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TRACE ELEMENTS CONCENTRATION OF COMMERCIALLY AVAILABLE DRINKING WATER IN KANO STATE

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Abstract

Drinking water is important for the survival of all living beings. Many trace elements, both metals and non-metals, in drinking water are capable of causing human diseases if their concentrations exceed certain permissible levels. This study aims at measuring the concentrations of Zinc, Chromium and Cadmium in the commercially available drinking water in Kano state using Atomic Absorption Spectrometry technique. A total of 94 water samples were analyzed. The mean concentrations of the metals obtained in this study are within the maximum permissible levels for the drinking water recommended by the World Health Organization (WHO) and Standard Organization of Nigeria (SON). Conductivity and pH of the water samples were also measured to investigate correlation between their values and the concentrations of the three metals. A positive correlation is obtained between the metal concentrations and the corresponding conductivity values, while no significant correlation is seen between the pH values and the metal concentrations.

Keywords: Zinc; Chromium; Cadmium; Drinking water; Atomic absorption spectrometer; pH; Conductivity

Introduction

Human health can be affected by the quality of the food and drink that we take. Water intended for human consumption must be free from harmful organisms and from concentrations of chemical substances that may be hazardous to health. Recent studies show that the levels of trace elements present in drinking water could seriously affect human health (Alam and Saddiq 1989; Ameer et al. 1990, Maroof et al 1986; Maroof et al, 2010 and Moukarzel et al. 1992).

Great emphasis is placed on the quality of drinking water by the World Health Organization (WHO) and it has recommended upper limits for a number of trace elements for drinking water (WHO 1977 and WHO 1980). Chromium (Cr) may be present in water in the hexavalent (chromate) or trivalent form, but trivalent chromium rarely occurs in potable water. Water soluble hexavalent compounds are extremely irritating and toxic to human tissues. Chromate poisoning causes skin disorders and liver damage. Chromium is an objectionable contaminant in drinking water due to its suspected carcinogenic effects (Ameer et al., Hassan et al. 1989, Juma, 1989 and Mustafa et al. 1988). In human body, Cadmium (Cd) accumulates in the liver and kidney, particularly in the kidney cortex. Manifestations of cadmium toxicity such as histological changes in the kidney, liver, testes, pancreas, bowels, blood vessels, etc. has been reported in the literature (Maroof et al. 1986, Maroof et al. 2010, Mustafa et al. 1988 and Ling-Wei 2005). In general, Zinc (Zn) deficiency in animals including humans causes stunted growth and male sexual immaturity. An excess accumulation of Zn in the human body causes harmful effects such as acceleration of anemic conditions (Maroof et al. 1986, Maroof et al. 1990, Ling-Wei, 2010 and Underwood 1977).

Tayyeb et al (2000) studied the aluminum and lead concentrations in the commercially available drinking water of the Western Province of the Kingdom of Saudi Arabia. The results of the study of Zn, Cr and Cd concentrations provide a more complete profile of the levels of heavy metals in the drinking

water of the Western Province. Several physical and chemical parameters are known to affect the concentrations of trace elements in water. Among these, pH and conductivity are important.
In this study pH and conductivity were also measured to investigate any correlation between these parameters and the measured trace metal concentrations.

Material and Methods

Water from different locations of Kano State (North and Central) was collected into different containers, while the other type is the natural/mineral water sold in sealed plastic bottles, this is known as bottled water. Both tap and bottled water sourced from the two strategic locations were studied. The VARIAN Atomic Absorption Spectrometer (AAS), Model Spectra AA – 30 P consisting of a double beam, four lamps Turrent Spectrometer with a Deuterium Background corrector and a temperature programmable graphite tube furnace assembly (GTA – 96) was used in the analyses of the water samples. Temperature programme of the furnace was optimized to obtain the best signal during the atomization process. The drying time and ashing temperature for each element was determined earlier. All these data were fed into the computer associated with the AAS machine. Standard aqueous solution of different elements obtained from Fisher Scientific Company, USA were used to calibrate the AAS machine. The calibration curves were drawn for Zn, Cr and Cd by Macintosh microcomputer using linear regression analysis of the concentrations of the standard solutions versus absorbance values. 20 µl of each water sample, without any pre-treatment, was injected directly into a pyrolytically coated graphite tube of the AAS machine with the help of an auto-sampler and the elemental concentration was read from the output of the printer. Each sample was repeated three (3) times for each element. The concentrations of Zn, Cr and Cd were determined for each sample and the results were tabulated. The sensitivity of the AAS machine was tested by using 10 ppb standard Lead (Pb) solution. The mean absorbance value of several measurements was found to agree well with the manufacturer's stated value with a Relative Standard Deviation (RSD) of 1.6%.
A Fisher PH-lon Meter, model 230A was used for pH measurements and a conductivity meter made by Yellow Springs Instrument Co. (Model 33) was employed for the conductivity measurements.

Results, Discussions and Conclusions

The calibration curves for Zn, Cr, Cd obtained in this study were fairly linear. The results of the present study for three trace elements: Zinc, Chromium and Cadmium and two physical parameters: pH and conductivity in 94 public/commercially available drinking water samples from three different sources are summarized in Table 1. Tap water from Kano north shows the highest mean zinc concentration (16.09 ± 4.94) ppb, followed by Kano central tap water (8.56 ± 4.39) ppb and the least bottled water (8.25 ± 4.50) ppb. But for chromium, bottled water has the highest mean concentration (3.45 ± 0.97) ppb, while both Kano north and central water are characterized with lower Chromium concentrations than bottled water which are (1.66 ± 1.12) ppb and (1.50 ± 1.07) ppb respectively.
Cadmium concentrations are low compared to Zinc* and Chromium concentrations. Kano north tap water and bottled water have same Cadmium concentrations of (1.30 ± 0.28) ppb.

Table 1: Zinc, Chromium and Cadmium concentrations and pH and Drinking Water from three (3) different sources in Kano, Nigeria

Sources of water	No of samples	Mean concentration of Zinc (ppb)	Mean concentration of Chromium (ppb)	Mean concentration of Cadmium (ppb)	Mean pH	Mean conductivity µ mhos/cm
Kano north water	22	16.09± 4.9	1.50±1.07	1.30±0.47	7.42±2.4	380.00±18.96
Kano central water	52	8.56± 4.39	1.66±1.12	1.22±0.28	7.50±2.5	439.44±19.32
Bottled water	20	8.25±4.50	3.45±0.97	1.30±0.45	7.87±28	467.50±20.17

The Maximum Permissible Level (MPL) for Zinc in drinking water as recommended by the Standard Organization of Nigeria (SON) (Tayyeb et al. (2000) and World Health Organization (WHO) is 5000 ppb. The present values of Zn concentrations in drinking water are far below the MPL recommended by SON and WHO. The present values of Chromium concentrations in drinking water are also below the MPL of the drinking water recommended by SON (Tayyeb et al. (2000) and WHO (1979) which is 50 ppb. Again the maximum Cadmium concentrations found in the present study is below the MPL of 5-10 ppb for drinking water as recommended by SON (Tayyeb et al, 2000) and WHO (1979).

Correlation between pH concentration and conductivity and concentration were also studied. The figures are not shown here. The correlation coefficients were determined. A positive correlation is observed between the metal concentrations and the corresponding conductivity values. However, no significant correlation is obtained between pH values and metal concentrations.

Recommendation

The issue of health is very important and requires no compromise; hence everybody should have concern and treat whatever keeps one healthy with utmost care. Anything which is undermining good health when consumed should be discarded.

As recommended by the Standard Organization of Nigeria (SON) and World Health Organization (WHO), appropriate level of drinking water is put at the maximum of 5000 ppb. Therefore, any drinking water whether bottled water, sachet ("pure water") or pipe bore (tap) water, should be maintained at a level recommended by the regulatory body - WHO and SON.

To those of us who are making use of pipe borne (tap) water, it is better to boil it before drinking to be sure that it is free from pipe borne diseases.

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