Physico-Chemical Analysis of Drinking Water from Maoa (Zafar) Village, Yemen

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Submitted: Aug 10, 2013; Accepted: Oct 8, 2013; Published: Nov 12, 2013

Abstract: Maoa (Zafar) village near Dhamar. Dhamar is a city in south western Yemen. It is situated 100 Km to the south of Sana'a (capital of Yemen) 2700 m above sea level. It is located at 14°33'0"N 44°24'6"E Coordinates, at an elevation of around 2400 meters. Maoa (Zafar) is gaining importance as an archaeological and tourist village. Maoa (Zafar) residents complain the prevalence of colon cancer and drinking water may be the reason, where drinking water samples are not treated before it is consumed. This study consisted of the determination of the trace metals and some physical and chemical parameters in drinking water samples from the Zafar village, Dhamar governorate. The analysis have been investigated by using Uv-Vis spectrophotometer, flame photometer and standard analytical methods. The data show that: the physical and chemical parameters and levels of the nitrogenous compounds are agreement with the standard values of the World Health Organization (WHO) but concentrations of all the metal elements and the metal ions are very below compared with the standard acceptable levels for drinking water.

Key words: Physico-chemical parameters • Drinking water • Anions • Cations and metal elements

INTRODUCTION

Water is one of the very precious substances on the earth. Water quality analysis is one of the most important aspects in groundwater studies [1]. The natural water analysis for physical and chemical properties including trace element contents is very important for the public health and the environment studies [2-5]. There are around thirty chemical elements that play a pivotal role in various biochemical and physiological mechanisms in living organisms and recognized as essential elements for life [6]. For example the possible health consequences of low mineral content water consumption are: Direct effects on the intestinal mucous membrane, metabolism and mineral homeostasis or other body functions. 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. Health damage caused by toxic metals may be less (irritation) or acute (teratogenic, mutagenic and carcinogenic) [7]. Groundwater often consists of seven major chemical elements: Ca$^{2+}$, Mg$^{2+}$, Cl$^{-}$, Na$^{+}$, K$^{+}$, HCO$_3^{-}$ and SO$_4^{2-}$. The chemical parameters of groundwater play a significant role in classifying and assessing water quality [1]. Some transition metals like Fe, Mn, Cu, Zn, Co, Ni etc at trace levels in our metabolism are very important for the proper functioning of the biological system and their deficiency or excess in the human system can lead number of diseases [8, 9]. Trace metals Cu and Fe play a major role in health, for even minute portions of them can significantly affect health. Fluoride is a trace element increases the resistivity of tooth enamel against acids which cause the initiation of tooth decay. Calcium and magnesium are both essential elements. Calcium plays a role in neuromuscular excitability and the coagulability of blood. Magnesium plays an important role as a cofactor and activator of more than 300 enzymatic reactions including glycolysis, transport of some elements...
through membranes, synthesis of proteins and nucleic acids, neuromuscular excitability and muscle contraction. Recent studies also suggest that the intake of soft water, i.e. water low in calcium, may be associated with higher risk of fracture in children, certain neurodegenerative diseases [10], pre-term birth and low weight at birth [11] and some types of cancer [8, 9]. In addition to an increased risk of sudden death [14-16], the intake of water low in magnesium seems to be associated with a higher risk of motor neuronal disease [17], pregnancy disorders [18] and some types of cancer [19-20]. The results of Yang C. Y. et al. show a significant negative relationship between drinking water hardness and colon cancer mortality, where trend analyses showed an increasing odds ratio for colon cancer with decreasing levels of hardness in drinking water [23]. The area under investigation has a high prevalence of colon cancer compared to other parts of the Dhamar Governorate based on information of general hospital of Dhamar and national assembly against cancer in Yemen, in addition to the author's visit to the area and interview a number of area residents. Hence this study aims to knowledge if there any relation between this phenomenon and the drinking water in this village. According to our literature review, there has been no published report concerning the drinking water quality in the Maoh (Zafar), Dhamar Governorate, Yemen.

RESULTS AND DISCUSSION

Average data of pH, electrical conductivity (EC), total dissolved solids (TDS), alkalinity and total hardness of the investigated samples are listed in Table 1. pH average values of all the samples in the range safe 6.5-8.5, where pH average value of the both samples S1 and S2 equal to 7.3 and pH average value of the sample S3 equal to 7.8. This will indicate that water is probably hard and calcium and magnesium. Results of the electrical conductivity show that the EC average values of the samples S1 and S2 are 570 µS/cm and 593 µS/cm respectively, which within the recommended values average value (400 µS/cm) of WHO [24]. Average value of the EC can give idea of the amount of dissolved chemicals in water and it has a significant impact on user's acceptance of the water where it effects on the taste. Total dissolved solids (TDS) levels of all the investigated samples are a agreement with the standard value of WHO [24]. This result is good and it means that the samples contain low concentration of dissolved salts and inorganic population. Ranges for alkalinity were 196 to 260 mg/l and these are satisfied ranges for drinking water according on the standard ranges of WHO [24]. Total hardness average values of the investigated
The investigated samples were in the range of 320 to 214 mg/l which within the range (100-500) mg/l of WHO [24]. According on the average values of total hardness of drinking water in the village of Maoh (Zafar) can be considered this water (as CaCO₃) is hard.

Levels of the Nitrogenous Compounds: Ammonia (NH₃), Nitrate (NO₃), Nitrite (NO₂) are given in Table 2. Levels of NO₃ of the samples S₁, S₂ and S₃ are 0.09, 0.011 and 0.01 mg/l respectively and these levels within the standard concentration range (25-50 mg/l) of WHO but Concentration of NO₂ of the samples S₁ and S₃ are not appropriate Data of major anions (chloride, fluoride, cyanide and sulphate ions) are shown in Table 3. From this table it can be seen that concentrations of chloride ion (Cl⁻) in the samples S₁, S₂ and S₃ are 0.116 and 0.06 mg/l respectively and these concentrations within the standard concentration (0.05-0.5 mg/l) of WHO whereas, level of NH₃ in the sample C (0.0385 mg/l) is smaller than the lowest average value of NH₃ in the range of WHO [24]. Standard value of NO₂ level in WHO is 25-50 mg/l. Results of NO₂ levels of the samples S₁, S₂ and S₃ equal to 28, 9 and 13 mg/l respectively, this means that the level of NO₂ in the sample S₁ is appropriate but levels of NO₂ of the samples S₁ and S₃ are not appropriate Data of major anions (chloride, fluoride, cyanide and sulphate ions) are shown in Table 3. From this table it can be seen that the concentrations of chloride ion (Cl⁻) in the samples S₁, S₂ and S₃ are 0.09, 0.011 and 0.01 mg/l respectively and these concentrations within the standard concentration (25-50 mg/l) of WHO [24]. Concentrations of cyanide ions (CN⁻) of all the samples within the values range of W.H. O as shown in the Table 2. Concentration of sulphate (SO₄²⁻) of the samples S₁ and S₂ are 44.5 and 45.5 mg/l respectively, these Concentrations in the range of values (25-400 mg/l) of WHO but Concentration of SO₄²⁻ (19.5 mg/l) of the sample S₃ is smaller than the lowest value (25mg/l) of WHO [24]. Similarly, concentrations of fluoride ions (F⁻) of the samples S₁ and S₂ are 0.58 and 0.5 mg/l respectively which within the standard range of WHO. Concentration of F⁻ ions 0.32 mg/l of the sample S₁ is smaller than the lowest value in WHO range [24] and This may be leads to decreases the resistivity of tooth [13].

Measurements of the metal elements and the major cations are listed in the Table 4. Results show that concentrations of the both metal elements (Zn and Fe) and all the metal ions (Cu²⁺, Ca²⁺, Mg²⁺ and K⁺) are smaller than the standard concentrations of WHO, this leads to possible bacterial growth [24]. The lowest concentration values of the metal elements and the metals ions in the sample S₁, which represent the president source of drinking water for the popular of Maoh village. This means that the drinking water springs in the Maoh (Zafar) village are very poor in mineral metals this may be the reason of the prevalence of colon cancer among Maoa (Zafar) residents [12, 22].

**CONCLUSION**

Thirty drinking water samples were collected from three springs, which using by Maoa (Zafar) residents. The physical and chemical properties and trace metal elements were investigated. Results of this study show that the springs of drinking water
in the Maoh (Zafar) village are very poor in the metal elements and metal ions. This study recommends Water Authority Dhamar search for the new and convenient source of drinking water or treatment drinking water of springs S1, S2 and S3 before use.

REFERENCES