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Chemical and Ecological Studies on Tilapia Nilotica

A. E. MOHAMED, R. M. AWADALLAH* and S. A. GABR
Chemistry Department
Faculty of Science, Aswan, Egypt.

Atomic absorption spectrophotometry was utilized for the determination of Ag,Au,Ca,Cr,Cu,Fe,K,Mg,Mn,Na,Ni,Pb,Sr and Zn in 42 Tilapia nilotica fish samples collected from river Nile at Aswan (15 samples from the place between the conservation area of Awada and Gebel Tagoug, and 27 samples from the main stream, 15 from the latter samples were placed in the middle of Kima drain draft and the remainder in the river Nile just beyond the end of Kima drain draft contact with Nile). Average length ranges from 13 to 26 cm, weight ranges from 98–400 gm, and water content equals 74.37–75.40%. The results show that trace element concentrations are clearly consistent with size of fish species (length and weight), particularly, relatively large size fish contain higher concentrations of Na,Mn,K,Cu,Cr,Sr and Zn. Also, contaminated Kima drain draft water may not reflect any change in concentrations of the metals in fish. The trace element concentrations in the investigated fish samples are below the safety baseline levels. Statistical relative errors equal 4.8–8.5% and standard deviation = 0.0263–303.557.

INTRODUCTION

Tilapia nilotica species has a wide distribution, ranging from lake Galilee and Jordan southwards to the Great Lake and East Africa, westwards through the Chad Basin in Chad to the Senegal, Niger and Ubanghi (Middle Africa). Tilapia nilotica is very common and economic in the High Dam Lake and in the river Nile. Tilapia nilotica is notable as frequently appearing in the well-done graphic representations of the ancient Egypt. The oldest known representation, before 500 B.C. is a glazed pottery model of Hierakopolis. Numerous figures of this fish are recognizable in the mural paintings in the Tomb of Ti (Sakkara, Giza), Tomb and Chapel of ptah Hotep, etc.

Trace elements play a very important and vital role in catalyzing biological, biochemical, metabolic, catabolic and enzymatic reactions in the living cells of plants, animals and human beings.[1] Its importance is very pronounced on the health and disease of plants, animals and human beings as they are dependent on the trace elements needed to have from soil, fertilizers and irrigation water for plants, vegetables and crops, from water and plants for animals and from plants, vegetables, crops, drink water and animals for human beings. Trace elements are important as indicators and guide elements for plants, mineral resources and geochemical and biogeochemical reactions.[2]

Continuity to our earlier studies on water[3–6], sediments[7], crops[8–11], Egyptian cane sugar[12–14], Egyptian molasses[15] and in fish[16–18], we report our communication to assess the value of determining and to study trace elements concentration in 42 Tilapia nilotica samples in river Nile on the basis of the results of the chemical analysis and to indicate ecological relationship to the distribution of trace metals pollution. A further aim is to provide information on trace metal concentrations on Tilapia nilotica species fish.

EXPERIMENTAL

Sample collection

Forty two different specimens of Tilapia nilotica species (locally called Bolti), of varying weights (98–400 gm.) were collected from the river Nile at Aswan city in April 1988. Of which 15 (samples no. 1–15) fish samples (98, 101, 105, 120, 135, 142, 151, 170, 172, 183, 190, 195, 198, 202, and 210 gm.) were collected from the place between Gebel Tagoug (very near to Kalabsha Hotel) and Awada conservation area (island in the river Nile and in the front of Aswan Nassr City). The other samples (27) were collected from the main stream of the river Nile. From these, 12 (samples no. 16–27) samples (116, 121, 127, 138, 160, 185, 196, 206, 212, 216, 224 and 230 gm.) were inserted in a suitable net fish and placed in the middle of Kima drain draft. After two hr. fish samples were died and then the samples were taken out. The remaining 15 (samples number 28–42) samples were put in the river nile just beyond the end of Kima drain draft in the northern direction of the river Nile.

Samples preparation

The fish samples (42) were washed well using tap water, then kidney, liver, gills and digestion canal were removed from the fish samples. The samples were washed again several times with tap and double-distilled water. The samples were dried on filter papers and placed in an electrical furnace at 105° for 48 hr. to remove water content. After drying and cooling, the samples were collected, powdered and kept in small polyethylene bottles.

Working procedure

5 gm. portion of each of the dried fish samples was wet ashed with 50 ml concentrated nitric acid (A.R., 70%, Riedel de Haën) in a teflon beaker. The beaker was placed on a sand bath till all the fumes of nitric acid ceased to evolve. Near dryness, 25 ml portion of nitric acid was added to the beaker, then 2 ml hydrofluoric acid (A.R., 40% BDH) and the mixture was placed again on a sand bath and heated for complete digestion. After

cooling, the clear content was transferred into volumetric flask and made upto 100 ml using double-distilled water.

Preparation of standard solutions

Standard solutions of Ag, Au, Ca, Co, Cr, Cu, K, Mg, Mn, Na, Ni, Pb, Sr and Zn were prepared by dissolving the appropriate amounts of the Analar salts [(99.9%, BDH, E. Merck or Riedel de Haën) of $AgNO_3$, Au metal (99.99%), $CaCO_3$, $CoCl_2.6H_2O$, $K_2Cr_2O_7$, $CuSO_4.5H_2O$, KCl, $MgCl_2$, $MnSO_4.H_2O$, NaCl, $NiSO_4.7H_2O$, $Pb(NO_3)_2$, $SrCl_2$, and $ZnSO_4$ in double-distilled water [$CaCO_3$ was dissolved in HCl (1 : 1) then diluted with double-distilled water to 100 ml].

Calibration graph

Standard curve for each metal was constructed by representing the absorbance values versus the concentration of the metal salt solutions. Atomic absorption spectrophotometric measurements were undertaken at Aswan, Faculty of Science on pye Unicam SP 1900 absorption spectrophotometer, Digital, Readout Direct Concentrations. Measurements were made at the characteristic wavelengths of the elements using hollow cathode lamps.

RESULTS AND DISCUSSION

The data obtained are recorded in Table 1. The Table shows the trace elements of Ag, Au, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn in the investigated 42 Tilapia nilotica samples. The elements Ca, Co, Cr, Cu, Fe, Mg, Mn, Ni and Zn are important, necessary and essential nutrients for the life of fish and are dietary essentials for human beings. They may act as active centres and have vital biological and biochemical roles, and metabolic functions. For example, the presence of Ca and Mg are very important, they are essential nutrient elements and act as binding agents to fuse the walls of the cells together[19]. In addition, calcium plays an important role in nitrogen metabolism by participation in the reduction of nitrates and depresses the entry of sodium and potassium[19]. Calcium has an interesting effect on the absorption or utilization of other divalent heavy metals such as Pb, Cu and Zn by fish as is evident from the results [high calcium intake promotes deficient Zn absorption by fish in hard water (Kima drain draft water) than in soft water (river Nile water)][18]. Magnesium plays a significant role in carbohydrate metabolism and respiration by regulating phosphate metabolism[19]. Sodium, potassium and manganese may be present in fish as chlorides. NaCl exists in the gastric juice, regulates osmotic pressure and releases during later stages of digestion in the extracellular fluids. Potassium is an essential nutrient element and has an

important role in the synthesis of amino acids and proteins from ammonium ions and has a good relation with hypertension[19]. Manganese is an essential element and necessary for bone growth and egg production and has effect on tissue mucopolysaccharide content[20]. Mn is also an activator and metal cofactor[21] for enzymes (hydrolases. kinases, decarboxylases and transferases) involved in respiration, nitrogen metabolism and glycoprotein synthesis[22], and for enzymes of fatty acids synthesis in fish. The darker centres on scales, dark spots on the operculum, dull purplish red colour over the head and on the lower part of the body, and the oblique dark streaks on dorsal, anal and caudal fins may be attributed to the presence of Mn[1,19]. Its deficiency causes grey speck of oats[19], reduces avimanganin content in liver and products of glycosyltransferase enzyme reactions and may be replaced by magnesium[23]. Co and Fe are essential activators involving vitamin B_{12} synthesis and nitrogen fixation[19] Co coordinates with carboxypeptidase enzymes and catalyzes amino acids[24]. Iron is also important for erythrocytes, as haemoglobin and haematin in blood. It occurs as transferrin in the plasma and functions as oxygen carrier[25]. Iron and copper[26] are important essential metals and have fundamental relation (serum copper protein ceruloplasmin and iron metabolism). They form a number of copper and iron proteins. The presence of copper may reflect its usefulness in the growth of fish as dietary food. It may give the greenish olive colour. It labilizes the lysosomal membranes[19,25]. Ag, Au, Cr and Ni are also essential nutrient elements. Ag interferes with Cu but not with Zn metabolism because it has the same chemical parameters of Cu^{27} and Zn^{2+} interfers with Cu^{2+} metabolism for the same reason[27]. Cr is an essential nutrient element and increases the rate of growth of fish. Ni is an essential element and activates a number of metals and bounds to ribonucleic acid. It has a special affinity for bond and has been suggested to play an important role in pigmentation and colouration of fish[19]. Lead may be present in tissues and in bones of fish[19], and the concentration increases gradually with the age and with the size. Presence of lead in the fish samples may be related to the presence of lead coming from river Nile water polluted by gasoline from boats working in the river Nile, particularly, in the Hotel district. Zn is an important essential micronutrient element and cofactor in number of enzyme systems and in the synthesis of RNA and DNA. It has an important role in cell replication and for the alteration of the genetic potential in cell proliferation in fish tissues. Firm fish may be ascribed to Zn where it stabilizes the lysosomal membranes. The presence of trace elements in the investigated fish samples in concentrations reported in the Table is in safety baseline levels for man. The results show that trace element concentrations (e.g., Ag, Au, Cr, Cu, Mn, Na, Sr, Zn) are clearly consistent with the size of fish species (length and weight)

TABLE 1
RESULTS OF TRACE ELEMENT CONCENTRATION IN TILAPIA NILOTICA SAMPLES DETERMINED BY AAS METHOD (Ca by EDTA)

Element Sample No.	Ag(ppm)	Au(ppm)	Ca %	Co(ppm)	Cr(ppm)	Cu(ppm)	Fe(ppm)	K(ppm)	Mg(ppm)	Mn(ppm)	Na(ppm)	Ni(ppm)	Pb(ppm)	Sr(ppm)	Zn(ppm)
1	0.03	0.18	0.025	0.18	1.42	0.41	17.38	1023.61	198.40	2.07	339.98	1.05	0.54	0.57	3.58
2	0.03	0·09	0.032	0.20	1.05	0.29	18.38	838.61	178.40	1.72	289.98	0.74	0.36	0.36	3 02
3	0.06	0.22	0.096	0.32	1.67	0.33	24.58	1223.61	218.40	5.07	589.98	1.24	0.00	0.62	4.67
4	0.04	0.19	0.090	0.25	2.12	0.36	25.98	1053.61	143.40	1.73	289.98	1.45	0.74	0.64	4.84
5	0.03	0.12	0.054	0.23	1.79	0.32	21.48	1168.61	213.40	1.55	439.98	1.05	0.52	0.45	4.04
6	0.03	0.14	0.050	0.20	1.48	0.69	18.98	1488.61	208.40	2.16	419.98	1.07	0.93	0.44	4.07
7	0.00	0.17	0.074	0.25	1.19	0.33	24.58	643.61	128.40	1.86	289.98	0.98	0.60	0.60	3.36
8	0.02	0.13	0.054	0.16	0.99	0.18	18.18	663.61	103.40	1.27	219.98	0.67	0.21	0.28	3.22
9	0.02	0.15	0.032	0.19	0.18	0.31	16.98	848.61	138.40	1.56	274.98	0.80	0.33	0.39	2.86
10	0.03	0.11	0.049	0.17	1.22	0.47	13.48	948.61	148.40	1.30	314.98	0.92	0.44	0.37	3.03
11	0.04	0.18	0.115	0.21	1.28	0.38	18.48	978.61	208.40	2.99	419.98	0.93	0.53	0.47	3.75
12	0.03	0.22	0.069	0.22	1.62	0.69	14.28	698.61	168.40	1.98	324.98	1.16	0.46	1.28	3.70
13	0.03	0.20	0.063	0.19	1.43	0.41	17.88	1463.61	203.40	1.69	434.98	1.41	0.42	0.36	3.89
14	0.04	0.21	0.101	0.27	1.73	0.46	17.48	1253.61	188.40	2.37	454.98	1.27	0.72	0.69	3.63
15	0.04	0.25	0.108	0.30	1.76	0.41	24.88	1513.61	253.40	2.39	514.98	1.12	0.76	0.61	5.15
16	0.02	0.00	0.076	0.24	1.80	0.18	12.00	933.04	38.79	1.24	365.75	1.60	0.10	0.25	1.47
17	0.04	0.04	0.101	0.32	1.54	0.24	13.90	1038.04	83.79	3.78	550.75	1.68	0.35	0.65	1.70
18	0.02	0.00	0.040	0.16	0.41	0.08	7.70	408.04	13.79	0.83	130.75	0.65	0.10	0.25	0.66
19	0.01	0.04	0.094	0.17	2.72	0.15	14.60	678.04	8.79	0.50	130.75	2.08	0.04	0.16	0.87
20	0.04	0.02	0.050	0.33	1.99	0.23	13.50	583.04	33.79	3.34	230.75	3.89	0.34	0.65	1.93

21	0.01	0.00	0.078	0.26	1.75	0.16	12.10	628.04	33.79	1·81	200.75	1.51	0.51	0.60	1.17
22	0.04	0.01	0.06	0.27	1.87	0.15	14.20	883.04	53.79	2.99	270.75	1.65	0.31	0.65	2.32
23	0.03	0.00	0.081	0.25	1.50	0.27	11.30	1008.04	53.79	2.22	295.75	1.36	0.22	0.51	1.87
24	0.02	0.00	0.110	0.17	1.51	0.17	11.10	678.04	18.79	1.11	175.75	1.40	0.11	0.29	1.09
25	0.04	0.00	0.072	0.28	0.98	0.14	8.20	878.04	33.79	3.34	210.75	1.15	0.23	0.59	1.60
26	0.03	0.05	0.06	0.26	1.37	0.18	11.00	913.04	63.79	2.91	275.75	1.34	0.22	0.56	1.71
27	0.00	0.00	0.102	0.04	0.00	0.05	3.60	153.04	0.00	0.78	50.00	0.22	0.01	0.36	0.35
28	0.03	0.20	0.105	0.22	1.50	0.31	18.18	1378.04	218.40	0.99	404.98	1.14	0.50	0.42	4.25
29	0.04	0.27	0.092	0.29	2.00	0.33	20.38	1223.61	203.40	2.15	424.98	1.41	0.41	0.77	5.21
30	0.04	0.28	0.104	0.32	1.77	0.47	55.48	1268.61	213.40	4.29	344.98	1.29	0.74	0.60	7.12
31	0.05	0.27	0.067	0.18	1.73	0.33	43.98	1378.61	223.40	2.58	414.98	1.31	0.73	0.76	2.67
32	0.03	0.17	0.078	0.29	1.06	0.32	30.68	828.61	148.40	1.09	299.98	1.04	0.54	0.59	5.46
33	0.07	0.42	0.045	0.45	2.44	0.52	20.00	1248.04	178.79	5.52	1060.75	1.97	0.78	1.14	4.96
34	0.07	0.32	0.038	0.4L	1.81	0.40	16.50	778.04	123.79	2.17	605.75	1.67	0.74	0.80	4.58
35	0.08	0.36	0.054	0.50	2.11	0.35	19.40	1403.04	218.79	3.64	880.75	1.87	0.70	1.06	4.24
36	0.08	0.31	0.038	0.47	2.33	0.41	20.80	1058.04	168.79	2.69	790.75	2.00	0.60	0.98	4.87
37	0.06	0.29	0.074	0.43	2.06	0.33	17.30	843.04	83.79	2.87	695.75	1.69	0.38	1.00	4.03
38	0.07	0.28	0.050	0.44	2.08	0.35	17.10	903.04	123.79	3.10	655.75	1.77	0.63	1.16	4.01
39	0.06	0.13	0.047	0.41	2.03	0.32	19.30	968.04	173.79	2.42	890.75	1.72	0.49	0.80	4.14
40	0.10	0.32	0.047	0.48	2.58	0.36	19.60	1373.04	123.79	2.52	975.75	2.05	0.77	0.14	5.00
41	0.05	0.18	0.056	0.37	3.91	0.30	25.40	1013.04	138.79	1.95	670.75	2.97	0.42	0.66	4.03
42	0.07	0.16	0.029	0.40	1.99	0.34	12.50	818.04	118.79	1.91	620.75	1.76	0.50	0.76	3.53
$\bar{x}$	0.042	0.191	0.068	0.281	1.716	0.32	18.638	977.954	134.575	2.296	434.413	1.427	0.455	0.626	3.373
S.D.	0.206	0.099	0.026	0.108	0.568	0.137	8.925	303.557	71.28	1.097	237.864	0.623	0.235	0.273	1.516
S.E.	0.003	0.017	0.004	0.017	0.089	0.021	1.377	46.839	11.132	0.169	36.703	0.096	0.037	0.042	0.234

$\bar{X}$ = mean element concentration, S.D. = standard deviation, S.E. = statistical error.

and contaminated (Kima drain draft) and contaminated (river Nile) waters have no effect on trace element levels in fish.

This work has provided new information on the levels of Ag, Au, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn in Tilapia nilotica fish. The information gained on elements of a nutritional interest will help in establishing baseline levels.

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