EUROPEAN ACADEMIC RESEARCH
Vol. XI, Issue 1/ April 2023

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

The Seasonal Availability of Some Minerals in Drinking Water Samples from the Northern State (Sudan)

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Abstract

This study was aimed to measure the minerals availability in drinking water sources of the Northern State localities during winter and summer to investigate the seasonal variations effect on drinking water quality. Ninety-four (94) samples were collected twice from seven localities,(47) samples during winter and (47) during summer from the same sources. A.A.S. analysis was carried for measuring the different minerals concentration in the two seasons. The obtained results were statistically analyzed. The mean concentrations during summer were,Na(5.1217 mg/L), K(6.0375 mg/L), Mg(24.1413mg/L), Ca(24.3062mg/L), Mn(0.1716mg/L), Fe(0.0621mg/L), Ni(0.1532mg/L), Cu(0.0046mg/L), Zn(0.0136mg/L), Cd(0) and Pb(0.0454 mg/L). During winter the mean concentrations were, Na(5.2891mg/L), K(8.5180 mg/L), Mg(14.7685mg/L), Ca(22.1796mg/L), Mn(0.0917mg/L), Fe(0.0287mg/L), Ni(0.0075mg/L), Cu(0.0669mg/L), Zn(0.0235 mg/L), Pb(0) and Cd(0.0026 mg/L).High concentrations were shown by Mg, Ca, Ni, Mn, Fe and Pb during summer, whereas K, Cu, Zn and Cd were high during winter. Almost similar mean content was shown by Na in the two seasons. The concentrations of all minerals were within the permissible WHO(2004) and SSMO guideline values.

Keywords: Northern State, River Nile, Seasonal variations, Groundwater, Minerals, A.A.S.

INTRODUCTION:

Minerals toxicity, can persist for long periods in the contaminated areas and may accumulate in the food chains as a global problem for all natural habitats from industrial, urban and agricultural activities Sonone, S. S.*et al.,*(2020). Heavy metals contamination can extremely increase the concentration of toxic minerals in the aquatic environments (Wildi et al., 2004; Tokatlı *et al.,* 2013). Water sources may be polluted by minerals transformation from rocks, soil or industrial waste. Drinking water suitability from minerals content sight of view is normally determined by measuring some macro, trace and toxic minerals like Na, K, Mg ,Ca, Fe, Ni, Mn, Cu, Zn, Cd and Pb, as, major inorganic pollutants. Other water pollutants include organic matter, nutrients, microorganisms, sediment ions, oil and temperature (World Water Development Report 2009). Although people have already started in taking precautions, water pollution

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levels are raising rapidly today as a result of the dramatic world population expansion and increasing human activities (Begum Luxmy, Eng P. 2015). Mustapha *et al.,* (2013) measured the parameters (DO), (BOD5), (COD), (SS), pH, (NH_3N), (TDS), (NO^3), (Cl), (PO_4^3), Escherichia coli (E. coli) and fecal coliform bacteria (FCB) in Surface water from some parts of Nigeria and recommended that, more effective methods may be needed to control the pollution point sources. Bouza-Deano R, *et al.,* (2008) reported a reduction in phosphate concentration and increase in pH levels at the Ebro Basin during the period (1981-2004). Calijuri M L, *et al.,* (2011) reported integrated effects of human activities and natural characteristics of karstic environments on surface and groundwater quality in the environmentally sensitive watershed. Sabah, R. *et al.,(*2018) quantified the fresh water quality of the Blue Nile River before processing and reported that, the water quality is good. Koklu R.*et al.,* (2010), reported that, the important factors which determine the major pollution sources in Melen River Basin were soil structure and erosion, domestic, municipal and industrial effluents, agricultural activities, atmospheric deposition and seasonal effect factors. According to Bashir, N. H. *et al.,* (2018), the mean minerals availability in drinking water samples from River Nile at Dongola locality were exceeding the WHO (2004) acceptable levels as Pb(4.92 ppm), Ni(16.535 ppm), Fe(0.46 ppm) and Cd(0.013 ppm), whereas tap water showed Pb(22.445 ppm), Ni(5.985 ppm), Fe(0.485 ppm),), Cr(0.06 ppm), Cd(0.013 ppm) and Hg(0.003 ppm) and that of ground water was Pb(4.145 ppm), Co(4.315 ppm), Ni(20.25 ppm), Cd(0.007 ppm), Cr(0.07 ppm), and Hg(0.002 ppm).Merowe Locality samples followed the same trend as, Pb(4.7ppm), Ni(14.495ppm), Cd(0.0131ppm) and Fe(0.325 ppm) in River Nile surface water samples whereas tap water showed minerals availability as Pb(4.72ppm), Ni(18.33ppm), Cd(0.012ppm), Fe(0.37ppm) and Hg(0.002ppm). The ground water mineral means were, Pb(2.84ppm), Co(2.360ppm), Ni(18.635ppm), Cd(0.004ppm), Cr(0.055 ppm) and Hg(0.002 ppm). As a result, Bashir *et al.,* (2018) concluded that all water sources in Dongola and Merowe Localities are not suitable for drinking and require urgent attention by the authorities. In El- Gedarif State, Hamdia M. *et al.,* (2023),reported mean minerals availability in surface water 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) and in Ground water mineral as 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). In Southern Kordofan State, Madena K. *et al.,*(2019) reported some variations in minerals content for ground water as, Na (2.87-2.72mg/l),K(9.94-0.76mg/l) and Ca(47.4-11.5mg/l) whereas, the variations in surface water ranges were, Na(1.23-0.00037mg/l).K(6.56-3.31mg/l) and Ca(44.39-18.36mg/l).

THE STUDY AREA:

The study area is 348,765 Km2 with a total population of 833,743 people (2006 estimation). The State is characterized by several notable locations, including Dongola town, Jabal Al-Barkal and Jabal Al- Oweinat which is situated at the border of Egypt, Libya, and Sudan. The State consists of seven localities including, Dongola, Halfa, Merowe, Al-Burgaig, Al-Dabbah, and Delgo,(fig1).

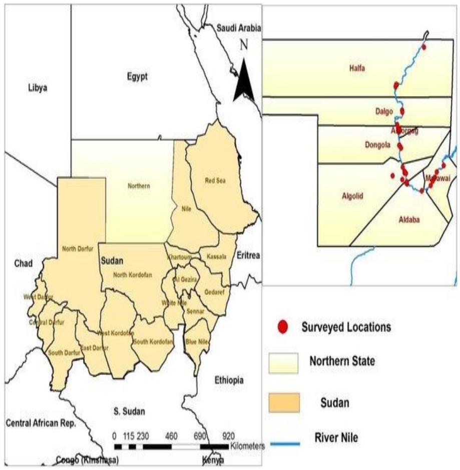

Figure1: The study area.

METHODOLOGY:

The samples were collected from 47 drinking water sources twice during winter and summer. Atomic absorption spectroscopy was used for measuring Na, K, Mg, Ca, Mn, Fe, Ni, Cu, Zn, Pb, and Cd in each season. All chemicals used were of analytical grade.

RESULTS AND DISCUSSION:

Table1 and fig2 Show the macro minerals mean concentrations in summer as, Na(5.1217mg/L), K(6.0375mg/L),Mg(24.1413mg/L) and Ca(24.3062mg/L),whereas during winter they were, Na(5.2891mg/L), K(8.5180mg/L), Mg(14.7685mg/L) and Ca(22.1796mg/L). The seasonal variations were significantly low for Na which showed almost similar minimum, maximum and mean concentrations. The mean content of K was relatively high during winter and that of Ca was high in summer. Significantly high difference was shown by Mg. The availability of the four minerals Na, K, Mg and Ca was within the permissible drinking water quality guideline values WHO(2004) and SSMO . The presence of Mg and Ca may reflect the geological background of the study area and may results in high total water hardness.

Table (1): Seasonal mean concentration of minerals (mg/L)

Mineral	Season	Min	Max	Mean
Na	summer	4.448	5.820	5.1217
	winter	4.448	5.825	5.2891
K	summer	3.421	15.007	6.0375
	winter	3.421	16.765	8.5180
Ca	summer	11.22	42.48	24.3062
	winter	11.22	39.28	22.1796
Mg	summer	0.96	50.34	24.1413
	winter	0.96	39.64	14.7685

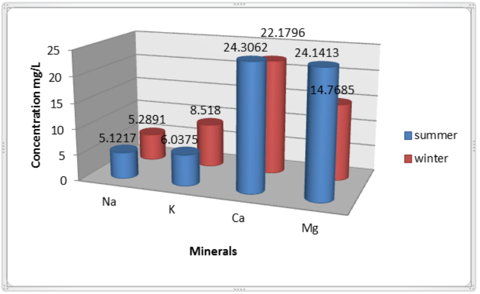

Figure 2: The seasonal variations of Na, K, Mg and Ca content.

Table 2 and fig 3 show relatively high mean concentrations of some trace minerals as Mn(0.1716ppm), Fe (0.0621 ppm) , Ni (0.1532ppm) in summer, whereas during winter the relatively high mean concentrations were Cu(0.0669ppm) and Zn(0.0235ppm). The high levels of Mn, Fe and Ni may be essential for human health, but sometimes higher levels of these minerals may cause toxicity problems. The hazardous minerals Cd and Pb showed different concentration in the tow seasons, where Cd was not detected in summer and showed low mean availability in winter as (0.0026ppm).On the other hand Pb was not detected during winter and showed mean concentration as(0.0454ppm)in summer. All the measured trace minerals were within the permissible guideline values for drinking water quality WHO(2004) and SSMO.

Table 2: The seasonal availability of some trace minerals.

Mineral	Season	Min	Max	Mean
Fe	summer	0	0.36	0.0621
	Winter	0	0.13	0.0287
Ni	summer	0	0.412	0.1532
	Winter	0	0.046	0.0075
Mn	summer	0	1.621	0.1716
	Winter	0	0.252	0.0917
Cu	summer	0	0.08	0.0046
	Winter	0	0.378	0.0669
Zn	summer	0	0.184	0.0136
	Winter	0	0.253	0.0235
Cd	summer	0	0	0
	Winter	0	0.010	0.0026
Pb	summer	0	0.098	0.0454
	Winter	0	0	0

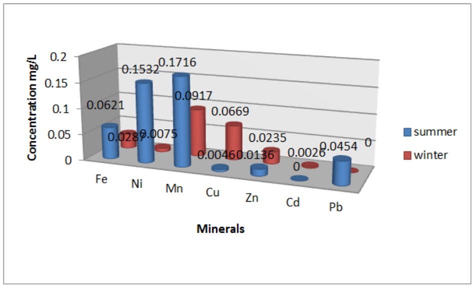

Figure 3: Seasonal mean concentration of Fe, Ni, Mn, Cu, Zn,Cd and Pb.

CONCLUSION:

- Significant season variation were shown by K, Mg, Fe, Ni, Mn, Cu, Zn,Cd and Pb.
- All the sources of the analyzed samples were suitable from drinking water quality sight of view and may be safe for irrigation, animal watering and human consumption.

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