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A Qualitative and Quantitative Study on El-Gharbia Main Drain Wastewater

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ABSTRACT

The use of El-Gharbia main drain wastewater for agriculture practices and fishing poses serious risks to the residents of villages in El-Gharbia and Dakahlia governorates, as well as a number of Kafr El-Sheikh centers. Three sources of wastewater disposal into El-Gharbia main drain, such as sewage, agricultural and industrial drainage. The current study aims to estimate the quality of El-Gharbia main drain water for reuse to irrigate agricultural soils according to environmental quality standards. Samples (water and sediments) were collected from fifteen sites along El-Gharbia main drain (more than 100km) in the winter of 2020 and the summer of 2021. The results showed that the content of water and sediments samples of micronutrients (Fe, Mn, Zn, Cu and B) and heavy metals (Cd, Co, Cr, Ni and Pb) differed from one site to another. In some cases, the overall mean exceeded the permissible limit in both seasons under study, but the pollution degree was higher in the summer season. The biological analysis of pathogenic bacteria under study showed that the numbers of pathogenic bacteria exceeded the permissible limit in both seasons under study, and the numbers of pathogenic bacteria in summer was higher.

Keywords: El-Gharbia main drain water, micro-nutrient, heavy metals and pathogenic bacteria.

INTRODUCTION

Water pollutants generated from human activities might be toxic and cause imbalance in the natural balance of ecosystems (Maanan,2008). The residents of El-Gharbia and Dakahlia governorates villages and a number of Kafr El-Sheikh centers face a major danger resulting from the use of wastewater from El-Gharbia Drain to irrigate agricultural soil and fishing. The extension of El- Gharbia Drain is more than 100 kilometers, starting from El-Mahalla El-Kubra in El-Gharbia Governorate and ending in El-Burullus in Kafr El-Sheikh, where the drain receives industrial drainage from El-Mahalla El-Kubra factories and some of Kafr El-Zayyat factories, in addition to receiving sewage from Tanta city.These wastewater resources led to spread the diseases such as hepatitis C virus in some population of the surrounding villages, especially the villages of El-Hamoul, Bealla and Baltim centers.

The dissolution of micronutrients (Fe, Mn, Zn, Cu and B) and heavy metals (Cd, Co, Cr, Ni and Pb) in wastewater showed concentrations above the permissible limits and caused a high the bioaccumulation within living organisms (Rajeshkumar and Li, 2018), then, an accumulation of toxic metals occurs within organs of human body, such as liver and kidney, and the biochemical processes of these organs are affected, in addition to bones, heart, blood vessels, and nerves (Tchounwou *et al*., 2014). Moreover, pollutants may organic and inorganic materials, liquid or solid form such as oils, lubricants, pesticides and fertilizers so that it's have a harmful effect on society and biological resources (Chang *et al*., 2012) and this leads to the consumption of dissolved oxygen in water bodies as a result of decomposition Anaerobic for organic and inorganic wastes (Zaghloul and Elwan, 2011)

Wastewater is a potency source of many human pathogenic bacteria which poses a serious health risk to all people. When wastewater infiltrates into the soil, then pathogenic bacteria pass into groundwater, increasing the vulnerability of groundwater (jin and flury, 2002), which is considered one of the sources of drinking water in many regions of the world. Because of this, the diseases will spread significantly, such as malaria, cholera, diarrhea, typhoid fever, and dysentery (Ogbonna, 2014). Municipal and industrial wastewater production increases with urban and rural populations. Their wastewater discharge to the environment contributes to increasing highly toxic compounds, unknown levels of pathogens, hydrocarbons, nutrients, toxins, organic and inorganic matter, and endocrine disruptors that deteriorate the ecosystem and accelerate eutrophication (Moretti *et al*., 2019).

In many developing countries, wastewater treatments are expensive, energy-intensive and unsustainable or have low yield in reusable water (khandil, 2005, Abinandan *et al*., 2018)

Microbial contamination of groundwater due to sewage outfalls and agricultural runoff can be a serious threat. Globally, the most commonly occurring diseases (and agents) transmitted through drinking of unsafe water are: infectious hepatitis (A, B and C viruses), cholera (Vibrio cholerae), bacillary dysentery (Shigella spp.), typhoid (Salmonella enterica), paratyphoid (Salmonella paratyphi), salmonellosis (Salmonella spp.), colibacillosis (Escherichia coli), giardiasis (Giardia lamblia), cryptosporidiosis (Cryptosporidium spp.) and amoebiasis (Entamoeba group) (Pal *et al*., 2018). The current study aims to estimate the quality of El-Gharbia main drain wastewater

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from its content of micronutrients, heavy metals and pathogenic microbes.

MATERIALS AND METHODS

For the safe reuse of El-Gharbia main drain wastewater in agriculture, its content of micronutrients and heavy elements must be estimated. To achieve this purpose, samples were taken from fifteen sites along El-Gharbia main drain in winter of 2020 and summer of 2021. The samples include soil and plants from each site, Table 1 shows the sampling sites and its coordinates.

Table 1. Sampling sites along El-Gharbia main drain

Site No.	Site Name E.	Longitude (E)	Latitude (N)
1	Segaeya	31° 3' 42.373" E	30° 59' 16.062" N
2	Segaeya after uploading station	31° 4' 17.600" E	31° 1' 9.323" N
3	After Nemra Albasal	31° 4' 55.324" E	31° 3' 47.393" N
4	Before Dukhmays	31° 4' 23.211" E	31° 5' 49.515" N
5	Mansheya Nasrya	31° 4' 23.074" E	31° 9' 42.549" N
6	Ezbet George Dagher	31° 6' 57.130" E	31° 11' 5.214" N
7	Before Ezbet Neel El-Kbeir	31° 7' 27.539" E	31° 13' 47.324" N
8	Ezbet Mashrqi	31° 7' 16.078" E	31° 16' 4.776" N
9	After El-Hamoul	31° 9' 19.013" E	31° 19' 47.516" N
10	Qetaa Alzaweyah	31° 10' 15.726" E	31° 21' 7.117" N
11	Before Ezbet elbadarwa	31° 11' 4.500" E	31° 22' 16.883" N
12	Before Qaria 7	31° 11' 7.050" E	31° 23' 28.045" N
13	After Qaria 9	31° 10' 23.592" E	31° 26' 22.848" N
14	Before Qaria 13	31° 9' 45.446" E	31° 28' 3.322" N
15	After uploading station AlKhashaa	31° 8' 47.136" E	31° 29' 59.130" N

Sediment samples preparation

Sediment samples were collected from all sites and kept in polyethylene bags. The samples were air dried and sieved through a <0.2 mm and stored in the labeled polythene sampling bags (Lei *et al.*, 2008). One gram of each sample was digested according to Cottenie *et al.*, 1982 to determine total contents of micro nutrients and heavy metals, with three replicates.

Water samples preparation

Water samples were collected from each site (Table 1) in opaque polyethylene bottles and were rinsed earlier by distilled water, kept in ice tank and stored at 4°C until analysis according to the procedure described by Chary *et al.,* (2008). The electrical conductivity (EC) of the water samples was determined using EC meter model WTW Series Cond 720.

Samples analysis

Available micro nutrients and heavy metals were extracted using a NH_4HCO_3-DTPA (AB-DTPA) solution, according to Lindsay and Novell (1978). The total and available micro nutrients and heavy metals contents of Cd, Co, Cu, Cr, Fe, Pb, Mn, Ni and Zn for all samples (water and sediment) were determined by using inductively coupled plasma (ICP- JY ULTIMA).

Bacteriological Examination

90 water sample were collected along El-Gharbia main drain stream in sterile 250 ml glass bottles and were subjected to bacteriological analysis within two hours.

1. Total coliform: Total coliform was determined by membrane filtrations technique. Under aseptic conditions, 100 ml of water was filtration through a girded sterile cellulose nitrate membrane filter (0.45 µm pore size, 47 mm diameter, Sartorius type filters) under partial vacuum. The membrane filters were placed on m-Endo agar for total coliform bacteria detection after 24h at 35 ºC (APHA, 2012).
2. Fecal coliform: Membrane filtration technique for fecal coliform was determined according to standard method for water and waste water by using mfc agar media filtration, 100 ml from sample was filtered into membrane (0.45 µm pore size) then transferred the membrane into Petri dish contains solidified media, then Petri dishes were incubated at 44 ºC for 24h (Standard methods, 2017).
3. Fecal streptococcus: Fecal streptococci were detected by membrane filtration technique using m-enterococcus solidified media, then the Petri dishes were incubated at 35 ºC for 24 h.
4. Salmonella and Shigella: Sallmonella and Shigella were detected by membrane filtration technique then were used with (S.S agar media), and then the Petri dishes were incubated at 35 ºC for 24 h (APHA, 2012).
5. Vibreo Cholera: Vibro cholera was detected by membrane filtration technique using especial media (Vibro cholera agar media), the Petri dishes are incubated at 35 ºC for 24 h (APHA, 2012).
6. Dissolved oxygen (DO): Dissolved oxygen (DO) was measured by WTW instrument.
7. Biological oxygen demand (BOD) and chemical oxygen demand (COD) are measured according to the reference methodology reported by standard methods (APHA, 2012).

RESULTS AND DISCUSSION

Environmental pollution resulting from various sources of drainage (agricultural, industrial and sewage) in water bodies, whether this pollution by heavy metals or pathogenic microbes, is a serious problem facing the aquatic ecosystem in Egypt (Nawal *et al.,* 2021).

1- Contents of the El-Gharbia main drain water of salts, macronutrients and heavy metals.

The salt and heavy metals concentration is the most one important determinants of wastewater reuse in agriculture. The data in Table 2 (winter season) and Table 3 (summer season) show the results of electrical conductivity (EC), concentration of micro nutrients and heavy metals in the water of El-Gharbia main drain.

Table 2. Electric conductivity (EC), micro nutrients and heavy metal content in El-Gharbia drain water at winter

Sites	EC (dSm^{-1})	mg l^{1}									
		Fe	Mn	Zn	Cu	B	Cd	Co	Cr	Ni	Pb
1	1.47	0.03	0.30	0.21	0.017	0.03	0.050	N.D.	N.D.	N.D.	0.099
2	1.25	0.02	0.12	0.20	0.020	0.05	0.099	N.D.	N.D.	0.033	N.D.
3	0.67	0.02	0.03	0.19	0.012	0.04	N.D.	N.D.	N.D.	0.014	N.D.
4	1.33	0.03	1.00	0.18	0.017	0.09	0.098	N.D.	N.D.	0.021	N.D.
5	1.98	0.01	0.02	0.30	0.012	0.021	N.D.	N.D.	N.D.	0.011	N.D.
6	1.54	0.28	0.12	0.30	0.023	0.033	N.D.	N.D.	N.D.	0.029	N.D.
7	1.40	0.02	0.25	0.32	0.024	0.023	0.075	N.D.	N.D.	N.D.	N.D.
8	0.68	0.03	0.07	0.33	0.017	0.029	N.D.	N.D.	N.D.	N.D.	0.049
9	1.32	0.09	0.20	0.33	0.029	0.018	N.D.	N.D.	N.D.	0.074	N.D.
10	1.44	0.05	0.23	0.31	0.024	0.012	0.012	N.D.	N.D.	0.099	N.D.
11	1.76	1.21	0.04	0.35	0.018	0.039	0.410	N.D.	N.D.	0.056	N.D.
12	1.56	0.04	0.40	0.70	0.021	0.027	0.230	N.D.	N.D.	0.321	N.D.
13	1.70	0.09	0.20	0.60	0.019	0.062	0.086	N.D.	N.D.	0.099	N.D.
14	1.64	0.11	0.28	0.70	0.022	0.041	0.074	N.D.	N.D.	0.084	N.D.
15	1.96	0.24	0.14	0.70	0.018	0.072	0.016	N.D.	N.D.	0.067	0.11
Mean	1.45	0.15	0.23	0.38	0.020	0.04	0.120	-	-	0.08	0.09
SD	0.38	0.30	0.24	0.19	0.000	0.02	0.110	-	-	0.08	0.04
Permissible limits	2.50[a]	5.00[b]	0.20[b]	2.00[b]	0.20[b]	-	0.01[b]	-	0.01[b]	0.20[b]	5.00[b]

N.D. Not detected, SD: Standard deviation (statistically significant coefficients $p < .05$), Permissible limits according to (a) FEPA and (b) FAO (2006)

Table 3. Electric conductivity (EC), micro nutrients and heavy metal content in El-Gharbia main drain water at summer

Sites	EC (dSm^{-1})	Mg l^{-1}									
		Fe	Mn	Zn	Cu	B	Cd	Co	Cr	Ni	Pb
1	0.35	0.161	0.072	0.297	0.021	0.020	0.052	N.D.	N.D.	N.D.	0.812
2	1.42	0.145	0.080	0.292	0.025	0.040	0.130	N.D.	N.D.	0.030	N.D.
3	1.48	0.157	0.078	0.296	0.018	0.080	N.D.	N.D.	N.D.	0.012	N.D.
4	1.34	0.165	0.084	0.299	0.021	0.100	0.115	N.D.	N.D.	0.023	N.D.
5	1.81	0.149	0.073	0.304	0.023	0.020	N.D.	N.D.	N.D.	0.015	N.D.
6	1.14	0.153	0.080	0.312	0.017	0.030	N.D.	N.D.	N.D.	0.031	N.D.
7	0.87	0.158	0.076	0.321	0.025	0.030	0.064	N.D.	N.D.	N.D.	N.D.
8	1.07	0.164	0.081	0.331	0.021	0.020	N.D.	N.D.	N.D.	N.D.	1.009
9	1.18	0.171	0.079	0.338	0.024	0.021	N.D.	N.D.	N.D.	0.008	N.D.
10	1.22	0.156	0.075	0.344	0.027	0.010	0.149	N.D.	N.D.	0.120	N.D.
11	1.19	0.143	0.083	0.352	0.022	0.040	0.230	N.D.	N.D.	0.085	N.D.
12	1.25	0.150	0.071	0.379	0.020	0.030	0.196	N.D.	N.D.	0.516	N.D.
13	1.23	0.142	0.087	0.364	0.026	0.070	0.052	N.D.	N.D.	0.085	N.D.
14	1.28	0.155	0.078	0.370	0.023	0.030	0.023	N.D.	N.D.	0.092	N.D.
15	3.53	0.153	0.073	0.379	0.021	0.030	0.012	N.D.	N.D.	0.048	0.125
Mean	1.36	0.155	0.078	0.332	0.020	0.040	0.100	-	-	0.090	0.650
SD	0.46	0.010	0.000	0.030	0.000	0.030	0.080	-	-	0.130	0.320
Permissible limits	2.50[a]	5.00[b]	0.20[b]	2.00[b]	0.20[b]	-	0.01[b]	-	0.01[b]	0.20[b]	5.00[b]

N.D. Not detected, SD: Standard deviation (statistically significant coefficients $p < .05$), Permissible limits according to (a) FEPA and (b) FAO (2006)

About EC values were ranged between 1.45 to 1.36 dsm^{-1} as mean in both winter and summer seasons, respectively, and the highest value was 3.53 dsm^{-1} in site No.15 at summer season, which exceeds the permissible limit according to Federal Environmental Protection Agency (FEPA) (1991). As for the micronutrients are less than the permissible limits in both seasons, except for Mn in some sites with mean was 0.23 $mgkg^{-1}$ at winter season, but, the values of heavy metals contents in El-Gharbia main drain water were less than the permissible limits except for Cd in some sites with mean was 0.11 and 0.10 $mgkg^{-1}$ at winter and summer seasons, respectively. Moreover, figure 1 showed that the EC values of all sites in El-Gharbia main drain water at winter and summer season under study.

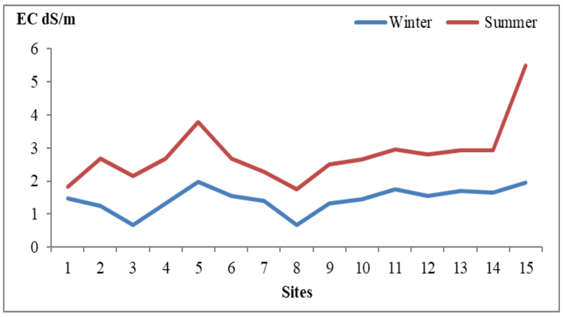

Fig. 1. Electrical conductivity (EC) values of water samples of all sites along El-Gharbia main drain at winter and summer season under study.

2- Effect of wastewater on the sediment content from micronutrients and heavy metals at El-Gharbia main drain

The results in Tables 4 and 5 shows the sediment content in El- Gharbia main drain stream of micronutrients and heavy metals of all sites in winter and summer seasons, respectively. The results of micronutrients (Fe, Mn, zinc, Cu and B) showed that it did not exceed the permissible limits according to the European Union (2006) for all sites in the winter season. Also, the same results in the summer season except for Cu on site No. 11 with value were 108.80 mg kg^{-1}. On the other hand, the results indicated that the sediment content of heavy metals (Cd, Co, Cr, Ni and Pb) exceeded the permissible limits in some sites, according to the European Union (2006). The mean values content of Cd and Ni in the sediments were 12.96, 4.37, 101.89 and 120.80 mg kg^{-1} for both winter and summer seasons, respectively. As for, the sediments content of Pb element, all sites did not exceed the permissible limits except for sites No.1 and 4 at winter season and1, 5 and 12 at summer season, with values were 102.40 and 115.50, 114.80, 158.80 and 104.95 mg kg^{-1} for both two seasons, respectively. While, the sediments content of Cr element was under the permissible limit except for site No.15 with value was 143.55 mg kg^{-1} at winter season, but the mean values of Cr were exceed the permissible limit with value was 133.98 mg kg^{-1} at summer season. The values of Co element content of all sites, it didn't exceed the permissible limit in both seasons under study.

Table 4. Effect of low-quality water on sediments content in El-Gharbia main drain stream of micro-nutrients and heavy metals at winter season

Sites	%	mgkg-1								
	Fe	Mn	Zn	Cu	B	Cd	Co	Cr	Ni	Pb
1	5.43	989.30	152.10	68.00	48.60	29.18	20.9	38.80	83.90	102.4
2	5.06	1422.50	140.20	52.30	44.00	30.65	20.8	56.00	57.50	76.8
3	4.57	940.10	79.20	32.40	36.40	6.35	17.5	50.30	51.40	66.9
4	5.11	13510	201.60	55.70	43.20	6.15	22.00	40.60	80.70	115.5
5	5.23	1098.60	188.50	73.30	73.70	6.18	22.50	87.00	141.20	75.9
6	5.04	1617.70	104.90	47.40	50.80	27.38	20.10	91.60	71.10	69.1
7	5.20	1018.60	92.10	51.20	54.10	27.38	20.70	28.70	160.30	73.6
8	4.77	902.20	130.00	50.70	71.45	31.65	19.80	37.20	168.70	84.5
9	5.13	1241.90	81.70	50.30	70.05	7.41	19.40	39.00	225.10	56.8
10	5.95	1154.80	87.10	59.60	105.42	7.40	21.50	57.00	109.30	98.7
11	4.78	940.70	71.90	47.80	51.60	2.30	25.00	76.40	66.10	50.1
12	4.87	857.00	78.30	47.60	47.20	2.40	25.00	93.50	65.90	52.3
13	5.36	943.90	92.80	64.60	44.50	2.70	28.10	75.80	60.30	43.9
14	4.50	1035.00	95.00	63.00	45.60	3.70	32.40	74.10	65.30	63.2
15	7.52	1513.10	110.95	78.30	76.30	3.60	36.55	143.55	121.50	96.95
Mean	5.23	1135.09	113.76	56.15	57.53	12.96	23.48	65.97	101.89	75.11
SD	0.73	240.08	40.55	11.78	18.29	12.08	5.23	30.35	51.36	21.05
Permissible limits	-	2000.0	300.0	100.0	-	3.0	50.0	100.0	100.0	100.0

SD: Standard deviation (statistically significant coefficients p < .05), Permissible limits according to European Union (2006)

Table 5. Effect of low-quality water on sediments content in El-Gharbia main drain stream of micro-nutrients and heavy metals at summer season

Sites	%	mgkg-1								
	Fe	Mn	Zn	Cu	B	Cd	Co	Cr	Ni	Pb
1	4.26	775.20	74.80	73.10	55.10	2.40	22.20	119.20	123.10	114.80
2	4.44	946.60	84.00	59.00	36.50	2.40	22.70	157.50	62.50	51.50
3	4.29	877.70	73.00	64.60	34.50	2.20	21.50	147.40	51.40	56.70
4	5.13	849.40	80.70	51.30	50.70	2.60	25.00	165.12	236.60	224.00
5	4.84	981.70	70.80	49.90	55.20	2.00	24.90	167.30	172.70	158.80
6	4.69	961.30	68.80	57.60	45.00	3.30	23.00	176.80	103.00	93.30
7	4.65	893.50	186.90	135.20	43.00	3.10	22.20	174.50	53.40	78.60
8	5.13	949.00	143.40	60.40	54.20	1.90	23.90	163.30	84.00	69.80
9	4.45	901.10	86.30	65.00	35.70	2.50	24.20	116.30	60.30	59.30
10	4.16	936.70	119.70	62.00	29.90	1.70	20.60	91.90	41.70	82.30
11	6.71	1269.90	139.25	108.80	62.05	3.15	32.40	93.50	80.15	98.60
12	6.90	1657.90	148.40	79.25	70.35	4.25	32.25	78.90	297.35	104.95
13	6.81	1347.80	132.40	89.20	66.45	3.50	28.45	80.15	202.75	70.85
14	7.56	1366.00	177.70	79.15	97.05	3.23	34.40	143.55	133.55	86.60
15	7.22	1409.90	176.05	80.75	86.30	27.38	21.30	134.30	109.55	70.24
Mean	5.42	1074.91	117.48	74.35	54.80	4.37	25.27	133.98	120.80	94.69
SD	0.12	262.55	43.09	22.95	19.26	6.40	4.46	34.96	75.73	44.87
Permissible limits	-	2000.0	300.0	100.0	-	3.0	50.0	100.0	100.0	100.0

SD: Standard deviation (statistically significant coefficients p < .05), Permissible limits according to European Union (2006)

It was noticeable that the sediments content of the El-Gharbia main drain from some heavy metals at summer more than at winter as shown in Fig. 2 for both winter and summer seasons, respectively, in order to human consumption increase of water and detergents thus increase wastewater disposal (Aonghusa and Gray, 2002).

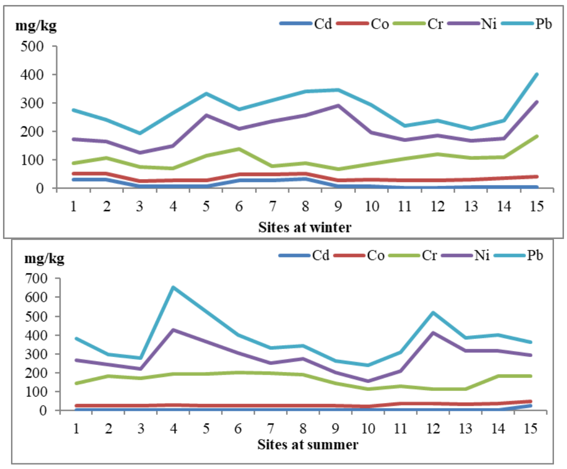

Fig. 2. Heavy metals content in sediments samples at winter and summer seasons.

3- Chemical parameters and biological pathogenic for El-Gharbia main drain water

Data in Tables 6 and 7 showed that the chemical parameters such as concentrations of dissolved oxygen (DO), chemical oxygen demand (COD) and biological oxygen demand (BOD) in winter season were varied between 0.51 (site 9) to 2.30 (site 11), 180 (site 6) to 270 (site 15) and 108 (site 6) to 175.5 (site 15) mg l^{-1}, respectively, Fig. 3 shown the chemical parameters values at winter season. While the same chemical parameters in summer season were varied between 0.20 (site 7) to 5.78 (site 1), 360 (site 11) to 450 (site 15) and 220 (site 11) to 288 (site 15) mg l^{-1}, respectively.

Fig. 3 showed that the COD and BOD values at summer season were exceeded than the permissible limits according to Alberta (2000). The chemical parameters of water samples were altered due to various charges of pollutants into the water stream (Mahmoud *et al.*, 2008). It was clear that various physicochemical parameters including EC, pH, TDS, turbidity, TSS, TS, DO, BOD, COD indicate the stream water quality (Schwarzenbach *et al.*, 2010).

Table 6. Chemical parameters and biological pathogenic for El-Gharbia main drain water at winter

Sites	(mg/l)			(CFU/100 ml)						
	DO	COD	BOD	Total coliform	Fecal Coliform	Fecal Streptococcus	Vibro Cholera	Salmonella /shigella	Pseudomonas aeroginosa	Total bacteria
1	3.17	138	230	660	350	120	8	270	360	550
2	1.17	134.20	220	910	800	500	220	330	550	460
3	0.55	136.50	210	540	550	410	144	40	680	690
4	1.77	119	190	820	660	550	92	60	600	150
5	1.50	126	200	900	710	610	216	20	720	180
6	0.65	108	180	630	790	500	40	50	910	820
7	0.85	121	190	750	860	360	16	20	950	430
8	0.90	120	200	880	800	660	120	30	970	500
9	0.51	130	200	1120	960	850	32	20	750	640
10	0.80	129	212	670	950	710	64	10	690	190
11	2.30	161	260	950	880	400	164	30	800	500
12	1.82	143	220	1060	920	480	192	<1	795	280
13	1.40	142	230	600	680	390	20	60	620	470
14	1.44	144	240	820	700	300	36	<1	500	350
15	1.40	175	270	1200	400	250	252	50	420	810
Max. value	3.17	175	270	1200	960	850	252	330	970	820
Min. value	0.51	108	180	540	350	120	8	10	360	150

DO: Dissolved oxygen, COD: Chemical oxygen demand, BOD: Biological oxygen demand

Table 7. Chemical parameters and biological pathogenic for El-Gharbia main drain water at summer

No. of Sites	(mg/l)			(CFU/100 ml)						
	DO	COD	BOD	Total coliform	Fecal Coliform	Fecal Streptococcus	Vibro Cholera	Salmonella /shigella	Pseudomonas aeroginosa	Total bacteria
1	5.78	410	246	13600	350	10100	2200	1100	5	139
2	0.99	390	234	14500	800	11600	5000	1000	4	450
3	0.53	380	228	13000	550	11200	1700	500	5	420
4	0.54	391	235	15000	660	11900	3600	1000	500	370
5	0.23	382	230	14100	710	10700	6000	1800	3	211
6	0.61	374	232	11500	790	10900	4500	600	5	195
7	0.20	375	240	15000	860	12500	5500	4500	7	220
8	0.31	370	244	11300	800	10300	5000	1500	6	311
9	2.16	375	240	10900	960	9500	6900	1500	100	350
10	1.22	363	232	13000	950	11300	5000	1100	2400	410
11	1.40	360	220	11200	880	9200	3000	1500	200	370
12	4.32	375	244	14000	920	10800	6000	1200	600	320
13	4.35	370	241	9600	680	6300	4000	600	5	345
14	4.40	388	253	9800	700	7600	5500	400	8	211
15	4.37	450	288	10600	400	8500	1000	200	10	260
Max. value	5.78	450	288	15000	960	12500	6900	4500	2400	450
Min. value	0.2	360	220	9600	350	6300	1000	200	3	139

DO: Dissolved oxygen, COD: Chemical oxygen demand, BOD: Biological oxygen demand

Furthermore, figure 3 showed that the difference in DO, COD and BOD values during the winter and summer seasons under study.

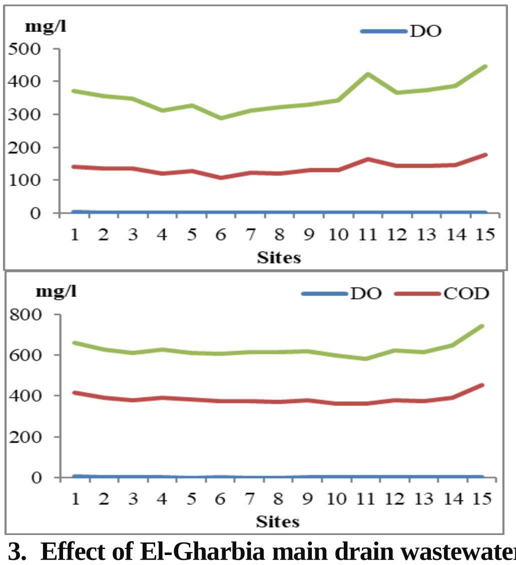

Fig. 3. Effect of El-Gharbia main drain wastewater on chemical parameters dissolved oxygen (DO), chemical oxygen demand (COD) and biological oxygen demand (BOD) at winter and summer season

High inorganic matter and nutrient waste discharges might decrease the DO concentrations because of increased microbial activity (respiration of microorganisms) (Das and Acharya, 2003). The increased values oxygen-related characteristics indicate the excessive content of the biodegradable organic matter that increases de-oxygenation of water to the level that aquatic life cannot survive (NBI, 2005). The COD is an indicator of oxidation of the organic and inorganic materials in water and sewage (El-Bourie, 2008). The biological oxygen demand (BOD) concentration in the drain meets the quality criteria for only class A crops, (FAO, 2015). Chapman, 1992 reported that clean and wastewater had BOD values of 2 and 10 mg l^{-1}, respectively.

The BOD values of Kitchener drain water exceeded the limits of the Egyptian Law (48/1982) for water stream (Chapman, 1992).

In another study, levels of BOD and COD were reported to be higher than the permissible levels at El-Gharbia, Dakahlia, and Damietta, which was an indication of pollution with non-degradable chemicals (NBI, 2005).

Also, in Tables 6 and 7 It was found that the biological pathogenic in winter season, such as the number of total coliform, fecal coliform, facel streptococcus, vibro cholera, salmonella/ shiglla, psudomonas aeroginosa and total bacterial were varied between 540 (site 3) to 1200 (site

15), 350 (site 1) to 960 (site 9), 120(site 1) to 850 (site 9), 8 (site 1) to 252 (site 15), < 1 (sites 11 and 14)to 330 (site 2), 360 (site 1) to 970(site7) and 150 (site 4) to 820 (site 6) CFU/100 ml, respectively. The effect of wastewater pollution on numbers of pathogenic at El-Gharbia main drain as shown in Fig. 4.

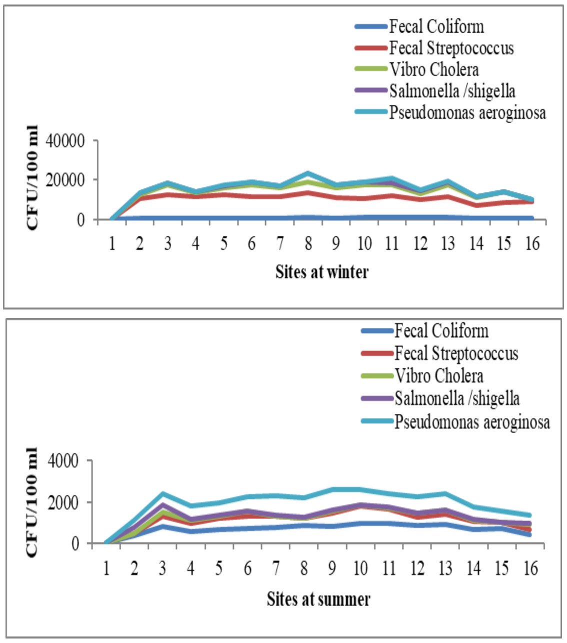

Fig. 4. Effect of deferent sources of drainage on pathogenic numbers at El-Gharbia main drain wastewater

While, in the summer season the results of the same biological pathogenicity were varied between 9600 (site 13) to 15000 (site 4), 350 (site 1) to 960 (site 9), 6300 (site 13) to 12500 (site 7), 1000 (site 15) to 6900 (site 9), 200 (site 15) to 4500 (site 7), 3 (site 5) to 2400 (site 10) and 139 (site 1) to 450 (site 2) CFU/100 ml, respectively.

From the results, it is clear that the increase in numbers of pathogenic bacteria in the summer season is higher than in the winter season, and therefore the consumed oxygen demand increases, whether chemically or biologically, as well as the dissolved oxygen decreases. This is due to human water consumption increasing due to the rise in summer temperatures, which increases wastewater discharge in addition to industrial and agricultural drainage (Chang *et al.*, 2014). Bacteriological analysis is very important. It's a clue to environmental pollution; it was found that there was an increase in the number of the studied bacteria. However, fecal coliform was reported as a major pollutant in rivers and water streams, where it originates mainly from human sources (Edberg *et al.*, 2000). These sources of contaminants, in addition to skin irritants and toxic chemicals, cause hazards to agricultural workers, farmers, their families, people living in proximity to wastewater irrigation and the consumers of wastewater-irrigated crops (Dickin *et al.*, 2016). Untreated wastewater contains different pathogenic microorganisms causing several waterborne infections and diseases like bacterial enteritis (cholera, salmonellosis, shigellosis and E. coli), viral enteritis, protozoan enteritis (cryptosporidiosis, giardiasis and diarrhea encephalitis) and fungal diseases (candidiasis, blastomycosis and cryptococcosis) (Olaolu *et al.*, 2014).

CONCLUSION

It can be inferred that the ongoing release of sewage, agricultural, and industrial wastewater into El-Gharbia Drain will result in increased levels of pollution from micronutrients, heavy metals, and pathogenic bacteria in the water. Furthermore, the sediments are likely to become a repository for hazardous pollutants.

As recommendations, it is suggested to implement regular monitoring of harmful elements and pollutants in the wastewater. To ensure safe reuse of wastewater for agricultural purposes, it is recommended to treat each drainage source separately before mixing. Lastly, adopting cost-effective wastewater treatment techniques is recommended

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دراسة نوعية وكمية لمياه مصرف الغربية الرئيسى

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الملخص

يعتبر المصرف الرئيسى بالغربية (كتشنر) من المخاطر الجسيمة التى تواجه سكان قرى محافظات الغربية الدقهلية وعدد من مراكز محافظة كفر الشيخ. حيث يتلقى ثلاثة مصادر لمياه الصرف وهي الصرف الصحي والزراعي والصناعي والتي تستخدم في الممارسات الزراعية والصيد. تهدف الدراسة الحالية إلى تقدير جودة مياه مصرف الغربية الرئيسى لإعادة استخدامها لري التربة الزراعية بأمان. تم أخذ عينات (مياه ورواسب) من خمسة عشر موقعاً بمحاذاة المصرف الرئيسي بالغربية (أكثر من ١٠٠ كم) في شتاء ٢٠٢٠ وصيف ٢٠٢١. أظهرت النتائج أن محتوى عينات التربة والنباتات من المغذيات الدقيقة (Fe, Mn, Zn, Cu and B) والمعادن الثقيلة (Cd, Cr, Co, Ni and Pb) اختلفت من موقع إلى آخر، في بعض الحالات تجاوز المتوسط العام للعناصر محل الدراسة الحد المسموح به في كلا الموسمين قيد الدراسة ولكن درجة التلوث كانت أعلى في فصل الصيف. أظهر التحليل البيولوجي للبكتيريا الممرضة قيد الدراسة أن أعداد البكتيريا الممرضة تجاوزت الحد المسموح به في كلا الموسمين قيد الدراسة، وأن أعداد البكتيريا المسببة للأمراض في فصل الصيف كانت أعلى.