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MAJOR AND TRACE ELEMENTS IN MILLET AND SOILS OF THREE DIFFERENT EXPERIMENTAL FARMS

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The major and trace elements in millet and soil samples of three different experimental farms on the beaches of High Dam Lake (Kalabsha, Gerf Hussein and Allaqi) at 10, 30, 60 cm depths were determined using atomic absorption spectrophotometer (AAS), ion selective electrode (ISE) and titrimetric techniques. The results indicated that in Kalabsha, the soil samples at 30 cm depth exhibited high concentrations of Ca, Co, Cr, Fe, K, Mg, Na, Ni, Pb, Sr and Zn. High concentration of Ca, Cl, K, Mg, and Na were detected at 10 cm depth in soil of Allaqi. Higher concentration of elements were found in millet planted in Allaqi area than that planted in the other two areas. Good correlation coefficeint values were found between the elements in millet, soil samples and millet/soil ratio.

Key words: Millet, Trace elements, Soils.

Introduction

Geomorphology. Gerf Hussein [1] farm belongs to the lower Nubia plain which is located in the El-Dakka area. The beds of this area are composed of varicoloured sandstones and characterised by the lack of polymoitic conglomerate accumulations. The major part of Kalabsha [2] is composed of grey, reddish, darkbrown, black ferrugenous sandstones, sand polished pieces of white limestone and sandy clay with limestone deposits. Wadi Allaqi [3] is composed mainly of Nile alluvial beach, dunes, wind blown sands, Nubia granite, serpentines, talc and gold dissiminated deposits and quartz veins.

Soil classification. The areas of Gerf Hussein and Allaqi are composed of four main soil groups, Lithic Torripsamments, Typic Torripsamments, Lithic Quartzipsamments and Typic Quartzipsamments. In Kalabsha, the soil belongs to Entisols, suborders Psamments and Orthents [1-3].

Trace elements play a very important role in chemical, biological, biochemical and enzymatic reactions in the living cells of plants, animals and humans. The trace elements in Egyptian cane sugar [4], crops [5,6], medicinal plants [7], fish [8,9], soil [10,11], vegetables [12], fenugreek and lupin [13], barley, beet and purslane [14], African tea, black pepper and tomatos [15,16] and in biological materials [17, 18] were determined using atomic absorption spectrophotometer, inductively coupled plasma atomic emission spectrometric and instrumental neutron activation analyses. Ion selective electrode was also used in the determination of trace elements and chloride in plants [19, 20], vegetables [21], fish cakes [21] as well as fluoride in plant tissue [22] and in faeces [23].

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This work is devoted to determine the major and trace elements in soil samples of the new formed lands (Kalabsha, Gerf Hussein and Allaqi areas) at 10, 30, 60 cm depths and in the millet planted in these areas.

Experimental

Sample collection. The planted millet samples were collected, washed, dried at 105°C for 48hrs., crushed and powdered. The soil samples were collected at 10,30 and 60 cm depths, dried at 105°C for 24hrs and powdered.

Sample preparation. 1-*For atomic absorption spectroscopy (AAS) (a).* Ten grams of the dried millet samples were wet ashed with 40 ml (1:1) HNO_3 - $HClO_4$ and heated to near dryness. Drops of HF acid were added and heating was continued to dryness. The residue was treated with 10 ml conc. HCl and boiled for 30 min; then 20 ml double distilled water was added and solution was heated for 15 min and made up to 100 ml with double distilled water.

(b). One gram of the dried soil samples was dissolved in 10 ml (1:1) HNO_3 - HCl and heated to dryness. The residue was dissolved in HNO_3 - HCl (1:1) and reheated to dryness. The content was dissolved in 10 ml (2N) HCl, heated for 5 min, filtered and made to 100 ml with double distilled water.

2-*For ion selective electrode (ISE) (a).* One gram of dried millet samples was added to 50 ml of 1 M $NaNO_3$, filtered and washed with deionized water.

(b) Ten grams of powdered soil samples were shaken with 100 ml chloride free deionized water, filtered and washed with deionized water.

Standard Solutions

(a) *For atomic absorption spectroscopy (AAS).* Stock 500 ml solutions (1000 ppm) of different metals were purchased from Aldrich Chemical Co. (USA). The working standard

TABLE 1. RESULTS OF TRACE ELEMENT CONCENTRATIONS IN SOIL SAMPLES OF MILLET (KALABSHA AREA).

Element / Sample No.	1			2			3			4			5			6		
Depth, (cm)	10	30	60	10	30	60	10	30	60	10	30	60	10	30	60	10	30	60
Ag (pmm)	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.10	0.01	0.01
Au (ppm)	0.08	0.08	0.14	0.11	0.10	0.18	0.06	0.15	0.19	0.06	0.05	0.03	0.12	0.08	0.06	0.08	0.05	0.09
Ca (%)	2.88	5.05	6.31	4.32	4.00	2.70	3.60	5.68	7.57	2.16	1.26	1.35	4.32	2.88	2.70	2.88	1.80	2.70
Cl (ppm)	0.25	0.23	0.30	0.26	0.24	0.30	0.26	0.26	0.40	0.24	0.23	0.31	0.22	0.22	0.25	0.24	0.22	0.27
Cl*(ppm)	0.24	0.22	0.30	0.25	0.23	0.29	0.25	0.24	0.39	0.25	0.22	0.30	0.21	0.21	0.24	0.23	0.21	0.27
Co (ppm)	0.22	0.19	0.24	0.19	0.22	0.18	0.23	0.20	0.28	0.21	0.17	0.15	0.21	0.20	0.18	0.19	0.15	0.24
Cr (ppm)	0.00	0.00	0.10	0.00	0.01	0.00	0.11	0.01	0.05	0.00	0.00	0.04	0.07	0.01	0.07	0.02	0.00	0.10
Cu (ppm)	0.14	0.20	2.36	0.17	0.56	0.12	0.23	0.14	0.21	3.72	0.09	1.15	0.16	0.24	0.14	0.21	0.83	0.19
Fe (ppm)	316.5	298.5	300.5	302.0	307.0	333.5	463.0	775.0	330.0	254.0	145.5	166.0	128.5	274.0	270.0	313.0	167.5	345.0
K (ppm)	35.0	20.5	47.0	38.0	46.0	35.0	83.0	142	55.0	31.5	18.0	15.5	64.5	21.5	34.0	40.5	10.0	45.5
Mg (ppm)	74.0	84.5	106.5	100.0	94.5	63.5	128.5	11.5	105.0	66.0	39.0	44.5	122.0	59.0	76.0	88.0	44.0	84.5
Mn (ppm)	3.06	2.74	3.00	2.38	3.28	3.49	5.30	3.52	3.88	3.39	3.24	3.33	4.22	3.15	2.34	3.08	2.32	3.23
Na (ppm)	7.5	5.0	6.5	6.3	10.00	4.0	5.00	1.6	5.5	2.5	2.2	1.0	3.0	1.5	4.5	2.0	1.0	3.5
Ni (ppm)	0.08	0.20	0.23	0.20	0.15	0.11	0.15	0.12	0.10	0.17	0.19	0.04	0.00	0.03	0.00	0.13	0.05	0.07
Pb (ppm)	0.17	0.27	0.46	0.18	0.27	0.16	0.23	0.28	0.27	1.24	0.18	0.28	0.23	0.23	0.17	0.18	0.60	0.16
Sr (ppm)	0.36	0.38	0.60	0.31	0.34	0.30	0.30	0.47	0.60	0.21	0.09	0.06	0.46	0.33	0.25	0.27	0.06	0.29
Zn (ppm)	0.16	1.93	7.75	0.09	4.09	0.03	1.12	4.40	0.23	8.54	0.90	6.57	0.22	2.23	0.71	0.71	8.52	0.18

Table 1 Contd...

	7			8			9			10			11			12		
	10	30	60	10	30	60	10	30	60	10	30	60	10	30	60	10	30	60
Ag (ppm)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Au (ppm)	0.05	0.09	0.05	0.06	0.16	0.14	0.10	0.06	0.10	0.14	0.10	0.14	0.12	0.13	0.10	0.14	0.13	0.13
Ca (%)	1.17	1.80	1.44	3.06	7.66	4.41	2.97	2.52	3.06	4.23	3.69	4.32	4.41	3.96	2.88	4.50	3.69	2.88
Cl (ppm)	0.26	0.24	0.31	0.29	0.30	0.31	0.27	0.26	0.24	0.25	0.23	0.31	0.27	0.34	0.25	0.29	0.27	0.26
Cl* (ppm)	0.25	0.23	0.30	0.28	0.29	0.30	0.27	0.25	0.23	0.24	0.22	0.30	0.26	0.33	0.24	0.28	0.26	0.25
Co (ppm)	0.15	0.16	0.17	0.19	0.23	0.24	0.20	0.18	0.16	0.20	0.15	0.16	0.23	0.21	0.12	0.19	0.20	0.13
Cr (ppm)	0.00	0.00	0.01	0.20	0.30	0.27	0.18	0.24	0.24	0.28	0.40	0.25	0.29	0.52	0.57	0.78	0.64	0.51
Cu (ppm)	0.14	0.09	0.20	0.13	0.17	0.24	0.19	0.46	0.20	0.11	0.10	0.10	0.08	0.19	0.12	2.92	0.18	0.11
Fe (ppm)	142.0	221.0	160.5	361.5	433.0	307.5	371.5	279.5	258.5	389.0	400.0	293.0	404.5	404.5	257.0	445.5	452.0	308.0
K (ppm)	8.0	27.5	16.5	46.5	65.5	43.5	62.5	29.5	30.0	65.0	40.0	33.0	21.5	75.5	37.0	77.5	79.5	43.5
Mg (ppm)	40.0	58.5	37.5	84.0	119.0	84.0	108.0	73.0	73.0	104.0	100.0	86.5	111.5	115.5	68.5	105.0	114.0	70.5
Mn (ppm)	3.00	2.46	3.13	3.64	3.62	3.0	4.08	3.22	2.52	4.54	2.74	2.26	4.63	4.83	3.09	4.53	5.11	3.54
Na (ppm)	4.0	1.5	1.5	2.0	4.0	2.5	6.0	2.5	5.0	5.5	4.5	3.0	5.5	4.5	1.5	4.5	7.0	2.5
Ni (ppm)	0.04	0.00	0.02	0.12	0.18	0.09	0.40	0.31	0.28	0.18	0.16	0.14	0.30	0.44	0.31	0.56	0.81	0.39
Pb (ppm)	0.15	0.15	0.10	0.15	0.19	0.18	0.18	0.18	0.24	0.24	0.25	0.23	0.24	0.27	0.19	0.38	0.22	0.20
Sr (ppm)	0.04	0.08	0.07	0.29	0.41	0.48	0.26	0.20	0.25	0.39	0.33	0.30	0.26	0.34	0.22	0.40	0.44	0.34
Zn (ppm)	0.17	0.15	0.12	0.12	0.29	0.65	0.18	4.45	0.76	0.23	0.52	0.52	0.59	0.88	0.18	7.83	0.61	0.22

Table 1 Contd...

	13			14			15			16		
	10	30	60	10	30	60	10	30	60	10	30	60
Ag (ppm)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.01
Au (ppm)	0.15	0.14	0.15	0.10	0.13	0.09	0.07	0.08	0.09	0.15	0.14	0.16
Ca (%)	3.60	3.24	4.05	2.25	4.03	5.23	2.88	3.60	2.07	4.77	4.95	5.23
Cl (ppm)	0.29	0.28	0.24	0.26	0.25	0.32	0.30	0.33	0.31	0.25	0.35	0.34
Cl*(ppm)	0.28	0.27	0.23	0.25	0.24	0.31	0.29	0.32	0.30	0.24	0.34	0.33
Co (ppm)	0.15	0.26	0.28	0.20	0.28	0.19	0.15	0.17	0.15	0.19	0.21	0.20
Cr (ppm)	0.66	0.67	0.61	0.53	0.57	0.55	0.69	0.57	0.65	0.27	0.81	0.65
Cu (ppm)	0.07	0.13	0.20	0.18	0.15	0.17	0.12	0.27	0.17	0.20	0.31	0.19
Fe (ppm)	370.0	593.0	449.5	392.5	440.5	388.5	394.0	431.5	336.0	450.0	508.5 5	540.5
K (ppm)	48.0	97.0	47.5	62.5	77.5	67.5	60.0	68.5	49.0	82.0	99.5	94.0
Mg (ppm)	98.5	123.0	103.0	108.0	134.5	116.5	110.0	120.0	78.5	132.0	134.0	131.0
Mn (ppm)	3.81	4.43	5.33	3.79	6.68	4.89	3.86	5.33	7.56	6.14	6.41	5.79
Na (ppm)	4.0	3.0	1.5	2.5	2.0	3.5	2.5	2.5	3.5	4.0	6.0	5.0
Ni (ppm)	0.59	0.80	0.70	0.57	0.88	0.84	0.69	0.79	0.58	0.78	0.71	0.58
Pb (ppm)	0.17	0.22	0.27	0.19	0.31	0.29	0.19	0.69	0.25	0.59	0.34	0.32
Sr (ppm)	0.28	0.27	0.34	0.42	0.63	0.47	0.48	0.41	0.18	0.67	0.51	0.41
Zn (ppm)	0.23	0.69	0.55	0.35	0.37	0.40	0.12	8.35	0.31	8.32	0.50	0.08

*Determined by Chloride ion selective electrode.

Table 1 Contd ...

Table 1 Continue

Element	Depth, (cm)	Mean			S.D.			R.E		
		10	30	60	10	30	60	10	30	60
Ag (ppm)		0.01	0.011	0.011	0.002	0.003	0.003	0.012	0.010	0.010
Au (ppm)		0.09	0.10	0.10	0.034	0.036	0.043	0.046	0.040	0.050
Ca (%)		3.37	3.92	3.68	1.01	1.80	1.74	0.25	0.33	0.32
Cl (ppm)		0.26	0.26	0.29	0.02	0.05	0.04	0.04	0.05	0.05
Cl*(ppm)		0.25	0.26	0.28	0.02	0.04	0.04	0.03	0.05	0.05
Co (ppm)		0.19	0.198	0.19	0.025	0.036	0.050	0.039	0.047	0.050
Cr (ppm)		0.37	0.39	0.31	0.27	0.28	0.25	0.15	0.15	0.12
Cu (ppm)		0.54	0.25	0.36	1.09	0.199	0.58	0.26	0.115	0.19
Fe (ppm)		343.5	383.5	315.2	98.9	161.7	93.6	2.18	3.17	2.41
K (ppm)		51.6	57.3	45.0	21.7	36.9	20.3	1.16	1.51	1.12
Mg (ppm)		98.6	95.2	83.0	23.8	31.7	26.9	1.21	1.40	1.24
Mn (ppm)		3.57	3.96	3.76	1.56	1.35	1.43	0.31	0.29	0.29
Na (ppm)		4.14	4.50	3.4	1.7	3.8	1.6	0.32	0.48	0.31
Ni (ppm)		0.32	0.36	0.29	0.24	0.32	0.26	0.12	0.14	0.13
Pb (ppm)		0.29	0.28	0.24	0.275	0.140	0.084	0.13	0.09	0.07
Sr (ppm)		0.33	0.33	0.32	0.138	0.150	0.150	0.092	0.090	0.090
Zn (ppm)		1.81	2.29	1.47	3.19	2.80	2.50	0.44	0.43	0.39

* Determined by chloride ion selective electrode.

TABLE 2. RESULTS OF TRACE ELEMENT CONCENTRATIONS IN MILLET (KALABSHA AREA).

Sample No. Element	1.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Mean	S.D.	R.E.
Ag (ppm)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	1.9x10-6	0.001			
Au (ppm)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	1.9x10-6	0.001			
Ca (%)	0.45	0.40	0.40	0.38	0.31	0.33	0.31	0.47	0.29	0.33	0.27	0.29	0.31	0.38	0.22	0.40	0.34	0.06	0.061
Cl (ppm)	93.0	113.0	119.0	105.0	116.0	118.0	142.0	121.0	145.0	161.0	130.0	129.0	121.0	116.0	129.0	125.0	17.4	1.04	
Cl*(ppm)	91.0	110.0	115.0	101.0	113.0	116.0	139.0	118.0	140.0	147.0	159.0	124.0	128.0	110.0	114.0	123.0	121.0	17.4	1.04
Co (ppm)	0.047	0.040	0.040	0.032	0.022	0.045	0.037	0.027	0.030	0.027	0.025	0.030	0.022	0.022	0.030	0.008	0.020		
Cr (ppm)	0.217	0.222	0.222	0.220	0.225	0.212	0.227	0.210	0.220	0.217	0.207	0.205	0.215	0.212	0.210	0.205	0.215	0.006	0.019
Cu (ppm)	0.095	0.107	0.107	0.090	0.107	0.097	0.117	0.120	0.102	0.107	0.100	0.110	0.105	0.107	0.162	0.145	0.110	0.018	0.030
Fe (ppm)	103.5	90.00	100.5	67.00	47.00	100.5	41.5	122.0	91.5	126.5	76.5	52.0	156.5	75.5	38.5	75.5	85.5	32.9	1.43
K (ppm)	832.5	920.0	1000	907.5	920.0	877.5	912.5	1022	1105	887.5	1157	1112	1475	1665	1347	1045	265.9	4.07	
Mg (ppm)	57.5	80.5	92.5	77.5	70.00	57.5	85.0	105.0	67.5	65.0	65.0	95.0	67.5	65.0	73.9	14.78	0.96		
Mn (ppm)	1.045	0.947	0.947	1.127	1.202	0.945	0.705	1.205	1.047	1.555	0.747	0.890	0.960	0.880	0.670	0.865	0.980	0.210	0.110
Na (ppm)	10.00	11.00	17.00	10.00	5.00	6.2	12.00	12.00	12.00	12.00	12.00	12.0	0 3.7	10.00	10.0	0 9.9	2.4	0.38	
Ni (ppm)	0.087	0.067	0.067	0.067	0.060	0.087	0.095	0.082	0.080	0.070	0.075	0.072	0.067	0.052	0.057	0.072	0.011	0.020	
Pb (ppm)	0.062	0.060	0.070	0.047	0.047	0.060	0.045	0.062	0.040	0.060	0.055	0.065	0.057	0.060	0.040	0.065	0.050	0.009	0.020
Sr (ppm)	0.225	0.120	0.277	0.275	0.162	0.120	0.090	0.250	0.225	0.215	0.232	0.142	0.112	0.132	0.092	0.230	0.181	0.066	0.064
Zn (ppm)	0.167	0.255	0.255	0.250	0.220	0.240	0.150	0.257	0.087	0.215	0.210	0.272	0.185	0.295	0.256	0.797	0.270	0.150	0.100

* Determined by chloride ion selective electrode.

TABLE 3.CORRELATION COEFFICIENT VALUES BETWEEN TRACE ELEMENT CONCENTRATIONS PRESENT IN SOIL OF KALABSHA AREA PLANTED BY MILLET.

(A) AT 10 Cm DEPTH

	Ag	Au	Co	Cr	Cu	Fe	K	Mg	Na	Ni	Pb	Sr	Zn
Au	0.681	1.00											
Co	-0.075	-0.640	1.00										
Cr	0.0371	-0.084	0.605	1.00									
Cu	-0.282	-0.583	-0.016	-0.290	1.00								
Fe	-0.762	-0.663	0.482	0.292	-0.085	1.00							
K	0.352	-0.033	0.561	0.995	-0.368	0.322	1.00						
Mg	0.483	0.342	0.194	0.875	-0.561	0.138	0.911	1.00					
Mn	0.273	-0.347	0.783	0.943	-0.039	0.316	0.907	0.665	1.00				
Na	-0.489	0.056	0.003	-0.263	-0.645	0.484	-0.187	-0.108	-0.376	1.00			
Ni	-0.835	-0.446	-0.294	-0.310	0.401	0.587	-0.283	0.276	-0.304	0.174	1.00		
Pb	0.345	-0.304	0.312	0.542	0.586	-0.144	0.466	0.284	0.673	-0.921	-0.106	1.00	
Sr	0.807	0.749	0.022	0.328	-0.765	-0.484	0.355	0.522	0.155	0.113	-0.861	-0.186	1.00
Zn	-0.271	-0.727	0.712	0.711	0.274	0.675	0.679	0.381	0.827	-0.270	0.257	0.616	-0.403

Table 3 Contd...

Table 3 Continue....

(B) AT 30 cm DEPTH.

	Ag	Au	Co	Cr	Cu	Fe	K	Mg	Na	Ni	Pb	Sr	Zn
Au	0.876	1.00											
Co	0.123	0.573	1.00										
Cr	0.404	0.666	0.804	1.00									
Cu	-0.321	0.130	0.851	0.499	1.00								
Fe	0.963	0.965	0.343	0.525	-0.133	1.00							
K	0.977	0.938	0.304	0.524	-0.115	0.971	1.00						
Mg	0.658	0.907	0.683	0.508	0.353	0.817	0.759	1.00					
Mn	0.657	0.561	0.228	0.629	0.031	0.557	0.712	0.259	1.00				
Na	-0.835	0.932	0.505	0.502	0.192	0.889	0.923	0.901	0.587	1.00			
Ni	-0.147	-0.255	-0.391	-0.761	-0.092	-0.212	-0.147	-0.001	-0.332	0.057	1.00		
Pb	0.222	0.629	0.811	0.430	0.620	0.464	0.352	0.872	-0.127	0.596	-0.005	1.00	
Sr	0.887	0.847	0.658	0.563	0.225	0.781	0.638	0.895	0.078	0.684	-0.306	0.846	1.00
Zn	-0.634	0.908	0.829	0.794	0.523	0.771	0.776	0.899	0.567	0.892	-0.257	0.744	0.769

(C) AT 60 cm DEPTH.

	Ag	Au	Co	Cr	Cu	Fe	K	Mg	Na	Ni	Pb	Sr	Zn
Au	0.142	1.00											
Co	0.069	0.994	1.00										
Cr	-0.049	0.304	0.389	1.00									
Cu	0.441	0.588	0.613	0.785	1.00								
Fe	0.489	0.714	0.667	-0.070	0.215	1.00							
K	0.229	0.951	0.948	0.337	0.544	0.849	1.00						
Mg	0.193	0.910	0.933	0.613	0.741	0.679	0.949	1.00					
Mn	0.058	0.487	0.418	-0.502	-0.014	0.246	0.267	0.091	1.00				
Na	0.417	0.793	0.800	0.526	0.666	0.811	0.921	0.940	-0.065	1.00			
Ni	0.773	0.586	0.549	0.359	0.849	0.458	0.548	0.611	0.273	0.634	1.00		
Pb	0.318	0.421	0.446	0.723	0.948	-0.066	0.301	0.526	0.062	0.396	0.782	1.00	
Sr	-0.102	0.434	0.448	0.351	0.607	-0.255	0.164	0.297	0.529	0.013	0.470	0.722	1.00
Zn	0.213	-0.150	-0.121	0.555	0.645	-0.550	0.281	-0.018	-0.149	-0.115	0.472	0.828	0.638

TABLE.4. CORRELATION COEFFICIENT VALUES BETWEEN TRACE ELEMENT CONCENTRATIONS PRESENT IN MILLET OF KALABSHA.

	Co	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	Pb	Sr
C	1.00										
Cr	0.605	1.00									
Cu	-0.016	-0.290	1.00								
Fe	0.294	-0.074	-0.303	1.00							
K	0.215	0.781	0.046	-0.040	1.00						
Mg	0.073	0.551	0.210	0.100	0.945	1.00					
Mn	0.007	-0.031	0.285	-0.865	-0.310	-0.479	1.00				
Na	0.449	0.356	0.030	0.761	0.561	0.677	-0.824	1.00			
Ni	0.277	-0.561	0.070	0.379	-0.835	-0.766	0.096	-0.112	1.00		
Pb	0.417	0.337	-0.495	0.902	0.307	0.342	-0.871	0.835	0.041	1.00	
Sr	0.793	0.259	0.567	0.228	0.195	0.222	0.007	0.516	0.316	0.181	1.00
Zn	-0.278	0.279	0.399	-0.173	0.806	0.910	-0.283	0.389	-0.816	-0.009	0.025
Ca	-0.712	0.583	-0.313	0.814	0.457	0.905	-0.00	0.553	-0.805	0.508	-0.817
Cl	-0.751	0.915	0.914	0.553	-0.331	-0.423	-0.151	0.046	-0.415	0.617	-0.715

solutions were obtained after diluting the stock to the required concentrations.

(b) *For ion selective electrode (ISE).* Stock 1000 ppm solution of chloride was prepared from primary standard solid NaCl.

Determination of elements by AAS. The element concentrations in millet and soil samples were measured on a Pye Unicam SP 1900 Atomic Absorption Recording Spectrophotometer with direct readout concentrations, using hollow cathode lamps of the elements at the characteristic wavelengths. Atomic absorption data were acquired by aspirating aqueous single element standard solutions, blank and samples with two deionized water rinses between each two readings. Appropriate dilutions were made for sample solutions.

Determination of chloride by ion-selective electrode (ISE). The outer chamber of the double junction reference electrode was filled with 10% KNO_3. One ml of low level ionic strength adjustor (ISA) 1 M $NaNO_3$ was added to sample and standard solution. The chloride and reference electrodes were immersed in the solutions followed by stirring and the concentration was read out directly.

Titrimetric determination of Ca and Cl. Calcium was determined by comlexmetric titration using standard Na_2 EDTA solution and calcon as indicator. pH was adjusted using 30% NaOH. KCN was also used as complexing agent. The chloride concentration was determined titrimetrically (24) using $Hg(NO_3)_2 \cdot H_2O$ solution and diphenyl carbazone - bromophenol blue mixed indicator.

Results and Discussion

Representative data for the major and trace elements concentration present in the soil of Kalabsh at 10, 30, 60 cm depths and in the millet planted in this area are given in Tables 1 and 2 respectively.

In general, the results reveal that in soils of Kalabsha, Gerf Hussein and Allaqi areas, K is in the range (8.0-99.5), Cl (0.214-1.27), Na (1.0-23.0), Mn (1.75-7.56), Mg (40.5-134.5), Fe (188.5-775), Co (0.04-0.28), Cu (0.09-3.72), Zn (0.03- 8.54), Ni (0.02-0.88), Cr (0.01-0.81), Sr (0.06-0.6 0), Pb (0.09- 1.24), Ag (0.01-0.03), Au (0.01-0.19) ppm and Ca (0.72- 8.1%). The elements Au, Cl, Cu, K, Mg, Na, Pb, Sr and Zn are concentrated at 10 cm depth, Ag, Ca, Cl, Pb, Mg, Na and Zn at 30 cm and Cl, Co, Cr, Fe, Mg, Mn, Na, Ni, pb and Zn at 60 cm depth. Kalabsha soil contains higher concentrations of elements than other two areas. At 30 cm depth in Kalabsha soil, the elements Ca, Co, Cr, Fe, K, Mg, Na, Ni, Pb, Sr and Zn are present in high concentrations. In Gerf Hussein, the elements Ag, Au, Ca, Co, Cr, Fe, Mn, Pb, Sr and Zn are present at 60 cm depth. In Allaqi, samples at 10 and 60 cm depths exhibit high concentrations of Ag, Au, Ca, Co, Cr, Fe, K, Mn, Na, Ni, Pb and Zn. These differences may be related to the differences in mineralogical and chemical compositions, geochemical and biogeochemical fractionation and differentiation, textures and structures, weathering and soil types [1-3].

In millet planted in the three experimental farms, K is in the range (363 - 1665), Cl (22.0 - 159), Na (4.2 - 9.9), Mn (0.536 - 1.41), Mg (73.9 - 113), Fe (38.5 - 85.2), Co (0.024 - 0.03), Cu (0.067 - 0.172), Zn (0.27 - 0.51), Ni (0.062 - 0.07) Cr (0.067 - 0.215), Sr (0.12 - 0.181), Pb (0.03 - 0.05), Ag (0.0036 - 0.006), Au (0.005 - 0.008) ppm and Ca (0.34 - 0.50%). Cl, K, Mg, Na, Sr and Zn are concentrated in millet than in soil. Millet in Kalabsha exhibits high concentrations of Cl, Cr, Fe, K and Na, in Gerf Hussein, Ag, Ca, Fe, Mn, Ni, Sr and Zn and in Allaqi, Ag, Cl, Cu, Fe, K, Mg, Sr and Zn. The elements Ag, Ca, Cl, Co, K, Mg, Mn, Ni, Pb, Sr and Zn accumulate in millet planted in Allaqi compared to that planted in other two areas because Allaqi soil at 10 and 60 cm depths exhibits high concentrations of these elements and the roots of millet extend to this depth. These elements are essential for plant growth, metabolism, activation of enzymes and in chlorophyll synthesis.

The high correlation values obtained for the element concentrations in soil samples of the three experimental farms at 10, 30, 60 cm depths (Table 3, Kalabsha as exmaple), in millet (Table 4) and in millet/soil ratio (Table 5) suggest that these metals exist in soil as amorphous Fe/Mn/Al minerals, sulphides (Ag, Au, Ni), carbonates, silicates, humates, clay,

Table. 5. Correlation Coefficient Values of Trace Elements Millet/Soil Ratio

Elements	(A) Kalabsha			(B) Gerf Hussein			(C) Allaqi		
	M/S_{10}	M/S_{30}	M/S_{60}	M/S_{10}	M/S_{30}	M/S_{60}	M/S_{10}	M/S_{30}	M/S_{60}
Ag	-0.96	-0.98	-0.99	-0.99	-0.99	-0.99	0.49	0.0	0.0
Au	-0.89	-0.90	-0.91	-0.99	-0.99	-0.99	-0.99	-0.69	0.86
Ca	-0.05	0.57	0.54	-0.98	0.99	-0.98	1.00	-0.99	-0.99
Cl	0.19	0.35	-0.35	0.96	0.97	0.03	-0.99	-0.99	-0.97
Co	0.49	0.21	0.30	0.80	-0.12	0.0	-0.90	-0.90	0.82
Cr	0.35	-0.81	0.88	-0.49	0.75	-0.49	0.51	0.28	0.99
Cu	-0.72	-0.77	-0.78	0.29	-0.25	0.18	-0.61	-0.13	0.78
F	0.32	0.33	0.35	0.54	0.63	-0.67	-0.93	-0.90	0.18
Mg	0.46	0.19	0.27	-0.94	0.93	0.32	0.95	0.93	0.97
Mn	0.02	-0.43	-0.57	0.69	-0.72	0.65	-0.89	0.99	-0.99
Na	0.43	0.64	0.14	0.04	-0.39	-0.56	0.21	-0.99	-0.99
Ni	-0.51	-0.39	-0.39	-0.43	-0.11	0.59	-0.65	-0.36	-0.95
Pb	-0.09	-0.09	0.25	0.49	0.00	0.69	-0.93	-0.65	0.27
Sr	0.05	0.11	0.32	-0.98	0.75	0.94	0.99	0.88	0.94
Zn	0.58	-0.10	-0.19	0.59	-0.43	-0.73	-0.99	-0.97	-0.44

M = mean of element concentration in plant; S_{10}, S_{30} & S_{60} = mean of element concentration in soil 10, 30 and 60 cm depth.

silt, kaolinite, feldspars, limestone or metal-refractory organic carbon complexes, and adsorbed, exchangeable, replaceable and occluded forms of these metals are removed by aqua regia extract. In millet, the elements perhaps exist as essential elements in the interstitial spaces and as mixed metal-high molecular weight complexes, chlorophyll, carbohydrate, amino acid and vitamin in the plant cells. The importance of each element for plant growth, root formation, photo-synthesis, activation of the enzymatic reactions of carbohydrate metabolism, pigmentation and colouration has been discussed in our previous papers [13-14].

The conclusion is that the soil of Kalabsha, Gerf Hussein, and Allaqi is suitable for cultivation with addition of inorganic fertilisers to improve soil reclamation. The soils of these areas are of a clean environment and not polluted with toxic elements. Kalabsha soil contains higher concentrations of elements than other areas. High concentration of elements are found in millet planted in Allaqi area relative to the others.

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