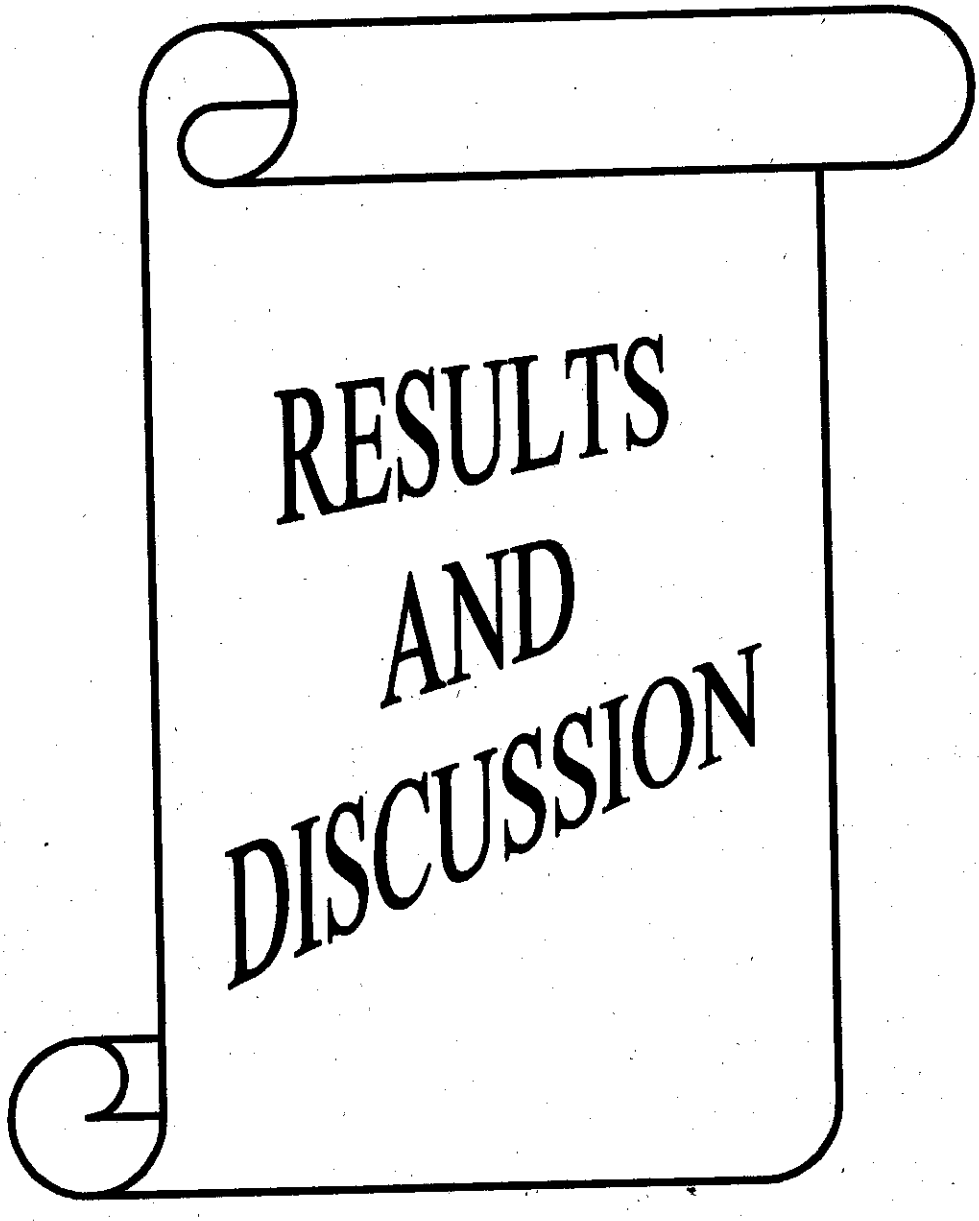
RESULTS
AND
DISCUSSION

4- RESULTS AND DISCUSSIONS

The chemical composition of sewage effluents varies from on place to another, and after from one time of the year to another.

Thus, the suitability of a given effluent for irrigation can only be assessed after monitoring the quality of the effluent for a fairly long time **(Arar 1988 and Biswas 1993)**

4.1. Sewage effluents characteristics:

Samples of sewage effluents were collected monthly from the selected sites i.e the inlet (site 1) and the (site 2) outlet of El-Berka - WWTP station as well as the third one from a site at 2 km apart from the emergency canal to which the treated effluents are disposed (El- Berka site 3). Also, samples were monthly collected from Helwaan WWTP station from the outlet of the station, (Helwan site1), from the beginning of El-Saff El Gadida canal (Helwan site2) and at 3 km apart from this canal (Helwan site3). This work was conducted over a year extending from September (1999) to August (2000). Results of the chemical analyses of the effluent samples are given in Tables 1(a, b and c) and 2 (a, b and c).

These results are discussed under the following subheadings:

4.1.1. Effluents (pH):

Data presented in Table 1 (a, b and c) reveal that effluents pH values slightly fluctuated between 7.15 and 7.45 for the at inlet of El- Berka sludge station (site 1). The corresponding values of the outlet (site2) ranged from 7.38 to 7.65 while the effluent pH values at 2 km from the emergency canal (El-Beraka site3) fluctuated such result reveal between 7.10 and 7.29.

Results of **Hashem et al (1992)** revealed that the pH value of

Table (1a) Chemecal composition of sewage effluent from El-Berka treatment plant at Madinet El-Salam. (site 1)

Date of sampling	PH	EC (dS/m)	Soluble ions (meq/l)								SAR	RSC	Adj SAR	Concentration of trace elements (ppm)				
			Cations				Anions							B	Heavy metals			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO	Cl	SO_4^{--}					Co	Pb	Cd	Ni
September (1999)	7.45	1.17	2	0.95	4.8	0.51	0	3	4	3.26	3.05	-1.9	7.35	0.17	n.d	0.02	0.01	0.30
October (1999)	7.2	1.28	2.5	3.8	4.3	0.51	0	2.4	4	4.21	3.43	-0.9	5.15	0.16	n.d	0.02	0.01	0.31
November (1999)	7.28	1.14	3	2.4	4.1	0.44	0	2.6	4	3.34	2.5	-2.6	5.73	0.22	n.d	0.04	0.01	0.31
December (1999)	7.3	1.36	4.5	2.4	4.3	0.51	0	2.6	4	5.11	2.31	-4.3	5.22	0.17	n.d	0.02	0.01	0.30
January (2000)	7.3	1.27	3	3.4	4.1	0.49	0	2.8	4	4.39	2.29	-3.8	5.34	0.18	n.d	0.02	0.01	0.28
February (2000)	7.4	1.27	3.4	3	3.9	0.46	0	3	4	3.76	2.16	-3.4	5.21	0.17	n.d	0.03	0.01	0.31
March (2000)	7.22	1.26	3.5	1.35	3.9	0.44	0	2.6	4	2.59	2.5	-2.25	5.85	0.17	n.d	0.04	0.01	0.30
April (2000)	7.15	1.25	4	1.6	3.9	0.49	0	2.2	4	3.79	2.34	-3.4	5.19	0.17	n.d	0.04	0.01	0.27
May (2000)	7.18	1.09	3.5	1.5	3.9	0.47	0	2.2	4	3.27	2.44	-2.9	5.49	0.17	n.d	0.03	0.02	0.31
June (2000)	7.2	1.1	2.8	1.65	4.3	0.47	0	2	4	3.22	2.87	-2.45	5.11	0.17	n.d	0.02	0.03	0.31
July (2000)	7.2	1.05	2.6	1.6	4.3	0.47	0	2	4	2.97	2.97	-2.2	5.26	0.17	n.d	0.04	0.04	0.32
August (2000)	7.2	1.15	2.5	1.65	4.3	0.46	0	2.2	4	2.71	3.98	1.95	5.36	0.18	n.d	0.03	0.02	0.32

n.d : not detected RSC: Residual Sodium Carbonate

Location1: Inlet of the station

Table (1b) Chemecal composition of sewage effluent from El-Berka treatment plant at Madinet El-Salam. (site 2)

Date of sampling	PH	EC (dS/m)	Soluble ions (me/l)								SAR	RSC	Adj. SAR	Concentration of trace elements (ppm)				
			Cations				Anions							B	Heavy metals			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}					Cc	pb	Cd	Ni
September (1999)	7.6	1.05	3	1.95	4.1	0.51	0	3	4	3.56	2.61	-1.95	5.25	0.19	n.d	9.82	0.01	0.29
October (1999)	7.55	1.05	3	1.9	4.1	0.47	0	3	4	3.47	2.61	-1.9	5.25	0.19	n.d	0.03	0.01	0.3
November (1999)	7.6	0.99	2.6	1.7	3.9	0.59	0	3	4	1.79	2.65	-1.3	5.35	0.19	n.d	9.05	0.02	0.29
December (1999)	7.4	0.98	2.5	1.4	4.1	0.56	0	2.8	4	1.76	2.83	-1.1	5.54	0.19	n.d	0.04	8.01	8.31
January (2000)	7.45	1.02	2.7	1.45	3.9	0.51	0	3	4.2	1.36	2.71	-1.15	5.26	0.19	n.d	9.05	0.01	0.31
February (2000)	7.45	0.97	2.5	1.7	4.1	0.56	0	2.9	4.5	1.46	2.83	-1.3	5.45	0.19	n.d	0.03	0.02	0.29
March (2000)	7.65	0.98	3	1.5	3.9	0.49	0	3.2	4.7	0.99	2.6	-1.3	5.23	0.18	n.d	0.04	0.03	0.28
April (2000)	7.6	0.97	2.8	1.64	4	0.47	0	3	4.6	1.31	2.68	-1.44	5.28	0.19	n.d	0.05	0.02	0.31
May (2000)	7.45	0.98	2.59	1.95	4	0.51	0	3	4.6	1.45	2.65	-1.54	5.35	0.2	n.d	0.03	0.01	0.31
June (2000)	7.4	0.95	2.5	1.85	3.9	0.54	0	2.9	4	1.85	2.65	-1.45	5.14	0.19	n.d	9.03	0.03	0.28
July (2000)	7.38	0.9	2.45	1.9	3.9	0.47	0	2.8	4	1.82	2.65	-1.55	5.12	0.2	n.d	0.04	0.02	0.3
August (2000)	7.6	0.96	3	1.5	4.1	0.51	0	3.2	4	1.51	2.73	-1.3	5.49	0.19	n.d	0.03	0.01	0.31

n.d not detected

Locatin 2: Outlet of the station

Table (1c) Chemecal composition of sewage effluent from El-Berka treatment plant at Madinet El-Salam. (site 3)

Date of sampling	PH	EC (dS/m)	Soluble ions (me/l)								SAR	RSC	Adj. SAR	Concentration of trace elements (ppm)				
			Cations				Anions							B	Heavy metals			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$					Co	Pb	Cd	Ni
September (1999)	7.15	1.12	2.95	1.55	4.60	0.59	0.00	2.20	5.00	2.49	3.07	-2.30	5.62	0.19	n.d	0.02	0.01	0.31
October (1999)	7.18	1.15	3.50	1.80	4.10	0.56	0.00	2.30	5.00	2.66	2.52	-3.00	5.64	0.18	n.d	0.01	0.01	0.31
November (1999)	7.10	1.17	3.00	1.95	4.30	0.62	0.00	2.00	5.00	2.87	2.74	-2.95	5.01	0.20	n.d	0.03	0.01	0.30
December (1999)	7.20	1.16	3.10	2.00	4.30	0.67	0.00	2.80	5.00	2.27	2.69	-2.30	6.35	0.19	n.d	0.03	0.01	0.31
January (2000)	7.20	1.05	3.50	1.95	4.10	0.59	0.00	2.80	5.00	2.34	2.48	-2.65	5.73	0.19	n.d	0.02	0.01	0.31
February (2000)	7.15	1.07	3.50	1.90	4.10	0.62	0.00	2.60	5.00	2.52	2.52	-2.80	5.77	0.19	n.d	0.02	n.d	0.30
March (2000)	7.10	0.99	3.20	1.80	4.30	0.64	0.00	2.60	5.00	2.34	2.72	-2.40	6.39	0.19	n.d	0.03	0.01	0.31
April (2000)	7.25	1.05	3.20	2.00	4.10	0.56	0.00	3.00	5.00	1.86	2.55	-2.20	6.07	0.18	n.d	0.02	n.d	0.31
May (2000)	7.20	1.08	3.50	1.90	4.30	0.54	0.00	3.10	5.00	2.14	2.62	-2.30	6.21	0.19	n.d	0.01	n.d	0.30
June (2000)	7.19	0.95	3.10	1.95	4.30	0.46	0.00	2.80	5.00	2.01	2.70	-2.30	6.40	0.19	n.d	0.03	0.01	0.30
July (2000)	7.21	1.05	3.10	2.00	4.10	0.47	0.00	2.80	4.80	2.07	2.56	-2.30	6.04	0.20	n.d	0.02	n.d	0.30
August (2000)	7.29	1.04	3.00	1.90	4.20	0.33	0.00	2.45	4.90	2.08	2.68	-2.45	5.17	0.19	n.d	0.02	0.01	0.30

n.d : not detected

Location 3: At 2km upart from the emergency canal

Table (2a) Chemecal composition of sewage effluent from Helwan treatment plant (site 1)

Date of sampling	PH	EC (dS/m)	Soluble ions (me/l)								SAR	RSC	Adj SAR	Concentration of trace elements (ppm)				
			Cations				Anions							B	Heavy metals			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$					Co	Pb	Cd	Ni
September (1999)	7.30	2.34	6.00	2.40	12.60	0.56	0.00	3.80	11.00	6.46	6.27	-4.30	14.04	0.18	n.d	0.03	0.02	0.32
October (1999)	7.20	2.13	6.00	2.10	12.30	0.56	0.00	3.20	11.00	6.76	5.12	-4.90	13.26	0.19	n.d	0.02	0.01	0.30
November (1999)	7.20	2.22	5.50	1.70	12.60	0.67	0.00	3.00	11.00	6.47	6.63	-4.20	14.72	0.19	n.d	0.02	0.02	0.31
December (1999)	7.30	2.13	5.00	1.75	12.80	0.67	0.00	3.20	11.00	6.02	6.96	-3.55	16.00	0.18	n.d	0.02	0.02	0.27
January (2000)	7.19	2.13	5.00	1.75	12.60	0.72	0.00	2.80	11.00	6.27	6.85	-3.99	15.34	0.21	n.d	0.02	0.02	0.26
February (2000)	7.10	2.03	5.50	1.80	12.20	0.72	0.00	3.00	11.00	6.22	6.39	-4.30	14.06	0.20	n.d	0.02	0.02	0.32
March (2000)	7.12	2.03	5.00	1.80	12.60	0.71	0.00	3.00	10.50	6.61	6.60	-3.80	14.98	0.18	n.d	0.03	0.01	0.28
April (2000)	7.16	2.14	5.00	1.80	12.60	0.69	0.00	3.10	11.00	5.99	6.60	-3.70	15.11	0.18	n.d	0.02	0.03	0.29
May (2000)	7.18	1.99	5.00	1.95	12.60	0.69	0.00	3.00	10.56	6.66	6.85	-3.95	15.14	0.19	n.d	0.02	0.01	0.25
June (2000)	7.11	1.89	4.90	1.95	11.70	0.46	0.00	3.60	9.00	6.41	6.32	-3.30	14.85	0.18	n.d	0.02	0.01	0.25
July (2000)	7.14	1.78	4.50	1.95	11.60	0.46	0.00	3.00	9.20	6.31	6.27	-3.45	14.61	0.18	n.d	0.03	0.02	0.27
August (2000)	7.21	1.71	5.50	1.80	11.60	0.59	0.00	3.20	10.00	6.29	6.07	-4.10	13.60	0.17	n.d	0.02	0.01	0.30

n.d : not detected

Location 1: Outlet of the station

Table (2b) Chemecal composition of sewage effluent from Helwan treatment plant.. (site 2)

Date of sampling	PH	EC (dS/m)	Soluble ions (me/l)								SAR	RSC	Adj. SAR	Concentration of trace elements (ppm)				
			Cations				Anions							B	Heavy metals			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$					Co	Pb	Cd	Ni
September (1999)	7.32	2.01	5.50	2.00	11.10	0.72	0.00	3.60	9.00	6.72	5.72	-3.90	12.93	0.18	n.d	0.02	0.01	0.32
October (1999)	7.15	2.27	5.00	2.00	12.30	0.62	0.00	3.30	10.00	6.62	6.67	-3.70	14.96	0.24	n.d	0.02	0.02	0.30
November (1999)	7.19	2.36	5.50	2.20	12.30	0.67	0.00	3.00	11.00	6.67	6.22	-4.70	13.37	0.25	n.d	0.02	0.01	0.29
December (1999)	7.20	2.05	5.50	2.10	11.40	0.69	0.00	3.20	10.00	6.45	5.85	-4.40	12.87	0.20	n.d	0.02	0.02	0.28
January (2000)	7.40	2.34	5.50	2.00	11.90	0.74	0.00	3.60	10.00	6.54	6.13	-3.90	13.79	0.19	n.d	0.02	0.02	0.29
February (2000)	7.40	2.34	5.00	2.15	11.90	0.64	0.00	3.80	9.00	6.79	6.30	-3.35	14.42	0.22	n.d	0.02	0.02	0.31
March (2000)	7.47	2.24	5.50	1.80	11.70	0.74	0.00	3.80	9.00	6.94	6.13	-3.50	14.10	0.19	n.d	0.02	0.01	0.32
April (2000)	7.40	2.45	5.50	1.70	11.50	0.72	0.00	3.20	10.00	6.22	6.05	-4.00	14.26	0.19	n.d	0.02	0.02	0.29
May (2000)	7.20	2.22	5.00	1.80	12.50	0.33	0.00	3.40	9.70	6.53	6.79	-3.40	15.75	0.19	n.d	0.01	0.01	0.27
June (2000)	7.24	2.39	5.00	1.90	12.30	0.62	0.00	3.20	10.50	6.62	6.88	-3.70	15.69	0.18	n.d	0.02	0.01	0.28
July (2000)	7.27	2.18	5.50	2.25	12.90	0.64	0.00	3.40	10.91	6.93	6.54	-4.35	14.39	0.19	n.d	0.02	0.02	0.32
August (2000)	7.40	2.87	5.00	1.95	12.20	0.74	0.00	3.20	10.00	6.69	6.56	-3.75	14.96	0.19	n.d	0.02	0.01	0.31

n.d : not detected

Locatin 2: The beginning of El-Saff El-Gadida canal

Table (2c) Chemecal composition of sewage effluent from Helwan treatment plant. (site 3)

Date of sampling	PH	EC (dS/m)	Soluble ions (me/l)								SAR	RSC	Adj. SAR	Concentration of trace elements (ppm)				
			Cations				Anions							B	Heavy metals			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$					Co	pb	Cd	Ni
September (1999)	7.40	2.05	6.00	1.75	13.50	0.72	0.00	3.30	10.00	8.67	6.85	-4.45	14.93	0.18	n.d	0.02	0.02	0.30
October (1999)	7.45	2.30	6.00	1.75	13.50	0.72	0.00	3.00	10.00	8.97	6.85	-4.75	14.66	0.19	n.d	0.01	0.01	0.31
November (1999)	7.55	2.15	5.00	1.80	13.30	0.72	0.00	3.80	9.70	7.32	7.22	-3.00	17.14	0.19	n.d	0.01	0.02	0.30
December (1999)	7.45	2.20	5.50	1.85	13.30	0.70	0.00	3.44	10.01	7.90	6.92	-3.91	15.57	0.19	n.d	0.01	0.02	0.29
January (2000)	7.60	2.22	5.50	1.85	13.05	0.74	0.00	3.40	10.00	7.74	6.80	-3.95	15.38	0.18	n.d	0.01	0.02	0.31
February (2000)	7.50	2.30	5.50	1.95	13.00	0.70	0.00	3.30	9.99	7.86	6.74	-4.15	14.96	0.18	n.d	0.01	0.02	0.30
March (2000)	7.26	2.22	4.90	1.55	13.10	0.70	0.00	3.00	10.00	7.25	7.28	-3.45	16.89	0.19	n.d	0.01	0.02	0.31
April (2000)	7.17	2.25	4.80	1.55	13.30	0.70	0.00	3.00	10.00	7.35	7.47	-3.35	15.91	0.24	n.d	0.02	0.01	0.29
May (2000)	7.51	2.01	4.50	1.95	13.30	0.33	0.00	3.00	10.00	7.08	7.39	-3.45	17.14	0.19	n.d	0.01	0.02	0.30
June (2000)	7.44	2.01	4.61	1.95	12.40	0.44	0.00	3.00	9.00	7.40	6.85	-3.56	15.82	0.18	n.d	0.01	0.02	0.28
July (2000)	7.46	1.99	4.69	1.25	12.50	0.38	0.00	3.20	9.00	6.62	7.27	-2.74	16.14	0.19	n.d	0.02	0.02	0.28
August (2000)	7.45	2.01	5.42	1.30	12.60	0.51	0.00	3.20	9.00	7.63	6.88	-3.52	15.82	0.19	n.d	0.01	0.01	0.31

n.d : not detected

Location 3: At 3km distance from the beginning of El-Saff El-Gadida canal

sewage effluents used for irrigating El-Gabal El-Asfar farm averaged 7.40. On the other hand **Abdellah (1995)** demonstrated that the pH value of these effluents differ according the sampling time of the year ranging between 7.10 and 7.40 with an average of 7.24.

Comparison of the results obtained herein with those mentioned above indicate that values of water PH did not differ widely over the period extending from 1992 to 2000.

Such a finding may be due to the anthropogenic source of pollution remained the same over the above mentioned period.

Table 2 (a, b and c) shows that pH values of the effluent at the outlet of Abou Saeid sludge station (site 1) fluctuated between 7.10 to 7.30. The corresponding pH values at the beginning of El-Saff El- Gadida canal (Helwan site2) ranged from 7.15 to 7.47 while those of (Helwan, site 3) i.e at 3 km apart from the beginning of this canal ranged from 7.17 to 7.46.

These results illustrate that the investigated effluents are almost neutral to slightly alkaline showing a close coincidence with the results obtained by **Abdellah (1995)** upon his work on the sewage effluents at the same site (Helwan) .

4.1.2. Electrical conductance (EC)

Data presented in Tables (1a, b and c and Tables 2a, b and c) show that values of the electrical conductance (EC) of the studied effluents differed slightly according to time of sampling and source of sewage effluents.

The EC values of the effluent at the inlet of El-Berka sludge station (El-Berka site1) ranged between 1.05 to 1.36 dSm^{-1}, with an

average of 1.20dsm^{-1} the corresponding EC values of the effluent at the outlet of the some station (El-Berka site2) varied from 0.90 to 1.05dSm^{-1}, average 0.99 dSm^{-1}, while those of the effluent located at 2 km part from the beginning emergency canal (El-Berka site 3) ranged between 0.95 and 1.17dSm^{-1}, with an average of 1.07 dSm^{-1}

The EC values of the effluent discharged from Helwan Sludge Station at the outlet of the station (Helwan site1) fluctuated between 1.71 to 2.34 dSm^{-1}, with an average 2.04 dsm^{-1} the corresponding EC values of the effluents taken from the beginning of El-Saff El-Gadida canal (Helwan site2) ranged from 2 to 2.87 dSm^{-1}, averaging 2.31dSm^{-1} while the corresponding ones of the effluent taken from site 3 located at 3 km apart from the beginning of this canal (Helwan site, 3) ranged from 1.99 to 2.30 dSm^{-1} with an average of 2.14 dsm^{-1}

The EC value of the effluents of Helwan Sludge Station reported by Abdellah ranged from 2.10 to 2.39 dsm^{-1} being almost similar to those obtained herein.

It is worthy to mention that the EC values of the effluent samples taken from El-Berka Sludge Station were generally lower than those taken from Helwan Sludge Station which may suggest that the water of El-Berka Sludge Station could be more suitable for irrigation than that of Helwan Sludge Station according to EC basis.

4.1.3. Ionic Composition:

It could be deduced from data presented in Tables 1 (a, b, and c) and 2 (a, b and c) that Na^+ dominated the cationic composition of all the studied effluent samples, Ca^{2+} came in the second order followed by Mg^{2+} while K^+ was at the least abundance i.e. the soluble cations content of effluents could be arranged descendingly,

in general, as follows: $Na^{+}>Ca^{2+}$ > Mg2>>K^{+}, yet it should be noticed that in same little cases Mg^{2+} was found in nearly equal concentration to that of Ca or even exceeded it.

Regarding the anionic composition it could be seen that Cl^{-} was the predominant anion whereas CO_3^{2-} anion was not found in any detected amount, No wide difference appeared between concentrations of SO_4^{2-} and HCO_3 in the sewage effluents of El-Berka. However, SO_4^{2-} anion were presented in Helwan effluents in concentrations obviously higher than those of the HCO_3- anions. Thus, two patterns of anions distribution could be distinguished. The first pattern characterizing El-Berka effluents is as follows, Cl^{-} >SO_4^{2-} ~ HCO_3. The second pattern is $Cl^{-}>SO_4^{2-}$ > HCO_3- . which is characterizing Helwan effluents.

Abd El Aziz (1992) and Abdellah (1995) went almost to similar results.

Regarding concentration of boron, data in Tables 1(a, b and c) and 2(a, b and c) reveal B values varied very slightly or even remained almost constant over the period of investigation . As a general trend, concentrations of B in all the effluent samples were very low and did not exceed 0.22 mgL^{-1} in El-Berka effluent and 0.25 mgL^{-1} in Helwan ones. Also, no evident variations in B could be observed between times of sampling or even sources of effluents.

4.1.4. Trace elements content:

Data presented in Tables 1(a, b and c) & 2 (a,b and c) reveal that Co^{2+} was not found in detectable concentrations in all the investigated effluents. While is obvious from this tables and Fig (4and 5) Pb concentrations within all the studied sewage effluents ranged from 0.01 to 0.05 mgL^{-1} in the effluents of El-Berka and

from 0.01 to 0.02 mgL^{-1} only in those of Helwan.

Values of Cd concentration [Table 1 (a, b, c) & 2 (a, b, c,) and Fig 6 and 7] varied from not detectable values up to 0.04 mgL^{-1} in the sewage effluents of El-Berka whereas the corresponding values of Helwan sewage effluents did not exceed 0.02 mgL^{-1} .

Unlike Co, Pb and Cd, Ni concentrations [Table 1 (a, b, c) & 2 (a, b, c,) and Fig 8 and 9] were higher in effluents of both El-Berka and Helwan, fluctuating however, within a narrow range 0.27 to 0.31 mgL^{-1} in effluents of El-Berka and 0.25 to 0.32 mgL^{-1} in the effluents of Helwan.

The values obtained by **Hashem et al. (1992)** for Cd and Pb concentrations in the sewage effluents used for irrigating El-Gabal El-Asfar farm were very close to the corresponding values obtained herein where they were 0.01 and 0.03 respectively. while **Abdallah (1995)** reported higher values for Ni ranging from 0.31to 0.67mhL^{-1} whereas he recorded values for Pb and Cd ranging from 0.03 to 0.05 and from 0.01 to 0.05 mgL^{-1}, respectively in the sewage effluents used for irrigating the some area. The corresponding values in Helwan Sludge Station ranged from, 0.01 to 0.04, 0.01 to 0.04 and 0.04 to 0.06 mgL^{-1} respectively.

4.2. Evaluation of suitability of the effluents water used for irrigation:

Among the several systems which have been used for assessing the suitability of waters for irrigation are those developed by the USS Lab.**(Richards, 1954) and Gupta (1979) .**

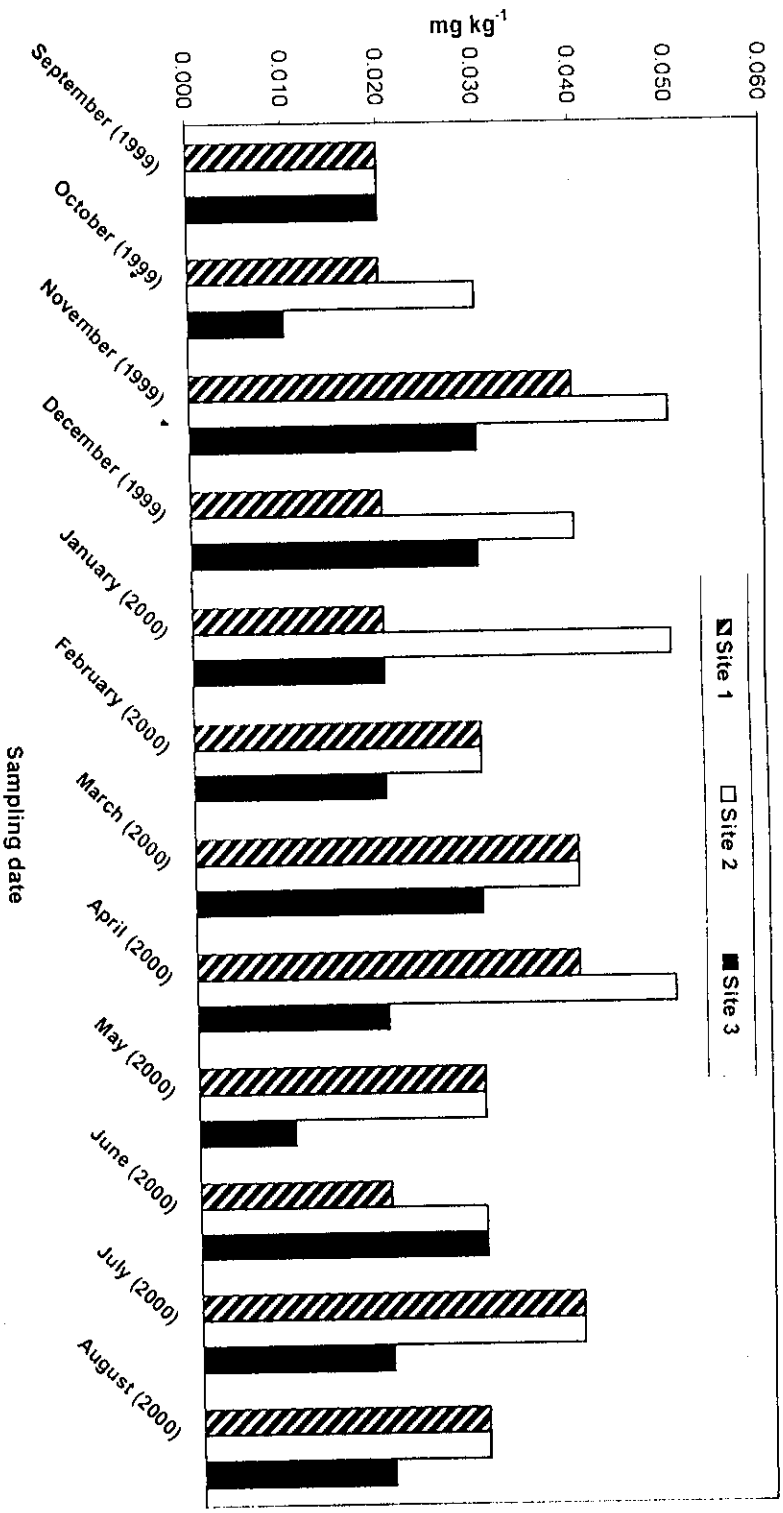

Fig (4) Lead content in sewage effluent and water of El-Berka WWTP.

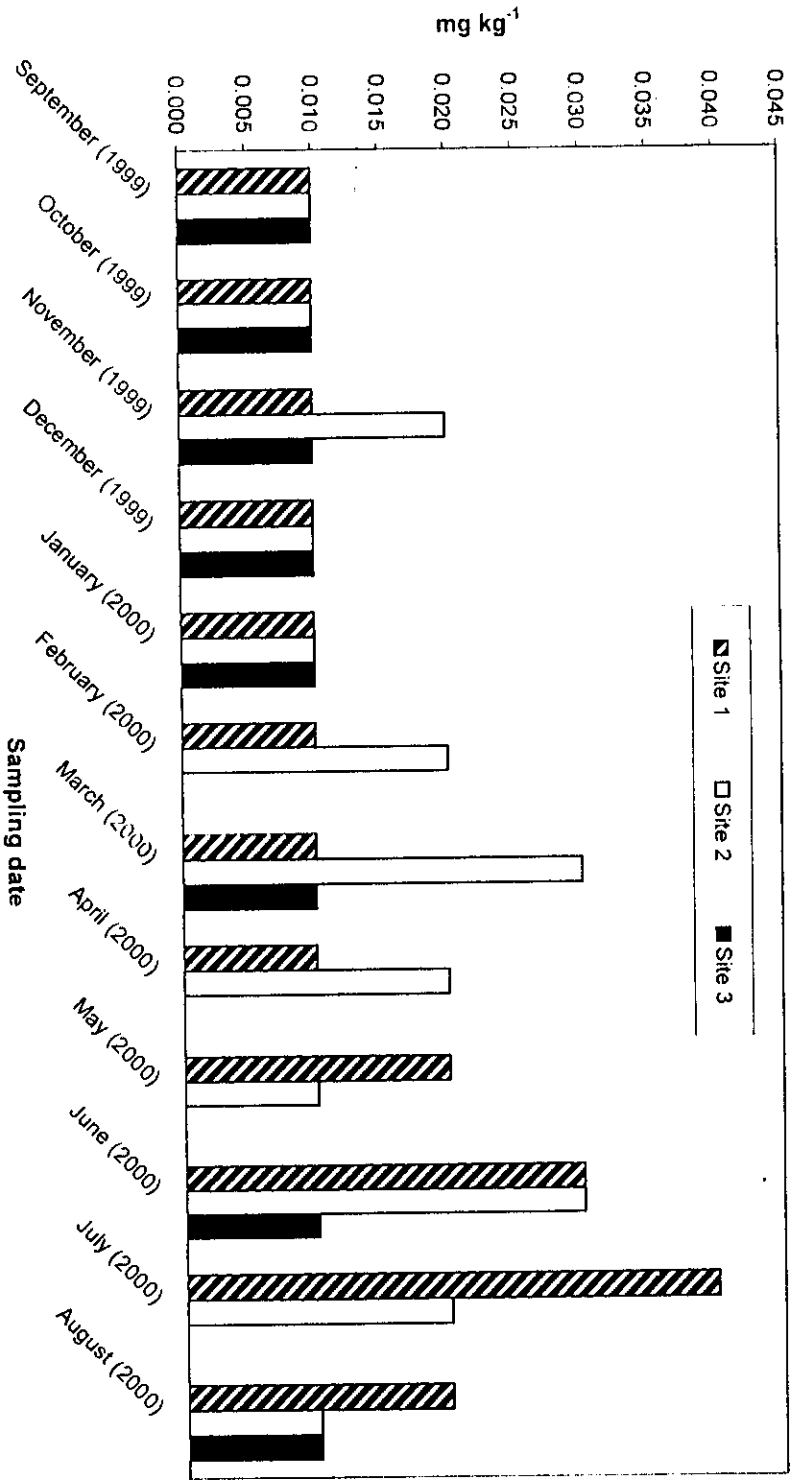

Fig (5) Cadmium content in sewage effluent and water of El-Berka WWTP.

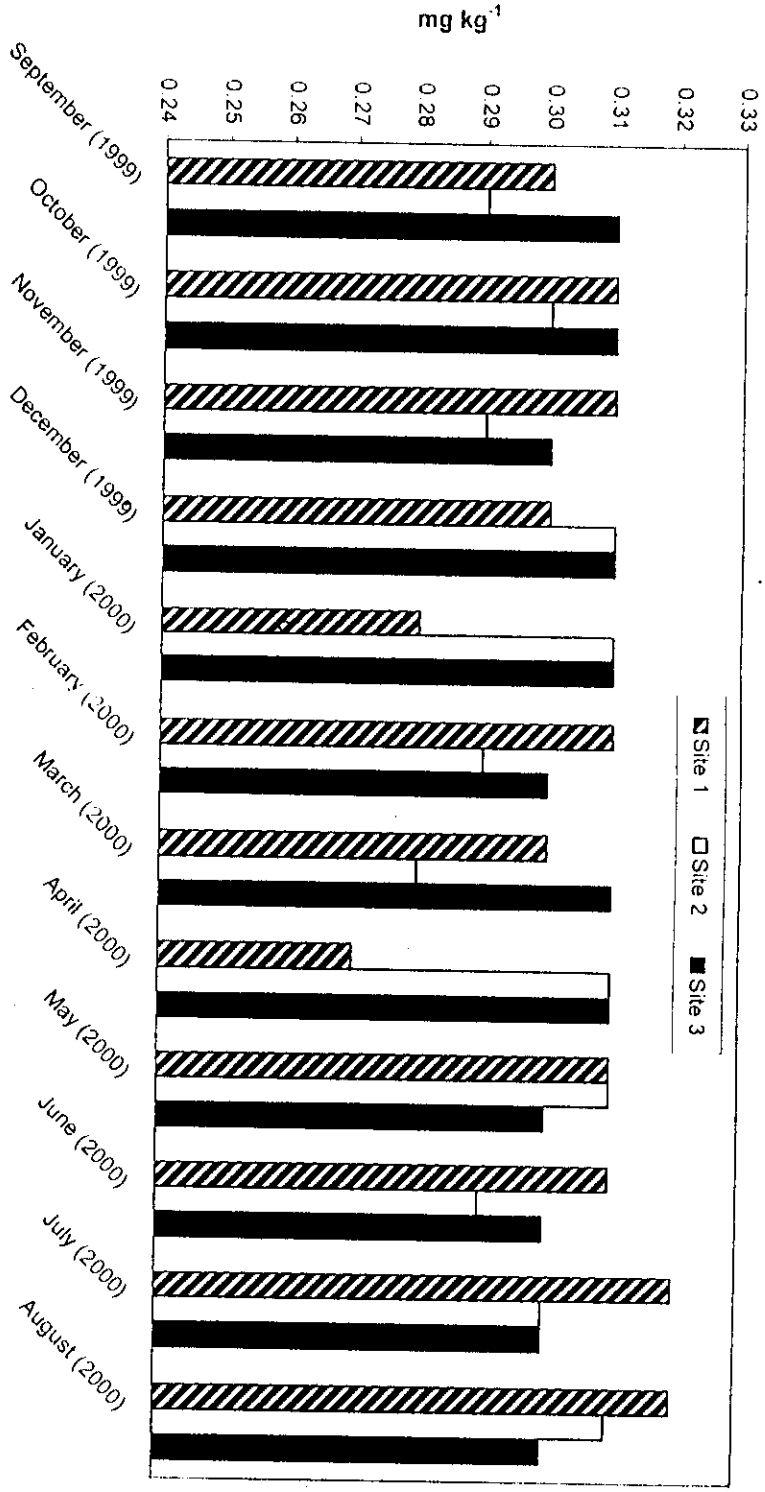

Fig (6) Nickel content in sewage effluent and water of El-Berka WWTP.

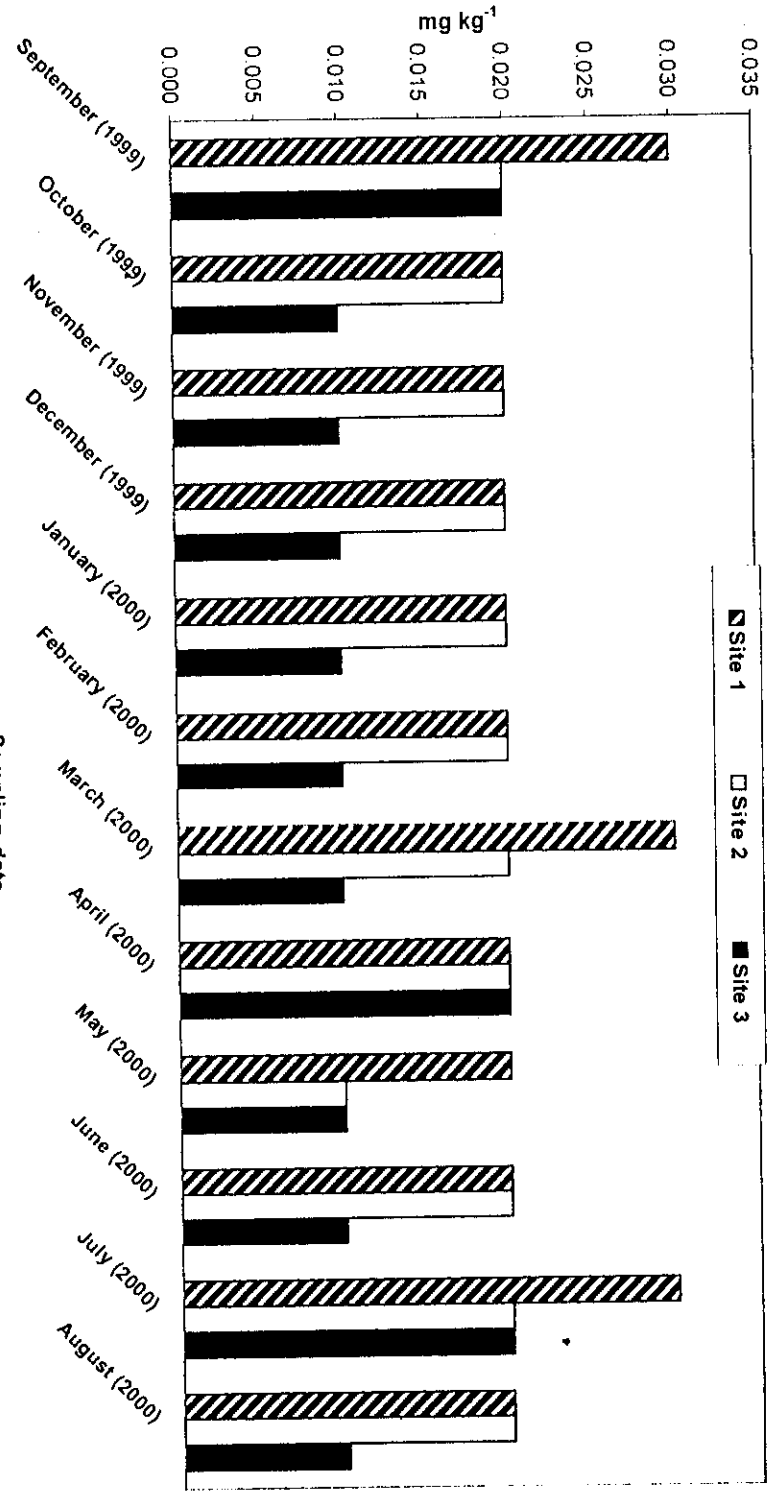

Fig (7) Lead content in sewage effluent and water of Helwan WWTP.

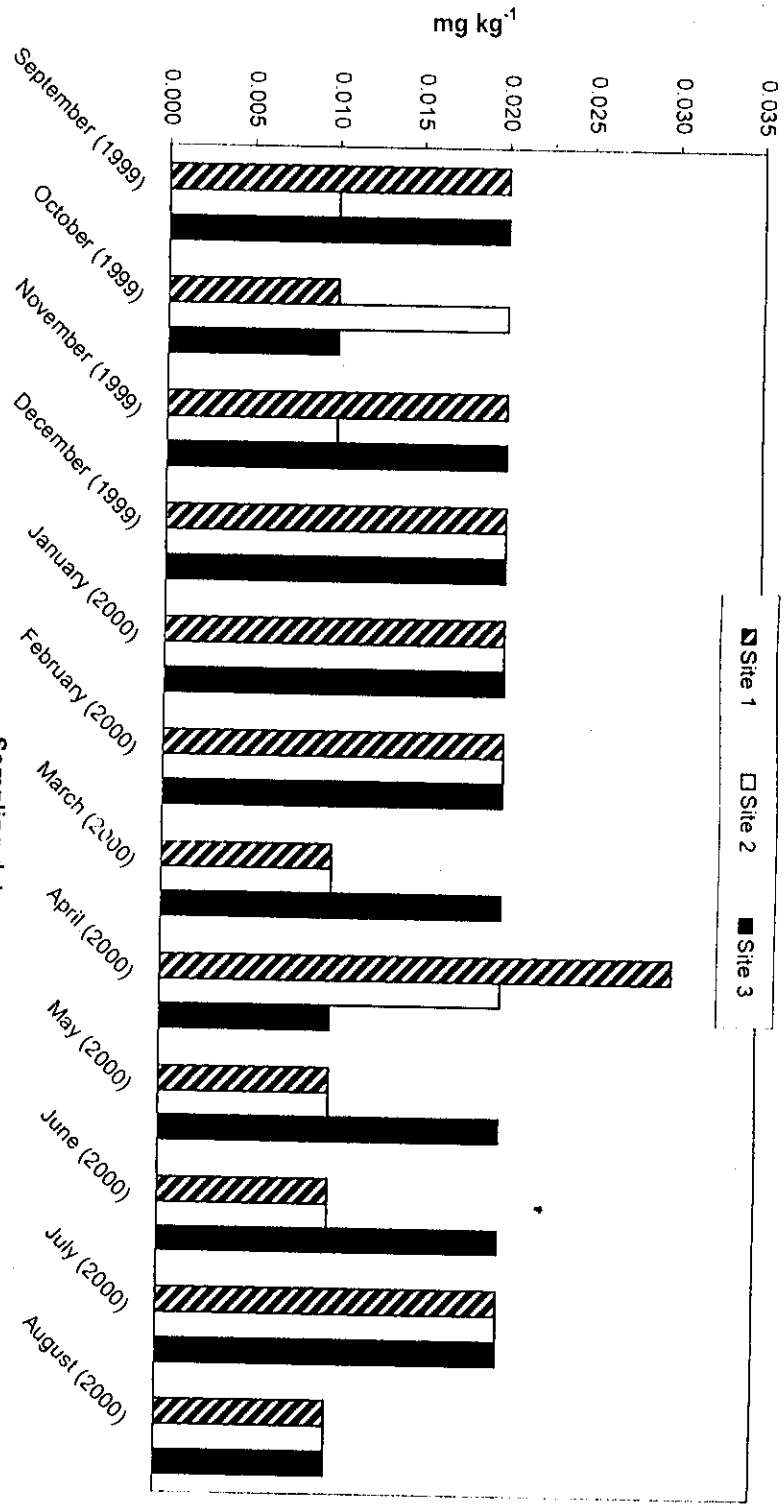

Fig (8) Cadmium content in sewage effluent and water of Helwan WWTP.

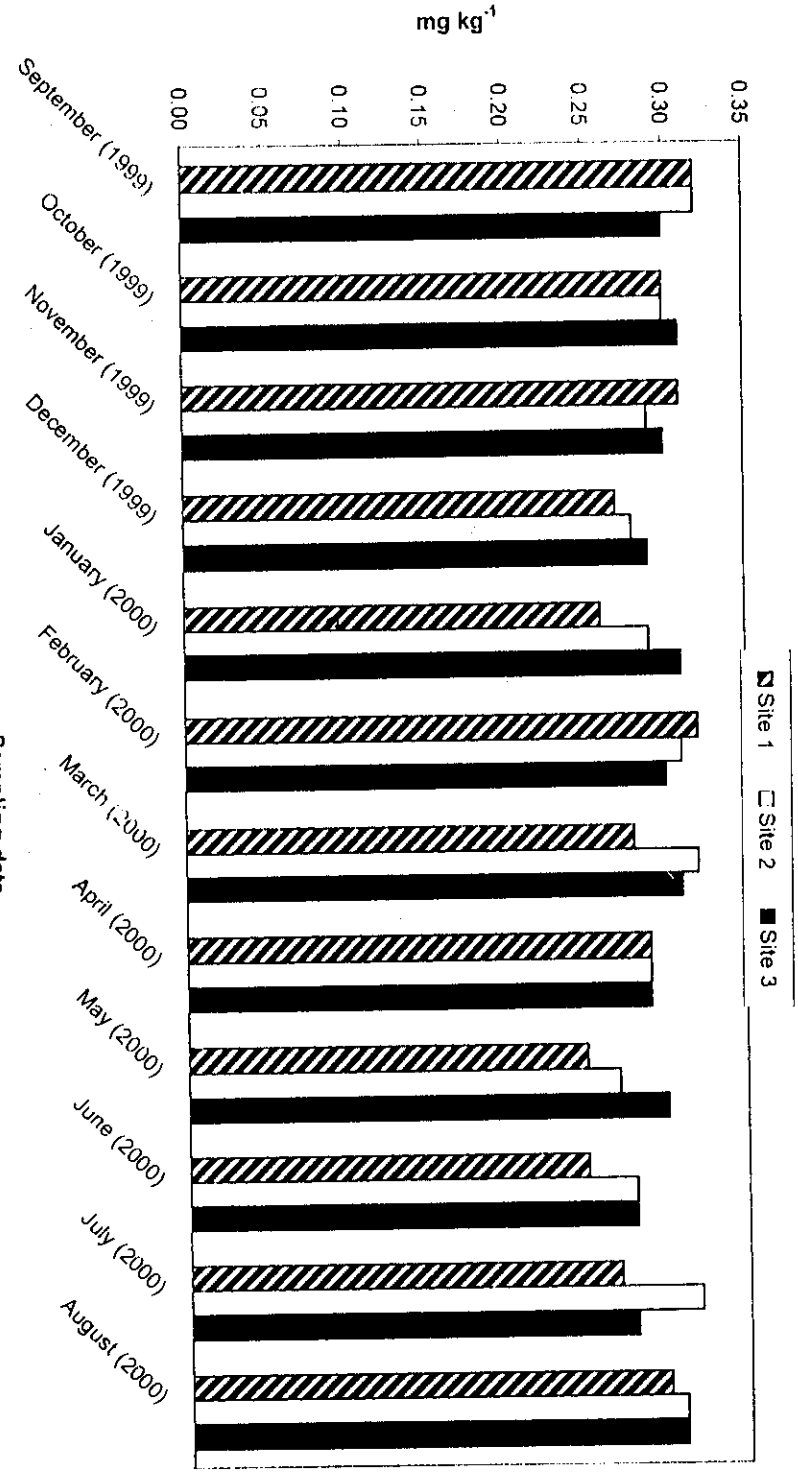

Fig (9) Nickel content in sewage effluent and water of Helwan WWTP.

4.2.1. Evaluation according to the USS Lab(Richards, 1954):

4.2.1.1. Salinity hazard:

Values of EC of the effluents of El-Berka Sludge Station ranged from as low as 0.9 to as high as 1.36 dSm^{-1}. This means that these effluents are considered of medium - high salinity water which belongs to C3 category that has EC values ranging from 0.75 to 2.25 dSm^{-1}. These effluents cannot be used for soils with restricted drainage and even in case of soils with adequate drainage special management for salinity control might be required and plant with good salt tolerance should be selected **(Richards, 1954).**

EC values of Helwan effluents are relatively higher, than those of El-Berka. These values ranged from 1.71 up to 2.39 dSm^{-1}, being mostly below 2.25 dSm^{-1} and in few times higher than this range, hence the effluents of Helwan are fluctuating between the C3 category and C4 one whose water may be used occasionally under very special circumstances. The soil must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt tolerant plants should be selected.

4.2.1.2. Sodicity hazard:

Data presented in Tables1(a, b, and c) and 2(a, b, and c) reveal that the SAR values of both El- Berka and Helwan were below 10.

Such results may indicate that the studied effluents belong to S1 category; thus no sodicity hazard due to using such effluents water for irrigation is expected, and hence no or little development only of harmful exchangeable sodium levels may be arise under such circumstances.

4.2.1.3. Boron hazard:

In addition to the elements that frequently may occur in relatively high concentrations, boron may cause injury to growing plants even when present in very low concentrations in the soil solution. Boron is essential to the normal growth of all plants, but the concentrations are extremely low and exceeded may cause injury. However boron is very toxic to certain plant species that called boron sensitive plants and the concentrations that may injure such plants are often approximately comparable to those required for normal growth of very tolerant plants.**(Richards, 1954)**

The probable occurrence of boron at toxic concentrations in irrigation waters makes it necessary to consider this element in assessing the irrigation water quality.

Data in Tables 1(a, b and c) and 2(a, b and c) reveal that B concentrations in all the investigated effluents did not exceed limit 0.33 mg/L^{-1} proposed by **Scofield (1940)** beyond which the sensitive crops may be injured and hence the studied effluents are safe from this stand point of view.

4.2.1.4. Residual sodium carbonate (RSC):

On the basis of residual sodium carbonate, (RSC), concept of Eaton (1950) [$RSC=CO3^{2-} + HCO_{3-}) - (Ca^{2+}+ Mg^{2+})$in which the ionic constituents are expressed as meL^{-1}, it was concluded by **Richards (1954)** that waters with more than 2.5 meL^{-1} residual sodium carbonate are not suitable for irrigation purposes. Water containing 1.25 to 1.5 meL^{-1} are marginal and those containing less than 1.25 meL^{-1} are probably safe.

Data presented in Tables 1(a, b and c) and 2(a, b and c) reveal that all values of RSC are negative, thus the water of the

investigated sewage effluents according to this parameter are suitable for irrigation .

4.2.2. Evaluation according to Gupta (1979) :

4.2.2.1. Sodicity hazard:

Data presented in Tables 1(a, b, and c) and 2(a, b, and c) reveal that values of adj SAR of the sewage effluents water of El-Berka station belongs to the normal water. A1 since all of these values are less than 10.

Also, the Adj SAR values of the sewage effluents water of Helwan are lower than 10 i.e. they belong to the normal water.

4.2.2.2. Boron hazard:

Values of boron concentration in all the studied sewage effluents are less than 1 mgL^{-1} Tables 1(a, b and c) and 2 (a, b and c). This means that B concentration of those effluent samples are within the permissible limits for sensitive plants and thus B concentration herein belongs to the normal water(B1).

4.2.2.3. Salinity hazard:

According to the classification of **Gupta (1979)** and data in Tables (1 and 2), it could be concluded that the sewage irrigation water of El-Berka station belongs to the normal i.e C1 while these of Helwan belongs to C_2 category. .

4.2.3. Assessment of suitability according to trace elements content:

Data presented in Tables 1 (a, b and c) and 2 (a, b, and c) and values of Co, Pb, Cd, and Ni given by the **national. Academy of science (1972) and Pratt (1972)** as recommended maximum concentrations of trace elements in irrigation water, it could be

concluded that all the tested type of effluent water are safe from the stand point of Co content whose maximum permissible limit is 0.05 mgL^{-1} and Pb whose maximum permissible limit is 5.0mgL^{-1}. On the other hand, Cd was found in effluents, sometimes, in amounts exceeding the maximum permissible limit in irrigation water which is 0.01 mgL^{-1}. Moreover, Ni in all the studied effluents was found in values relatively higher than that considered as a maximum permissible limit (0.2 mgL^{-1}).

4.3. Effect of irrigation with Helwan water on physical and chemical properties of El- Saff soil:

4.3.1. Particle size distribution:

Data presented in Table (3) show the particle size distribution of El-Saff soil as effected by irrigating the soil with effluents water of Helwan Sludge Station. It is obvious from these data that very little variations could occur on particle size distribution. The most pronounced change resulted in clay content of the soil. Such an increase in clay content could be due to the agricultural management practices.

The sand fraction dominated over the other soil fractions in the virgin (non-cultivated soil) as well as in the soils irrigated with the sewage effluents however, no variation in sand content could be observed due to irrigation with the sewage effluents.

Thus, it could be concluded that the slight increase in the clay fraction with time of irrigation might be at the expense of the silt fraction especially when irrigation period with effluents water was extended to seven years.

It is of importance to refer that the soil textural class

Table (3) some physical and chemical properties of soils irrigated at El-Saff area as affected by irrigation with sewage effluents water

Period of application	Soil depth (cm)	O.M (%)	CaCO3 (%)	Particle size distribution (%)				Textural class	PH (soil pasle)	EC. (ds/m) in sturation extract	Heavy metals concentration mgKg			
				C.Sand	F.Sand	Silt	clay				Co	Pb	Cd	Ni
Without application	0-15	0.15	30.30	55.00	26.90	15.40	2.70	L. sand	7.55	12.85	1.02	1.30	0.96	2.42
	15-30	0.12	33.21	54.40	22.50	20.10	3.00	L. sand	7.54	16.70	0.98	1.24	0.66	2.48
	30-60	0.17	38.79	59.10	17.50	20.70	2.70	L. sand	7.40	16.70	1.04	1.18	0.96	1.64
	60-90	0.23	32.48	66.46	13.30	17.20	3.10	L. sand	7.55	14.80	1.06	1.11	0.70	2.44
1 year	0-15	0.98	26.61	56.74	26.30	12.15	5.08	L. sand	7.42	2.91	1.06	1.56	1.26	2.12
	15-30	0.35	27.15	54.31	29.45	11.56	4.68	L. sand	7.52	2.61	0.99	1.32	0.82	4.94
	30-60	0.20	36.36	47.29	31.35	14.35	7.03	L. sand	7.42	2.61	1.12	1.20	0.92	1.22
	60-90	0.17	35.15	63.23	25.47	8.24	3.06	L. sand	7.44	2.91	1.08	1.12	0.64	2.38
5 year	0-15	1.05	16.00	56.79	26.47	10.37	6.37	L. sand	7.35	3.66	1.28	1.96	1.14	3.60
	15-30	0.32	17.90	54.22	27.69	11.81	6.28	L. sand	7.30	2.58	1.04	1.34	0.94	4.28
	30-60	0.26	11.50	50.27	26.70	14.59	8.44	L. sand	7.43	2.94	1.20	1.16	0.96	1.50
	60-90	0.20	19.50	60.26	24.30	9.36	6.08	sandy	7.48	3.17	1.12	1.10	0.68	2.10
7 year	0-15	1.25	14.70	55.96	28.73	3.83	11.48	L. sand	7.32	3.59	1.25	3.10	1.09	4.02
	15-30	0.70	18.70	56.97	27.85	3.71	11.47	L. sand	7.33	2.43	1.08	1.34	0.84	4.10
	30-60	0.23	11.50	60.46	24.61	6.06	8.87	L. sand	7.38	2.39	1.12	1.16	0.96	1.02
	60-90	0.20	17.90	63.69	19.85	5.15	11.31	sandy	7.38	2.33	1.10	1.16	0.70	2.22

remained almost constant within the whole period of irrigation with the effluents water. This finding is in a well agreement with those of **Allam (1986), Abdellah (1995) and Matter (1999).**

4.3.2. Soil reaction (pH):

Values of pH in the virgin soils as well as the irrigated ones were slightly alkaline. These values were not affected with soil depth and seemed not to be affected also with period of irrigation with the effluents water, where the fluctuations in the soil pH did not exceed 0.25 unit. However, one exception could be observed, where the soil pH decreased slightly due irrigation with the effluents water up to seven years. Such a decrease might be attributed to decomposed organic matter which tended to accumulate in the effluent irrigated soils in relatively higher amounts than in the virgin ones. Decomposition of soil organic matter produces some organic acids besides CO_2 yielded by the organic matter decomposers upon exhalation, **Abd- Elnaim et al (1982), Sadik et al (1987) and Abdellah (1995)** went almost to similar findings.

4.3.3. Soil salinity (EC):

Data presented in Table (3) and illustrated in Fig. (10) show that soil salinity as expressed in terms of electrical conductivity (EC) decreased due to irrigation with the sewage effluents water. The decrease was more obvious by increasing irrigation period. This finding is in accordance with those **of Allam (1986), Abd El Aziz (1992), Abdellah (1995) and Matter (1999)** .

Regarding distribution of salts with depth, data reveal that the EC values of the surface layers (0 - 15 cm) of the virgin soil did not show any specific trend with depth. However, by putting the soil under cultivation, the EC values tended to be higher in the surface

layers and being decreased with depth until the third layer (30 - 60 cm) beyond which EC values increased once again. Such a pattern of salinity distribution might indicate the inadequate inefficient drainage system.

4.3.4. Organic matter:

It is obvious from data presented in Table (3) and Fig (11) that putting the soils under cultivation could increase their content of organic matter specially in the surface layers. The increase in the soil organic matter content was more pronounced by prolonging the period of irrigation with sewage effluents water up to seven years.

4.3.5. Calcium carbonate content

Data presented in Table (3) anf Fig (12) reveal that CaCO3 content in the tested soils tended to be decreased due to irrigation with the water of sewage effluents. Such decrease seemed more obvious by prolonging the irrigation period up to seven years.

The decrease in $CaCO_3$ content might be attributed to partly dissolution of $CaCO_3$ (Brown et. al. 1983). Similar findings were reported by **Allam (1986), Hegazy (1993), Abdellah (1995) and Matter (1999).**

4.3.6. Trace elements:

4.3.6.1. Cobalt (Co):

Data presented in Table (3) reveal that putting the investigated soil under cultivation resulted in a pronounced increase in its content of DTPA- extractable Co, Pb, Cd and Ni. The increase was more obvious in the surface and subsurface soil layers than the deeper ones. Prolonging the irrigation period of soil with effluents water of Helwan. semeed to be of effective influence in enriching

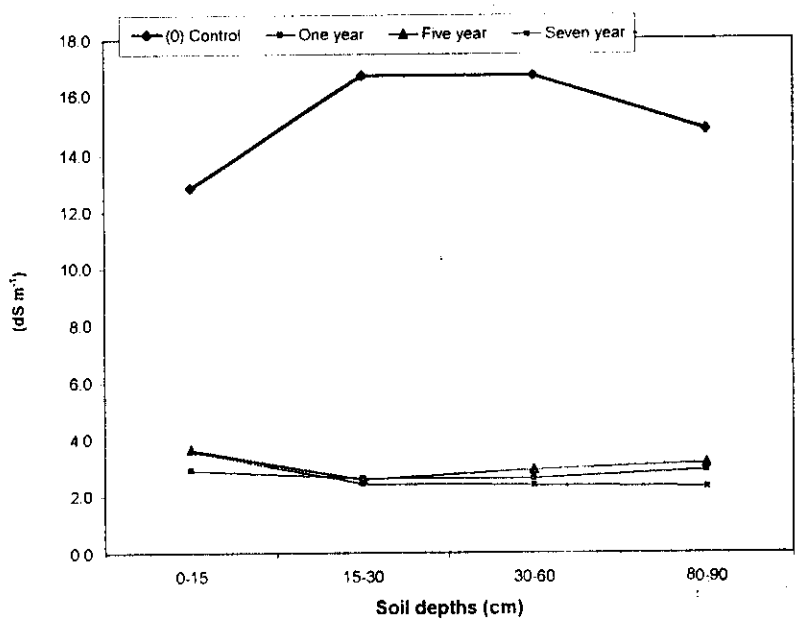

Fig. (10) Electrical conductivity of soil as affected bypriod irrigation with sewage effluents water at El Saff area.

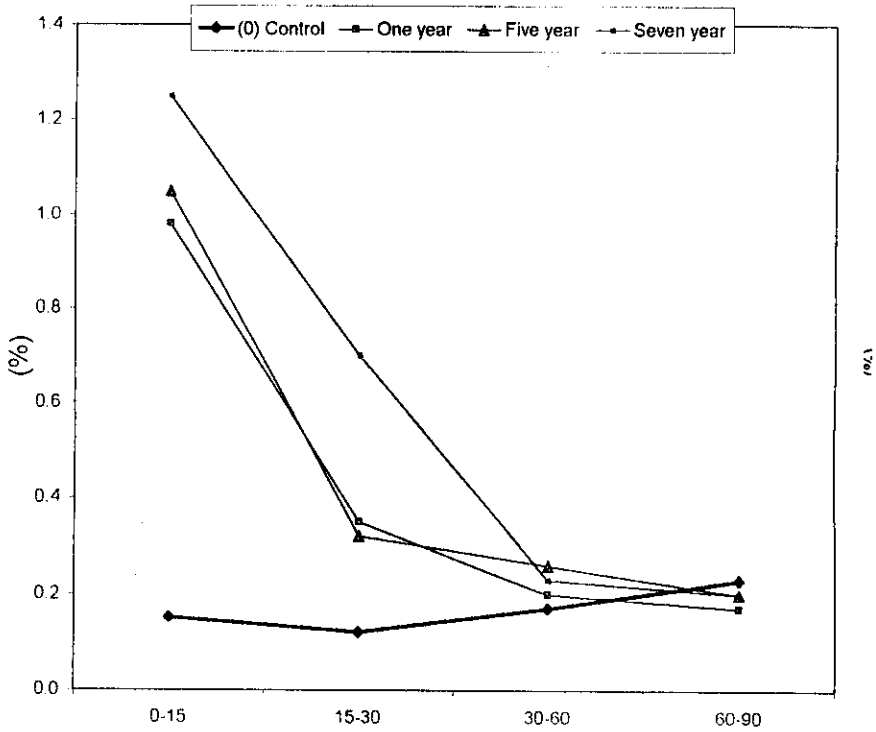

Fig. (11) Organic matter of soil as affected by bypriod irrigation with sewage effluents water at El Saff area.

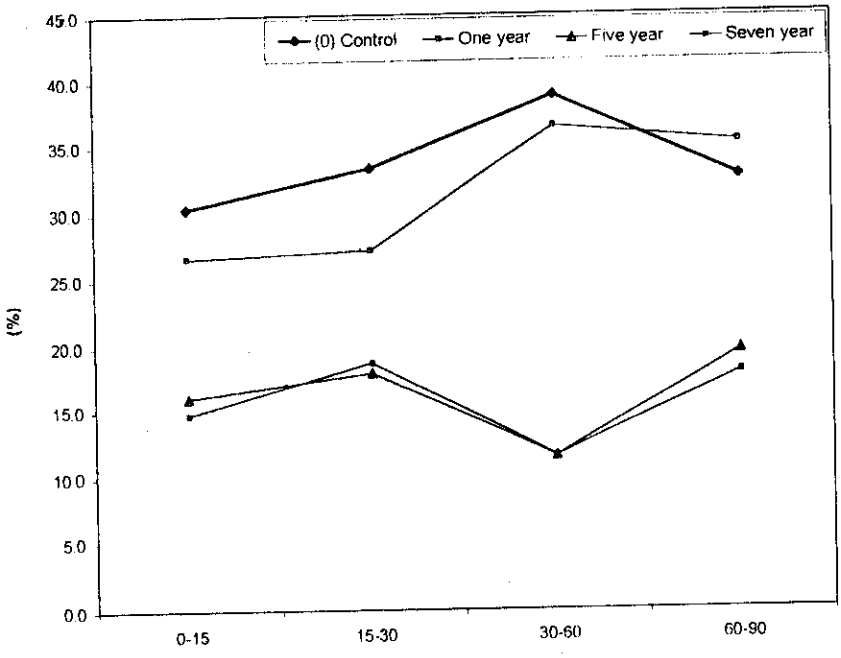

Fig. (12) Calcium carbonate of soil as affected by bypriod irrigation with sewage effluents water at El Saff area.

soil with the trace elements under consideration.

Regarding soil content of the DTPA- extractable Co, data reveal that its content in the virgin (unirrigated) soil ranged from 0.92 to 1.06 $mgkg^{-1}$. The lightest value was that of the deepest soil layer whereas the lowest one characterized the subsurface soil layer (15 - 30 cm).

Irrigating soil with the sewage water seemed to increase slightly the DTPA- extractable Co in most of the soil layers. For example, the DTPA- extractable Co content of the surface and subsurface layers increased from 1.02 and 0.98 $mgkg^{-1}$ in virgin soil to 1.06 and 0.99 $mgkg^{-1}$, respectively due to irrigation with such water for one year only. However the corresponding values were higher (1.28 and 1.04 $mgkg^{-1}$) after 5 years of irrigation with effluents water. while after seven years of irrigation they did not exceed 1.25 and 1.08 $mgkg^{-1}$ in the surface and subsurface layers, respectively.

Such a slight but consistent increase in soil available Co content could not be attributed to the effluent content of Co whose concentration was not detected, yet it might be attributed to the agricultural management practices with some types of manures that might contain Co even in traces that accumulated in soil upon prolonged application of such manures.

However, it should be kept in mind that although the increase in DTPA - extractable Co was very limited, yet this extracted portion represents only a very small percent of its total content in soil.

4.3.6.2. Lead (Pb):

DTPA extractable Pb was found in both virgin and effluents

water - irrigated soils at relatively higher content than Co. The Pb content in the virgin soil ranged from 1.11 to 1.30 $mgKg^{-1}$ being highest in the surface layer and lowest in the deepest one. It is obvious that DTPA- extractable Pb increased in all the soil layers especially in the surface one upon putting the soil under cultivation. Also, the increase was more obvious by prolonging the period of irrigation with effluent water. The DTPA- extractable Pb in the surface layer gradually increased from 1.30 $mgKg^{-1}$ in the virgin soil to 3.10 $mgKg^{-1}$ in the soil irrigated with the sewage effluents for a period of about seven years.

Pb content of the sewage effluents probably resulted in a slight increase in soil content of this element. The airborn Pb, which can travel hundreds of kilometers, and upon its deposition on soil, may also increase its content of total Pb some extent and the DTPA-extractable Pb. Yet, the most important reason for such an increase in Pb might be the accumulation precipition of Pb from the different residues or wastes that inter the soil due to the anthropogenic activity. This finding agrees with those obtained by **Abdellah (1995) and Matter (1999).**

4.3.6.3. Cadmium (Cd)

Owing to the low Cd content of the sewage effluents used for irrigating the studied soil, the increments in soil Cd seemed not to be affected obviously by irrigation with the sewage effluents water or by the prolonged irrigation period up to seven years. However, these low increments in DTPA extractable Cd may reflect more marked increments in Cd total content in soil. The contamination effected of Cd due to fertilizers applied to the soil especially super phosphate.

Seemed to be slight. **Mortvedt (1987)** reported that adding Cd to soils as contaminant in P- fertilizers at the rate ranging from 0.3 to 1.2 g/ha/yr did not appear to increase greatly the Cd concentrations in plants. The use of phosphatic fertilizers should invariably increase, at least to a slight extent, the Cd concentration in all soil used for agricullure as long as the accumulation exceesd th amount removed by both harvested crops and leaching from plough layer **(Singh, 1994)**

4.3.6.4. Nickel (Ni):

Unlike the other studied trace elements, Ni was found in soil at relatively higher contents than the other studied trace elements. This held true for the Ni content of the virgin soil as well as Ni content in the sewage effluents- irrigated ones. This is attributed mainly to the origin from which the soil was developed rather than the Ni content of sewage effluents.

DTPA- extractable Ni was highest in subsurface layer of the virgin soil. Its content increased due to irrigation with the sewage effluent. This occurred in all soil depths, especially the surface one where DTPA- extractable Ni content is very close to that of the subsurface layer after seven years of irrigation with sewage effluents water. However, the increase in Ni could not be attributed to the sewage effluents only but probably some other factors might contribute to such increase among which application of certain phosphate fertilizers as reported by **Pendias and Pendias (1984)**

4.4. Microbiological composition of the sewage effluents:

This part of study aims at following up the microbiological indicators in the investigated effluents allround the year months.

4.4.1. Total bacterial count:

Data in Tables (4,5,6) and illustrated by Fig (13) reveal that counts of total bacteria varied widely from time to time. The highest numbers were found in the summer months (June, July, August) whereas the lowest numbers were indicated in autumn (September, October, November) .

This Finding held true (with a very few exceptions) for both the studied sewage effluents treatment plants and at all the investigated sites from which the water samples were taken. Moreover, it is worthy to indicate that great variations in total bacterical counts could be observed among the different investigated sites of each treatment plant. Generally, total bacterial counts exceeded 10^{10} at the inlet of El-Berka treatment plant. This counts decreased at site 2 to lower than 10^{7}. Such a decrease was expected because of the mechanical, biological and / or chemical treatments, of sewage effluents that led to ,killing a lot of the bacteria. This finding stands in well agreement with those of **El-Taweel et al (2000)**. Despite these, treatments, the final effluents water remained containing many organisms which is coincided with **Pike (1984), Kawamura and Kaneko (1986) and El- Taweel et al (2000).**

Counts of the bacteria remaning after the different treatments were enormoused once again in the samples representing site 3 and reached about 10^{8} / ml. This is probably due to the human activity which misuse the course of the treated water canal. Regarding total bacterial counts of the effluents at inlet of Helwan treatment plant, data in Tables(7,8 and 9) anf Fig. (14) reveal an obvoius variation among the different months of study, generally, relatively lower

Table (4) Classical bacterial indicators of pollution of Sewage effluents from El-Berka treatment plant (Site 1)

Date of sampling	TBC	TC	FC	FS
September (1999)	3.5×10^{10}	4.5×10^{9}	2.4×10^{9}	2.0×10^{5}
October (1999)	3.4×10^{10}	4.2×10^{9}	2.1×10^{9}	3.6×10^{5}
November (1999)	3.5×10^{10}	5.2×10^{9}	2×10^{9}	4×10^{5}
December (1999)	3.6×10^{10}	6.2×10^{10}	4×10^{9}	6×10^{5}
January (2000)	4.1×10^{10}	8.0×10^{10}	6×10^{9}	1.7×10^{6}
February (2000)	4.5×10^{10}	6.8×10^{10}	6×10^{9}	2.2×10^{6}
March (2000)	4.7×10^{10}	8.0×10^{10}	7.1×10^{9}	2.4×10^{6}
April (2000)	5.8×10^{10}	7.2×10^{10}	7.2×10^{9}	4×10^{6}
May (2000)	5.1×10^{10}	2.1×10^{11}	8.0×10^{9}	2.1×10^{7}
June (2000)	6.2×10^{10}	2.6×10^{11}	8.2×10^{9}	3×10^{7}
July (2000)	7.2×10^{10}	2.8×10^{11}	8.4×10^{9}	2.1×10^{7}
August (2000)	8.1×10^{10}	3.2×10^{11}	8.6×10^{9}	5×10^{7}

Site 1 : inlet

TBC : Total Bacteria Count /1 mL

TC : Total Coliforms / MPN index 100mL

FC : Faecal Coliforms / MPN index 100mL

FS : Faecal streptococci / MPN index 100mL

Table (5) Classical bacterial indicators of pollution of Sewage effluents from El-Berka treatment plant (Site 2)

Date of sampling	TBC	TC	FC	FS
September (1999)	3.5×10^4	2.1×10^4	1.2×10^3	6.2×10^2
October (1999)	3.4×10^4	2.4×10^4	1.4×10^3	5.4×10^2
November (1999)	3.5×10^4	3.6×10^4	2.1×10^3	6×10^3
December (1999)	3.6×10^4	2.2×10^4	1.4×10^3	7×10^2
January (2000)	4.1×10^4	2.6×10^4	2.1×10^3	5.2×10^2
February (2000)	4.5×10^5	2.2×10^6	4.2×10^4	6.2×10^3
March (2000)	4.7×10^5	2.7×10^5	1.4×10^4	4.8×10^2
April (2000)	5.8×10^5	2.1×10^5	2.4×10^4	2.5×10^3
May (2000)	5.1×10^6	2.2×10^5	3.6×10^4	3.2×10^3
June (2000)	6.2×10^6	2.1×10^5	4.1×10^4	3.6×10^3
July (2000)	7×10^6	2.2×10^5	4.2×10^4	4×10^3
August (2000)	8×10^6	2.4×10^5	5.2×10^4	5.4×10^3

site 2 : outlet

TBC : Total Bacteria Count /1 mL

TC : Total Coliforms / MPN index 100mL

FC : Faecal Coliforms / MPN index 100mL

FS : Faecal streptococci / MPN index 100mL

Table (6) Classical bacterial indicators of pollution of Sewage effluents from El-Berka treatment plant (Site 3)

Date of sampling	TBC	TC	FC	FS
September (1999)	4.1×10^6	3.6×10^5	2.2×10^3	4.1×10^3
October (1999)	3.6×10^6	2.2×10^5	2.4×10^3	4.4×10^3
November (1999)	2.6×10^6	3.1×10^5	3.6×10^4	3.8×10^3
December (1999)	2.8×10^6	4.8×10^5	2×10^3	3.2×10^3
January (2000)	3.8×10^6	6.8×10^5	3.8×10^3	4.1×10^3
February (2000)	4.1×10^7	7×10^6	4.1×10^4	5.8×10^3
March (2000)	4.8×10^6	3.2×10^5	6×10^4	6.2×10^3
April (2000)	6×10^6	3.6×10^5	7.1×10^4	2.1×10^4
May (2000)	6.8×10^6	4×10^6	7.4×10^4	2.4×10^4
June (2000)	7×10^7	4.2×10^6	8.1×10^4	3.1×10^4
July (2000)	8×10^7	5×10^7	9×10^4	3.6×10^4
August (2000)	9.2×10^7	5.2×10^7	8×10^5	4.1×10^4

site 3 :2 km away from the emergency canal

TBC : Total Bacteria Count /1 mL

TC : Total Coliforms / MPN index 100mL

FC : Faecal Coliforms / MPN index 100mL

FS : Faecal streptococci / MPN index 100mL

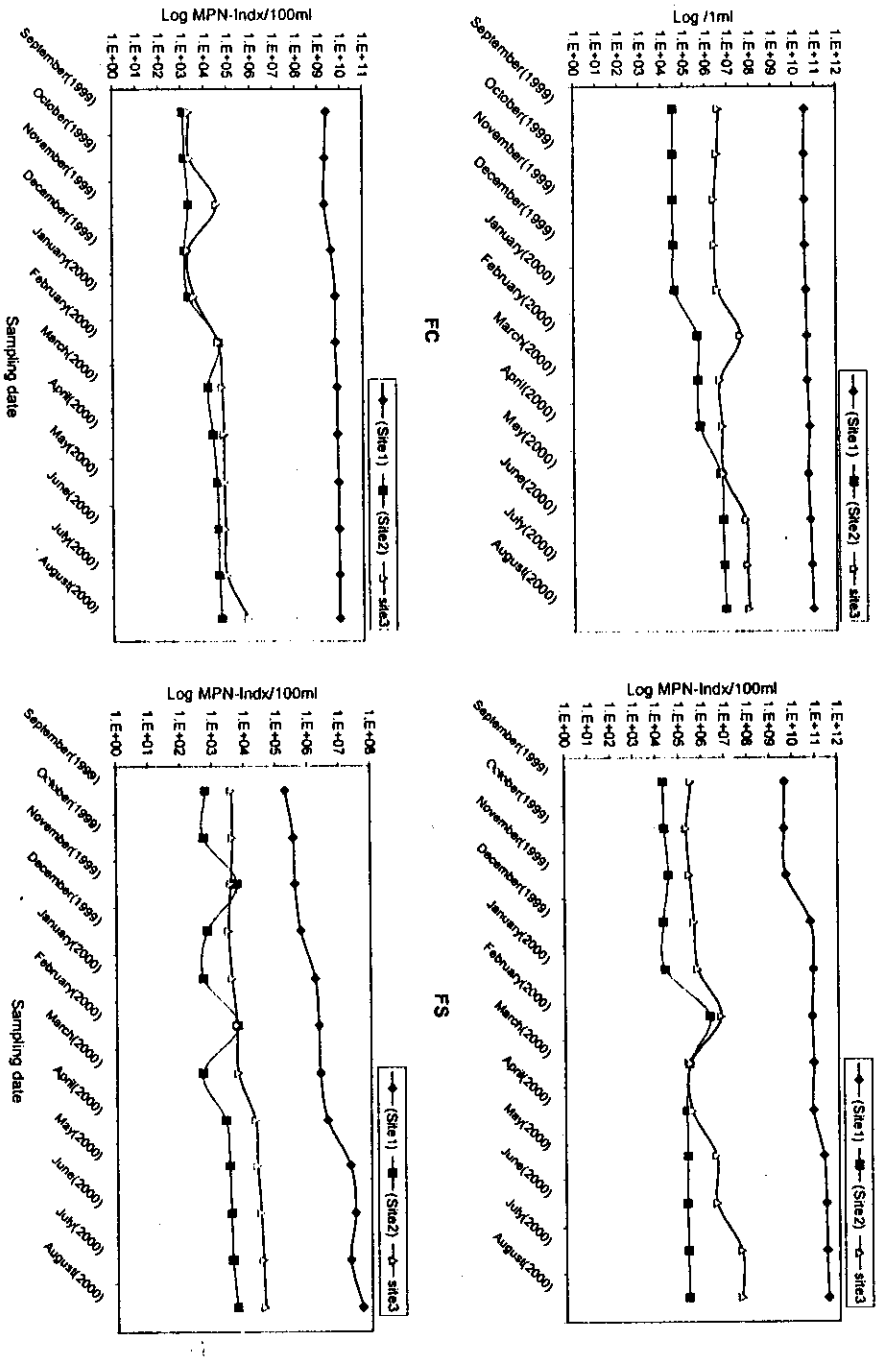

Fig (13) Classical indicators of pollution in sewage effluents and water at El-Berka WWTP.

Table (7) Classical bacterial indicators of pollution of Sewage effluents from Helwan treatment plant (Site 1)

Date of sampling	TBC	TC	FC	FS
September (1999)	2.8×10^3	1.2×10^2	1.1×10	2.1×10
October (1999)	3.1×10^3	1.4×10^2	2×10	1.3×10
November (1999)	3.3×10^3	1.6×10^2	3×10	2.2×10
December (1999)	3.4×10^3	2.0×10^2	3×10	3.2×10
January (2000)	3.2×10^3	3×10^3	4×10^2	4×10^2
February (2000)	3.1×10^3	2.6×10^2	2×10	2.6×10^2
March (2000)	4.5×10^4	3.6×10^4	3×10^2	3×10^3
April (2000)	3.1×10^3	3.6×10^3	2.2×10	1.2×10^2
May (2000)	3.8×10^4	3.8×10^3	3×10^3	2.1×10^2
June (2000)	4.2×10^4	4.1×10^4	4×10^3	2.6×10^2
July (2000)	4.4×10^4	4.2×10^4	5.1×10^3	3.6×10^2
August (2000)	4.8×104	5.2×104	5.2×104	4.8×102

site 1 : Outlet

TBC : Total Bacteria Count /1 ml

TC : Total Coliforms / MPN index 100mL

FC : Faecal Coliforms / MPN index 100mL

FS : Faecal streptococci / MPN index 100mL

Table (8) Classical bacterial indicators of pollution of Sewage effluents from Helwan treatment plant (Site 2)

Date of sampling	TBC	TC	FC	FS
September (1999)	1.2×10^4	2.4×10^2	6×10	3×10
October (1999)	1.6×10^4	2.6×10^2	7×10	2.8×10
November (1999)	1.8×10^4	2.8×10^2	9×10	3.1×10
December (1999)	2.1×10^4	3×10^2	9×10	4.8×10
January (2000)	2.2×10^4	4×10^3	6×10^2	6×10^2
February (2000)	2.1×10^4	3.8×10^2	8×10	7×10^2
March (2000)	2.4×10^4	4.8×10^4	7×10^2	6.2×10^2
April (2000)	3.2×10^4	5×10^3	5×10	3.1×10^2
May (2000)	4.8×10^4	6×10^3	4×10^3	4.8×10^2
June (2000)	5.2×10^4	6.8×10^4	5.6×10^3	5.4×10^2
July (2000)	6.2×10^4	7.2×10^5	6.2×10^3	6.2×10^2
August (2000)	6.4×10^4	8.4×10^5	7.4×10^4	7.2×10^2

site 2 : the beginning of El-Saff El-Gadida canal (komombo canal)

TBC : Total Bacteria Count /1 ml

TC : Total Coliforms / MPN index 100mL

FC : Faecal Coliforms / MPN index 100mL

FS : Faecal streptococci / MPN index 100mL

Table (9) Classical bacterial indicators of pollution of Sewage effluents from Helwan treatment plant (Site 3)

Date of sampling	TBC	TC	FC	FS
September (1999)	2.5×10^5	3.6×10^2	8×10	4.2×10^2
October (1999)	3.1×10^5	3.8×10^2	1.1×10^2	3.8×10^2
November (1999)	2.8×10^5	4.1×10^2	1.2×10^2	4.4×10^2
December (1999)	3.2×10^5	5.1×10^2	1.4×10^2	5.2×10^2
January (2000)	4.8×10^5	6×10^3	8.2×10^2	8×10^3
February (2000)	3.1×10^5	5.8×10^2	1.4×10^2	9×10^2
March (2000)	5.6×10^5	5.8×10^4	1.3×10^3	8×10^3
April (2000)	4.2×10^5	7.1×10^3	8×10^2	4.8×10^4
May (2000)	5.2×10^5	8×10^3	5.2×10^3	6.2×10^4
June (2000)	6×10^5	9.2×10^4	7.2×10^3	8.2×10^4
July (2000)	6.8×10^5	8.2×10^5	8.2×10^3	8.4×10^4
August (2000)	7.2×10^5	9×10^5	8.4×10^4	9.2×10^4

site 3 : 3 km apart from the beginning of El-Saff El-Gadida canal.

TBC : Total Bacteria Count /1 ml

TC : Total Coliforms / MPN index 100mL

FC : Faecal Coliforms / MPN index 100mL

FS : Faecal streptococci / MPN index 100mL

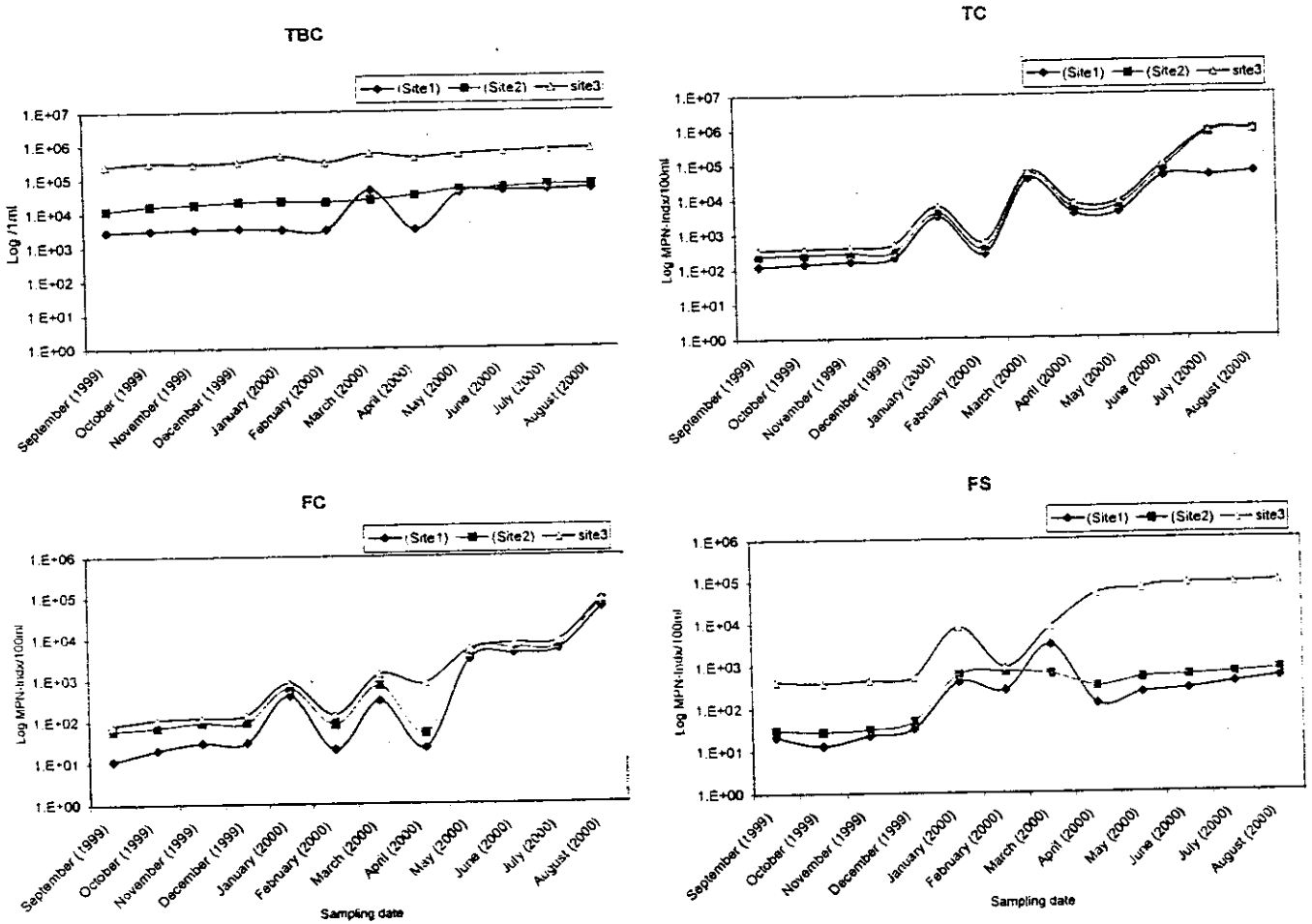

Fig (14) Classical indicators of pollution in sewage effluents and water at Helwan WWTP.

total bacterial counts in autumn (September, October and November) than those of summer (June, July, August).

Such a finding is similar to those observed at all the studied site of El- Berka treatment plant and coincides with total bacterial counts at the other studied sites of Helwan Treatment plant.

Total bacterial counts of site 2 seemed more than the corresponding values at site 1 whereas those of site 3 seemed to be the highest. The increase in total bacterial counts at sites 2 and 3 might be due to disposal of polluted water into the course of the canal besides mal man activities along the banks of the canal.

4.4.2. Total coliforms:

Coliforms bacteria are always taken as proof that the effluents in which they are detected have been in contact with faeces.

Data presented in Tables (4-9) anf Fig.(10 and 11) reveal the presence of coliforms in all the studied effluent sampils. Total coliform densities were in the ranges of 4.2×10^{9} to 3.2×10^{11} MPN-index /100 ml at site 1 (intake of El-Berka treatment plant). The corresponding values were 2.1×10^{4} to 2.7×10^{5} and 2.2×10^{5} to 5.2×10^{7} MPN- index /100 ml at sites 2 and 3 representing El-Berka. Densities of total coliform at the three sites representing Helwan treatment plant ranged from 1.2×10^{2} to 5.2×10^{4}, 2.4×10^{2} to 8.4×10^{5} and $3.6X10^{2}$ to $0\,9\times10^{5}$ MPN- index /100 ml, respectively.

The high coliform counts in the effluents and in effluents water could be due to high amounts of suspended matter and /or to increased faecal pollution from domestic birds, animals or any other source of man made pollution.

It is of interrested to indicate that the treated effluents are characterized by lower counts of coliforms, however, remarkable increases occurred by going away from the plants which may give further support to the gust aforementioned explanation.

4.4.3. Faecal coliforms (Tables 4-9):

It is clear that faecal coliform mosly represent a part from total coliform. The densities of faecal coliforms ranged from 2×10^9 to 8.6×10^9, 1.2×10^3 to 5.2×10^4 and 2.2×10^3 to 8×10^5 MPN- index / 100 ml at sites 1.2 and 3 representing El-Berka effluents treated and untreated. As for the faecal coliforms densities at site one (i.e the outlet) of Helwan station were lowest compared with the corresponding densities at sites 2 and 3 where the counts ranged from 1.1×10 to 5.2×10^4, 6×10 to 7.4×10^4 and 8×10 to 8.4×10^4 MPN- index /100 ml.

It is worthy to indicate that faecal coliforms counts obtained herein are far lower than those reported by **El- Taweel et al (2000)** upon her work on treated effluents taken from different treatment plants.

4. 4. 4. Faecal Streptococci (Tables 4-9):

Faecal streptococci as a supplementary indicator of faecal pollution levels and mostly considered where the source of pollution must be defined ranged from 2×10^5 to 5×10^7, 5.4×10^2 to 5.4×10^3 and 3.2×10^3 to 3.6×10^4 MPN /100 ml at sites 1,2,3 respectively that represent El- Berka treatment plant. The corresponding values of Helwan treatment plant ranged from 1.3×10^2 to 4.8×10^2, 2.8×10 to 7.2×10^2 and 3.8×10^2 to 9.2×10^4 MPN / 100 ml at sites 1, 2 and 3 , respectively.

4. 5. Biological evaluation of the studied effluents:

The aforementioned results reveal that although chlorination succeeded to reduce the densities of faecal coliforms at sites 2 and 3 of El-Berka treatment plant, yet the residual counts were still high and did not fit with the **WHO (1989)** guidelines for unrestricted irrigation or with the Egyptian law 48/1982 regulating the discharge of wastewater into agricultural canal or drains which recommended, counts of less than 1000 cell of feacal coliforms per 100 ml .

Such results may attract the attention to the essentiality of controlling such levels of pollution in the outlet along the canals under consideration and even in the inlet in order to keep safe levels of pollution microorganisms in such types of irrigation water.

On the other hand, it seemed that the chlorination process succeeded enough in reducing feacal coliforms at all the studied sites of Helwan treatment plant to counts in a good agreement with the **WHO guidelines (1989)** and the Egyptian law (48/1982).