence of iron in all sampled wells. Its concentrations exceed the Maximum Contaminant Level (MCL) in 46.5% of the samples. Mn, Al, Se, Ba and Hg exceeded the MCL in 18.0, 2.5, 8.5, 0.5 and 19.5% of the total samples respectively. It is recommended that an adequate and suitable treatment must be applied to the wells having elevated concentrations of the metals and supplying drinking water to the consumers.

Balakrishna *et al*., (2008) conducted an analysis to evaluate the groundwater quality questioned as a result of the renowned dyeing activity taking place, twenty water samples were collected around Kancheepuram town in Tamil Nadu were analyzed with reference to drinking and irrigation purposes. The result indicated that the levels of chloride, sulphate, iron, total hardness and lead were found to be high and exceed the permissible limits of WHO and BIS standards.

Abolude *et al*. (2009) investigated the distribution of trace elements in Kubanni Reservoir in Zaria (7°38' and 11°11') between November 2002 and April 2004 using Atomic Absorption Spectrophotometer (AAS). The trace elements detected in the water were calcium, iron, manganese, zinc, chromium, cobalt, nickel, copper, cadmium and lead. Mean monthly concentrations of trace elements that ranged from 0.021-1.00mg/L were Cd, Cu, Cr, Zn and Mn. While trace elements that ranged from 1.22-2.36mg/L were Pb, Ni, Co, and Fe. Elements like Zn, Cu, Ni and Pb had higher concentrations in the dry season than the rainy season. Anova showed that there were significant variations between the months, stations, seasons, months versus stations and seasons versus stations. On the other hand, the concentrations of Fe, Mn and Cr were significantly higher in the rainy season than the dry season. Water temperature showed high significant positive correlation with Fe, Mn, Cr, Co and Pb. Furthermore, water temperature showed significant negative correlation with Zn and Ni ($P<0.01$). A noteworthy observation was that seven (Fe, Mn, Cr, Co, Ni, Cu and Pb) out the nine trace elements determined exceeded maximum permissible concentration for drinking water.

Usman *et al.* (2010) analyzed water samples from Amba River in Nassarwa State for some trace metals using Atomic Absorption Spectrophotometric (AAS) method. The results of the analysis were compared with World Health Organization (WHO) and European Union's (EU's) standards for domestic water. The concentration levels of Copper, Zinc and Manganese were found to be within the permissible limit while those of Lead, Chromium, Cadmium and Iron were above the tolerable limit.

Soylak *et al* (2001) evaluated major and minor ions in the drinking water supplied to the city of Yozgat and its surrounding villages in Turkey, in order to ascertain water quality for human consumption. Standard methods were used to determine the chemical and physical characteristics of the water samples. Cu, Fe, Pb, Ni and Mn contents of the drinking water samples were determined by Atomic Absorption Spectrophotometer (AAS) after preconcentration on Diaion HP-20 resin column. The data showed the variation of the investigated parameters in water samples as follows: pH 6.90-8.13, conductivity (EC) 57.3-694.5 us/cm, calcium 15-120 mg/L, magnesium 3-47 mg/L, chloride 11-77 mg/L, bicarbonate 180-701 mg/L, hardness 50-330 mg $CaCO_3$/L, total alkalinity 150-575mg/L, Cu 0.17-1.19 µg/L, Fe 16.11-79.30µg/L, Pb 0.18-0.99µg/L and Mn 0.15-2.56µg/L. Ni Concentrations of investigated parameters in the drinking water samples from Yozgat were within the permissible limits of the World Health Organization drinking water quality guidelines and the Water Pollution Control Regulation of the Turkish authorities.

1.11 Aim and Objectives

1.11.1 Aim

The aim of the study is to determine the level of some heavy metals (Co, Cu, Ni, Zn, and Pb) present in drinking water samples from Gandun Albasa area, Kano Municipal Local Government, Kano State.

1.11.2 Objectives

- To ascertain the quality of drinking water from some selected areas of Gandun Albasa, Kano Municipal Local Government using Atomic Absorption Spectrophotometer (AAS).
- Establishing the constituent purity of the water by comparing the results with the standards sets by health organizations such World Health Organizations (WHO) and Standard Organization of Nigeria (SON) guidelines for drinking water standards to ascertain their suitability for drinking and domestic purposes.

2. MATERIALS AND METHOD

2.1 MATERIALS AND INSTRUMENTS

- Atomic Absorption Spectrophotometer
- Beaker
- Camping gas
- Conical Flask
- Filter paper
- Funnel
- Measuring cylinder (10, 100 & 1000) cm^3
- Micro pipette
- Pots
- Sample bottle
- Sand bath
- Stirrer
- Volumetric flask (100 & 1000) cm^3.

2.2 REAGENTS

- Concentrated Nitric Acid (Analar grade)
- Distilled water.

Distilled water and Reagents of Analar grade were used throughout the study. The apparatus and glass wares were thoroughly washed and dried. Three water samples (Borehole, Tap, and Well) were analyzed using Atomic Absorption Spectrophotometer (AAS).

2.3 STUDY AREA DESCRIPTION

The study area, Gandun Albasa is situated in Municipal Local Government, Kano State. The city is among those with relatively large population in Nigeria, for this reason and the rate at which refuse disposal and waste are improperly handle, the concentrations of contaminants including heavy metals are expected to be high such region.

2.4 SAMPLE COLLECTION

Three (3) water samples were collected from various sampling sites within Gandun Albasa area, Municipal Local Government, Kano. The water samples used are: borehole water, tap water and well water from different regions of Gandun Albasa area. The samples were collected in clean polyethene plastic containers which were rinsed with the respected water before collection. Each sample was labeled immediately after collection. The samples were labeled as GDB, GDT, and GDW. Each sample was collected three times at an interval to represent the whole water for that particular area (Jimoh, 2011).

2.5 SAMPLE TREATMENT

The samples were first boiled and allowed to settle down then followed by decantation. Exactly 1 liters of each sample were measured and transferred to the new pot for evaporation on sand bath, when the samples are reduced to about a 50 ml are then transferred to a Pyrex beaker/Conical flask for the completion of the evaporation to dryness (Jimoh, 2011).

Each of the evaporated samples was dissolved in a beaker with 30ml of 0.25M HNO_3. Their solutions were filtered into a volumetric flask after which they were transferred into 60ml sample bottle and the samples were made up to 50ml with 0.25M HNO_3.

2.6 PREPARATION OF REAGENT

In the preparation of reagent, all glass wares were washed with detergent, rinsed with water and were also rinsed with distilled water, the chemical of analytical grade purity and distilled water were used.

2.7 PREPARATION OF 0.25 M NITRIC ACID

11ml of the concentrated analytical grade nitric acid was dissolved by transferring it into a $1000cm^3$ volumetric flask and made to the mark with distilled water.

2.8 SAMPLE ANALYSIS

Presence and concentration of the 5 metals (Pb, Zn, Co, Cu, Ni) were analyzed in each of the sample solution using Atomic Absorption Spectrophotometer (PerkinElmer PinnAAcle 900h AAS).

2.9 PROS OF AAS

- **Accuracy:** AAS is a great method of producing accurate results, normally with a rate of 0.5-5%, or an even better rate if appropriate standards are used.
- **Sensitivity:** An incredibly sensitive method of detection, AAS can actually measure all the way down to parts per billion of a gram in a substance. As such, it has revolutionized the way certain practices are carried out, in all sorts of fields. For example, in medicine, it can be used to detect trace toxin levels of atmosphere or medication. Similarly, in pharmaceuticals, the undesirable trace elements of a catalyst that had sometimes been present in the final product can now be detected. And in agriculture, AAS has been used to identify trace elements that we were previously unaware of, such as cobalt or molybdenum, and to identify their importance, presence or absence in soil.
- **Cost:** Since AAS often uses less argon than other methods, running costs are often lower.
- **Accessibility:** Due to the process relying upon radiation and light absorption, it can reach previously inaccessible places. For example, miners can now use AAS to determine if a rock contains enough elements of gold or other precious metals to be worthwhile mining.

2.10 CONS OF AAS

- **Lack of Versatility:** Most AAS practices are more geared towards testing liquids rather than solids. This is because the substance has to be vaporized before it can be analyzed. Liquids lend themselves to this much more than solids, some of which take a very long take to be dissolved and some of which do not support dissolution at all. Furthermore, the techniques which do allow for solid-substance testing cannot be used on non-metals. For a closer look at the relationship between solids and liquids in AAS, please see this article: Overview of Most Commonly Used Analytical Techniques for Elemental Analysis.

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- **Equipment:** Though the equipment is often more portable than previous instrumentation, it also often comes with a heftier price tag, making it unfeasible for widespread lab use.
- **Precision:** Other chemicals that are found in the sample or in the surrounding atmosphere can have an interfering and distorting effect on the results of the study.

2.11 INSTRUMENTATION

PerkinElmer Pin AAcle 900h was used in this study. AAS uses the absorption of light to determine the concentration of specific metal atoms in a solid or liquid by vaporizing the sample in a flame (FAAS) or graphite furnace (GFAAS). The ground state free metal atoms are excited by a specific wavelength of light, with the amount of energy absorbed proportional to the number of atoms of that element in the sample. The difference between the sample and the background absorption is then measured, and compared with the absorption of a series of standard solutions.

Fig. 2.1: PerkinElmer Pin AAcle 900h

3. RESULTS AND DISCUSSIONS

3.1 RESULTS

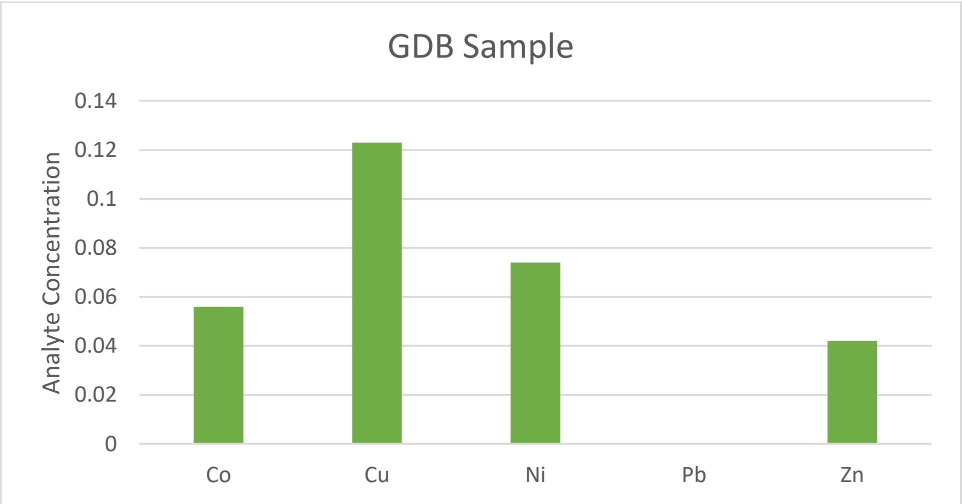

Figure 3.1: A graph of Analyte concentration in GDB sample

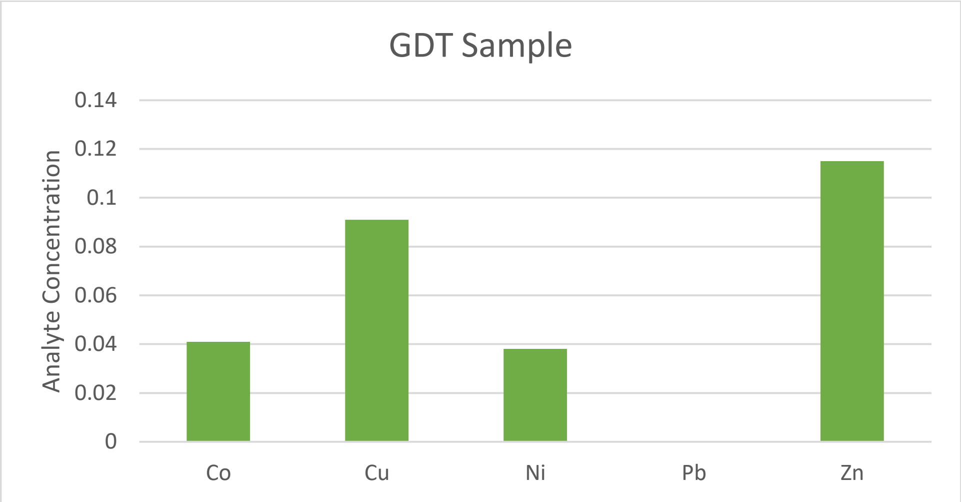

Figure 3.2: A graph of Analyte concentration in GDT sample

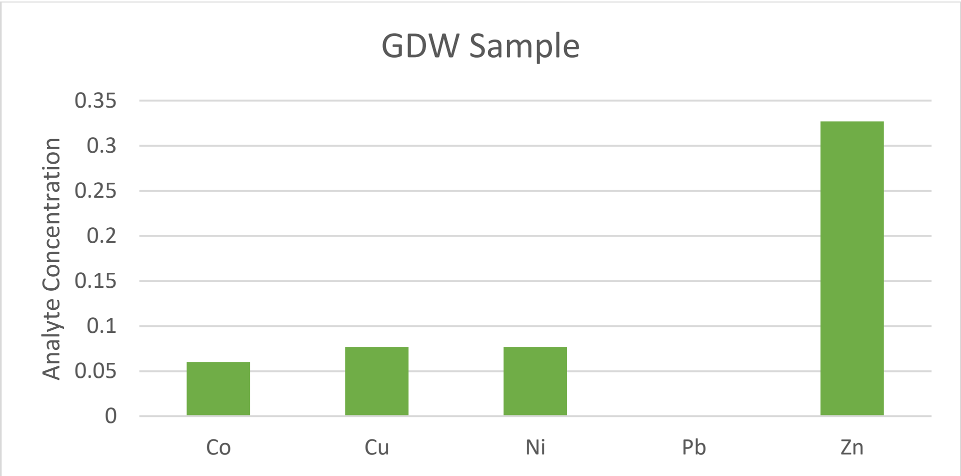

Figure 3.3: A graph of Analyte concentration in GDW sample

Table 3.1: Results of GDB (Borehole Water) Samples Analyzed in (mg/L)

Analyte	Concentration
Co	0.056
Cu	0.123
Ni	0.074
Pb	0.000
Zn	0.042

Table 3.2: Results GDT (Tap Water) Samples Analyzed in (mg/L)

Analyte	Concentration
Co	0.041
Cu	0.091
Ni	0.038
Pb	0.000
Zn	0.115

Table 3.3: Results of GDW (Well Water) Samples Analyzed in (mg/L)

Analyte	Concentration
Co	0.060
Cu	0.077
Ni	0.077
Pb	0.000
Zn	0.327

3.2 DISCUSSION

The use of water for any purpose is guided by standard set by the World Health Organization (WHO) and other related agencies.

The analytical results obtained were compared with World Health Organization limits (WHO, 2011) & Standard Organization of Nigeria. All the heavy metals analyzed were considerably below the permissible limit of WHO's drinking water standard (WHO, 1993).

Table 3.4: WHO Limits (Recommended and Maximum permissible) for some metals in drinking water

S/N	METALS	RECOMMENDED VALUE (mg/L)	PERMISSIBLE VALUE (mg/L)
1.	**Co**	**0.05**	**10.0**
2.	**Cu**	**0.20**	**5.0**
3.	**Ni**	**0.50**	**2.0**
4.	**Pb**	**0.01**	**0.1**
5.	**Zn**	**2.0**	**5.0**

3.2.1 Cobalt

Co was detected in all the samples with the highest concentration found to be 0.060 mgL^{-1} was detected in sample **GDW** and the lowest concentration of 0.041 mgL^{-1} was detected in sample **GDT** as shown in the figure 3.4 below.

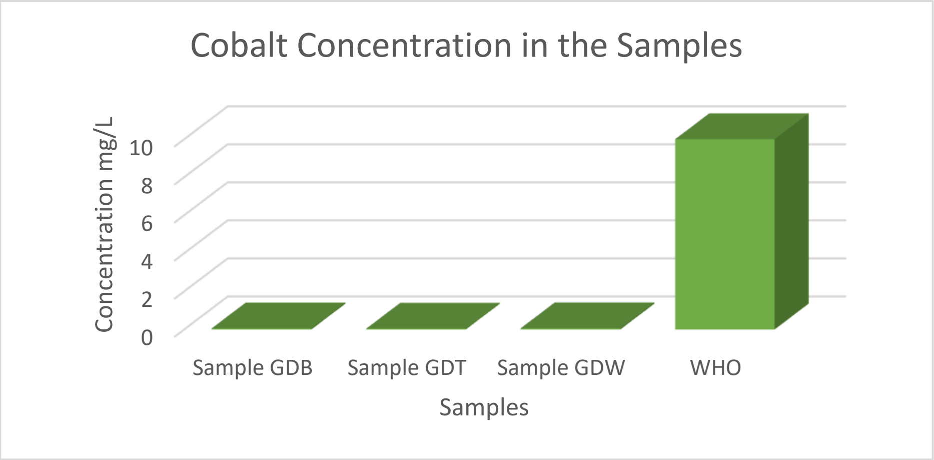

Figure 3.4: Graph of Cobalt concentration in the samples

3.2.2 Copper

Cu was detected in all the samples with the highest concentration found to be 0.123 mgL^{-1} was detected in sample **GDB** and the lowest concentration of 0.077 mgL^{-1} was detected in sample **GDW** as shown in the figure 3.5 below.

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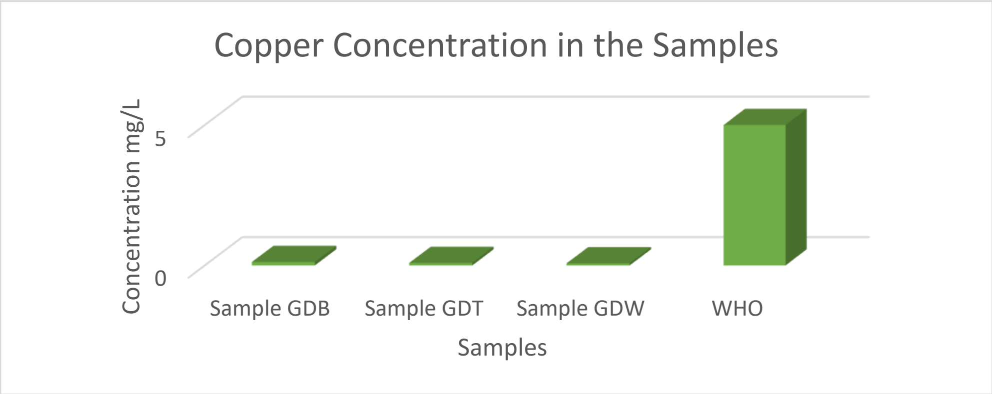

Figure 3.5: Graph of Copper concentration in the samples

3.2.3 Nickel

Ni was detected in all the samples with the highest concentration found to be 0.077 mgL^{-1} was detected in sample **GDW** and the lowest concentration of 0.038 mgL^{-1} was detected in sample **GDT** as shown in the figure 3.6 below.

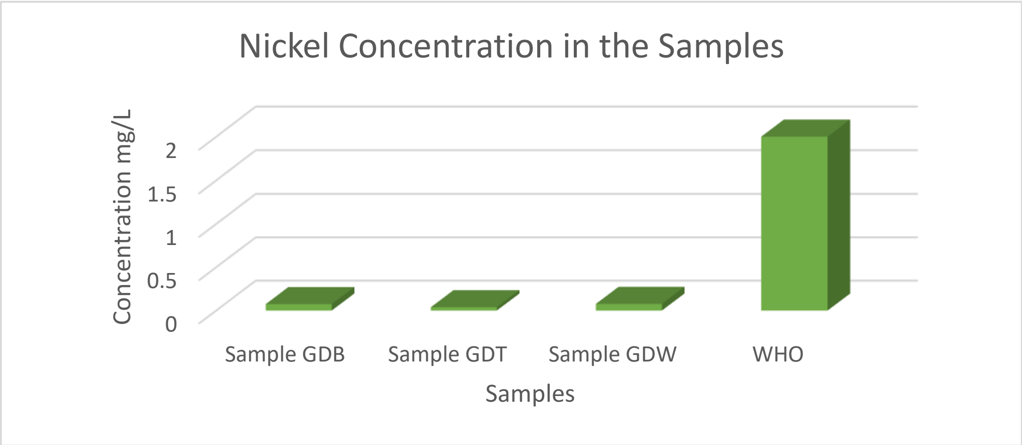

Figure 3.6: Graph of Nickel concentration in the samples

3.2.4 Lead

Pb was not detected in all the samples. This shows that it is below the level of detection (L.O.D), confirming absence of its deposits on the site where the sample was collected.

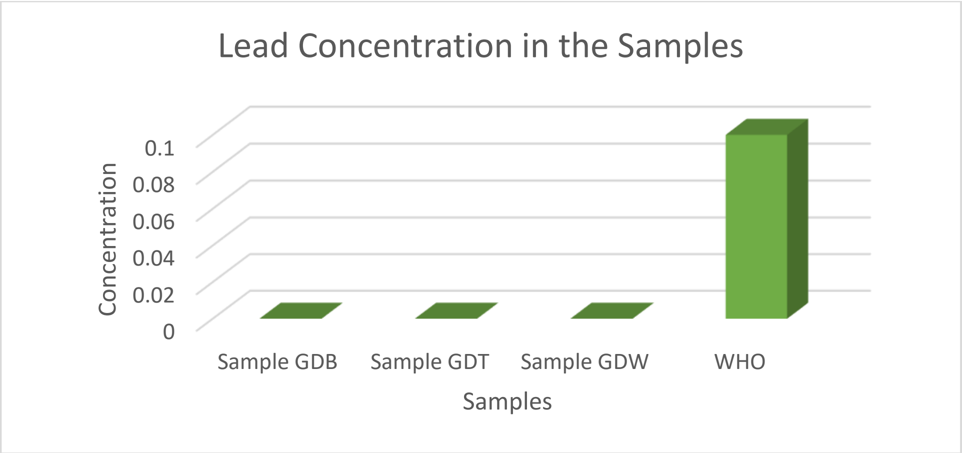

Figure 3.7: Graph of Lead concentration in the samples

3.2.5 Zinc

Zn was detected in all the samples with the highest concentration found to be 0.327 mgL^{-1} was detected in sample **GDW** and the lowest concentration of 0.042 mgL^{-1} was detected in sample **GDB** as shown in the figure 3.8 below.

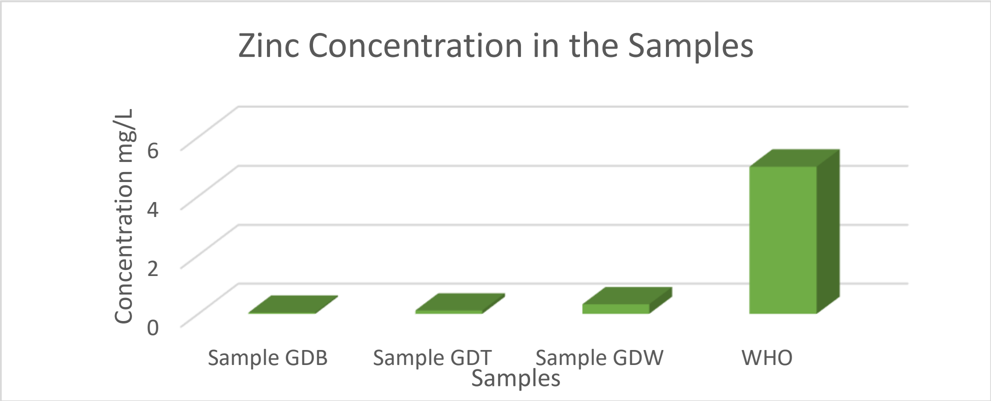

Figure 3.8: Graph of Zinc concentration in the samples

3.3 CONCLUSION

The results of the analysis of the various water samples showed that the levels of trace elements, Co, Cu, Ni, and Zn were all below the WHO threshold limits i.e were found to be below the guidelines for drinking water given by WHO and SON. Also the concentration of Pb was not detected in all the samples analyzed which shows that it is below the level of detection (L.O.D). Thus, confirming absence of its deposits. Conclusively, the drinking water samples analyzed from Gandun Albasa are safe for human consumption based on the 5 metals analyzed.

3.4 RECOMMENDATION

It is recommended that further research should be considered into the followings:

1. Concentration of other metals in the bore hole and drinking water in the area should be investigated.
2. Other physical parameters require to be investigated as the metals concentration in water are affected by diversified factors such as pH, conductivity, temperature as well as organic contents.
3. World Health Organization and other standard organizations should look into the impact of elements found in solid residues and proposed their permissible limits in both sachet and borehole water.
4. The research conducted was only for some heavy metals Cobalt, Copper, Nickel, Lead and Zinc in drinking water samples from Gandun Albasa, Kano municipal Local Government area, Kano. Further research work can be done on some chemical & physical parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), phosphates and other trace metals such as Magnesium, Iron and so on, to further determine the wholesomeness and purity of the drinking water samples.

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