SPECTROPHOTOMETRIC DETERMINATION OF PHOSPHATES, NITRATES AND PHENOLS IN GROUND WATER COLLECTED FROM KAFIN HAUSA, JIGAWA STATE.

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Abstract: The major source of water in Kafin Hausa is ground water. The flooding experienced annually coupled with the indiscriminate disposal of agricultural and domestic waste had aroused the need for this research. The aim of this study was to determine the concentration of phosphate, nitrate and phenol in boreholes water in Kafin Hausa Local Government area of Jigawa State Nigeria. Seven samples were collected from boreholes located at Turawa, Magaman Ashura, Fanisau, Gambawa, Kofar-Fada, Kiginawa and 'Yan Gobir quarters of Kafin Hausa Local Government area of Jigawa State. The analyses were carried out using UV-Visible spectrophotometer. From the results, it was found that the samples had a mean phosphates concentration of 3.74 ± 0.002 mg/L which was above the World Health Organization maximum contaminant limit of 0.03 mg/L. Nitrate has a mean concentration of 2.01 ± 0.01 mg/L which was below the World Health Organization tolerable limit of 50mg/L. The mean levels (0.0299 ± 0.00) of phenol were found to be slightly below the tolerable limit set by WHO (0.03 mg/L). Phosphate has been implicated for eutrophication, nitrate lead to methemoglobinemia (baby blue syndrome).

Keywords: Phosphates, Nitrates, Phenols, Kafin Hausa

Introduction

Water is one of the most treasured natural resources and its importance to living things cannot be over emphasized. In Kafin Hausa Local Government Area, the major source of drinking water is borehole water. In recent years, because of rapid urbanization and growing population, the rate of discharge of pollutants into the environment has increased. Some of these pollutants percolate into the soil while others are carried in the flood water into other water bodies. Since, surface water is generally more polluted than ground water; the latter is preferred as the major source of drinking water (Sa'id and Mahmud, 2013). Ground water can also be contaminated through various ways such as seepage from effluent waters, percolation of fertilizer from agricultural activities, sewage and mining activities etc. (Sa'id and Mahmud, 2013). There is growing concern among scientists and policymakers with respect to the effects of these pollutants on living organisms (William *et al.*, 2017).
Phenolic compounds are among the chemicals of major concern in this regard as they tend to persist in the environment over a long period of time, accumulate and exert toxic effects on humans and animals Afilah *et al.* (2014). Phenolic compounds can be absorbed through the skin and the walls of gastrointestinal tract of humans. When phenols are absorbed they are transformed in the presence of oxygen by oxygenase . In this reaction, phenoxy radicals and intermediate metabolite like semiquinones and quinine methides are formed. These products are toxic and bind with DNA or protein in the cell and damage it, Afilah *et al.*, (2014). These compounds have been found to alter the development of mammary glands in animals which are exposed to them, Monica *et al.*, (2005). Similarly, Phenol irritates skin and causes its necrosis, it damages kidneys, liver, muscle and eyes. The damage it causes to the skin is due the reaction of phenol with aminoacids contained in keratin of epidermis and collagen in inner skin Schweigert *et al.*, (2001). Furthermore, phenolic compounds act as carcinogens, cause damage to the red blood cells and the liver, even at low concentrations (Anku *et al.*, 2017).
The source of phenolic compounds in aquatic environment could be from the degradation of natural organic matter, industrial, domestic or agricultural activities (William *et al.*, 2017). Phenolic compounds have been enlisted by the United States Environmental Protection Agency (USEPA) and the European Union (EU) as pollutants of priority concern. The occurrence of phenolic compounds in the aquatic environment is therefore undesirable and calls for concern.

Materials and Methods

Study area

The study was conducted in Kafin Hausa local government Area of Jigawa state, Nigeria. Its geographical coordinates are 12º 14' 26" N and 9º 54' 47" E. It has an area of 1,380 km^2 and has a population of 271,058 at the 2006 census.

Figure 1: Map of Kafin Hausa.

Sampling and sample pre-treatment

Seven samples were collected from boreholes located at Turawa, Magaman Ashura, Fanisau, Gambawa, Kofar

Fada, Kiginawa and 'Yan Gobir quarters of Kafin Hausa Local Government area of Jigawa State. The water samples were collected in plastic sample bottles of 1 L capacity by allowing the water to run for 2 minutes and rinsing the sample bottles 3 times with the sample and then the sample was collected. The samples were labeled and transported to the laboratory for analysis. The water samples were filtered through Whatmann-41 filter paper. The filtrate was stored in a clean labelled sample bottle and the residue was discarded.

Sample digestion

The water samples from each sampling bottle were mixed thoroughly by shaking, 50 ml of the water sample was measured and transferred into volumetric flask, 3 ml of concentrated HNO_3 and $_3$ ml H_2O_2 were added and heated at 70°C until clear solution was observed. The clear solution was transferred to a 100 ml volumetric flask and diluted with distilled deionized to the mark and blank digestion was also carried out in the same way. (Birtukan and Gebregziabher, 2014).

Spectrophotometric determination of phosphate

Exactly 25cm^3 of water sample was pipetted into a 250cm3 volumetric flask, 2.5cm3 of Ammonium molybdate solution followed by 3.0cm3 of ascorbic acid were added with swirling, the mixture was diluted to the mark with deionised water and was allowed to stand for about 30 minutes for maximum colour development, the absorbance was then read at 660nm including the blank. This procedure was applied for the remaining samples and the standard solutions. (Sa'id and Mahmud, 2013).

Spectrophotometric determination of nitrate

10cm^3 of the sample was pipetted into a 100cm^3 volumetric flask, few drops of phenolphthalein indicator solution was added, 10cm^3 of 0.5M NaOH solution and 10cm^3 of reducing agent were added and heated for 15minutes at 52^{0}C. 10cm^3 of 0.0581M acidic sulphanilamide solution was added, shaken thoroughly for 5minutes for the diazotization reaction to go to completion. Thereafter, 10cm^3 of N-(1-Naphthyl) ethylenediamine dihydrochloride solution was added to form an azo dye and the contents were diluted to 100cm^3 with water. The absorbance of the pink coloured dye was measured using UV-2100 spectrophotometer at 540nm. This procedure was applied for the remaining samples and the standard solutions. (Johnes and Heathwaite, 1992).

Spectrophotometric determination of phenol

Exactly 50cm^3 of the sample was measured into 100cm^3 volumetric flask to which small quantity of 1M Na_2CO_3 was added and the pH was 11.5. To this solution, small quantity of saturated NaNO2 was added, 10ml of diazotized sulphanilic acid was added and made up to the mark with distilled water. The absorbance of the yellow coloured azo compound was measured using UV-2100 spectrophotometer at 460nm. This procedure was applied for the remaining samples and the standard solutions. (Kulkarni and Shrivastava, 2004).

Results and Discussion

Phosphate

Figure 2, shows the levels of phosphate in the water samples. The mean value of phosphate in water samples was 3.74 ± 0.002 mg/L. The highest concentration was found in sample Yan Gobir, quarters (6.90 mg/L) while the lowest concentration was found in sample Kiginawa (1.09 mg/L). The statistical analysis (single factor ANOVA), shows that there was significant difference among the phosphates concentration from the various sites. The concentration of phosphates in Yan Gobir quarters were significantly than those collected from Turawa, Magaman Ashura, Fanisau, Gambawa, Kofar Fada and Kiginawa The concentration of phosphates were found to decrease significantly in this order Yan Gobir quarters > Magaman Ashura > Gambawa > Fanisau > Kofar Fada > Turawa > Kiginawa. This high level of phosphate recorded can be attributed to run off from farm lands in these vicinities. The people in these areas are mostly farmers, in an attempt to boost their crop yield; they applied organophosphorus insecticides, inorganic and organic fertilizers, which were washed off by rain water to ground and surface water bodies. Meanwhile, the phosphate levels were found to be above the permissible limit of 0.03 mg/L set by WHO.

Figure 2: Levels of phosphates in water samples.

The levels of phosphate observed in this study ranged from 1.09 to 6.89 mg/L, which were similar to the value (1.0 to 4.7 mg/L), reported by (Azuka *et al.,* 2020), in borehole water collected from western Niger Delta, but greater than 0.21–0.30 mg/L reported by (Shigut *et al.,* 2016)

Nitrate

The mean value of nitrate in water samples was 2.01± 0.01 mg/L (Figure 2). The highest concentration of nitrate was found in samples collected from Turawa (2.45 mg/L) while the lowest concentration was found in samples collected from Yan Gobir quarters (1.56 mg/L). The statistical analysis showed that there was no significant difference among the nitrates concentrations from the various sites. However, nitrate levels were found below the WHO acceptable limit of 50 mg/L. Though, this low values signify that the borehole water is safe for drinking with respect to nitrate, nevertheless, nitrate could still accumulate from anthrophogenic origins, the use of nitrogenous fertilizers and manures. Sharma and Kaur (2016), reported that the level of nitrate in ground water samples collected from Narnala, india ranged from 16 to 95 mg/L, these values were significantly higher than those obtained in this study.

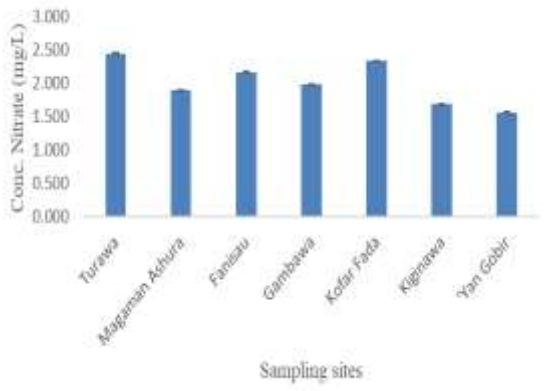

Figure 3: Levels of Nitrate in Water Samples.

Phenol

The mean value of phenol in water samples was 0.0299 ± 0.00 mg/L (Figure 4). The highest concentration of phenol was found in samples collected from Magaman-Ashura (0.038 mg/L) while the lowest concentration was found in samples collected from Gambawa (0.024 mg/L). Statistical analysis revealed that there was no significant difference among the phenol concentrations from the various sites.

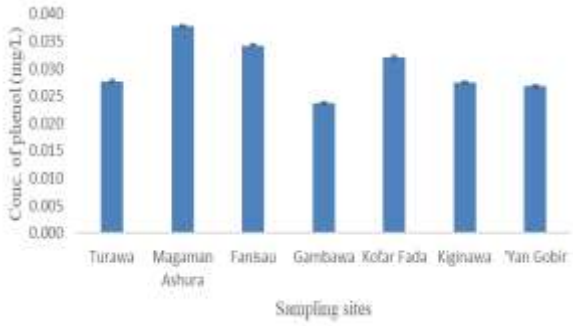

Figure 4: Levels of phenol in water samples.

However, the levels of phenol obtained were a little above the tolerable limit (0.03 mg/L) set by WHO, at the upper limit.. Phenolic compounds exist in water bodies due to the discharge of polluted untreated wastewater from industrial, agricultural, and domestic activities into the water bodies, it can also occur as a results of natural phenomena. Phenol and it derivatives are known to be toxic and can cause severe damage to humans and animals (William *et al.,* 2017). Chimuka *et al.*, (2007), reported that concentrations of phenols in river water ranged from 0.0042 mg/L 0.0050 mg/L, which was lower than the values reported in this study.

Conclusion

The results shows that all the sampling sites had phosphate levels above the WHO acceptable limits of 0.03 mg/L, the nitrate levels were found below the WHO acceptable limit of 50 mg/L, while for phenol levels it was found above the permissible limit set by WHO. When the average concentrations of the phosphates, nitrates and phenols were statistically analyzed using ANOVA and Tukey test, the result shows that in each case, there was no significant difference among the samples at ($P<0.05$).

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