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DETERMINATION OF SOME HEAVY METALS IN DRINKING WATER IN WUDIL LGA, KANO STATE, NIGERIA

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Drinking water, Heavy metals, Maximum concentration, Atomic Absorption spectrophotometer (AAS), World Health Organization (WHO)

ABSTRACT

Concern over the exposure of drinking water to contaminants, specifically trace elements and their ability to cause adverse effects on human health after a prolonged period of exposure resulted to this study. The study is aimed at assessing the concentration of some elements in tap water, well water, boreholes, pond water and sachet water consumed in Wudil Local Government Kano State. Drinking water samples were collected in clean polyethylene plastic containers from different sampling sites in Wudil LGA. The samples were analyzed for cadmium, iron, magnesium, manganese, and lead. These metals were analyzed using Atomic Absorption Spectrophotometric (AAS) method. The result obtained showed that there was no cadmium obtained. While Lead was within the range of (1.77–44.059µg/L) with maximum concentration value of 44.059µg/l in pond water. Iron was only detected in tap water with a concentration of (3.636) µg/l. Magnesium (3.402 –6.974) µg/l with maximum concentration value of 6.974µg/l in borehole water, Manganese (0.052–0.226)µg/l with maximum concentration value of 0.226µg/l in tap water. The results obtained for (Cd,Fe, Mn, Pb and Mg) were below the WHO/SON permissible limits.

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1. INTRODUCTION

Water is a fundamental resource vital for all living beings on Earth. It plays a crucial role in the survival of humans, animals, and plants alike. Constituting a significant portion of the body, water comprises approximately 70-80% of the weight of various tissues such as muscles, brain, and liver. Water may be defined as a liquid which sustains life it is referred to as a universal solvent because of its tendency to dissolve nearly all things which it comes into contact. Water is the most essential that support all forms of plant and animal life [29] and its generally obtained from two principal natural sources; Surface water such as fresh water, lakes, rivers, streams etc. and groundwater such as borehole water and well water [16] and [35].

Water is the only substance that occurs at ordinary temperature in the three states of matter i.e. solid, liquid and gas. Water has unique chemical properties due to its polarity and hydrogen bond which means it is able to dissolves, absorb, adsorb or suspend many different compounds [6], thus in nature water is not pure as it acquires contaminants from surrounding and those arising from human and animal as well as other biological activities [16). Water is vital for consumption, domestic use and serves as a habitat for thousands of plant and animal species. Water function as a solvent in which many of the body's solute dissolved and also as a solvent for chemical substance. 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% [20]. Water that is fit for human consumption is known as drinking water of portable. Good drinking water quality is essential for the well-being of all people. Contaminated water has serious implication on the health and economic status of the population.
It has been suggested that water is the leading world-wide cause of deaths and diseases, and that it accounts for the death. Human and industrial activities result in the discharge of various pollutants into the aquatic environment threatening the health of the population and damaging the quality of the environment by rendering water bodies unsuitable [9].

The fact that water is basic for existence of human, plants and other animals, inadequate provision of water and water pollutions caused by solid waste and effluents from various sources such as chemical industries, tanneries, abattoirs, homes and farms e t c. make it necessary for people to look for alternative sources of water that is clean and pure [25].

The study is intended to determine the level of some metals (Cd, Fe, Mg, Pb and Mn,) in drinking water supply (Bore hole, tap water, well water, sachet water, and pond water) in Wudil Local Government Area (LGA) of Kano State..

2. LITERATURE REVIEW

2.1 Study Area

This research is centered on Wudil local government area, one of the forty-four LGAs comprising Kano state, situated within the North-west geopolitical region of Nigeria. Wudil is positioned amidst latitude 11.8167N and 8.8500E and extends northward to the international boundary of Gaya LGA. Wudil has a landmass of about 362 square kilometers and a population of 185,189 at 2006 census. Wudil has an average rainfall of between 600-1000mm annually 4 to 8 months of dry season, maximum and minimum temperature of 45^oC and 15.18^oC respectively. Low temperature of 10^oC during Harmatan has been recorded. Consequently waste is being indiscriminately and improperly disposed off within the LGA. Thus the level of heavy metals in water, soil and plants growth within the metropolis, are expected to be considerably high. The administrative center of Wudil Local Government Area (LGA) is located in Wudil town. The LGA encompasses various towns and villages such as Achika, Juma, Lajawa, Yarka, Utai, Makera, Kausani, Gware, Dagumawa, and Buda. It is estimated that the population of Wudil LGA is approximately 182,304 residents, predominantly consisting of individuals from the Hausa/Fulani ethnic group. The primary language spoken in the area is Hausa, and Islam is the predominant religion practiced by the residents.

Many works has been reported on water quality assessment. Bamishaiye and colleagues (2011) conducted a study to assess the levels of trace metals in water samples from various sources in Wudil LGA. They collected twenty samples each of borehole, sachet, pond, well, and tap water randomly. The researchers employed Atomic Absorption Spectrophotometry (AAS) to analyze dissolved analytes in the water samples following filtration, evaporation, and acid preservation techniques. Prior to analysis, the water samples were pre-concentrated and the residue dissolved in 0.1M nitric acid (HNO_3). The analytes measured include manganese, iron, lead, cadmium and magnesium. The highest concentration of iron and lead was detected in sachet water; borehole contains the highest concentration of copper, while the highest concentration of zinc was detected in pump water. As observed from the test result, Cadmium was not detected in all of the water samples, while the highest concentration of arsenic was recorded in the well water. The concentrations of iron, and zinc metals were found to be below World Health Organization limit in some samples.

Sa'id, (2008), conducted a research of different water samples taken from some selected areas of Kano metropolis and environs and heavy metals concentrations were measured. Ten (10) well, borehole and dam water samples were analyzed using Atomic Absorption spectrophotometer for their zinc, copper, cadmium and lead content and their levels compared with WHO specified maximum contaminant level.

According to the WHO the maximum contaminant Level (MCL) for zinc, copper, cadmium and lead are 3000, 2000, and 10µgL-1respectively. Cadmium level was found to be 0.382±0.25, lead was 1.561±0.54µgL-1, copper level was found to be 1.164±0.430µgL-1 while Zinc level was 5.308±5.27µgL-1.

Ogbonna (2011) conducted a research on determination of heavy metals (As,Cd, Cu, Fe, Pb and Zn) in some water samples in Kano metropolis using AAS. The concentrations of these elements were found to be below the WHO limits in some samples, while in some were found to be above permissible limits.

Aminu (2012) reported the study of trace elements (Co, Cr Cu, Fe, Mn, Ni, Zn, and mg) in drinking water supply of Ifeodun Local Government area Osun State using AAS .The results showed that the concentrations of cobalt, copper, iron, manganese, zinc and magnesium were within the WHO permissible levels in all the samples analyzed while for nickel and chromium some concentrations were within WHO permissible limit while some had concentrations above the WHO limit.

Jimoh and Sholadoye (2011) conducted a study for the determination of trace elements (Cr, Co Cu, Fe, Mg, and Mn) in drinking water in Offa metropolis Kwara State using AAS. The results showed that all the sample concentrations were within the permissible limit of the WHO guidelines for drinking water quality except chromium with twenty one samples above the WHO threshold limit and four samples within the limit.

Hussain et al (2012) Performed a Research of Mardan area of Pakistan and showed the concentration of trace elements (Ni, Pb, Cr, Cd, Cu, Zn) and cations like (Na, K, Ca, Mg) in the drinking water of district Mardan. The magnesium level was found to be very high 292.6mg/l, that is, higher than the WHO recommended level of 150mg/l. Water of Mardan tube well is fit for drinking after Mg is removed by boiling.

Abdulrahman et al (2011) carried out theAssessment of trace metals in ground water used for drinking purposes in Riyadh region in the Kingdom of Saudi Arabia. All samples were analysed for 17 trace and macro elements (Al, As, Ba, Be, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Se, Mo, Ag, Hg, V and Zn) using Inductively Coupled Plasma (ICP) spectrophotometer. The results indicated the presence of iron in all sampled wells. Its concentrations exceeded the maximum contaminant level (MCL) in 46.5% of the samples. Manganese, 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.

Djibo (2003) reported the levels of Cu, Zn, Pb and Ni in water samples collected from five different water sources around the old city walls of Kano metropolis were analysed using AAS and reported concentrations of 1.57mg/dm^3, 3.85mg/dm^3, 3.34mg/dm^3 and 3.78mg/dm^3 respectively.

Said (2008) conducted chemical analysis of water samples in Kano state. The samples were analysed for As, Fe Na, Li, K, Cd, Pb, Cu and Zn using spectrophotometric method. The results revealed that for most of these metals their mean concentrations were below the WHO threshold limits.

3. MATERIALS AND METHODOLOGY

3.1 Apparatus and equipment

Conical flask, Sample bottle, Beaker, Funnel, Filter paper, Wash bottle, Micro pipette, New and old pot, Measuring cylinder (10, 100 and 1000) cm3, Volumetric flask (25, 100 and 1000) cm3, Sand bath, Hot plate/stove.

3.2 Reagents

Reagents used were of analytical grade and were prepared in line with standard methods as described within the Manual for normal Analytical Procedures (1999). The reagents used include, concentrated nitric acid (Analar grade) and Distilled water.

3.3 Sample Collection

Seven water samples were randomly collected from the various sampling sites (1 well, 1 borehole and 1 tap, 1 pond,1 sachet) in different areas of Wudil local government, Kano State and labelled A, B, C, D, and E. The water samples were collected in clean 5 liter polythene plastic containers, the sample containers were rinsed with respective water sample before filling each with the sample. For borehole and tap water, samples were collected and were allowed to run for some minutes before filling the sample containers so as to obtain a composite sample as recommended by Oporaocha et al (2010).

3.4 Sample Treatment

Exactly 5 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 liter is then transferred to a Pyrex beaker for the completion of the evaporation to dryness. (Jimoh and Sholadoye 2011; Jimoh and Aminu 2011). Each of the evaporated samples was dissolved in a beaker with 10ml of 0.5M HNO_3. The solution was then filtered in to a 25ml volumetric flask and made up to the mark with 0.5M HNO_3.

3.5 Preparation of Reagents

Chemicals of analytical grade purity and distilled water were used for the preparation of Reagents. 0.5 M Nitric Acid (HNO_3) was prepared by dissolving 3.15cm^3 of the concentrated nitric acid (Specific Gravity 1.44, percentage purity 70%) in distilled water in a 100cm^3 volumetric flask and made to mark with distilled water.

3.6 Sample Analysis

Concentrations of the five (5) metals were determined in the samples using atomic absorption spectrophotometer. (AAS) All absorption measurements of the 5 metals were recorded using atomic absorption spectrophotometer (AAS).

3.7 Principle of AAS

While a sample is being aspirated into a flame, a light-beam is directed through the flame into a monochromatic and onto a .detector that measures the amount of light absorbed by the atomized element in the flame. A source lamp composed of the element of interest is used because each element has its own characteristic wavelength. This makes the method relatively free from spectral or radiation interferences. The amount of energy at the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample over a limited concentration range.

4. RESULTS AND DISCUSSIONS

4.1 Results

Table 1. Concentration of the metals in various water samples in µg/L

S/N	PARAMETER	UNIT	A	B	C	D	E	WHO Limit 2022	NIS/SON Limit 2015
1.	Lead (Pb)	µg/L	ND	44.059	2.882	1.77	ND	10	10
2.	Cadmium (Cd)	µg/L	ND	ND	ND	ND	ND	3	3
3.	Manganese (Mn)	µg/L	ND	ND	0.052	0.226	ND	80	200
4.	Magnesium (Mg)	µg/L	6.974	4.143	3.825	5.148	3.402	NS	20,000
5.	Iron (Fe)	µg/L	ND	ND	ND	3.636	ND	NS	300

KEY: Sample **A**: Borehole water, Sample **B**: Pond water, Sample **C**: Well, water, Sample **D**: Tap water, Sample **E**: Sachet water, **ND**: Not detected, **NS**: Not specified, **NIS**: Nigerian Industrial Standard, **SON**: Standards Organization of Nigeria

4.2 Discussion.

The use of water for any purpose is guided by standard set by the World Health Organization and other related agencies. All the heavy metals analyzed were considerably below the limit permitted by W.H.O drinking water standard (WHO 2022) except for sample B which is very high, as such can cause serious damages to health.

Lead (Pb):
Lead is a toxic metal that is harmful to human health, there is no safe level for lead exposure. The degree of exposure depends on the concentration of lead, route of exposure (air, water, and food), current medical condition and age. Lead is a serious cumulative body poison (Edward 1980, APHA 1985, 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). 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). Lead was detected in sample B, C, D all the samples but the highest concentration of 44.059µg/L was detected in sample B, and the lowest concentration of 1.77µg/L was detected in sample D.

Cadmium (Cd):
Cadmium is extremely toxic at low level. Cadmium enters the human body by inhalation, by digestion and perhaps by absorption through the skin. Short term exposure to cadmium in drinking water can caused vomiting, Nausea and other digestive problems. Measurement of cadmium plays a vital rule in functioning of some important part of the body such as muscles and nerve cells response etc. Cadmium was not detected in all the samples.

Manganese (Mn)
Magnesium is the second most abundant mineral in sea water behind sodium, magnesium is common among many bodies of water found in most rocks, and the substance is washed from rock surface and then circulated into the water. Magnesium and other alkali earth metals are responsible for water hardness. Water containing large amount of alkali earth irons is called hard water and water containing low amounts is called soft water (25) Manganese was only detected in samples C (0.052 µg/l) and D (0.226µg/l).

Magnesium (Mg):
Magnesium was detected in all the samples but the highest concentration of 6.974µg/L was detected in sample A and the lowest concentration of 3.402µg/L was detected in sample E.The least concentration was detected in Borehole water while the highest concentration was found in Sachet water. Magnesium ions contribute to the hardness of water. No health based guideline was given for hardness; however the degree of hardness in water may affect its acceptability to the consumer in terms of taste and scale deposition [4].A value of 20mg/l was proposed based on consumer acceptability [1].

Iron (Fe):
Iron is one of the most abundant elements on earth. It is an essential element for humans, and it is used in a variety of industrial processes. It is also found in drinking water. High levels of iron can be fatal, but the amount found in drinking water is typically too low to be dangerous. Instead, high levels of iron in drinking water can cause non- health effects, including bad taste and discoloration Iron was only detected in sample D.

CONCLUSION

The results of the analysis of the water samples showed that the levels of Cd, Fe, Mn, and Pb, in this study were below WHO/SON threshold limits except for Pb in pond water which is extremely high and toxic to health. While no health based guidelines were proposed for Mg, as it is not of health concern at levels found in drinking water

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