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Availability of Macro and Trace Minerals in Drinking water from El-Gedarif State (Sudan)

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Abstract: *Drinking water in Gedarif State is directly obtained from, berholes, hand pumps, hand dug wells, rivers, creeks, dams, hafirs and Khors. This study was aiming to measure the concentrations of some macro and trace minerals in surface and ground drinking water sources. Fourty (40) drinking water samples were analyzed by Atomic Absorption. The results were statistically analyzed. Surface water showed mineral means as, Ca (106.48 mg/l), Mg (27.05 mg/l), Na (7.59 mg/l), K (0.50 mg/l), Mn (0.0303 mg/l), Fe (3.7198 mg/l), Ni (0.0604 mg/l), Cu (0.0522 mg/l), Zn (0.0115 mg/l) and Cd (0.0164 mg/l). On the other hand Ground water mineral means were Ca (152.52 mg/l), Mg (76.25 mg/l), Na (11.86 mg/l), K (0.67 mg/l), Mn (0.016mg/l), Fe (0.071mg/l), Ni (0.061mg/l), Cu (0.042 mg/l), Zn (0.0099 mg/l) and Cd (0.010 mg/l). Similar concentrations were shown by Pb in both surface and ground water samples as (0.07mg/L). Some trace minerals showed relatively high concentrations in surface than ground water as, Cd (0.1 mg/l), Cu (0.092mg/l), Fe (21.17mg/l) and Mn (0.037mg/l), whereas ground water showed higher concentrations of Ni (0.109 mg/l) and Zn (0.046 mg/l).*

Keywords: Surface water, Trace minerals, Gedarif basin, Top soil, aquifers

Introduction

Many parts of the world are currently facing critical problems in drinking water supply and quality. Heavy metals concentrations in some areas were reported to be higher than the acceptable drinking water guideline values (Fabián Fernández-Luqueño et al., 2013). It was reported that, millions of people have chronic heavy metals poisoning, and 1.6 million children die each year because of drinking water contamination. The main health effects of heavy metals are associated with exposure to cadmium, lead, mercury and arsenic but, there are other 19 elements known as heavy metals, including Sb , Bi, Ce, Cr, Co, Cu, Ga, Au, Fe, Mn, Ni, Pt, Ag, Te, Tl, Sn, U, V and Zn (Fabián Fernández-Luqueño et al., 2013). Heavy metals from soil may enter the food chains through water, plants or animal products where, it may lead to acute poisoning or chronic toxicity, resulting in brain damage, reduction of mental processes and central nerves function, damage of DNA or lowering of energy levels (Gaza et al., 2005, Bouchard et al., 2011, Holmstrup et al., 2011, Jomova et al., 2011). Heavy metals may also lead to alterations of gene expression and many other health problems (Burger et al., 2007, Salgado- Bustamante et al., 2010). Toxicity levels can just be above the natural background, but risky levels may be reached due to the rapid and excessive release of chemicals into the environment from, fertilizers, industrial waste, metal plating, mining activities, smelting, battery manufacture, tanneries, petroleum refining, paint manufacture, pesticides, pigment manufacture, printing or photographic industries (Aguilera et al.,2010). Once liberated to the environment, elements distributions are continually modified by complex geochemical and biological processes (Hayelom Dargo Beyene and Gebregziabher Brhane Berhe, 2015).

Drinking water in Al-Gedarif State

Al-Gedarif basin is dominated by sandstone, alluvium and basalt aquifers, as three primary sources of drinking water and the geological background of the area consists mostly of acidic rocks and Alluvium soil with clay layers, that may had been composed due to weathering, hydro-chemical reactions and solubility of minerals (Basheer A. E. et al., 2019). The people of the State obtain their drinking water directly from boreholes, hand pumps, hand dug wells, rivers, creeks, Khors, dams, hafirs, and ponds without any pretreatments (Fig.1, 2, 3 and 4).


Fig1. Water yard


Fig 2. Hand dug well


Fig3. Khor Abu Fargha.


Fig4. Water harvesting pond

Drinking water minerals were reported in Al-FAO and Al-Rahad localities as Na (76.00 to 359.00mg/L), K (15.00 to 70.00mg/L), Ca (4.45 to 130.00mg/L), Mg (11.66 to 120.53mg/L), whereas in Al-Gallabat and Al-Gurrasha localities were ranging as Ca (10.44 to 53.00 mg/L), Mg (11.56 to 72.00 mg/L), Basheer et al., (2019). Hussein and Adam (1995) reported the cations availability in groundwater at Al-Gedarif State, as, Na > Ca > Mg > K, and the anions were $HCO_3^- > Cl^- > SO_4^{2-} > CO_3^{2-}$ for sandstone aquifer, whereas for basalt aquifer they were $HCO_3^- > CO_3^{2-} > SO_4^{2-} > Cl^-$. According to Abdellah A. M. et al., (2014), drinking water of El- Hawata area contains Ca (24 to 212 mg/l), Mg (1.2 to 109 mg/l), Na (23 to 67 mg/l), K (0.50 to 1.0 mg/l) and Fe (0.00 to 0.39 mg/l).

Methodology

Fourteen (14) surface and twenty six (26) ground water samples were collected from nine localities of the State. Six (6) samples were from gold mining areas. The concentrations of Na, K, Mg, Ca, Mn, Fe, Ni, Cu, Zn, Cd and Pb were determined by AAS. The results were statistically analyzed using SPSS program.

Results and discussion

Macro minerals

The surface water samples show Na, K, Mg and Ca availability within the permissible WHO guideline values. Two samples showed relatively high Mg as (59.10 and 80.50 mg/L). Clearly high Ca was shown by three samples (160.30, 280.60 and 489 mg/L). The ground water samples were characterized by low Na and K content, but on the other hand, eleven ground water samples showed high Mg concentrations and fifteen samples showed Ca higher than the accepted drinking water standards. The mean concentrations of Na, K, Mg and Ca were higher in ground water sources than surface water (Fig. 5). The high concentrations of Mg and Ca may be due to the geological formations of the aquifers which may be dominated by $CaCO_3$, $MgCO_3$ or dolomite rocks $CaMg(CO_3)_2$. This may agree with the findings reported by Hussein and Adam (1995). Abdelmonem M. A. et al., (2014) reported mineral means as Na (62.1mg/l), K (0.6 mg/l), Mg (15.7 mg/l), Ca (56.1 mg/l) and Fe (0.60 mg/l).

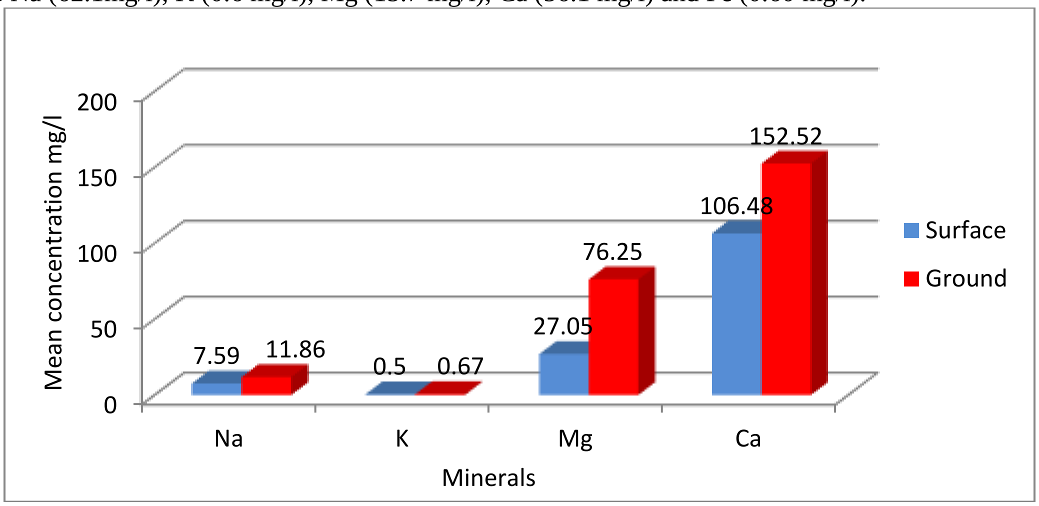

Fig. 5: Mean concentrations of Na, K, Ca and Mg in surface and ground water

Trace minerals

The analyzed surface water samples were characterized by significantly low availability of Mn, Ni, Cu and Zn. Therefore, the surface water sources in the area may be described as Mn, Cu and Zn deficient water. Different concentrations were shown by Fe, which ranges from (0.04 to 21.17 mg/L). The hazardous minerals Cd and Pb had extremely low availability. In ground water samples the micronutrients Mn, Fe, Ni, Cu, Zn and the toxic minerals Cd and Pb were significantly low. The mean concentrations of Mn, Cu, Zn and Cd were higher in surface than ground water. The mean Ni content of ground water was higher than that of the surface, whereas the mean availability of Pb was exactly typical in the two types of sources (Fig. 6). The availability of Fe in surface water was significantly high when compared with that of ground water (Fig.7). This may reflect some basic differences in chemical composition between the top soil layers and the deep formations of the water bearing rocks.

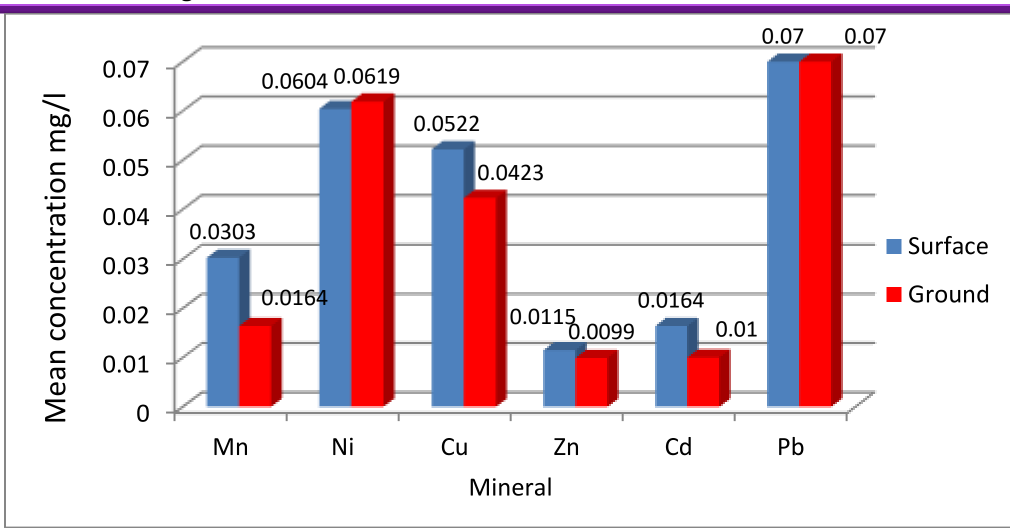

Fig. 6: Mean concentrations of trace minerals in surface and ground water

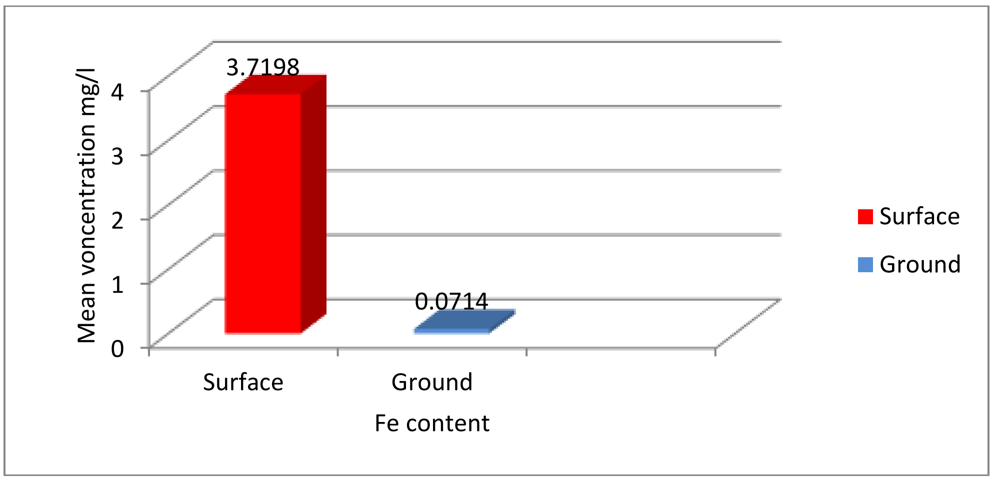

Fig. 7: Mean concentrations of Fe in surface and ground water

Conclusion

Minerals mean content showed clear differences between surface and ground water. From drinking water quality sight of view all the surface and ground water sources may be good and suitable for human consumption, animal watering and irrigation purposes, but, on the other hand drinking water sources in the study area may be lacking for some essential micronutrients especially Mn, Cu and Zn.

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