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ESTIMATION OF HEAVY METALS LEVELS IN NILE RIVER WATER, EGYPT

Dalia, E. El-Hefny[1]; Ahmed, A.A. El-Ghanam[1] and Abdel-Bast, A. El-Saidy[2]

[1] Pesticide Residues and Environmental Pollution Department, Central Agricultural Pesticide Laboratory, Agricultural Research Center, Dokki, Giza, Egypt.
[2] Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

ABSTRACT

The aim of this study is to determine the heavy metals levels (Cd, Cr, Cu, Mg, Mn, Ni, Pb and Zn), in water samples collected during the four seasons from different sites along the river Nile at Shubra Khait region, El-Beheira Governorate and Kafr El-Zayat region, El-Gharbia Governorate. The determination of metals levels carried out by atomic absorption spectrometry. The recovery was 86.14±1.58% for Cd, 81.75±0.97% for Cr, 92.27±1.59% for Cu, 88.04±3.14 % for Fe, 82.15±1.58% for Mg, 81.43±1.82% for Mn, 78.61±2.31% for Ni, 89.10±1.98% for Pb and 85.24±3.17 % for Zn. The mean concentrations of the heavy metals in water samples in two sites at the Rosetta branch along the Nile River at Kafr El-zayat were ranged between 0.15±1.05-0.99±1.02 µg/ml for Cd, ND-0.06±0.18 µg/ml for Cr, 0.14±1.39-0.24±1.51 µg/ml for Cu, 0.41±0.51-5.84±0.39 µg/ml for Fe, 4.28±1.52-6.29±1.06 µg/ml for Mg, ND-1.12±1.45 µg/ml for Mn, 0.16±1.24 -1.65±0.68µg/ml for Ni, ND-0.35±1.32 µg/ml for Pb and 0.18±0.65-0.64 ±1.49 µg/ml for Zn during all seasons for the two sites. Also, the mean concentrations of the heavy metals in water samples collected from Nile River at the Rosetta branch from two sites along the river at Shubra Khait region, El-Beheira Governorate. ranged between 0.12±3.00-0.93±2.14 µg/ml and the levels of Cr, Cu, Fe, Mg, Mn, Ni, Pb and Zn ranged between 0.04±1.11-0.13±1.97, 0.13±2.42-0.25±2.34, 1.14±1.93-5.61±1.99,

5.39±1.05-6.22±1.55,ND-0.16±1.95, 0.14±2.93-2.05±2.00, 0.01±2.06-0.07±2.39 and 0.15±1.47-0.55±1.72 µg/ml, respectively.

Also, all water samples in El-Beheira and El-Gharbia governorates had levels of Cd, Ni were higher than the maximum permissible levels. On the other hand, according to the different organizations such as, WHO, EU, ECS and EPA, the permissibe levels are differentiate. For example, according to Egyptian Chemical Standard all water samples had levels of Cr exceeded the maximum permissible levels except water samples which collected during summer season from the first site of Kafr El-Zayat region, but according to other organization some samples below the permissible limits and others excceded the limits.

Also, water samples had Fe levels higher than the permissible levels of WHO. While according to the permissible levels of Fe from Egyptian Chemical Standard all samples collected from the two sites at Shubra Khait region were had higher concentrations of Fe excceded the permissible limits. While samples collected from Kafr El-Zayat region at the first site had Fe concentration excceded the permissible levels during autumn and winter seasons and during summer and autumn seasons at the second site.

According to the permissible levels of Mn in water recommended by WHO samples were collected during spring and autumn seasons in the first site in Kafr El-Zayat region were higher than the permissible levels. While water samples had levels of Pb exceeded the permissible levels according to WHO**.**

All water samples which collected during all seasons in the study were had levels of Cu below the permissible levels according to WHO, Eropian Union and Egyptian Chemical Standard and EPA. Also, all water samples which collected during all seasons were had levels of Zn below the permissible levels WHO, EPA and Egyptian Chemical Standard.

According to WHO the permissible levels all water samples contain Mg concentrations below the permissible levels.

Key words: atomic absorption spectrometry, ECS, Egyptian Chemical Standard, EPA, WHO.

INTRODUCTION

The Nile River and its branches are considered to be the mainly basis of water for human, agriculture and livestock. The Nile river in Egypt confronted the main environmental problems which resulting from human activities as removal of agricultural, industrial, urban wastes, transport, manure, herbicides, soil, seawater and dust, **He *et al.* (2004)** and **(Abdel-Mohsien & Mahmoud (2015**). Freshwater contaminated with a wide variety of pollutants, which has become a great matter worry over the last few decades, **Al-Weher (2008**).

Heavy metals are double-edged sword. It become dangerous at high concentration because they bioaccumulate faster in living things such as fish than they are broken down, but at low level it can lead to severe health effects, **Ho and El-Khaiary (2009)**. Also, release heavy metals into river or any aquatic environment can transformation aquatic ecosystems, due to their toxicity, persistence and accumulative behavior, **Adewumi *et al.* (2014**).

Also, the major source of contamination in Nile River water at Kafer El-Zayat region is Kafer El-Zayat company for pesticides and chemicals and other factories such as Egyptian financial industrial company , salt and soda company.

The aim of this work is to determine the heavy metals levels in Nile River water during the different seasons in 2016 and 2017 at two sites in Kafer El-Zayet region, El-Gharbia governorate and two sites in shubra Khait region, El-Beheira Governorate.

MATERIALS AND METHODS

Stock solution of Cd, Cr, Cu, Fe, Pb and Zn were obtained from Merck in concentration of 1000 mg/L (Merck, Darmstadt, Germany. Nitric acid (HNO_3) (95% purity) was obtained from SDS, Peypin, France.

Water samples were collected from Nile River every three monthes at Rosetta Branchs of Kafer El-Zayet region, El-Gharbia governorate and shubra khait region, El-Beheira Governorate during 2016 and 2017.

Water samples preparation: five ml of the nitric acid (HNO_3, 95%) was added to 250 ml of water samples placed in 500 ml beaker. The solution was evaporated to near dryness on hot plate. After

cooling another five ml of nitric acid was added into the beaker covered with water glass .

Gentle heating continued until digestion was completed .The concentration was filtered and transferred to 25 ml standard flask and diluted to mark with distilled for determination using Thermo atomic absorption spectrometer, **Adewumi *et al.* (2014**).

Recoveries were approved by the addition of standards of each element to blank samples. Blank and recovery samples were analyzed in the same way as the digested samples. Calibration standards were regularly achieved to estimate the accuracy of the analytical method.

The digested samples were analysed for heavy metals (Cd, Cr, Cu, Fe, Mn, Mg, Ni, Pb and Zn) by Thermo atomic absorption spectrophotometer with hollow cathode lamp and wave length fixed for each metals. Air-acetylene flame was employed. The standard for each metal was then sprayed into flame as well as the samples and the corresponding absorbance values were taken. Both standards and samples were read under the same conditions.

RESULTS AND DISCUSSION

The recovery was completed by a spike and analyzed with known standard concentration of the metal interest. An acceptable recovery percentage (%R) was 86.14±1.58% for cadmium, 81.75±0.97% for chromium, 92.27±1.59% for copper, 88.04±3.14 % for iron, 82.15±1.58% for magnesium, 81.43±1.82% for manganese, 78.61±2.31% for nickel, 89.10±1.98% for lead and 85.24±3.17 % for zinc.

Concentrations of the measured heavy metals in the water samples varied with the different seasons. So the data in **(Table 1)** showed the mean concentrations of the heavy metals in water samples collected from two sites at the Rosetta branch along the Nile River at Kafr El-zayat region, El-Gharbia Governorate were ranged between 0.15±1.05-0.99±1.02 µg/ml for **Cd**, ND-0.06±0.18 µg/ml for **Cr**, 0.14±1.39-0.24±1.51 µg/ml for **Cu**, 0.41±0.51-5.84±0.39 µg/ml for **Fe**, 4.28±1.52-6.29±1.06 µg/ml for **Mg**, ND-1.12±1.45 µg/ml for **Mn**, 0.16±1.24 -1.65±0.68µg/ml for **Ni**, ND-0.35±1.32 µg/ml for **Pb** and 0.18±0.65-0.64 ±1.49 µg/ml for **Zn** during all seasons for the two sites. The levels of **Cd** metal in spring and autumn seasons were higher than those obtained in summer and winter seasons in the both

sites in Kafr El-Zayat region. Also, there more no differences observed among the seasons for **Cr** and **Cu**. The highest Fe concentrations were observed in autumn followed by winter, spring and summer in the first site while the highest **Fe** concentrations were being observed in autumn, summer, spring and winter in the second site. The concentrations of **Mg** metal in summer season were lower than other seasons in the first site, while in the second site the concentrations of **Mg** metal were lower in winter compared with other seasons. The levels of **Mn** in summer and winter in the first site and in spring, summer and winter in the second site were below the detection limits. The highest level of **Ni** were observed in winter season in both sites, while the lowest levels were observed in summer season. The **Pb** concentrations in autumn were higher than spring and winter in the first site while the concentration of **Pb** in summer was not detectable. In the second site the lead were detected in autumn only and the levels of the metal in spring, summer and winter were below the detection limits. The highest **Zn** concentrations were observed in autumn followed by winter, spring and summer in the first site, respectively and no observed seasonal differences for **Zn** concentrations in the other tested site.

Table 1. Mean concentrations of the heavy metals estimated in water samples collected from Kafr El-Zayat region.

Heavy metals	Amount of heavy metal detected (µg/ml)							
	Site 1				Site 2			
	spring	summer	Autumn	winter	Spring	summer	Autumn	Winter
Cd	0.44±0.23	0.21±1.12	0.73±2.23	0.15±1.05	0.55±1.02	0.31±1.07	0.99±1.02	0.26±1.68
Cr	0.06±0.18	ND	0.06±1.06	0.02±1.36	0.05±1.38	0.03±1.29	0.04±1.51	0.02±136
Cu	0.18±0.25	0.14±1.39	0.23±1.31	0.24±1.51	0.22±2.03	0.17±1.74	0.21±1.59	0.19±1.28
Fe	0.88±0.37	0.41±0.51	3.66±1.08	1.31±0.98	0.90±1.03	1.26±1.16	5.84±0.39	0.74±1.41
Mg	6.27±1.15	4.94±1.36	6.17±1.69	6.29±1.06	6.26±2.09	5.62±2.58	6.20±1.33	4.28±1.52
Mn	0.41±2.04	ND	1.12±1.45	ND	ND	ND	0.27±1.61	ND
Ni	0.75±1.09	0.20±1.25	0.38±1.61	1.31±2.11	1.42±1.16	0.16±1.24	1.12±0.33	1.65±0.68
Pb	0.25±0.07	ND	0.35±1.32	0.18±1.00	ND	ND	0.13±1.58	ND
Zn	0.34±0.18	0.18±0.65	0.64±1.49	0.48±0.92	0.27±0.86	0.25±1.79	0.24±1.09	0.21±1.81

ND : not dectable.

Data in **(Table 2)** showed the mean concentrations of the heavy metals in water samples collected from Nile River at the Rosetta branch from two sites on along the river at Shubra Khait region,

El-Beheira Governorate. The data showed that the levels of Cd ranged between 0.12±3.00-0.93±2.14 µg/ml and the levels of Cr, Cu, Fe, Mg, Mn, Ni, Pb and Zn ranged between (0.04±1.11)-(0.13±1.97), (0.13±2.42)-(0.25±2.34),(1.14±1.93)-(5.61±1.99),5.39±1.05-6.22±1.55, ND-0.16±1.95, 0.14±2.93-2.05±2.00, 0.01±2.06-0.07±2.39 and(0.15±1.47)-(0.55±1.72) µg/ml, respectively.

The levels of **Cd** metal in summer seasons in the first site were lower than those of other seasons in Shubra Khait region. Also there were no observed seasonal differences for **Cr** except the spring season in the second site, it was the highst level of **Cr** compared with other seasons. There were no observed seasonal differences for **Cu** in all seasons. The highest Fe concentrations were observed in autumn in both sites. The concentrations of **Mg** element in summer season were less than other seasons in both sites. The levels of **Mn** in summer and winter in the first site and in summer and autumn in the second site were below the detection limits, while the levels of **Mn** metal in autumn in the first site were higher than other seasons. The **Ni** levels were higher in spring and winter seasons in both sites and also, lower in summer season in both sites. Concentration of the lead detected were not differed with the different seasons. The lowest **Zn** concentrations were observed in summer season in both sites and the highest concentration of **Zn** was in spring season in the second site.

Table 2. Mean concentrations of the heavy metals estimated in water samples collected from Shubra Khait region.

Heavy metals	Amount of heavy metal detected (µg/ml)							
	Site 1				Site 2			
	spring	summer	Autumn	winter	Spring	summer	Autum	Winter
Cd	0.72±1.39	0.12±3.00	0.93±2.14	0.55±1.77	0.63±1.67	0.36±1.33	0.83±3.42	0.69±2.51
Cr	0.06±2.64	0.07±2.01	0.06±2.39	0.04±1.64	0.13±1.97	0.04±1.11	0.04±1.86	0.05±1.46
Cu	0.19±2.01	0.13±2.42	0.19±1.76	0.23±1.31	0.25±2.34	0.18±2.41	0.21±2.42	0.21±2.60
Fe	1.41±1.91	2.45±1.53	4.26±1.49	1.14±1.93	2.33±1.58	1.84±1.52	5.61±1.99	3.59±1.82
Mg	6.17±0.94	5.39±1.05	6.09±2.01	6.19±3.05	6.22±1.44	5.46±2.04	6.12±2.63	6.22±1.55
Mn	0.01±1.35	ND	0.16±1.95	ND	0.03±0.99	ND	ND	0.01±1.36
Ni	1.72±2.06	0.22±2.31	0.54±1.97	1.56±2.61	1.91±1.41	0.81±1.16	0.14±2.93	2.05±2.00
Pb	0.07±2.39	0.01±2.06	0.03±2.64	0.06±1.59	0.07±1.22	0.04±2.42	0.04±2.59	0.07±1.64
Zn	0.31±1.99	0.20±2.64	0.38±1.87	0.30±2.14	0.55±1.72	0.15±1.47	0.37±3.51	0.23±2.58

ND : not dectable .

According to the maximum permissible levels of Cd in water recommended by **WHO (2011)** (0.003 mg/L), **ECS, Egyptian Chemical Standard (1994)** (0.01 mg/L) and **EU (1998); US-EPA (2009) and Health Canada (2017)** (0.005 mg/L), so all water samples in all sites in the both governorates had levels of Cd were higher than the maximum permissible levels.

The maximum permissible levels of Cr in water recommended by **EU (1998); WHO (2011) and Health Canada (2017)** (0.05 mg/mL). So, the water samples which collected during spring and autumn seasons at the first site of Kafr El-Zayat region and samples which collected from the second site during spring season from Shubra Khait region were had Cr concentrations exceeded the permissible levels of WHO, Health Canada and EU. Also, samples which collected from the first site in Shubra Khait region during the winter season and samples which collected from the second site during summer, autumn and winter were had concentrations of Cr below the permissible levels of EU; WHO and Health Canada. While according to ECS (0.01 mg/L) all water samples had levels of Cr exceeded the maximum permissible levels except water samples which collected during summer season from the first site of Kafr El-Zayat region. While according to the permissible levels of Cr in water recommended by US-EPA (0.1 mg/L), all samples had concentrations of Cr below the the maximum permissible levels except the samples were collected from the second site of Shubra Khait region during spring season.

The permissible levels of Fe according to **WHO (2011); US-EPA (2009) (0.3 mg/L)** and **EU (1998)** (0.2 mg/L) so all samples had Fe levels higher than the permissible levels. But according to the permissible levels of Fe from ECS (1 mg/L) all samples collected from the two sites at Shubra Khait region were had higher concentrations of Fe excceded the permissible limits. While samples collected from Kafr El-Zayat region at the first site had Fe concentration excceded the permissible levels during autumn and winter seasons and during summer and autumn seasons at the second site.

According to the permissible levels of Mn in water recommended by WHO (0.4 mg/L) samples were collected during spring and autumn seasons in the first site in Kafr El-Zayat region were higher than the permissible levels, while according to **US-EPA**

(2009) and **EU (1998)** (0.05 µg/mL) samples collected during sumur, winter, seasons in the first site and during spring, summer and winter seasons in the second site in Kafr El-Zayat region and during autumn season in the first site in Shubra Khait region were higher than the permissible levels.

The permissible limits of Ni were (0.02 and 0.07 mg/L) according to the **EU (1998)** and **WHO (2011)**, so all water samples had Ni levels exceeded the permissible levels.

The samples were collected during summer season at the first site and spring, summer and winter seasons at the second site in Kafr El-Zayat region were below the detection limits. Other water samples had levels of Pb exceeded the permissible levels according to **WHO (2011); US-EPA (2009)** and **Health Canada (2017)** (0.01 mg/L) and **ESC (1994)** (0.05 mg/L), while water samples were collected from the first site in Shubra Khait region during summer, winter seasons and spring, winter from the second site were had levels of Pb exceeded the permissible levels.

All water samples which collected during all seasons in the study were had levels of Cu below the permissible levels (WHO and EU, 2 mg/L), (ECS, 1.5 mg/L) and (US-EPA 1.3 mg/L. Also all water samples which collected during all seasons were had levels of Zn below the permissible levels (WHO, 3 mg/L), and (USA-EPA and ECS, 5 mg/L).

According to WHO the permissible levels of Mg is 50 mg/L, so all water samples contain Mg concentrations below the permissible levels.

Our results were agreed with **Abd-Elsalam (2013)** who found that the range of mean cadmium concentrations in water was between 0.7 and 42.38 µg/L and the minimum concentration of cadmium was 0.08 µg/L at Balaqes canal and Zawyet el Nagger drain in spring while its maximum concentration was 98.49 µg/L at Zawet El-Naggar drain in winter. Also, **Aremu *et al.* (2002)** studied the levels of some ions of heavy metals know to be associated with petroleum industry operations, including Pb, Ni, V, Cr, Cd, Zn and Fe in untreated ground water from warri area Nigeria by suing atomic Absorption spectroscopy. They found that the concentrations of Pb, Ni and Fe in the groundwater samples of all areas studied ranged from 0.06-0.44, 0.008-0.19 and 0.135-2.753 mg/L, respectively. Also, **Akacy *et al.* (2003)** monitored the pollution in two economically important rivers

of Turkey, Gediz and Buyuk Menders. The results showed that the pollution levels were significant especially for Pb, Cr, Mn and Zn in the Gediz river and Co, Mn and Zn in the Buyuk Menders river. The pollution in these was probably originated from industrial, agricultural and domestic waste discharges. **Okonkwo and Mothiba (2005)** determined the pollution levels of heavy metals in the rivers in Thohoyandou, south Africa, the samples were analyzed for Cd, Cu, Pb, and Zn using ovarian flame atomic absorption spectrometer. The data showed that the concentration range of all the metals were 1.6-9.3, 2.0-3.0, 10.5-20 and 2.1-2.5 mg/L for Cd, Cu, Pb and Zn respectively. The concentration ranges of all the metals measured were found to be below the international guidelines and acceptable concentrations for drinking water except the values for Cd and Pb. On the other hand, **Yigit and Altindage (2006)** determined the concentration of heavy metals (Cr, Cd, Hg and Pb) by atomic absorption spectra- photometry in sediment, water, plankton and fish samples from lake Egidir in south-western turkey. The data showed that the heavy metals concentrations were in the order Cd > Pb> Cr > Hg in water, Cr >Pb > cd > Hg in plankton, Cd >Cr >Pb >Hg in the muscle and Cd > Pb >Cr >Hg in the gills of Ctenopharyngodon idella. The significant differences of concentrations occurred in water, sediment, plankton and fish tissues. While, **Undosen *et al.* (2007)** studied the levels of certain heavy metals Zn, Ni, Co, V, Fe and Pb in surface water and intertidal sediment collected monthly between May and November 2003 from stubs creek determined using unicam 939/959 atomic absorption spectrophotometer and chromatography, respectively. The result indicated that the trends in mean levels of heavy metals in sediment and water samples were Fe >V > Ni > Zn > Pb> Co and Fe> Ni >V>Pb > Co > Zn, respectively. Olatunji and Osibanjo, 2012 determined the concentrations of some heavy metals in freshwater from River Niger. The mean concentrations (mg/L) of heavy metals were Mn (3.85±0.93); Zn (2.72±0.57); Cu (2.17±0.73); Cr (2.08±1.27); Ni (0.78±0.12); Cd (0.05±0.02) and Pb (0.03±0.02). The concentration of Mn, 1.74 to 8.37 mg/L; Cu, 0.58 to 4.50 mg/L; Cd, 0.02 to 0.13 mg/L were variable and inundating. The variations in heavy metal levels between sampling stations were not significant (P > 0.05) with relative standard deviation from 2% for Cd and Pb to 12.7% for Cr. The order of dispersion (2 to 14%) showed that the measured metals are nearly homogenously distributed in the water

with Cr, Mn, Cu and Zn having the highest concentration variations in the water samples. The concentrations of the evaluated heavy metals were within the guideline levels for freshwaters, and did not appear to have significant negative impact on the water quality. Also, **Cobbina *et al.* (2015)** determined levels of heavy metals in drinking water in (Nangodi and Tinga) in northern Ghana. The mean levels (mg/L) of heavy metals in water samples from Nangodi and Tinga communities were 0.038 and 0.064 (Hg), 0.031 and 0.002 (As), 0.250 and 0.031 (Pb), 0.034 and 0.002 (Zn), and 0.534 and 0.023 (Cd), respectively, for each community. Generally, levels of Hg, As, Pb, Zn, and Cd in water from Nangodi exceeded WHO stipulated limits of 0.010 for Hg, As, and Pb, 3.0 for Zn and 0.003 for Cd for drinking water, and levels of Hg, Pb, and Cd recorded in Tinga, exceeded the stipulated WHO limits. Ingestion of water, containing elevated levels of Hg, As, and Cd by residents in these mining communities may pose significant health risks **(Table 3**) .

Table 3. The maximum permissible from of heavy metals in drinking water.

Element	Egyptian chemical standard (ECS) (1994)	Guiddelines for Canadian Drinking water Quality (mg/L) (2017)	National Primery Drinking water regulations (USA) (2009) mg/L	WHO (2011) Guiddelines for Drinking water Quality (mg/L)	Drinking water Directives EU (1998) (mg/L)
Cd	0.01	0.005	0.005	0.003	0.005
Cr	0.01	0.05	0.1	0.05	0.05
Cu	1.5	--	1.3	2	2
Fe	1	--	0.3	--	0.2
Pb	0.05	0.01	0.015	0.01	0.01
Mn	--	--	0.05	0.4	0.05
Ni	--	--	--	0.07	0.02
Zn	5	--	5	3	--
Mg	--	--	--	50	--

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تقدير مستويات المعادن الثقيلة في مياه نهر النيل ، مصر

داليا السيد الحفني[1]- أحمد علي عبدالقادر الغنام[1]– عبد الباسط الصعيدي[2]

[1] قسم بحوث متبقيات المبيدات وتلوث البيئة ، المعمل المركزي للمبيدات ، مركز البحوث الزراعية ، الدقي،الجيزة، مصر

[2] معهد بحوث وقاية النباتات ، مركز البحوث الزراعية ، الدقي ، الجيزة ، مصر

تهدف الدراسة تحديد مستويات المعادن الثقيلة (الكادميوم، الكروم، النحاس، الماغنسيوم، المنجنيز، النيكل، الرصاص و الزنك)، في عينات المياه التي تم جمعها في مواسم مختلفة من مواقع مختلفة من نهر النيل في منطقة شبرا خيت محافظة البحيرة وكفر الزيات محافظة الغربية. كما تم تحديد مستويات هذه المعادن عن طريق مطياف الامتصاص الذري. كانت معدلات الاسترجاع 86.14 ميكرو جرام / مل ± 1.58 ٪ للكادميوم، ميكرو جرام / مل 81.75±0.97 ٪ للكروم ، 92.27 ميكرو جرام / مل ±1.59 ٪ للنحاس ، 88.04 ميكرو جرام / مل ± 3.14 ٪ للحديد ، 82.15 ميكرو جرام / مل ± 1.58 ٪ للماغنسيوم، 81.43 ± ميكرو جرام / مل 1.82 ٪ للمنجنيز، 78.61 ± ميكرو جرام / مل 2.31 ٪ للنيكل- 89.10 ± ميكرو جرام / مل 1.89٪ للرصاص و 85.24 ميكرو جرام / مل ± 3.17٪ للزنك. كما تراوحت متوسطات تركيزات المعادن الثقيلة في عينات المياه في موقعين في فرع رشيد على طول نهر النيل في كفر الزيات بين 0.15±1.05 الي 0.99±1.02 ميكروجرام / مل للكادميوم، أقل من حدود التقدير الي 0.06 ± 0.18ميكروجرام / مل للكروم ، 0.14 ±1.39 الي 0.24 ±1.51ميكروجرام / مل للنحاس، 0.41± 0.51 الي 5.84 ±0.39ميكروجرام / مل للحديد، 4.28±1.52 الي 6.29 ±1.06 ميكروجرام / مل للماغنسيوم ، أقل من حدود التقدير الي 1.12± 1.45 ميكروجرام / مل من للمنجنيز، 0.16±1.24 الي 1.65±0.68 ميكروجرام / مل للنيكل ، أقل من حدود التقدير الي 0.35±1.32 ميكروجرام / مل للرصاص و 0.18±0.65 الي 0.64±1.49 ميكروجرام / مل للزنك. متوسط تركيزات المعادن الثقيلة في عينات المياه التي تم جمعها من نهر النيل في فرع رشيد من موقعين على طول النهر بمنطقة شبرا بخيت ، محافظة البحيرة. تراوحت بين 0.12±3.00 الي 0.93±2.14 ميكروجرام / مل من الكادميوم ، وتراوحت مستويات الكروم ، النحاس ، الحديد ، المغنيسيوم ، المنجنيز ، النيكل ، الرصاص والزنك بين 0.04±1.11 الي 0.13±1.97 ، 0.13±2.42 الي 0.25±2.34 ، 1.14±1.93 الي 5.61±1.99 ، 5.39±1.05 الي 6.22±1.55 ، أقل من حدود التقدير الي 0.16±1.95 و 0.14±2.93 الي 2.05±2.00 و 0.01±2.06 الي 0.07±2.39 و 0.15±1.47 الي 0.55±1.72 ميكروجرام / مل على التوالي.

لقد أوضحت النتائج ان جميع عينات المياه تحتوي على تركيزات من عناصر الكادميوم والنيكل أعلى من المستويات القصوى المسموح بها.

من ناحية أخرى ووفقًا للمنظمات المختلفة التي تضع الحدود المسموح بها للمعادن الثقيلة في المياه ، فإن المستويات المسموح بها تكون متباينة. على سبيل المثال وفقًا للمواصفات القياسية المصرية ، فإن جميع عينات المياه التي تحتوي على تركيزات من الكروم تجاوزت الحدود المسموح بها باستثناء عينات المياه التي تم جمعها خلال فصل الصيف من الموقع

الأول لمنطقة كفر الزيات ، ولذا فإن بعض العينات تحتوي علي تركيزات أقل من الحدود المسموح بها وآخرى تجاوزت الحدود.

أوضحت النتائج ايضا ان عينات المياه احتوت علي مستويات من عنصر الحديد أعلى من المستويات المسموح بها طبقا لمنظمة الصحة العالمية. بينما وفقًا للمستويات المسموح بها من عنصر الحديد طبقا للمواصفات القياسية المصرية ، فإن جميع العينات التي تم جمعها من الموقعين في منطقة شبراخيت كانت ذات تركيزات أعلى من الحدود المسموح بها لعنصر الحديد. في حين أن العينات التي تم جمعها من منطقة كفر الزيات في الموقع الأول كان فيها تركيز عنصر الحديد تجاوز المستويات المسموح بها خلال فصلي الخريف والشتاء وخلال مواسم الصيف والخريف في الموقع الثاني.

ووفقًا للمستويات المسموح بها من عنصر المنجنيز في المياه طبقا لمنظمة الصحة العالمية وجد ان عينات المياه التي جمعت خلال فصلي الربيع والخريف في الموقع الأول في منطقة كفر الزيات احتوت علي تركيزات أعلى من المستويات المسموح بها. ووجد أيضا ان عينات المياه احتوت على مستويات من عنصر الرصاص تجاوزت المستويات المسموح بها وفقا لمنظمة الصحة العالمية.

كما احتوت جميع عينات المياه علي تركيزات من عنصر النحاس و عنصر الزنك أقل من المستويات المسموح بها طبقًا لمنظمة الصحة العالمية والاتحاد الأوروبي والمواصفات القياسية المصرية ووكالة حماية البيئة. كما احتوت جميع عينات المياه على تركيزات من عنصر المغنيسيوم أقل من المستويات المسموح بها وفقًا لمنظمة الصحة العالمية.