**Original Research****EFFECT OF WASTE DUMP ON THE QUALITY OF GROUND WATER IN BASSA LOCAL GOVERNMENT AREA OF PLATEAU STATE****Gungshik, J. R., \*Lawal, R. A., Bauda, V.***Department of Chemistry, University of Jos, P. M. B. 2084 Jos, Plateau State.***ABSTRACT**

Received 28 June, 2018  
Revised 28 August, 2018  
Accepted 10 September, 2018

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Physicochemical parameters of some of selected ground water samples from Bassa Area were analyzed for temperatures, pH, turbidity conductivity, cadmium, sulphate, manganese, lead, cadmium, iron and zinc. Three samples each were collected at major dump sites and from distance 2 km away from dump sites. The samples were analysed using standard procedures. The results of the analysis indicated a higher level of the predictors at major dumpsites with the exception of chloride and sulphate which are relatively higher in samples distance 2 km away from dumpsites. The total hardness at major dumpsite were above the WHO permissible limits, with a mean concentration of  $281.6 \pm 6.24$  mg/L. Lead and cadmium levels in samples at major dumpsites and distance 2km away from dumpsites were also above the WHO permissible limits. The mean concentration of lead and cadmium were  $0.34 \pm 0.05$  mg/L and  $0.86 \pm 0.08$  mg/L at dumpsite respectively and  $0.29 \pm 0.04$  mg/L for cadmium at distance 2 km away from dumpsite. The presence of these toxic metals in the water is a health signal and requires urgent attention to avoid toxicity.

**Keywords:** Dumpsite; Groundwater Quality; Heavy metal; Bassa; Plateau

**INTRODUCTION**

Water is an essential component of human existence, the quality of which is a key indicator in the determination of quality of life, growth and development. Water quality assessment is essential, particularly in developing nations where people find it difficult to access adequate supply of water due to increase in human activity associated with population growth, industrialization and increase in commercial and social activities (Adeolu *et al.*, 2011; Bala *et al.*, 2008).

Ground water composition is usually affected by natural processes and human activities. It is the constituents dissolved or contained in the water (Alewunmi *et al.*, 2009). Ground water saturation

forms large water storage areas of water that interacts with various rocks minerals, microorganisms and any natural materials that may creep from the surface. Any substance that comes in contact with the ground can affect water quality (Egboka *et al.*, 1989).

Human activities have resulted in widespread contamination of water ways by a sample of organic and inorganic substances including trace and heavy metals, metalloids and non-metals (Adetoro and Popoola, 2014). Unlike many organic contaminants, inorganic contaminants do not degrade over time into less toxic substances but accumulate and persist in a range of chemical forms (Species) with varying

biological availabilities and toxicities (Chandra *et al.*, 1990).

Ground water contamination occurs when man-made products such as oils gasoline, salts, acids and other chemicals get into ground water and cause it to become unsafe and unfit for human use. Materials from the land surface can move through the soil and end up in the ground water (Gorde and Jaolhav, 2013). Road salts, toxic substances from mining sites and used motor oil also may seep into ground water. It is also possible for untreated waste from septic tanks, toxic chemicals from storage tanks and leaky landfills to contaminate ground water (Gorde and Jaolhave, 2013).

There have been several reports, to show that the limited fresh water sources in Nigeria are consistently severed by domestic, local material, oils, and agricultural activities, (Ojajire and Imeokparia, 2000). This has led to the emergence of several diseases and heavy metals poisoning across the country. It has been reported that heavy metals like lead, manganese, iron, zinc, copper, nickel, chromium and cadmium were found to be above the acceptable and permissible level in some Nigerian waters, such water were also polluted with chlorides, nitrates, sulphates oils, grease and phosphates, (Saraha, 2012).

## MATERIALS AND METHODS

### Materials

All chemicals used were of analytical –reagents grades obtained from BDH and unless otherwise specified. Deionize water was used throughout. A Pye Unicam SP9 Atomic Absorption Spectrophotometer, with various metal hollow cathode lamps, was used with air/acetylene flame under conditions specified in the operational manual. Other apparatus include Graffin conductance bridge recalibrated with 0.01M KCl solution, digital electronic pH meter fitted with temperature adjustment glass electrode and magnetic stirrer, and the corning model 252 colorimeter.

### Preparation of Stock Solutions

Stock solutions of manganese, iron, zinc, lead and cadmium were prepared from their chlorides and nitrates salts by dissolving in deionized water and making up the volume with 5 mL of concentrated HCl and HNO<sub>3</sub> to give 1000 mg/L solution. (Whiteside and Milner, 1983).

## Sample Collection and Pretreatment

Three water samples were collected from three different wells at the major dumpsites and also 2 km away from dumpsites were collected in 1.5L, pre-treated plastic bottles. 1M HNO<sub>3</sub> was added in drops to the samples to prevent alteration in some physicochemical parameters. All sample analyses were carried out using the standard methods for the examination of water (American Water Work Association, 1995).

### Determination of Colour and Turbidity

Each sample was filtered and the absorbance measured at 430 nm in a 10 mm cell. The absorbance was converted to absorbance parameter colour in Hazen Units (Hz) and turbidity obtained by multiplying absorbance parameter AbsM<sup>-1</sup> by factor, 10.5 and 3.5 respectively.

### Determination of pH

The pH meter was first standardized with a buffer solution of pH 9. The electrode was then rinsed, dried and immersed in a sample agitated with stirrer. It was allowed to equilibrate for about 2 minutes, after which pH was recorded.

### Determination of Total Dissolved Solids

100 mL of the sample was filtered with sintered glass and the filtrate transferred into a pre-weighed evaporating dish, and was evaporated to dryness at temperature of 100°C – 105°C. This was cooled to constant weight in desiccator and weighed (Ogbolue, 1990).

$$\text{Dissolved solid mg/L} = (y-x) * 10$$

Where: x = weight of empty dish; y = weight of dried residue + dish

### Conductivity

This was determined at 25°C using a conductivity meter - the electrolytic conductivity measured set, the Griffin conductance bridge, pre-calibrated with 0.01M KCl solution (specific conductivity at 25°C is given as 1413 µs/cm).

### Determination of Total Hardness

A 2 mL buffer solution was added to a 100 mL sample in a 250 mL beaker to adjust the pH to 10. This was

followed by the addition of two drops of indicator solution. The resultant solution was then titrated against EDTA titrant until the colour of the solution changed from wine red to light blue (APHA, 1985):

$$\text{Total hardness (mg/L CaCO}_3\text{)} = \frac{(A*B)*1000}{\text{vol of sample (mL)}}$$

Where A = mL of titrant  
B = mg of CaCO<sub>3</sub> equivalent to 1 mL EDTA at the calcium indicator end point  
1000 = total volume of sample (1000 mL or 1L)

### Determination of Temperature

The water sample was transferred into a beaker. The bulb end of the thermometer was carefully placed into the water in the beaker. The thermometer was left in the water sample for two minutes for the thermometer reading to stabilize. The temperature was then determined when the thermometer reading was stabilized.

### Determination of chloride

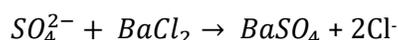
A 50 mL of the sample was titrated in the pH range of 7 to 10 directly against AgNO<sub>3</sub> of 0.014M, using K<sub>2</sub>CrO<sub>4</sub> as an indicator to give a pink-yellow colour end point, the chloride value of the blank solution was also determined.

Chloride mg/L = (A-B) x M x 35450/ml sample

Where A = mL of AgNO<sub>3</sub> used for sample; B = mL of AgNO<sub>3</sub> used for blank; M = molarity of AgNO<sub>3</sub> solution; 35450 = molarity of chloride x 1000

### Determination of Sulphate

A 5 ml conditioning reagent (hydrochloric acid) was added to 100 ml of sample in a 250 ml. Erlenmeyer flask and stored. Approximately 0.5 g of barium chloride crystal was added with continuous stirring for about 1 hr and the absorbance of the solution was read at 420nm. Sulphate concentration in the sample was obtained from a calibration curve prepared from standard sulphate solution.



### Determination of Manganese, Lead, Cadmium, Iron, and Zinc

A 100 ml sample was adjusted to pH 2.5 with 1.0M HCl and 2.5 mL of ammonia pyrrolidine dithiocarbamate (APDC), 1% and 10 mL of methyl

isobutyl ketone (MIBK) were added and shaken for 1 min in a separating funnel. The solution was allowed to stand to separate into two layers, the organic layer was collected in a beaker while the aqueous layer remained in the separating funnel. Further extraction was performed with 10 mL MIBK and the extract was aspirated into atomic absorption spectrophotometer. The concentrations of the metals were obtained from calibration curves of the corresponding metals (APHA, 1985).

## RESULTS AND DISCUSSION

The results of physicochemical parameters of water samples obtained at dumpsites and distance of 2 km away from dumpsites are shown in Tables 1 and 2 respectively.

Table 1: Physicochemical parameters results of water samples at dumpsites

| Parameter                    | Mean         | Range       | WHO (2008) Limit |
|------------------------------|--------------|-------------|------------------|
| Odour                        | Unobj.       | -           | Unobj.           |
| Temperate (°C)               | 22.50±0.377  | 22.00-23.00 | 30               |
| pH                           | 6.51±0.27    | 6.16-6.82   | 6.5-8.5          |
| Turbidity (NTU)              | 3.90±0.50    | 3.41-4.60   | 5.00             |
| Cond. (µs/cm)                | 701.67±8.50  | 690-710     | 1.00             |
| TDS (mg/L)                   | 463.33±12.47 | 450-480     | 500              |
| TH (mg/L CaCO <sub>3</sub> ) | 281.66±6.24  | 275-290     | 150              |

Unobj = Unobjectionable; Cond. = conductivity; TDS = Total dissolved solid; TH = Total hardness

Table 2: Physicochemical parameters results of water samples 2 km away from dumpsite

| Parameter                    | Mean        | Range       | WHO (2008) Limit |
|------------------------------|-------------|-------------|------------------|
| Odour                        | Unobj       |             | Unobj            |
| Temperate (°C)               | 22.66±0.45  | 22.00-23.00 | 30               |
| pH                           | 7.08±0.10   | 6.94-7.16   | 6.5-8.5          |
| Turbidity (NTU)              | 3.90±0.50   | 3.41-4.60   | 5.0              |
| Cond. (us/cm)                | 185±10.20   | 175-200     | 1.000            |
| TDS (mg/L)                   | 199.66±5.35 | 189-210     | 500              |
| TH (mg/l CaCO <sub>3</sub> ) | 127. ±6.15  | 120-135     | 150              |

Unobj = Unobjectionable; Cond. = conductivity; TDS = Total dissolved solid; TH = Total hardness

### Temperature, pH, Turbidity, Conductivity, Total Dissolved Solids and Odour

In this study it was observed that temperature, pH, turbidity, conductivity total dissolved solids all fall within the acceptable limit of World Health Organization standards for drinking water (2008). Higher values were recorded for total hardness,

conductivity and total dissolved solids for samples at dumpsites; compared to samples at distance 2 km away from dumpsites (Tables 1 & 2). Also from Table 1, the average pH of water samples close to dumpsites was observed to be weakly acidic.

### Total Hardness, Chloride and Sulphate

Water samples were observed to be very hard with an average of  $281.66 \pm 2.24$  mg/L while samples from distances 2 km away from the dumpsites had an average value of  $127.0 \pm 6.1$  mg/L which is within the acceptable limit (Tables 1 & 2). Exposure to hard water has been reported to be a risk factor that could exacerbate eczema. Other factors include dust, shampoo, sweating, swimming and wool (Lamparski, 2004). Another disadvantage associated with hard water is increased soap usage which results in metal or scum residue on the skin or on clothes that are not easily rinsed off and can lead to contact irritation.

Also from Tables 1 & 2, chloride and sulphate concentration indicated low values for samples at dumpsite and also distance 2 km away from dumpsite. And can be said to be within safe limit in accordance with WHO standards. Chloride concentrations in excess of 250 mg/L are merely detected by taste, high concentration of chloride in water gives a salty taste to water (WHO, 2008). The presence of sulphate in drinking water can cause noticeable taste at threshold value of 250 mg/L for sodium sulphate, to 1000 mg/L of calcium sulphate

### Trace metal concentration

The results of trace metal content of water samples obtained from dumpsites and distance 2 km away from dumpsites are shown in the Tables 3 and 4 respectively.

Table 3: Trace metal content of water sample at dumpsite

| Parameter        | Mean             | Range     | WHO (2008) Limit |
|------------------|------------------|-----------|------------------|
| Chloride (mg/L)  | $6.37 \pm 0.25$  | 4.75-9.60 | 250              |
| Sulphate (mg/L)  | $2.00 \pm 0.40$  | 1.95-2.05 | 400              |
| Lead (mg/L)      | $0.35 \pm 0.05$  | 0.31-0.40 | 0.01             |
| Manganese (mg/L) | $0.03 \pm 0.01$  | 0.01-0.05 | 0.50             |
| Cadmium (mg/L)   | $0.86 \pm 0.03$  | 0.76-0.86 | 0.003            |
| Iron (mg/L)      | $0.25 \pm 0.07$  | 0.15-0.33 | 0.30             |
| Zinc (mg/L)      | $2.54 \pm 0.050$ | 1.74-3.09 | 3.00             |

The mean concentrations of manganese, iron and zinc for water samples at dumpsites and for samples

distance 2 km away from dumpsites were within the WHO acceptable limits for drinking water. The concentration of cadmium were high with a mean values of  $0.86 \pm 0.08$  mg/L in samples at dumpsite (Table 3) and  $0.24 \pm 0.04$  mg/L in water sample distance 2 km away from dumpsite (Table 4). These values were higher than the WHO acceptable limit of 0.003 mg/L for portable drinking water.

Table 4: Trace metal content of water sample 2 km away from dumpsite

| Parameter        | Mean             | Range      | WHO (2008) Limit |
|------------------|------------------|------------|------------------|
| Chloride (mg/L)  | $18.52 \pm 0.25$ | 18.00-2.35 | 250              |
| Sulphate (mg/L)  | $2.19 \pm 0.15$  | 2.00-2.35  | 400              |
| Lead (mg/L)      | $0.29 \pm 0.02$  | 0.24-0.29  | 0.01             |
| Manganese (mg/L) | $0.03 \pm 0.00$  | 0.01-0.05  | 0.50             |
| Cadmium (mg/L)   | $0.24 \pm 0.04$  | 0.19-0.28  | 0.003            |
| Iron (mg/L)      | $0.03 \pm 0.01$  | 0.02-0.05  | 0.30             |
| Zinc (mg/L)      | $1.95 \pm 0.06$  | 1.31-2.86  | 3.00             |

Cadmium metal is used in steel industry, in plastic and also it is widely used in batteries. Cadmium can be released into the environment in waste water. Cadmium toxicity is mainly associated with kidney. It causes renal failure, arteriosclerosis, cancer, etc (Bala et al., 2008). Lead concentrations were higher in water samples close to dumpsites. Mean concentrations of lead were  $0.34 \pm 0.05$  mg/L and  $0.29 \pm 0.02$  mg/L respectively. These values exceeded the WHO acceptable limits of 0.01 mg/L for drinking water. Lead occurs geologically in association with sulphate minerals and may be present in generally elevated concentration in areas with ores and coal (Rumar and Sinha, 2010). Lead is a cumulative poison. It is toxic to the central and peripheral nervous systems causing neurological effects, cancer as well as retard mental development in infants. Lead interferes with functions performed by essential elements such as calcium, iron, copper and zinc. It also inhibits red blood cell enzymes, system (Vasudevan and Streekumari, 2000)

### CONCLUSION

Results of the analysis carried out on water samples of some selected areas in Bassa indicated that the concentrations of the parameters turbidity, conductivity, total dissolved solids, total hardness, chlorides, sulphate, manganese, iron and zinc were within the WHO standard limit for drinking water quality. While the concentrations of the toxic metals cadmium and lead exceeded the WHO standard limits.

The presence of these toxic metals at an elevated concentration indicates that consumptions of water from the well could have serious health implication and thus requires treatment to avoid toxicity.

In addition, certain environmental factors should be taken into considerations when siting a well in a particular area such as proximity to dumpsites, industries, mining, oil spills and other pollutants. Constant monitoring of water should be carried out to avoid long term effect of heavy metals on humans.

## ACKNOWLEDGEMENT

The authors acknowledge the management and staff of the University of Jos that gave support to this study.

## CONFLICT OF INTEREST

None declared.

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## Article's citation

Gungshik JR, Lawal RA and Bauda V (2018). Effect of waste dump on the quality of ground water in Bassa Local Government Area of Plateau State. *Ew J Anal & Environ Chem* 4(2): 187 – 191.

## Authors' contributions

GJR and LRA conceived and designed the study. LRA and BV carried out all laboratory work, interpreted data and wrote the initial manuscript. GJR and LRA managed the literature searches. GJR and LRA wrote and revised the manuscript. All authors read and approved the final manuscript.