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RESEARCH ARTICLE

HEAVY METAL LEVELS AND PHYSICO-CHEMICAL PARAMETERS OF POTABLE WATER IN NNEWI, ANAMBRA STATE NIGERIA

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ABSTRACT

Ten water samples from six randomly selected boreholes, three natural spring water and one sachet water from Nnewi in Nnewi North Local Government Area of Anambra State, Nigeria were collected. Physico-chemical parameters and heavy metals were determined using standard analytical procedures. The result of the physico-chemical analysis were obtained in the following range; pH (6.38-7.42), temperature (23-26^{0}C), conductivity (30.22-222.22 µS/cm), sodium (0.46-23.00mg/l), potassium (0.07-2.49mg/l), chloride (15.57-36.03mg/l), alkalinity (20-110mg/l) and hardness (45-275mg/l). The concentration of heavy metals (mg/l) in the samples were found within the following range; Pb (0.02-0.08), Fe (0.02-0.06), Cu (0.03-0.07), and Zn (ND-0.07). Cadmium was not detected in any of the water samples. Apart from lead that was found to be higher than the recommended limit for drinking water by World Health Organisation, all other results obtained were within the recommended limit.

INTRODUCTION

Water is vital to our existence in life and its importance in our daily life makes it necessary that thorough physico-chemical examinations be conducted on potable water sources. It is crucial for sustainable development, including the preservation of our natural environment and alleviation of poverty and hunger. Water is the most important and most abundant substance on earth. It covers about 75% of earth's surface. Water constitutes four fifths of the body's weight and performs and supports the internal functions of animals and plants. It is necessary for proper digestion of food and flushing toxins out of the body (Alais and Linden, 1999). The importance of water cannot be over emphasized. It is used for electrical generation. It also serves agricultural, industrial and recreational purposes. In nature, all water contains some impurities.

As water flows in streams, accumulates in lakes and filters through the layers of soil and rock on the ground, it dissolves or absorbs the substances that come in contact with it. Some of these substances are harmful and others are harmless. However, at a certain level, minerals may be considered contaminants that can make water unpalatable or even unsafe. These substances can be the result of human activities or can be found in nature. For instance, chemicals through the activities of man can be transferred from disposal sites to some other places even to drinking water sources thereby serving as contaminants to such sources. Heavy metals are natural components of the earth's crust. They are introduced into the aquatic system through several ways which include weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several anthropogenic activities such as mining, processing and the use of metal based materials (Adefemi and Awokunmi, 2010). Heavy metal contamination is a major environmental concern due to their toxicity, carcinogenicity and mutagenicity even at low concentration. They can cause damage to practically all organs of the body (Ifegwu and Anyakora, 2012). In this regard, World Health Organisation set an international reference point as standard for safe drinking water (World Health Organisation (WHO), 2004). The standard prescribed that safe drinking water is required to be wholesome or potable and palatable or aesthetically acceptable. The wholesome water must not contain disease causing organisms; it is free from poisonous substances and excessive amount of mineral and organic matter. Water is also said to be palatable when it is significantly free from colour, turbidity, taste and odour.

The importance of potable water has precipitated an increasing concern towards its analysis (Okonkwo *et al*., 2011; Nduka *et al*., 2008; Sandeep and Tiwari, 2009; Shittu *et al*., 2008). In Nnewi, a town popular for its commercial and industrial activities in Anambra State, Nigeria, most people depend on borehole, well water and "sachet water" as major potable water sources, while few and mostly the old folks in the rural part of the town still depend on natural water bodies (streams and springs) as potable water sources. This work seeks to determine the status of some heavy metals and the physico-chemical parameters of potable water sources in Nnewi. This is to assess the fitness of the water for drinking and other

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Table 1. Levels of the physico-chemical parameters of sampled drinking water sources

S/N	pH	Temp. (^{0}C)	Conduct. (µS/cm)	Na (mg/l)	K (mg/l)	Chloride (mg/l)	Alkalinity (mg/l)	Hardness (mg/l)
BH1	7.35	25.00	62.50	3.68	0.62	15.57	100.00	100.00
BH2	7.04	24.00	105.26	9.20	0.93	20.15	50.00	135.00
BH3	7.11	25.00	61.50	7.36	0.51	19.23	50.00	95.00
BH4	6.38	24.00	222.22	23.00	2.49	30.22	20.00	275.00
BH5	7.20	26.00	34.48	0.92	0.07	24.73	70.00	125.00
BH6	6.89	24.00	43.48	0.46	0.31	21.07	60.00	45.00
NW1	7.33	22.00	122.40	16.56	2.29	36.03	90.00	188.73
NW2	7.61	24.00	107.21	14.57	1.74	16.79	83.33	181.67
NW3	7.20	23.00	101.00	0.49	1.33	15.26	110.00	215.00
SW	6.82	24.00	30.32	1.82	0.39	22.90	40.00	185.00
WHO	6.50-8.50	-	500.00	200.00	200.00	250.00	-	500.00
SON	6.50-8.50	Ambient	-	200	-	250	-	150

BH-borehole, NW-natural spring water, SW-sachet water

purposes, the possible source of pollution if the water is contaminated and to ascertain their impact on public health.

Table 2. Concentration of heavy metals in sampled drinking water sources

S/N	Pb(mg/l)	Fe(mg/l)	Cu(mg/l)	Zn(mg/l)	Cd(mg/l)
BHI	0.03	0.02	0.04	0.05	ND
BH2	0.02	0.03	0.03	ND	ND
BH3	0.03	0.06	0.03	ND	ND
BH4	0.04	0.03	0.06	0.03	ND
BH5	0.08	0.04	0.06	0.03	ND
BH6	0.03	0.02	0.05	0.07	ND
NW1	0.04	0.02	0.05	ND	ND
NW2	0.04	0.02	0.05	ND	ND
NW3	0.04	0.02	0.07	ND	ND
SW	ND	0.03	0.04	0.03	ND
WHO	0.01	0.50	2.00	3.00	0.003
SON	0.01	0.30	1.00	3.00	0.003

ND-not detected

MATERIALS AND METHODS

Ten water samples were collected. Six water samples were randomly collected from six different boreholes from different locations in Nnewi. Three samples were collected from three different spring water sources while one "sachet water" was also collected. All samples were collected the same day in a 2.00L plastic bottle. The plastic bottles were thoroughly washed and rinsed, and properly labeled. The pH and temperature were measured *in situ*. A field portable pH and conductivity meter were used for the determination of pH and conductivity respectively. Alkalinity and chloride were determined titrimetrically (AOAC, 1984). EDTA titration method was used for hardness determination (APHA, 1992). The metals were determined with Bulk Scientific 205 AAS using air/acetylene flame while sodium and potassium were determined with Corning 400 flame photometer.

RESULTS AND DISCUSSION

The physico-chemical parameters obtained from the analysis of the sampled potable drinking water sources are shown in Table 1. In all water samples, the pH values ranged from 6.38-7.61. The temperature and electrical conductivity of the sampled water samples were between 22-26 ^{0}C and 30.32-222.22 µS/cm respectively. The pH and electrical conductivity values obtained for the samples were within the WHO (2004) and Standard Organisation of Nigeria, SON (2003) recommended range for potable drinking water. The values obtained for the sodium and potassium ranged from 0.46-23.00mg/l and 0.07-2.49mg/l respectively. These values were also within the WHO (2004) recommended limit for drinking water. The values obtained for chloride in all the samples were also within the WHO (2004) and SON (2003) recommended limit for chloride in drinking water. The values for alkalinity and hardness were found to be between 20-110mg/l and 45-275mg/l respectively. The values obtained for the sample hardness were within the recommended limit by WHO (2004) and SON (2003). Calcium and magnesium carbonate contribute significantly to water hardness. The hardness and alkalinity results showed that the values obtained for the hardness were higher than the corresponding alkalinity results except for sample BH1. This may be as a result of the low concentration of the basic salts (sodium and potassium salts) other than calcium and magnesium salts in the samples (Osibanjo *et al*., 2011). With a value of 100mg/l obtained for both alkalinity and hardness of sample BHI, calcium carbonate may have been the prevalent salt contributing to the hardness of the sample.

Heavy metal analysis (Table 2) showed that cadmium was not detected in any of the samples. Lead was detected in all samples except the sachet water sample. The values obtained for lead ranged from 0.02-0.08mg/l with the highest value of 0.08mg/l recorded for BH5 sample. Values obtained for lead were higher than the recommended limits (WHO, 2004; SON, 2003). Lead is ubiquitous in the environment because of its natural occurrence and industrial use (Momoh and Anyakora, 2001). This may be the reason it was found in these concentrations since Nnewi is a major commercial and industrial town. The concentration of iron in the samples analysed ranged from 0.02-0.06mg/l with sample BH3 having the highest concentration. Iron concentrations in all samples were lower than the recommended limit of 0.05mg/l (WHO, 2004) except in sample BH3. With a concentration range of 0.03-0.07mg/l, the copper content of all samples was lower than the WHO recommended limit for drinking water. Zinc concentration ranged from ND to 0.07mg/l. zinc was not detected in samples BH2, BH3, NW1, NW2, and NW3. The concentration of zinc in the other samples was also within the WHO (2004) recommended limit for drinking water.

Conclusion

The results of this study showed that the monitored physico-chemical parameters of the potable water samples under study were within limits for drinking water. Amongst the heavy metals assessed, lead was found to be higher than WHO (2004) recommended limit for drinking water while cadmium was not detected in any of the samples. It is recommended that potable water sources in Nnewi should be routinely monitored to ascertain its suitability for drinking and other purposes.

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