Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.5, No.3, 2015

The Level of Heavy Metals in Potable Water in Dowhan, Erop Wereda, Tigray, Ethiopia

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Abstract
The problem of environmental pollution due to trace metals has raised wide spread concerns in different parts of the world and results reported by various agencies have been alarming. Trace metals are among one of the significant pollutants of freshwater, with the development of mining, smelting, geochemical and other industrial activities. The study area is higly covered by soft and hard rock.the analysis Trace metals was conducted using Atomic absorption spectrometer (Varian AA240FS at Ezana analytical laboratory .The level of the trace metals in the two sites were not exceeded the WHO maximum permissible limits in drinking water except the cadmium (Cd) and cobalt (Co). The order of all metals concentration in ER-1and ER-2 samples areas were Zn>Mn>Cu>Fe>Cr and Mn>Co>Fe, Cr, Cu, Zn respectively, but Ni and Pb were below the detection limit.
Keywords: potable water, Trace Metals,WHO

1. INTRODUCTIONS

Water is one of the vital components of the physical environment. The quality of drinking water is closely associated with human health, and providing safe drinking water is one of important public health priorities. Estimated 80 % of all diseases and over none third of deaths in developing countries are caused by the consumption of contaminated water, and on an average as much as one tenth of each person's productive time is sacrificed to water-related diseases (UNCED, 1992) as reported by[1]. Potable water is the water of sufficiently high quality that can be consumed or used with low risk of immediate or long-term harm. Water has always been an important and life-sustaining drink to humans and is essential to the survival of all organisms. Excluding fat, water composes approximately 70% of the human body by mass. It is a crucial component of metabolic processes and serves as a solvent for many bodily solutes. Water is essential for the growth and maintenance of our bodies, as it is involved in a number of biological processes [2].

In recent times, there has been an increasing health related concern associated with the quality of drinking water in developing countries. According to a recent report by WHO/UNICEF, about 780 million people in the developing world lack access to potable water due largely to microbiological and chemical contaminations. Drinking water sources in these so-called developing countries are under increasing threat from contaminations by chemical, physical and microbial pollutants [3].

One of the important UN Millennium Development Goals is to reduce by half the proportion of people without sustainable access to safe drinking water by the year 2015. The United Nations Convention on the Rights of the Child stipulates that states and their partners have the obligation to provide clean drinking water to all children. The consumption of water containing pathogenic organisms or toxic chemicals and the use of inadequate volumes of water, resulting in poor hygiene, pose serious risks to human health. In addition, the physical condition of water (colour, taste and odour) might render it undrinkable as it can be rejected by end-users. For this reason, water quality assessment and continuous monitoring are of utmost importance [4].

Quality analysis of drinking water is less studied even though peoples are consuming or drinking water day to day that may result the accumulation of trace metals or unwanted materials in human body. However, to the extent of assessment done, there is no literature report on the physico-chemical properties of drinking water in Dowhan, Erope Wereda. Hence, this research is intended to determine on the physico-chemical properties of drinking water in Dowhan, Erope wereda, Tigray, Ethiopia.

1.1 OBJECTIVES

The general objective of this work was to determine quantitatively and qualitatively of some physical and chemical parameters drinking water with the following specific objectives:

- To determine the concentrations of some heavy metals (Fe, Mn, Cd, Cr, Cu, Co, Zn, Ni and Pb)
- To compare the collected drinking water samples analysis results with that of international quality standards and WHO guide line value
- To aware the local people on the health risk of drinking water

2. LITERATURE REVIEW

2.1. Trace metals

Around thirty chemical elements play a pivotal role in various biochemical and physiological mechanisms in living organisms, and recognized as essential elements for life. In fact, for many food components, the intake of metal ions can be a double-edged sword. Majority of the known metals and metalloids are very toxic to living organisms and even those considered as essential, can be toxic if present in excess Chemical elements present in the form of free ions are readily ionized and ultimately get absorbed completely by the body. Transition metals readily form stable covalent complexes and normally interact as parts of macromolecules (proteins, enzymes, hormones, etc.) according to their chemical characteristics including oxidation state .The behavior of metal ion release into befouled is governed by the electrochemical rule. Released metal ions do not al-ways combine with bimolecular to appear toxicity because active ion immediately combine with a water molecule or an anion near the ion to form an oxide, hydroxide, or inorganic salt. Thus, there is only a small chance that the ion wills combine with bimolecular to cause cytotoxisn, allergy, and other biological influences [5,6]. For example, Most of these metals especially Iron, manganese, chromium and cupper in small amount are an essential elements for most life forms on earth, because of their participation in many significant physiological processes within the biological bodies including humans and animals. While exceeds their level are associated with an increased risk for cancer, heart disease and other illness such as endocrine problem, arthritis, diabetes and liver disease. Toxic doses of trace metals causes' bad effect such as asthma, pneumonia, vomiting, vision problems and health problems [6].

Trace elements are contributed to groundwater from a variety of natural and anthropogenic sources. Once liberated to groundwater, element distributions are continually modified by complex geochemical and biological processes [6.7]. The problem of environmental pollution due to trace metals has raised wide spread concerns in different parts of the world and results reported by various agencies have been alarming. Trace metals are among one of the significant pollutants of freshwater, with the development of mining, smelting and other industrial activities. Metal pollution not only affects the productivity of crops, but also the quality of the atmosphere and water bodies and threatens the health and life of animals and human beings by way of the food chain. The presence of Iron, Cupper, Chromium, Cobalt, Manganese, Nikel, Zinc, Lead, Arsenic, Cadmium And Aluminum in high concentrations in groundwater can cause an adverse effect on human health and make that water not potable [78,9].

Chromium in water supplies is generally found in the hexavalent form which is highly toxic and in higher concentration to be carcinogenic. High concentrations of nickel (now considered to be a human carcinogen) as both soluble and sparingly soluble compounds may cause changes in muscle, brain, lungs, liver, kidney along with causing cancer (WHO, 2004). Copper in aqueous systems received attention mostly because of its toxic effects on biota. Arsenic forms a variety of inorganic and organic compounds of different toxicity reflecting the physicochemical properties of arsenic at different valence [**9,10]**.

Among Trace metals Cobalt, Copper, Iron, manganese and Zinc in small amount are an essential element for most life on earth, including humans and animals. High levels of them are associated with an increased risk for cancer, heart disease and other illness such as endocrine problem, arthritis, diabetes and liver disease. Also these metals that is essential for living organism. Nitrogen fixing organism and some Microorganisms need these elements for metabolism and growth but it causes digestion failure so much as other trace metals when the concentration of these elements exceeds from a certain level . When the concentration of these elements exceeds, it could be dangerous for human health. Toxic doses of trace metals causes' bad effect such as asthma, pneumonia, vomiting, vision problems and health problems [6,11,12.].

Heavy metals constitute a very heterogeneous group of elements widely varied in their chemical properties and biological functions. The term heavy metals defined as commonly held for those metals that have specific weights more than $5g/cm^3$. Heavy metals are kept under environmental pollution category due to their toxic effects in plants, human and food. Some of the heavy metals i.e. arsenic (AS), cadmium (Cd), lead (Pb), mercury (Hg) are cumulative poison. These heavy metals are persistence, accumulate and not metabolized in other intermediate compounds and do not easily break down in environment [10,13].

Table 2: Trace Metals and their WHO Limits in Drinking Water

No.	Trace Metals	WHO Limit(mg/l)	Reference
1	Cd	0.003	[11].
		0.002	[2]
2	Copper(Cu)	2	[11]
3	Cobalt(Co)	0.005	[2]
4	Chromium(Cr)	0.05	[11]
5	Iron(Fe)	0.3	[11]
6	Manganese (Mn)	0.4	[11]
		0.1(WHO1984)	[12]
7	Nickel(Ni)	0.02	[11].
8	Lead(Pb)	0.01	[2,11]
9	Zinc(Zn)	3.0	[11,113]
10	Arsenic (Ar)	0.05	[14]
		0.1	[11].
11	Aluminum(Al)	0.1	[11].
12	Mercury(Hg)	0.001	[11].

3. Materials and methods

3.1. Chemicals and materials

The chemicals were used $HClO_4$ and Salts of Fe, Mn, Cd, Cr, Cu, Co, Zn, Ni and Pb.The apparatus and instruments used for this study were beakers (SUNLEX), Burrate (Reli glass India),Pipette 5ml (borosilicate glass ,india),Conical flask (BOMEX,B.J,China),Volumetric flask (BOMEX,B.J,China), Absorption spectrometer (Varian AA240FS).

Sampling

Meaningful and reliable sampling assures the validity of analytical findings. Therefore, greatest care was exercised to ensure that the analyses were representative of the actual composition of the water samples. The samples were collected from different locations of Dowhan town in sterilized bottles and prior to filling the sample bottles were rinsed two to three times with the water to be collected. The collected samples were promptly carried to the Ezana analytical laboratory and almost all the trace metals were measured.

Trace Metal Analysis

50ml of each water samples were acidified with 10ml $HClO_4$. About 100mL each of the well-mixed acidified water was digested on hot plate for 1hr at 100 ^oC and transfer to100 ml volumetric flask dilute with distill water and mix thorourgly.The digested sample were analyzed for Cu, Co, Cd, Cr, Fe, Mn, Ni, Pb and Zn using Atomic Absorption Spectrophotometer (Varian AA240FS) at Ezana mining development analytical laboratory [15, 16].

Data analysis

Finally, the data was statistically analyzed using Axel and Origin.

4. RESULT AND DISCUSSION

Trace metals

The sample for metal analysis is collected from two area which is Dowhan town and Erope rural area. R values of the calibration curve of the metals were 0.99 which indicated good measurement agreements. Determination of Trace metals was conducted using Atomic absorption spectrometer (Varian AA240FS at Ezana analytical laboratory as shown the table below.

Table 3. The level of heavy metals in the samples.

Sample	Fe(mg/L)	Mn(mg/L)	Cd(mg/L)	Cr(mg/L)	Cu(mg/L)	Co(mg/L)	Zn(mg/L)	Ni(mg/L)	Pb(mg/L)
ER-1	0.01	0.07	0.01	0.00	0.02	0.01	1.03	0.00	0.00
ER-2	0.01	0.06	0.01	0.01	0.01	0.02	0.01	0.00	0.00
WHO	0.3	0.4	0.003	0.05	2.0	0.005	3.0	0.02	0.001

The level of the trace metals in the two sites were not exceeded the WHO maximum permissible limits in drinking water except the cadmium (Cd) and cobalt (Co). The order of all metals concentration in ER-and ER-2 samples areas were Zn>Mn>Cu>Fe>Cr and Mn>Co>Fe, Cr, Cu, Zn respectively, but Ni and Pb were below the detection limit.

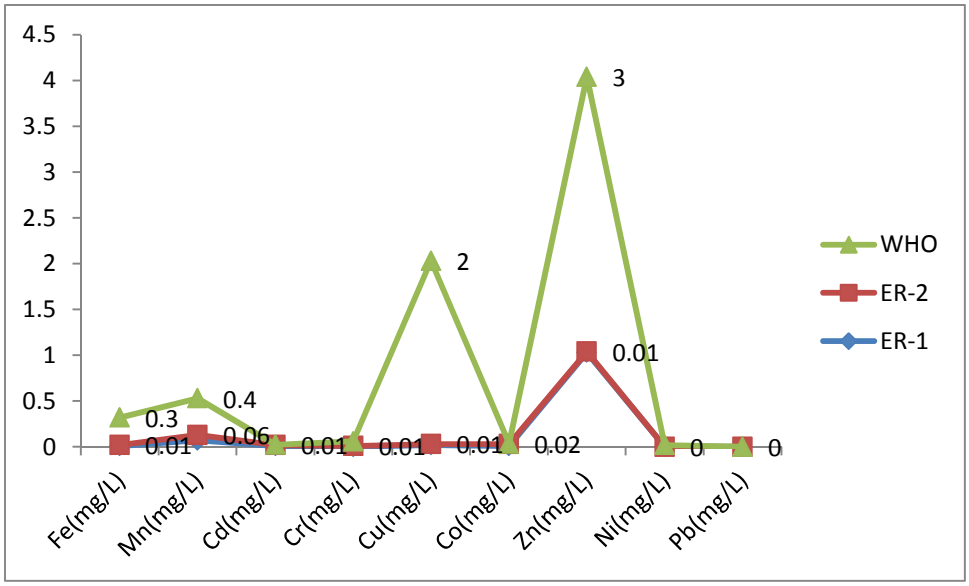

Fig.: The level of metals in the Dowhan and Erope rural area with comparison with WHO maximum limit**.**

Trace metals, among a wide range of contaminants, are consistently of health concern due to their own toxic potentials even at very low concentrations, and tendency to bioaccumlate in tissues of living organisms over time. They gain entrance into human systems via contaminated drinking water, food and air. Once in the body, the bioavailable form of these metals can compete with, and displace essential minerals such as zinc, copper, magnesium and calcium; and interfere with organ system function.

Toxic metals such as mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl) and lead (Pb) have no beneficial effects in humans, as such long-term exposure may cause more severe disruptions in the normal functioning of the organ systems where the metals are accumulated. Lead, for example, is associated with a wide range of negative pregnancy outcomes, including early membrane rupture and spontaneous abortion, erectile dyes function, and contributes to **c**ardiovascular diseases. Metals such as, Mn, Ti, Cd, Cr, V, Co, Cu, Fe, Pb, Ni, Zn and their compounds have been shown to be initiators or promoters of carcinogenic activity in animals. Also, Be, Sb, Al, Hg, Ni, Cd and Co can cause adverse reproductive/fertility problems.

However, as micronutrients, some trace metals such as zinc, copper, iron and manganese are required by the body in small amounts for metabolic activities. These same elements, at higher concentrations can cause adverse health effects or illness. Zinc toxicity leads to diarrhea, manganese may hamper the intellectual development of the child. Iron has been associated with genetic and metabolic diseases and, repeated blood transfusions and copper toxicity is related to several health concerns, including stomach cramps, nausea, vomiting, diarrhea, cancer, liver damage and kidney disease [3] In the two sample site copper and cadmium were above the WHO limit have the probability initiators or promoters of carcinogenic activity in animals. Also, Cd and Co can cause adverse reproductive/fertility problems stomach cramps, nausea, vomiting, diarrhea, cancer, liver damage and kidney disease.

5. Conclusions and Recommendations

The study was conducted to assess the physicochemical quality of water such as Total dissolved solids (TDS), Hardness, chlorides, sulphate and trace metals. The average value of the dissolved solids (TDS), Hardness, chlorides, sulphate were 2500mg/L, 275.8 mg/L,200.293mg/L and 490.085mg/L respectively. The TDS and sulphate content of water were above the permissible limits while the chlorides content of water was obtained below the permissible limit which is 250mg/L.the water hardness was obtained with range of permissible limit which is 200-500 mg/L.Eventhough the hardness was in between permissible value, it has the probability of to cause corrosion of the materials consumption of soaps during laundry. The high content of sulphate also contributes for the existence of permanent hardness.

The level of the trace metals in the two sites were not exceeded the WHO maximum permissible limits in drinking water except the cadmium (Cd) and cobalt (Co). The order of all metals concentration in ER-1 and ER-2 samples areas were Zn>Mn>Cu>Fe>Cr and Mn>Co>Fe, Cr, Cu, Zn respectively, but Ni and Pb were below the detection limit. Copper and Cadmium were above the WHO limit have the probability initiators or promoters of carcinogenic activity in animals.In conclusion from the results of the present study it may be said that the groundwater of Dawhan is though fit for domestic and drinking purpose need treatments to minimize the contamination especially the TDS, sulphate content, Copper and cadmium

Recommendations

As author I would like to recommend the following main points.

- The authorized body should be give special attention to remove the the Copper and Cadmium.
- The level of essential metals must analyzed for next
- Besides of this research, other researchers shall assess water quality area by using other parameters.

Acknowledgment

The authors are grateful to the chemistry department Laboratory for permission to use the laboratory facilities during the experimental phase. Next to that the author acknowledges the laboratory assistance Mr. Simon Gebretsadik and Mr. Hailay Kebede for their endless contributions in this study.

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