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Determination of iron and zinc in water samples using atomic absorption spectroscopy

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ABSTRACT

Both Iron and zinc metals are classified as essential, i.e. they are substantial elements for biological function of the organisms. But both can pose a health hazard to human when found in high concentrations. The purpose of this research work is to determine whether a significant difference in zinc and iron levels existed between the water sample obtained from various locations situated in Amravati region and the acceptable ISI standard for Fe and Zn concentrations in drinking water. Fifteen samples of water were collected form the different locations in Amravati region. The samples were prepared for testing and analyzed by AAS. 't- value' was calculated. The Fe and Zn concentrations of the water samples were shown to be significantly lower than the acceptable ISI Standard for Fe and Zn concentrations.

Key words: Atomic Absorption Spectroscopy, Iron, Zinc.

INTRODUCTION

In the category of the heavy metals exists sixty metals which have the density more than 4.5 mg/cm^3. Trace metal levels are important for human health. Metals like iron and zinc are essential metals, since they play an important role in biological system. The essential metals can also produce toxic effects when the metal intake is excessively elevated[1-2].

A human body contains about 4.5 g iron, about 70% of which is in hemoglobin, 26% in proteins and 3.5% in myoglobin. It is found in ferrous (2+) and ferric (3+) states depending upon redox potential of the water [3]. It functions as a respiratory pigment in addition to its engagement in the structure of catalyze enzyme. But iron (more than 10 mg/kg level) causes rapid increase in respiration, pulse rates, congestion of blood vessels, hypertension and drowsiness[4,5].

Similarly human body contains 300 mg of zinc, distributed in muscles (65%), bones (20%), plasma (6%), RBCs (2.8%) and liver (5.3%) [6]. It is essential element in the conservation of the structure and function of cell membrane. Zinc deficiency syndrome manifests itself by retardation of growth, anorexia, lesions of skin and appendages, impaired development and function of reproductive organs. But concentration above 5 mg/L can cause a bitter astringent taste to water. Zinc salts are relatively nontoxic, but heavy doses (165 mg) for 26 days cause vomiting, renal damage, cramps[7]. Inhalation of air containing ZnO at 1.34 mg/m^2 causes metal fume lever and pneumonitis in humans. Zinc most commonly enters the domestic water supply from deterioration of galvanized iron and lezincification of brass. Zinc in water also may result from industrial waste pollution[8].

Table 1 shows the limits of Fe and Zn prescribed by WHO[9] and ISI [10] for domestic water in parts per million. The purpose of this project was to determine whether a significant difference in Fe and Zn levels existed between water samples obtained from different locations situated in Amravati region and the acceptable WHO / ISI standards for their concentrations in domestic water. The working hypothesis was that there would not be a significant difference in Fe and Zn concentrations of water samples and the WHO / ISI standards for their concentrations.

EXPERIMENTAL

To determine whether a significant difference existed between Zinc and Iron concentrations of water samples and their respective standards given by WHO/ISI, the following procedure was conducted

Sample Collection

Fifteen water samples were collected from various locations in Amravati region. The samples were gathered in polythene bottles which were cleaned with a weak nitric acid solution, then rinsed with de-ionized water and dried.

Sample Preparation

Nitric acid was added to each sample to have pH less than 2.0.

Testing Analysis

Water samples were tested for Fe and Zn with a Model ELICO SL-163 atomic absorption spectrometer. Iron and Zinc lamps were installed into the spectrometer and the wavelength of 248.3 nm (Fe) and 213.9 nm (Zn) were programmed into a detector. Solutions with a known concentration of Fe and Zn were prepared and analyzed by AAS to determine concentration of both metal ions in water samples relative to standard solutions. The samples were then analyzed by spectrometer and the Fe and Zn concentrations were displayed in parts per million.

Statistical Procedure

Equation shows t– equation[11] that was used to determine whether a statistical difference existed between Zn and Fe concentration of water samples and their respective acceptable concentration set by WHO/ISI. In this equation $\bar{d}$ represents average difference between Fe and Zn concentration of the water samples, 'S' represents average sample standard deviation and 'n' represents the sample number.

$$t = \frac{\bar{d}}{s/\sqrt{n}}$$

RESULTS AND DISCUSSION

Table 2 shows the concentration of Fe and Zn in water samples in parts per million. The Fe concentration ranged from 0.003 to 0.089 ppm, while Zn concentration ranged from 0.000 to 0.077 ppm. It also shows each sample standard deviation Figure (1) shows average Fe concentration of the water samples *Vs* the acceptable Fe concentration

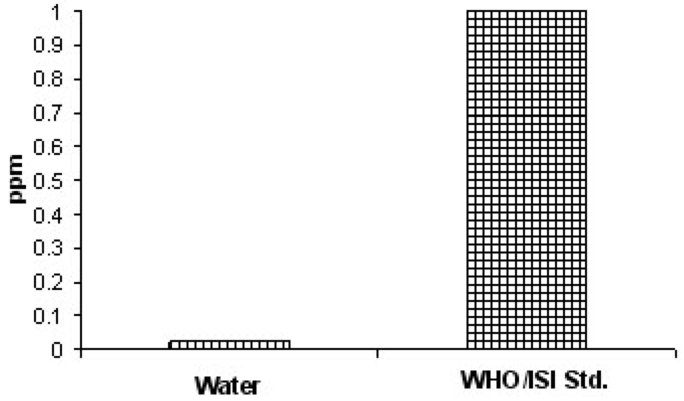

Fig. 1: Average Fe concentrations of water samples Vs. WHO / ISI Standards

for drinking water given by WHO/ISI. The water samples had an average Fe concentration of 0.243 ppm while the acceptable Fe concentration was 1.0 ppm.

Fig. 2 shows the average Zinc concentration of the water samples *Vs* the WHO/ ISI acceptable zinc concentration. The average zinc concentration was 0.225 ppm, while the WHO / ISI acceptable zinc concentration was 5.0 ppm.

Fig. 3 shows the results of two-tailed t-test that was calculated when the average Fe and Zn concentration of the water samples was compared to the WHO/ISI concentration for water. A t-value of 0.377 was calculated. Tabulated value of t for two tailed test for (n-1) degree of freedom at 5% level of significance is 2.145. Here calculated value of t is less than tabulated value of t for (n-1) degree of freedom at 5% level of significance. Therefore we accept null hypothesis which states that there is no significant difference between the two means.

No statistical difference was found to exist between average Fe and Zn concentration of water samples and their respective acceptable WHO/ISI standards, i.e. below permissible limit. So all water samples were found to be safe for domestic use.

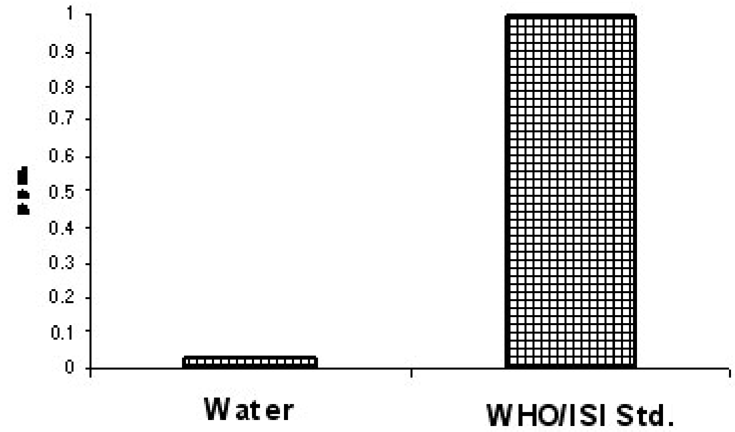

Fig. 2: Average Zn concentrations of water samples Vs. WHO / ISI Standards

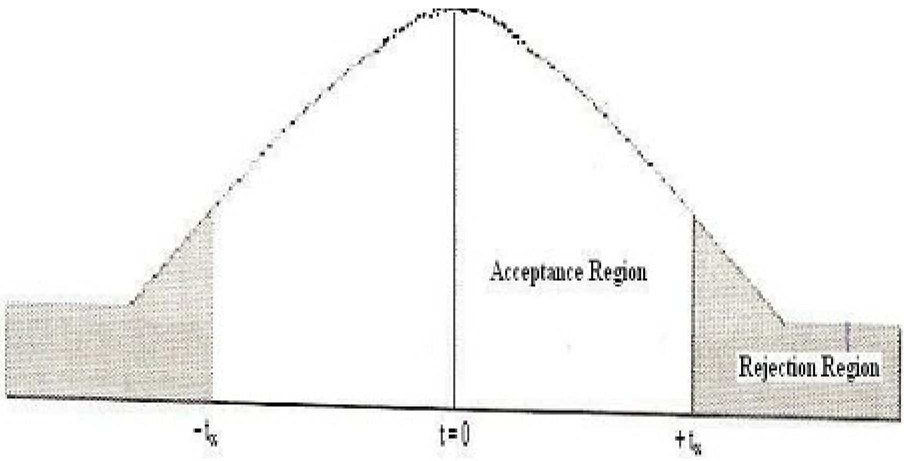

Fig. 3: Standard Normal Distribution (Two tailed t-test)

Table 1: Limits of Fe and Zn prescribed by WHO and ISI

Element	WHO	ISI	
		Permissive	Excessive
Iron	0.3	0.3	1.0
Zinc	5.0	5.0	15

Table 2: Concentration of Fe and Zn in water samples in parts per million

Samples	Fe (x_i) (ppm)	Zn (y_i) (ppm)	$d_i = x_i - y_i$	$(di - \bar{d})^2$
1	0.079	0.077	0.002	1.777×10^{-8}
2	0.029	0.022	0.007	2.635×10^{-5}
3	0.089	0.076	0.013	1.239×10^{-4}
4	0.023	0.019	0.004	4.551×10^{-4}
5	0.021	0.008	0.013	1.239×10^{-4}
6	0.013	0.018	0.005	4.715×10^{-5}
7	0.014	0.012	0.002	1.777×10^{-8}
8	0.015	0.000	0.015	1.725×10^{-4}
9	0.010	0.002	0.008	3.762×10^{-5}
10	0.009	0.000	0.009	5.088×10^{-5}
11	0.019	0.051	0.032	1.147×10^{-3}
12	0.003	0.008	0.005	2.690×10^{-3}
13	0.014	0.006	0.008	3.762×10^{-5}
14	0.007	0.005	0.002	1.777×10^{-8}
15	0.000	0.033	0.013	2.210×10^{-4}

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