Some Physicochemical Investigations on Water Resources Used in Feeding Ponds of El-Max Fish Farm, Egypt

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Abstract: El-Max fish farm is one of the most important fish farm in Alexandria. Therefore it is important to estimate the quality of its feeding water sources through evaluation of concentrations of some physicochemical parameters. El-Max fish farm is located at 15 Km west of Alexandria City. It contains 14 ponds. These ponds receive its feeding water from two main sources; brackish and saline. The source of brackish water comes from El-Umum Drain, whereas the saline water is input from three wells recently drilled inside the fish farm. The physicochemical properties for both water sources were studied during 2007. The average water salinity of two wells were 35.07 and 33.24 ‰ (saline), whereas, the third one had an average of 4.19 ‰ (brackish). In addition, the average salinity of brackish water comes from El-Umum Drain was 3.58 ‰. Dissolved Oxygen concentrations for both water sources (brackish and saline) recorded low values ($<$5 ml l^{-1}). Ammonia concentration was high for brackish feeding water comes from El-Umum Drain with an average of 104.839 μM before running into the ponds. However, its concentration was relatively low in the water of the three wells and recorded an average of 28.685 μM. In general, silicate concentrations were always very high both in brackish and saline water ($>$150 μM). The values for other nutrient salts of brackish water from El-Umum Drain ranged from 3.980 to 20.250 μM for nitrite; from 3.240 to 55.080 μM for nitrate and from 1.584 to 19.824 μM for phosphate. The well of low saline water always recorded the higher values for alkalinity, Chlorophyll-a and nutrient salts (ammonia, nitrite, phosphate and silicate) compared with the water of the other two wells. In conclusion, the characteristics of water resources were most suitable for aquaculture of Tilapia and Mugil fish.

Key words: El-Max fish farm · Feeding resources · Physicochemical parameters · El-Umum Drain · Wells

INTRODUCTION

The demand for fish as relative cheap source animal protein is necessary. El-Max fish farm is one of the most important fish farms in Alexandria, Egypt . Three wells were drilled recently inside the farm. The assessment of water quality of these wells to evaluate its suitability for using in aquaculture is an important need. Although many researchers have studied water quality of El-Max fish farm ponds in the last years, but there is a great necessity to continual studying of water resources for more development of El-Max fish farm. It consists of 14 ponds which receive the feeding water from El-Moghazy (a canal from El-Umum Drain supplies water into El-Max fish farm). The water of El-Moghazy is brackish and mixed with irrigation water, industrial effluents and other waste water discharged into El-Umum Drain. Recently, there are other water resources for feeding the ponds. These are three wells recently drilled inside the farm. (Fig. 1).

El-Max fish farm has been subjected to many research works during the last years. Tadros *et al.* [1] studied the physicochemical parameters of water for seven ponds of El-Max fish farm and its feeding source water (El-Moghazy). The study showed that concentrations of ammonia and silicate were very high ($>$100 μM) in the input source of the fish farm as well as in the selected water ponds. In addition, the study found that the other nutrient salts fluctuated depending on concentration in feeding source (El-Moghazy). The effect of physicochemical parameters of feeding sources water and their impact on phytoplankton community composition in ponds of El-Max fish farm was also studied by Zaghloul *et al.* [2]. The study concluded that El-Max fish farm ponds are a very fertile area. El Banna [3] studied

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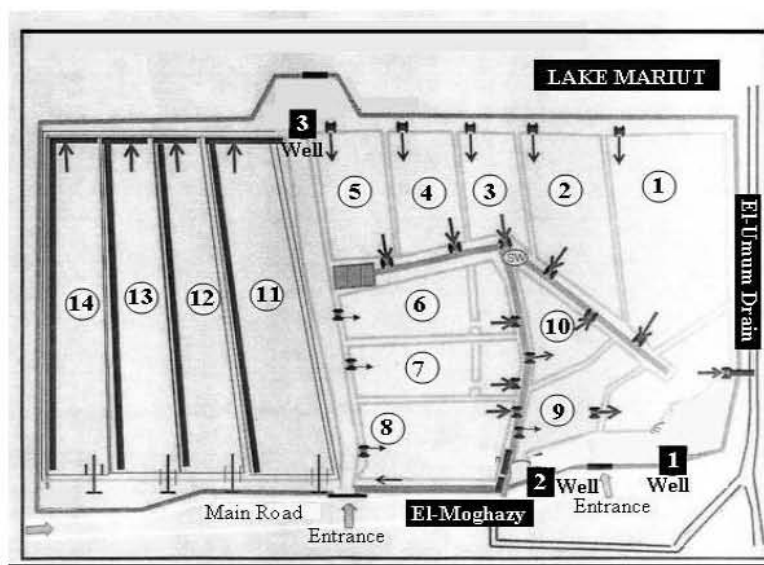Marine Chemistry Laboratory, Alexandria, Egypt

Fig. 1: Map of El-Max Fish Farm with the feeding water resources; El-Moghazy, Well 1, Well 2, and Well 3

the physicochemical characteristics and the primary production of five ponds (5, 6, 7, 9 and 14) in El-Max fish farm (Fig. 1). The results of the study revealed that the experimental ponds were suitable for fish culture and the primary productivity of ponds can be enriched through addition of inorganic fertilizers. Also, Wahby [4] concluded that the ponds fertilized with inorganic fertilizers were characterized by rapid consumption of nutrients as compared to these ponds which fertilized by organic fertilizers. Therefore the complete information about the water quality of feeding sources and assessment of physicochemical characteristic is an important demand for aquaculture inside the fish farm.

The present study was carried out to evaluate the water quality for the feeding sources of the three new drilled wells inside the farm and also to continuously assess the water quality comes from El-Umum Drain (El-Moghazy). This is to give recently clear picture about the suitability of feeding water of El-Max fish farm for aquaculture. The evaluation was via investigation of physicochemical properties temperature, pH, salinity, conductivity, total dissolved salts, chlorophyll-a, dissolved oxygen (DO), oxidizable organic matter (OOM), total alkalinity and the nutrient salts (nitrite, nitrate, ammonia, phosphate and silicate).

MATERIAL AND METHODS

The present study is a part of institutional research plan (Monitoring and Development the Environment of El-Max Fish Farm Ponds and its Feeding Water

Resources, 2007, National Institute of Oceanography and Fisheries).

Water samples from feeding water of El-Moghazy and three wells were monthly collected from April to December during 2007. Different chemical parameters were analyzed in the collected water samples. These include nutrient salts, oxidizable organic matter, dissolved oxygen and total alkalinity. Also pH, temperature and salinity were measured. In addition chlorophyll-a was also assessed.

These Parameters Were Measured Using the Following Methods/ Instrumentations:

Temperature and pH values of collected water samples were measured in-situ using graduated thermometer and portable digital pH meter (Model 201/ digital).

Water salinity was measured using Salinometer (Bekman, Model RS-10-X3).

Water conductivity was evaluated using conductivity meter (HI 9635 portable Waterproff Multi-Range conductivity/ TDS Meter).

Total alkalinity was analyzed by titration using 0.01N hydrochloric acid and methyl orange as indicator according to the method of Grasshoff [5].

Dissolved oxygen was determined using Winkler titration method of Strickland and Parsons [6].

Oxidizable organic matter was analyzed by boiling a known volume of water samples in the presence of alkaline potassium permanganate and titrating the librated iodine after adding potassium iodide against saturated sodium thiosulphate following the procedure described by Ellis [7].

Nutrient salts; nitrite, nitrate, phosphate, ammonia, and silicate were evaluated according to the methods of Grasshoff [5], Koroleff [8] and Strickland and Parsons [6] by using spectrophotometer (Shimadzu Double-Beam Spectrophotometer UV-150-02).

Chlorophyll-a was determined using the method of Strickland and Parsons [9] by spectrophotometer (Shimadzu Double-Beam Spectrophotometer UV-150-02).

Statistical Analysis: Correlation matrix (at p = 0.05) was estimated (using Microsoft Excel 2003) to reveal the relationship between the physicochemical parameters.

RESULTS

Physicochemical Characteristics for Water of El-moghazy: Table 1 lists monthly variations of physicochemical parameters of water for El-Moghazy from April to December during 2007.

The results revealed that both alkalinity and chlorophyll-a reached their minimum values in August (Fig. 2).

Concentration of nitrite and nitrate of El-Moghazy water are shown in Fig. 3 that illustrated the lower concentration for both of them from April to August comparing with their concentration from September to December.

Concentrations of DO and OOM of El-Moghazy water are shown in Fig. 4. Both OOM and DO behaved the same as they increased and decreased together during the period of study except in April and July.
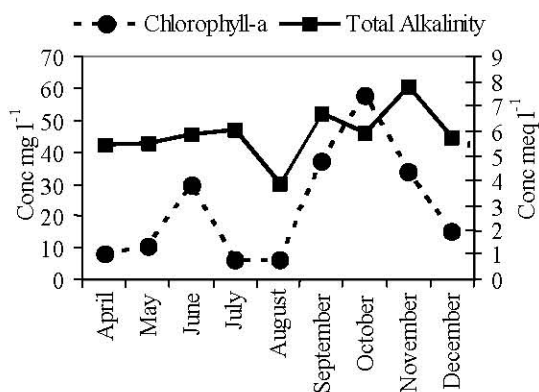

Fig. 2: Concentration of total alkalinity (meq l^{-1}) and chlorophyll-a (mg l^{-1}) of El-Moghazy water during 2007
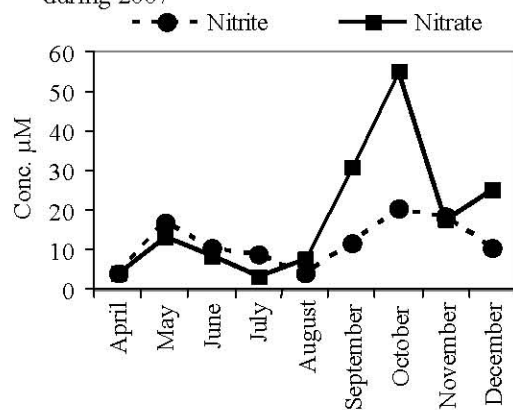

Fig. 3: Concentration of nitrite and nitrate of El-Moghazy water during 2007

Table 1: Some physicochemical parameters of El-Moghazy Water, 2007

Parameter	El-Moghazy									
	April	May	June	July	August	September	October	November	December	Average
pH	-	7.43	7.47	7.15	8.85	7.84	7.68	7.76	7.77	
Temperature, °C	-	27.80	29.10	29.60	29.00	26.90	26.40	19.30	17.50	25.70
S ‰	3.400	3.200	3.700	-	-	3.200	4.200	3.650	3.700	3.579
Conductivity, mhos	-	10.920	12.600	8.260	21.400	6.000	7.550	6.167	6.880	9.972
Chlorophyll-a, mg l^{-1}	7.800	10.440	29.800	6.250	6.115	37.530	57.720	34.160	14.860	22.742
Total alkalinity meq l^{-1}	5.445	5.500	5.890	6.050	3.905	6.710	5.940	7.800	5.748	5.888
DO ml l^{-1}	1.370	1.250	1.480	0.620	7.440	1.240	2.270	4.040	2.953	2.518
OOM mgO_2 l^{-1}	2.320	0.350	0.880	2.240	1.200	0.080	0.320	2.760	1.493	1.294
Ammonia, µM	73.700	42.350	176.700	92.050	6.950	85.300	126.900	178.000	161.600	104.839
Nitrite, µM	3.980	16.750	10.400	8.725	4.000	11.675	20.250	18.250	10.450	11.609
Nitrate, µM	4.070	13.070	8.410	3.240	7.670	30.715	55.080	17.510	25.040	18.312
Phosphate, µM	16.560	19.440	13.008	6.864	1.584	4.848	7.584	18.576	19.824	12.032
Silicate, µM	83.220	84.960	89.739	321.196	87.114	82.260	348.290	321.480	305.330	191.510

Table 2: Some physicochemical parameters of the three wells water, 2007

Input Sources	pH									
	April	May	June	July	August	September	October	November	December	Average
Well 1	7.80	8.00	7.79	7.65	7.05	7.73	7.01	7.30	7.34	
Well 2	-	-	-	-	8.15	8.22	7.98	8.43	8.08	
Well 3	7.00	7.51	7.24	7.35	7.65	7.65	7.75	7.43	7.39	

Table 2: Continued

| Temperature, °C									
Well 1	22.60	28.40	24.50	26.10	25.00	19.50	23.20	22.80	21.50	23.73
Well 2	-	-	-	-	29.00	29.00	26.20	21.50	19.50	25.04
Well 3	22.70	26.80	23.40	27.80	27.00	27.30	26.20	23.00	23.00	25.24
S ‰									
Well 1	28.000	32.300	-	-	-	38.500	35.400	40.020	36.200	35.070
Well 2	-	-	-	-	-	3.800	3.800	4.560	4.600	4.190
Well 3	29.400	30.200	30.800	-	-	35.600	31.900	37.570	37.200	33.240
Conductivity, mhos									
Well 1	80.000	72.800	16.900	50.200	76.200	58.400	23.600	56.180	55.600	54.431
Well 2	-	-	-	-	0.104	7.070	6.990	7.600	8.380	6.029
Well 3	87.100	75.100	76.100	48.100	85.100	53.900	48.800	52.940	57.100	64.916
Chlorophyll-a, mg l^{-1}									
Well 1	2.056	-	-	-	-	9.840	3.780	1.600	5.970	4.649
Well 2	-	-	-	-	5.419	1.367	35.580	5.210	18.130	13.141
Well 3	0.176	-	-	-	0.933	0.460	3.820	22.570	9.570	6.255
Total Alkalinity, meq l^{-1}									
Well 1	3.410	3.520	3.250	3.190	3.245	3.960	3.360	4.800	3.410	3.572
Well 2	-	-	-	-	4.235	4.455	4.680	3.550	5.178	4.420
Well 3	3.135	3.190	3.135	3.080	3.245	3.795	3.580	4.850	3.135	3.461
DO, ml l^{-1}									
Well 1	5.200	5.000	5.230	2.270	1.330	2.690	2.270	3.260	1.817	3.230
Well 2	-	-	-	-	3.620	1.760	1.660	5.460	4.659	3.432
Well 3	5.400	2.040	0.910	0.830	1.850	2.690	3.830	4.040	2.275	2.652
OOM, mgO$_2$ l^{-1}									
Well 1	0.960	-	1.040	1.040	2.320	1.040	-	2.950	1.173	1.503
Well 2	-	-	-	-	0.360	1.040	0.320	4.320	2.027	1.613
Well 3	1.440	1.150	1.360	-	-	-	-	3.440	2.057	1.889
Ammonia, µM									
Well 1	0.550	0.950	0.400	18.550	24.500	2.800	37.950	38.650	8.600	14.772
Well 2	-	-	-	-	98.700	12.500	31.250	6.900	71.800	44.230
Well 3	14.600	33.050	34.600	19.450	31.900	25.950	75.950	37.050	33.100	33.961
Nitrite, µM									
Well 1	0.150	0.500	0.325	2.125	0.975	0.225	0.224	0.200	4.075	0.978
Well 2	-	-	-	-	5.350	15.325	4.175	0.000	6.200	6.210
Well 3	0.000	0.275	0.125	1.900	0.375	0.050	0.300	0.175	0.125	0.369
Nitrate, µM									
Well 1	14.010	1.330	37.865	26.190	0.825	22.550	2.010	0.340	5.680	12.311
Well 2	-	-	-	-	1.190	23.375	18.090	5.700	4.000	10.471
Well 3	0.870	2.935	13.165	2.106	0.375	1.900	1.680	1.235	1.440	2.856
Phosphate, µM									
Well 1	0.432	1.582	0.912	3.312	0.672	0.384	0.288	0.768	1.632	1.109
Well 2	-	-	-	-	2.496	0.528	1.008	0.336	3.744	1.622
Well 3	1.920	1.056	0.432	3.504	1.584	0.192	0.144	0.624	1.104	1.173
Silicate, µM									
Well 1	89.760	87.084	38.940	202.724	180.865	79.080	368.590	313.080	258.770	179.877
Well 2	-	-	-	-	303.939	72.360	410.002	181.620	255.590	244.702
Well 3	113.100	81.420	90.034	92.630	154.639	68.820	299.570	325.680	226.560	161.384
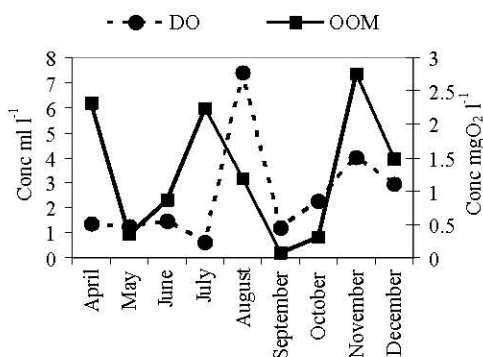
Fig. 4: Concentration of DO $(ml\,l^{-1})$ and OOM $(mgO_2\,l^{-1})$ of El-Moghazy water during 2007
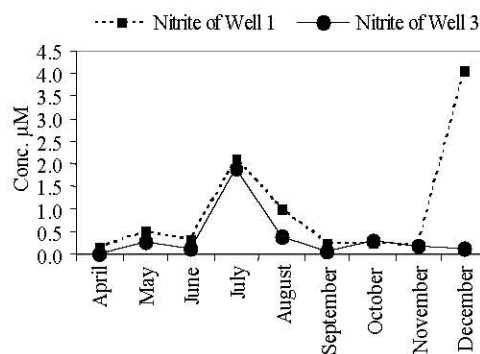
Fig. 7: Concentration of Nitrite in water of Well 1 and Well 3 during 2007
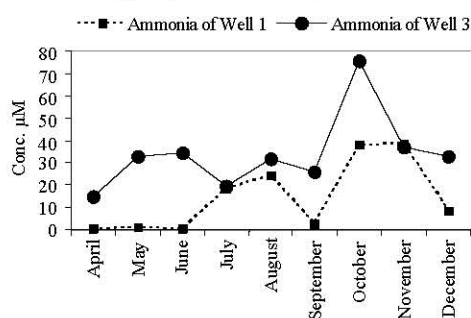
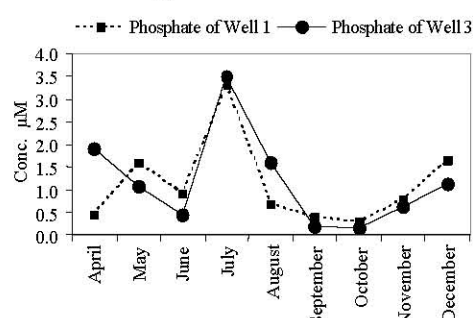Fig. 5: Concentration of Ammonia in water of Well 1 and Well 3 during 2007.

Fig. 8: Concentration of dissolved inorganic phosphate in water of Well 1 and Well 3 during 2007
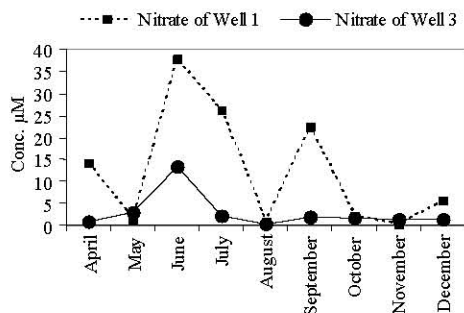
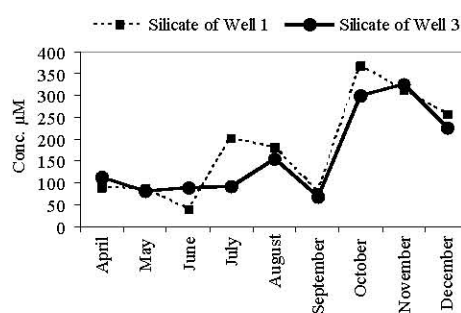Fig. 6: Concentration of nitrate in water of Well 1 and Well 3 during 2007.

Fig. 9: Concentration of silicate in water of Well 1 and Well 3 during 2007

Table 3: Correlation matrix between some physicochemical parameters of El-Moghazy and the three wells water, 2007

El-Moghazy	pH	Temp.	S‰	Cond.	Chl.-a	Total alkalinity	DO	OOM	Ammonia	Nitrite	Nitrate	Phosphate	Silicate
pH	1.000												
Temperature	-0.031	1.000											
S‰	0.092	-0.181	1.000										
Conductivity	0.676	0.505	-0.078	1.000									
Chlorophyll-a	-0.116	-0.146	0.645	-0.478	1.000								
Total alkalinity	-0.535	-0.468	0.038	-0.844	0.523	1.000							
DO	0.920*	-0.171	0.465	0.673	-0.126	-0.412	1.000						
OOM	-0.084	-0.420	0.048	-0.106	-0.408	0.243	0.139	1.000					
Ammonia	-0.455	-0.581	0.622	-0.609	0.510	0.690	-0.255	0.244	1.00				
Nitrite	-0.442	-0.319	0.417	-0.626	0.717	0.605	-0.213	-0.289	0.433	1.000			
Nitrate	0.009	-0.269	0.612	-0.463	0.848	0.264	-0.049	-0.534	0.271	0.673	1.000		
Phosphate	-0.441	-0.651	-0.168	-0.424	-0.141	0.350	-0.284	0.323	0.451	0.284	-0.140	1.000	
Silicate	-0.326	-0.526	0.771	-0.557	0.343	0.445	-0.022	0.362	0.538	0.492	0.436	0.123	1.000

Table 3: Continued

Well 1	pH	Temperature	S‰	Conductivity	Chlorophyll-a	Total alkalinity	DO	OOM	Ammonia	Nitrite	Nitrate	Phosphate	Silicate
pH	1.000												
Temperature	0.247	1.000											
S‰	-0.498	-0.414	1.000										
Conductivity	0.177	0.089	-0.513	1.000									
Chlorophyll-a	0.281	-0.928*	0.356	-0.084	1.000								
Total alkalinity	-0.072	-0.365	0.688	0.127	-0.161	1.000							
DO	0.768	0.274	-0.723	-0.013	-0.509	0.031	1.000						
OOM	-0.770	0.144	0.588	0.239	-0.534	0.642	-0.314	1.000					
Ammonia	-0.827	-0.025	0.541	-0.220	-0.493	0.366	-0.567	0.906*	1.000				
Nitrite	-0.173	-0.061	0.117	0.052	0.229	-0.305	-0.503	-0.225	-0.084	1.000			
Nitrate	0.529	-0.095	-0.086	-0.456	0.684	-0.301	0.339	-0.714	-0.523	-0.056	1.000		
Phosphate	0.266	0.505	-0.028	0.014	0.059	-0.294	-0.149	-0.252	-0.097	0.596	0.246	1.000	
Silicate	-0.813	-0.148	0.480	-0.231	-0.426	0.268	-0.623	0.658	0.887*	0.255	-0.594	0.010	1.000
Well 2													
pH	1.000												
Temperature	-0.177	1.000											
S‰	0.432	-0.952*	1.000										
Conductivity	0.081	-0.629	0.883	1.000									
Chlorophyll-a	-0.758	-0.207	-0.242	0.288	1.000								
Total alkalinity	-0.834	-0.135	-0.137	0.223	0.521	1.000							
DO	0.578	-0.739	0.979*	0.066	-0.329	-0.340	1.000						
OOM	0.806	-0.711	0.806	0.484	-0.342	-0.543	0.796	1.000					
Ammonia	-0.461	0.079	0.376	-0.679	0.043	0.408	0.164	-0.466	1.000				
Nitrite	-0.198	0.534	-0.579	0.038	-0.307	0.397	-0.637	-0.490	-0.088	1.000			
Nitrate	-0.194	0.450	-0.973*	0.408	0.177	0.146	-0.825	-0.329	-0.660	0.641	1.000		
Phosphate	-0.487	-0.346	0.495	-0.201	0.160	0.678	0.310	-0.235	0.851	-0.046	-0.611	1.000	
Silicate	-0.681	-0.042	-0.084	-0.261	0.817	0.293	-0.125	-0.420	0.456	-0.548	-0.261	0.328	1.000
Well 3													
pH	1.000												
Temperature	0.648	1.000											
S‰	0.346	-0.130	1.000										
Conductivity	-0.419	-0.229	-0.754	1.000									
Chlorophyll-a	-0.062	-0.546	0.685	-0.479	1.000								
Total alkalinity	0.269	-0.195	0.627	-0.431	0.784	1.000							
DO	-0.188	-0.454	-0.045	0.087	0.102	0.418	1.000						
OOM	0.305	-0.455	0.848	-0.816	0.992*	0.925*	0.337	1.000					
Ammonia	0.633	0.082	0.026	-0.385	0.132	0.240	0.133	0.407	1.000				
Nitrite	-0.006	0.537	-0.075	-0.386	0.040	-0.246	-0.506	0.062	-0.194	1.000			
Nitrate	-0.289	-0.242	-0.341	0.190	0.104	-0.230	-0.487	-0.379	0.028	-0.103	1.000		
Phosphate	-0.418	0.237	-0.329	0.080	-0.241	-0.437	-0.244	-0.337	-0.583	0.800	-0.262	1.000	
Silicate	0.290	-0.372	0.515	-0.430	0.760	0.621	0.447	0.975*	0.654	-0.196	-0.326	-0.338	1.000

* $p < 0.05$

Physicochemical Characteristics for Water of the Three Wells: Table 2 lists monthly physicochemical parameters of water for the three wells (1, 2 and 3) from April to December during 2007.

Concentration of ammonia, nitrate and nitrite in water of Well 1 and Well 3 are shown in Fig 5, 6 and 7, respectively.

Well 1 and well 3 showed a slight difference between of them for both the dissolved inorganic phosphate concentrations and Silicate concentrations as shown in Fig. 8 and 9, respectively.

Correlation matrix between physicochemical parameters for El-Moghazy and the three wells water are shown in Table 3.

DISCUSSION

Regarding the physicochemical characteristics for Water of El-Moghazy, the results revealed that the water of El-Moghazy is brackish. Also the results showed that the highest values for pH, DO and conductivity were noticed in August. On the other hand, both alkalinity and chlorophyll-a recorded their minimum values in the same month which expressed the lowest productivity of all studied months. However, in July both pH and DO reached their minimum values. The change in pH can be attributed to photosynthesis activities of phytoplankton, aquatic plants, respiration and variation in temperature as reported previously by Samaan [10].

The distribution of nutrient concentrations for El Moghazy revealed that the minimum concentration of dissolved inorganic phosphate was noticed in August. However, the maximum values were in November and December. These values agreed with the values of alkalinity that recorded a minimum value in August and a maximum value in November. According to Faust and Aly [11], it is difficult to establish a range of concentrations for phosphate in natural waters because the inputs from many sources are quite variable. Therefore the high level of phosphate may be attributed to the waste water discharged from El-Umum Drain.

In this study high level of ammonia was recorded during all sampled months except in August. The high level of ammonia can be attributed to the fact that ammonia is the nitrogeneous end product of the bacterial decomposition of natural organic matter containing N. It can also be attributed to discharge of ammonia into water bodies by industrial processes, community wastes and the use of ammonia containing fertilizers [12]. The maximum value of ammonia was during November and this may be attributed to the consumption of oxygen in oxidation of organic matter that recorded a maximum value in this month and consequently lead to a reduced form of nitrogen. However, the minimum value of ammonia was recorded in August may be due to the nitrification process (eq.1) took place easier in this month as a result of the highest values of dissolved oxygen and pH recorded in August. As reported by Vanloon and Duffy [13], optimum environmental pH for nitrification process should be between 6.5 and 8, where the reaction rate begins to decrease significantly when pH fall below 6.

$$NH_3 / NH_4 \text{ (Ammonia)} \rightarrow NO_2 \text{ (Nitrite)} \rightarrow NO_3 \text{ (Nitrate) (eq. 1)}.$$
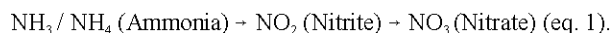
Nitrite appears in water results mainly from biochemical oxidation of ammonia (nitrification) or reduction of nitrate (denitrification). However, nitrate is the most stable form of inorganic nitrogen in oxygenated water as it is the end product of nitrification process. In this study, nitrite and nitrate attained lower concentrations from April to August. Their concentration values were close to each other with slight decrease of nitrate than nitrite except in April and August. This may be due to the lower concentration of oxygen during these months. However, from September to December both concentration of nitrite and nitrate increased with substantial increase of nitrate than nitrite except in

November as their concentrations were the same. The maximum values of nitrite and nitrate were recorded in October with correspondence increase of chlorophyll-a which recorded its maximum concentration in October. According to Cloern [14], the high nutrients concentration contributes to high chlorophyll and productivity.

According to Fahmy [15], silicate plays an important role in biological process and for diatoms. In El-Moghazy, the high values of silicate concentration were observed during all sampling months and varied from a minimum during September to a maximum during October. These values agreed with the values of nitrite, nitrate and chlorophyll-a as all of them recorded their maximum value in October.

With respect to the OOM, the minimum value was recorded in September which corresponds also with minimum value of silicate concentration. However the maximum value was detected in November. The variation in organic matter content can be referred to the quality and quantity of input source of El-Umum Drain loaded with organic and inorganic pollutants.

Comparison results of this study with those of Tadros *et al.* [1] shows that there are very slight changes in the average values of physicochemical parameters of El-Moghazy except for nitrate, phosphate, silicate, and DO. The average values of physicochemical parameters that recorded previously by Tadros *et al.* [1] and present study were 24.23, 25.70°C for temperature, 5.26, 5.888 meq l^{-1} for total alkalinity, 1.27, 1.294 mgO$_2$ l^{-1} for OOM, 3.60, 3.579 ‰ for salinity, 106.11, 104.839 µM for Ammonia, 10.54, 11.609 µM for nitrite, , 6.79, 18.312 µM for nitrate, 19.54, 12.032 µM for phosphate, 178.13, 191.510 µM for silicate and 4.20, 2.518 ml l^{-1} for DO respectively.

With respect to physicochemical characteristics for water of the three wells, wells number 1 and 3 were saline, because of the ground water coming from the sea. Water of well 2 was characterized by low salinity (brackish). The average temperature values of the three wells (1, 2 and 3) were near to each other. The pH values for water of well 2 was in alkaline side (>8). On the other hand, the pH values were less than 8 for water of both well 1 and 3 in all water samples during 2007.

The monthly variations in water alkalinity of the wells showed that the highest value was in December for well 2 (low saline water). The lowest total alkalinity value was recorded in July for well 3. Well 2 always recorded higher values of chlorophyll-a and reached its maximum value in October.

Results of analysis showed also that the maximum DO value was measured in water of well 2 in November that recorded the highest pH value in the same month. This may be due to the photosynthesis activities which is a contributing factor to higher content of DO and pH as reported previously by Samaan [10]. The values of DO higher than 5 ml l^{-1} were recorded for water of well 3 in April and for well 1 in April and June. As for well 2 this value (higher than 5 ml l^{-1}) was recorded in November. The rest values of DO concentrations during the period of study recorded values less than 5 ml l^{-1}.

OOM of well 2 recorded its minimum and maximum values during October and November, which may be due to the leakage and excess of oxygen in these two months, respectively. This was supported by the minimum and the maximum values of DO that were recorded in October and November, respectively. According to Wahby *et al.* [4], the value of DO in natural water is generally changeable and its concentration at any time represents a momentum balance between the rate of supply and consumption. Both well 1 and well 3 recorded their maximum values of OOM also during November.

Well 2 (brackish water) was characterized with higher average ammonia value compared with average value of well 1. This was followed by the higher average value of OOM of well 2 than well 1. Vanloon and Duffy [13] pointed out that most of organic matter contains nitrogen in different amount. When organic matter decomposes in water and soil, the nitrogen is first released in a reduced form as ammonium ions or ammonia depending on the ambient pH.

Well 1 was characterized with lower values of ammonia and higher values of nitrate than well 3 during all the period of study. However, for nitrite concentration of well 1 and well 3 there was a very slight difference between them during the period of study except in December. In addition, the concentrations of nitrite were low in general and very low than the concentrations of nitrate for both well 1 and well 3. In general, well 2 always recorded the highest values for both nitrite and nitrate compared with well 1 and well 3.

The dissolved inorganic phosphate concentration of well 1 and well 3 showed a very slight difference between them. However, phosphate values for well 2 were always slightly higher than well 1 and well 3.

Silicate concentration of well 1 and well 3 showed a slight difference between them. In addition, the silicate concentrations were high for the three wells.

In general, according to the average values well 2 was always characterized with relative higher nutrient salts (ammonia, nitrite, phosphate, silicate), DO, total alkalinity and chlorophyll-a compared with well 1 and well 3. However, both salinity and conductivity of well 2 were lower than well 1 and well 3. The water characteristic of well 1 and well 3 are slightly different.

In El-Moghazy there was a significant correlation between the DO and pH (r = 0.920, n = 8). However, the results showed that there were significant correlations in well 1 between chlorophyll-a and temperature (r = -0.928, n = 5), ammonia with OOM and silicate (r = 0.906, n = 7 and r = 0.887, n = 9 respectively). Respect to well 3 OOM had significant correlations with chlorophyll-a, total alkalinity and silicate (r = 0.992, n = 5; r = 0.925, n = 5 and r = 0.975, n = 5 respectively). However, for well 2 the salinity possessed a significant correlation with temperature, DO and Nitrate (r = -0.952, n = 4; r = 0.979, n = 4 and r = -0.973, n = 4 respectively).

In conclusion, the investigation for water characteristic of three new drilled wells inside El- Max fish farm showed that two of them are saline and the third one is brackish. Water of El-Moghazy is brackish. The water quality of El-Moghazy are steady and showed slight changes comparing with previous studies. The presence of two brackish and saline feeding water resources makes the fish farm ponds suitable for different fish aquaculture especially Tilapia and Mugil fish.

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