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CHEMICAL CHARACTERISTICS OF EL MAX FISH FARM PONDS

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ABSTRACT

El Max fish farm is located at 15 km westward of Alexandria city. It contains 14 basins, seven basins has been selected for physicochemical studies of their waters beside three input sources of the fish farm; El Moghazy, El Khandek and El Beer. Most of the water farm basins are of alkaline behaviour and highly oxygenated. Ammonia and silicate concentrations are very high in the input sources of the fish farm as well as in the selected water basins (> 100 µmole/l). The other nutrient salts are fluctuated depending on the concentrations in El Moghazy and El Khandek areas. Both areas are characterized by high oxidizable organic matter, low oxygen content and pH values lower than 8. Total hexachlorocyclohexanes (HCHs) of concentrations 11.28-44.48 ng/l, present no risk to marine organisms. On the other hand ,the total DDTs exceed the limited acceptable levels markedly in El Moghazy basin. The total PCBs concentrations were ranged from 4.65-313.09 ng/l with an average of 82.28 ng/l, and higher at basins 6, 8 and 11.

INTRODUCTION

El Max fish farm is located to the west southern part of Lake Mariout and at about one kilometer south of the Mediterranean Sea Coast. It is adjacent to El Max pumping station. The total area of the farm is 37 acres and consists of 14 basins. These aquatic fish farm basins receives the feeding waters from El Nobaria fresh water mixed with the water Drained through different waste production such as the irrigation water, industrial products and others which discharged into El umum Drain. The physicochemical characteristics of eight basins of El Max Fish Farm was assessed during 2003, as well as the feeding sources (El Khandek, El Moghazy and El Max pumping stations), Tadros et al., (unpublished data). They showed great variations among the hydrographical parameter of the feeding source of El Max Fish farm and the corresponding parameters in water of the analyzed basins during the same month and their impact on phytoplankton community composition was studied by Zaghloul et al. (2005).

The biological character of El Max farm was studied by Bishara (1967), on the growth and feeding of two species of *Mugil*. El Zarka and Fahmy (1968) conducted fertilization experiment to study the effect of organic and organic fertilizers on water quality and biological characteristics of the pond water. Wahby (1974) studied the effect of inorganic and organic fertilizers on the water quality of the fish farm. Bishara (1978& 1979) reported the effect of different fertilizers and supplemental feeds on growth rate of *Mugil cephalus* on seven ponds of the fish farm and the possibility of increasing growth rate of the same specie. El Banna (1993) studied the physicochemical characteristics and the primary production of five basins: 5, 6, 7, 9 and 10 in El Max farm.

Nutrient inputs are indispensable for the functioning of aquatic systems. OSPAR

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(1999) defines eutrophication as the enrichment of water by nutrients causing an accelerated growth or algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned, and therefore refers to the undesirable effects resulting from anthropogenic enrichment by nutrients. This definition, therefore, not only gives the cause but also describe the symptoms of effect. Occurrence of eutrophication effects indicate when the system cannot cope with the available internal and external nutrient inputs (Orive et al., 2002).

On the same context, chlorinated pesticides derived from human activities on land, are very persistent in the aquatic environment (Janiot et al., 1994; Berg et al., 1997; Villeneuve et al., 1999). Synthetic lipophilic organochlorines have been considered a serious threat to the long-term health of the environment for many years (Goldberg, 1976). The main reasons are their accumulation in the lipid tissues of biota as well as their high toxicity to marine organisms and their slow degradation. Much effort has been spent in studies on the distribution of these compounds on a worldwide scale, especially in biota (Walker and Livingstone, 1992). The interest in this class of chemicals has been steadily growing in recent years, because methods have become available for the accurate determination of individual compounds in various environmental compartments. Persistent organochlorines such as polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT) and its metabolites (DDE and DDD), hexachlorocyclohexane (HCHs), heptachloroepoxide, aldrin and dieldrin can accumulate in fish.

The present study aimed to investigate the economic value of El Max Fish Farm regarding fish production. Continuous monitoring of water quality of the farm basins as well as the feeding sources (El Khandek, El Moghazy and El Beer areas) was carried out through studying the physicochemical parameters; temperature, pH, salinity, dissolved oxygen, oxidizable organic matter and the total alkalinity also the nutrient salts; nitrite, nitrate, ammonia, dissolved inorganic phosphate and reactive silicate in the input sources and in water basins of El max Fish Farm were assessed. The effects of brackish water received in huge amount to El Max fish Farm through El Khandek and El Moghazy on the water quality of the farm basins planned to be investigated. In addition, statistical correlations according to Steel and Torrie (1960) are considered between the values of different measured parameters obtained from the aquatic basins and also the water feeding sources of the fish farm. Also the effect of saline water enters the farm through El Beer area on the water quality of the adjacent basin 11 is discussed (Fig 1). On the other hand, the present status of contamination by selected chlorinated pesticides (HCHs, DDTs, heptachlor, aldrin, dieldrin, heptachloroepoxide and PCBs) in water collected from El Max fish farm are studied in details using GC/ECD technique.

MATERIAL AND METHODS

El Max farm consists from 14 brackish water fish basins, water supply to the basins are from El Umum Drain. The water depth in the basins ranged from (1.4-1.8m). In this work seven basins; 11, 10, 9, 8, 7, 6 and 5 were chosen during 2004, in addition to their input sources; El Kandek, El Moghazy, and El Beer areas. Six research field trips have been done to El Max Fish Farm for sampling of water of the seven basins and eight field trips for water sampling of the input sources. The water samples have been analyzed for different chemicals parameters; nutrient salts, oxidizable organic matter, dissolved oxygen, total alkalinity, also, pH, temperature, and salinity.

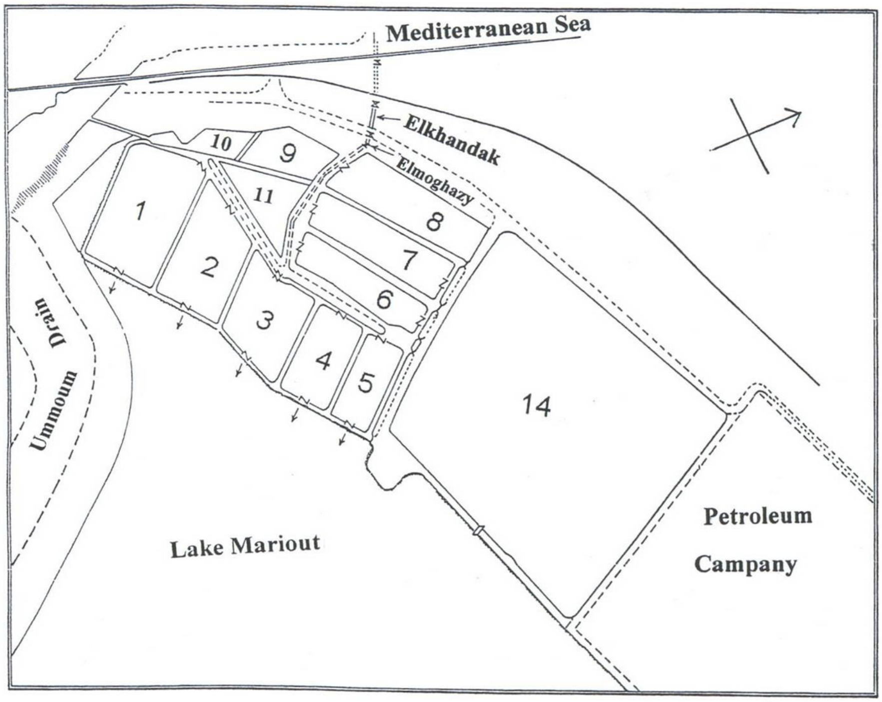

Figure (1): El-Max Fish Farm.

Physico-chemical analysis

1- Temperature and pH values of the water samples were measured in the field (El Max Fish Farm), directly after sampling using portable pH meter (Orion pH meter).

2-Total alkalinity, the total alkalinity was determined by titration using hydrochloric acid using methyl orange as indicator (Grasshoff, 1976).

3- Dissolved oxygen, was evaluated according to the Winkler titration method (Strickland and Parsons, 1968).

4- Oxidizable organic matter was estimated by boiling a known volume of the water samples in presence of alkaline potassium permanganate and titrating the librated iodine after adding potassium iodide against standard sodium thiosulphate (Ellis, 1946).

5- Nutrient salts; nitrite, nitrate, phosphate, ammonia, and silicate were determined spectrophotometrically according to the methods given by Grasshoff (1976); Strickland and Parsons (1968) and Koroleff (1969).

Organic analysis: chlorinated pesticides

The sampling locations were distributed along El Max fish farm. Water samples were collected at five basins in addition to two sources of enrichment (El Moghazy and El Beer) during May-October, 2004. At each site, a surface water samples (2–4 cm) were collected, stored and frozen at -4 °C until analyzed. Organochlorine pesticides and polychlorinated biphenyls were determined according to UNEP/IOC/IAEA, (1989, 1991); IOC (1993) and Khaled et al. (2004). Hewlett Packard 5980 series II high-resolution gas chromatograph (Hewlett Packard, USA) equipped with a 63Ni electron capture detector was used for the analysis.

Concentrations of individually resolved peaks were summed to obtain the total PCB concentration. An equivalent mixture provided by Dr. Ehrenstorfer Laboratories (Augsburg, Germany) with known PCB composition and content was used as the standard. Organochlorine pesticides were quantified from individually resolved peak areas with the corresponding peak areas of the external standards (POC mixture provided by IAEA).

RESULTS AND DISCUSSION

El Max fish farm is affected by El Umum Drain which supplies it with rich nutrient salts and organic matter. Eight water basins of the fish farm were studied chemically and biologically during 2003, starts from the second half of 2003 more water from El Moghazy area discharged into the farm and intern changed the water characteristics of its water basins. During 2003, the water of basins; 1,2,3, 7,9,10, 11 beside El Khandek El Moghazy and El Max pumping stations were sampled over ten months and analyzed for hydrographic parameters and nutrient salts, also, temperature and salinity were measured (Anon, 2004).

This work discussed the distributional feature of the physicochemical parameters of the farm basins and the input source as well as the relationship between each other and investigated the status of contamination by Organochlorine pesticides and PCBs in El Max fish farm.

Continuous monitoring of the physicochemical parameters of the water basins surrounded the input source of the fish farm (El Moghazy) was carried out (basins 11, 10, 9, 8, 7, 6, 5) for 6 months ,Tables (2-4), and the feeding sources were studied for8 months (Table 1).

Physicochemical characteristics of the water basins and the input sources of the fish farm

Temperature

The basins of the fish farm are shallow and their temperatures are affected by air temperature (El Banna, 1993). The temperature of the input source was varied from a minimum of 16.5 ^{o}C in January to 31.8 ^{o}C in July in El Moghazy water (Table 1) and its average in the water basins changed from 14.88-31.55 ^{o}C during the same months (Table 2B).The average temperature of the water basins showed no significant differences, it varied between 23.08 -24.08 ^{o}C over the studied months (Fig. 2). Similar results were obtained with some fish farm basins (7, 9, 10 and 11), (Tadros et al., Unpublished data).

Hydrogen ion concentration

The pH value of El Moghazy water during January-July, showed a narrow variations except in march, El Khandek area water is slightly neutral (pH 7.15) affected by that of El Khandek water which recorded during March of low value; 6.8 (Table 2 A). Respect to El Beer water, the pH values are in the alkaline side (>8) during the summer months and <8 during winter months. The change in the pH value is indirect relation with the change in temperature (r = 0.16) for the water basins (Table 5). The pH values of the studied basins were higher than their corresponding values in the input sources of El Max farm (Table 2A) following the increasing of temperature in the water basins than the temperature of the feeding sources. The pH of basin 9 (lies to the right of El Moghazy) is always higher than its value in El Moghazy water, due to high dissolved oxygen (average 11.75 m O_2/L; Table 3B). The changes in pH are mainly due to photosynthesis activities of phytoplankton, aquatic plants, respiration and variations in temperature Samaan (1974).

Total alkalinity

It was measured in the water of the seven selected basins and in the input sources of El Max fish farm. The data expressed in ml eq./L are given in Tables (1 and 2 C) and Fig. (2). The monthly variations in water alkalinity of the input source showed that the high values were recorded in summer months (June and July) and winter months (January and March) in both of El Moghazy and El Khandek. The lower total alkalinity values (3.3-3.9mleq./l) were measured in both areas during April and May. The change in the concentration of the total alkalinity in El Beer area (saline water) followed the same change in the different months similar to El Moghazy and El Khandek (brackish waters) and the lowest alkalinity was recorded in April (2.4mleq./l). Similar change was recorded during the monthly record of the total alkalinity of the water basins during 2003, and the minimum concentration was detected in April for both of El Moghazy and El Khandek waters (2.38 and 2.21 ml eq./l), respectively (Tadros et al., unpublished results). It is clear that the concentration of the total alkalinity did not show a pronounced change over the two years (2003, 2004), and recorded averages of 5.53 and 5.26 ml eq./l in El Moghazy area, respectively. The average in the total alkalinity in the water basins varies in the range (3.88-5.19 ml eq./l); (Table 2C). The high alkalinity values are detected in January and March with an average (6.61 and 5.95 ml eq./l), respectively and the low ones are given in spring months and early summer (May), then the concentration of the total alkalinity was gradually increased from June (av. 4.9mleq./l) to July (av. 5.37mleq./l) following the change in salinity and temperature. During the period of this study, alkalinity was correlated with salinity in the water basins and El Moghazy ($r = 0.45$) and inversely correlated with temperature in the water basins ($r = -0.58$), (Table 5). Also, a positive correlation was found between the carbonate levels with salinity ($r = 0.42$) for the samples of seawater mixing between El Umum Drain and El Noubaria canal and seawater (Youssef, 2001).

Salinity

The brackish water of the basins are affected by the salinity of the water of the feeding source which is ranged from 3.1‰ in January to 4.4‰ in March in El Moghazy water (Table 1). The second input source of El Max farm is El Beer area, its water is characterized by high salinity because of the ground water coming from the sea (Fig. 1). Its salinity is ranged from 33.6-34.9‰ during the months; January, March and April and decreases to 26.3‰ in May after suction its water by electric pump for half an hour. The salinity of basin 11 is highly affected by the saline water of El Beer and recorded the highest salinity respect to the other water basins salinity during January, May and June (Table 2D). In January, the basins are nearly dry and so their water recorded high salinity (Table 1D). The previous record was given for high salinity of basin 11 (6.4-8.0‰) over the period from April-July, 2003 (Tadros et al., unpublished results).

Dissolved oxygen

The analytical results of dissolved oxygen (DO), shows that the input source of El Max fish farm (El Khandek and El Moghazy) is below 5.0 ml/l in all the studied months during 2004 except in January. However, 8.64 ml/l in El Moghazy water with relatively high pH value 7.83 in the same month was recorded (Table 1). The average value of DO in El Khandek water (4.2ml/l) is lower than its corresponding value in El Moghazy water (2.75 ml/l)). The correlation coefficient between DO and OOM was 0.646 (Table 5) in El Moghazy water. Dissolved oxygen also recorded low values (<5.0 ml/l) in El Moghazy water during the monthly record of its water in 2003 (Tadros et al., unpublished results). The content of dissolved oxygen and the pH value are in linear distribution ($r = 0.1$) pointed to that, photosynthesis is a contributing factor to the higher content of DO and pH. El Beer water (saline water) is slightly higher than El Moghazy water in the studied months. In July, the content of DO was 10.2 ml/l resulted from low OOM and higher pH than El Moghazy water (Table 1).

The concentration of dissolved oxygen in the water basins is presented in Table (3B) and the mean values in Fig. (2). It was varied in the range (5.33 ml/l, basin 7 in March to 19.06 ml/l, basin 6 in July). Generally, higher DO content in water basins than their corresponding values in El Moghazy water (>5.0 ml O_2/l), is recorded except in May B 10 (DO, 3.79 ml/l) and in June B 5(3.01 ml/l). The average of DO ranged between a minimum of 7.87 ml/l basin (8) to a maximum of 12.0 ml/l for basin (6), (Fig. 2). 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 (Wahby et al., 1972).

Oxidizable organic matter (OOM)

The OOM of any system is produced mainly from the decomposition of planktonic organisms and particular organic detritus either through autolysis and/or bacterial action. A considerable additional amount of OOM is derived from domestic sewage of El Umum Drain .

The variation in organic matter content is mainly due to the quality and quantity of the input source of E Umum Drain loaded with organic and inorganic pollutants. Oxidizble organic matter of El Moghazy water was varied between (0.61-2.47 mgO_2/l) in April and July, respectively. In most water basins, higher content of OOM are given than their corresponding values in El Moghazy water (Table 3A). In June, the OOM of water basins 11, 10 and B6 showed the values (0.68, 0.87 and 0.86 mgO_2/l), respectively.

The variation in organic matter content is mainly due to the quality and quantity of the input source of El Umum Drain loaded with organic and inorganic pollutants. Oxidizable organic matter of El Moghazy water was varied between (0.61-2.47 mgO_2/l) in April and July respectively, in most water basins higher content of OOM than their corresponding values in El Moghazy water are reported (Table 3A). In June, the water of basins 11, 10 and 6 recorded OOM between (0.68, 0.87 and 0.86 mgO_2/l) respectively. In July, water basin 7 is the only low OOM values than El Moghazy water accompanied by high PO_4-P concentration (5.58 µmol/l). The average of OOM concentrations in water basins ranged between a minimum of 1.39 mgO_2/l; basin 7 to a maximum of 2.15 mgO_2/l at basins 6 and 10 (Table 3A and Fig. 2). The mean value of OOM is presented in Fig. 2, where lower concentration in El Moghazy water (1.27 mlO_2/l) was recorded compared with the mean value of water basins; 1.39-2.15 mgO_2/l (Table 3A). This may be related to the type of sediment of El Moghazy area (rocky) and the muddy nature of sediment of the studied basins.

Nutrient salts

The concentrations of nutrients in El Max Fish Farm in the present study Nutrients salts were analyzed in the water of basins 11, 10, 9, 8, 7, 6 and 5 from January to July 2004 (Tables 2 and 3). The results of the analysis were higher than those recorded in the unpolluted aquatic systems. However, they are comparable to polluted and eutrophic systems in Egypt. So, the extend of the nutrient loads in El Max Farm is directly dependent on the discharge of artificial fertilizers, detergents, industrial wastes and domestic sewage from El Umun Drain (Fig 1). Point source discharges are usually relatively easy controllable while diffuse and atmospheric sources are more difficult to control (Orive *et al.,* 2002). The increased and more efficient agriculture has included more efficient Drainage and thus the increased rate or run-off of organic matter and nutrients which contribute to high chlorophyll and productivity (Closer, 1991).

The distribution pattern of nutrient characteristics of the input sources, El Khandek, El Moghazy and El Beer and monitored from January to October 2004, Table (1).

Ammonia

Ammonia is the nitrogenous end product of the bacterial decomposition of natural organic matter containing N. It is also discharged into water bodies by industrial processes and as a component of municipal or community wastes as well as the use of ammonia containing fertilizer such as ammonium sulphate, ammonium nitrate, urea and ammonia itself (Abbas and Shakweer, 2001). This illustrates the high levels of NH_4-N recorded during the period of study in the input sources, El Khandek and El Moghazy with an average of 119.71 and 106.11 µmol/L, respectively (Table 4). Most of organic matter contains nitrogen in different amounts. 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 (Vanloon and Duffy, 2000). El Beer area had an average of 34.21 µmol/L, probably due to the low load saline water entering El Beer area with organic matter, as documented by the lowest OOM average of 0.79 mg O_2/L recorded during the present study (Table 2). Studied water basins recorded also high levels of ammonia (Table 4). The values varied between a minimum value of 1.17 µmol/L at basin 5 during June and a maximum value of 173.3 µmol/L at basin 8 during April. Harvey (1974), stated that most species of phytoplankton utilize ammonium ions in preference to other inorganic nitrogen forms, probably explain the decreasing of ammonia levels during summer in the water basins. Correlation between ammonia and pH was calculated, $r = -0.47$, in the water basins (Table 5).

Nitrite

Nitrite appears in water results mainly from biochemical oxidation of ammonia (Nitrification) or the reduction or nitrate (Denitrification). During the period of study, the water basins recorded high levels of nitrite ranged from depletion at basins 8 and 7 in January and the maximum value of 22.375 µmol/L at basin 5 in March (Table 3). In the present study, ammonia concentrations showed a negative correlation with D.O. in the water basins with $r = -0.554$, (Table 5). So these recorded high levels of NO_2-N might be attributed to the nitrification process occurred in all water basins. This is documented by the negative correlation between NO_2-N and NH_4-N concentrations appeared in the water basins with $r = -0.369$. With respect to the input sources, El Khandek and El Moghazy attained the maximum values of nitrite during January and April (> 21.0 µmol/L). While for the rest of the months they attained low values of nitrite El Beer area with an average of 1.66 µmol/L (Table 3). Both forms, NO_2 and NH_4 are positively correlated in El Moghazy water with $r= 0.406$, which could be related to the deficient of its DO (Table 1).

Nitrate

Nitrate is the most stable form of inorganic nitrogen in oxygenated water. It is the end product of nitrification process in natural water. Table (4), illustrates that the input sources, El Khandek and El Moghazy and El Beer attained lower values of NO_3-N than most of the studied basins during all months with averages of 9.14 µmol/L and 4.95 µmol/L, respectively. In the water basins, high levels of nitrate 27.748 µmol/L and 29.764µmol/L were recorded at basins 7 and 5, respectively during April. El Max fish farm receives huge amounts of Drainage water from El Umum Drain which is clearly the highest in April. Vanloon and Duffy (2000) reported that the use of ammonium containing fertilizer (ammonium sulphate, ammonium nitrate, urea, and ammonia itself), is a source of ammonium ion in water. In an aerobic environment, nitrification takes place as follows:

$$NH_3/NH_4 \xrightarrow{\text{Nitrosomonas}} NO_2 \xrightarrow{\text{Nitrobacters}} NO_3$$

The optimum environmental pH for nitrification process lies between 6.5 and 8 and the reaction rate decreases significantly when the pH falls below 6 (Vanloon and Duffy 2000). The pH and NH_4 are negatively related with the coefficient r = - 0.47 in the water basins. Difficult rates of oxidation (nitrification) may be account for irregular distribution of nitrate in El Max Fish Farm. However, NO_2 and NO_3 levels approached to each other in all basins. This proves that nitrification process took place in the basins especially of well oxygenated ones like basin 5 and 7 (Table 3B). Dissolved oxygen and NH_4 were negatively related in the water basins with r = - 0.554. Table (1) showing that in the input sources, and the NO_3 level was higher at El Moghazy source.

Dissolved inorganic phosphate

The environmental significance of phosphorus arises out of its role as a major nutrient for both plants and micro organisms (Vanloon and Duffy, 2000). Nutrients that contribute to eutrophication are most commonly phosphorus that can be considered as a pollutant if it is present as a higher concentration than the normal limit (Saad, 1973). Spatial distribution pattern of dissolved inorganic phosphate shows a characteristic pattern which is more or less related to the input sources of brackish or saline water (Fig. 2).

The input sources, El Kandek and El Moghazy attained higher values of dissolved inorganic phosphate than all basins during the period or study except basin 7 which recorded nearly and sometimes higher values (Fig. 2). Generally, based on the average values of phosphate, maximum values of 23.0 µmol/L and 19.54 µmol/L were recorded at El Khandek and El Moghazy (Table 2). However, El Beer recorded lower phosphate content than the studied basins except in January with an average of 10.84 µmol/L. The lowest average value of 7.49 µmol/L was recorded at basin 11 (Table 2). This basin which is directly affected by El Beer area. A positive correlation between salinity and phosphate (r = 0.303) is recorded in water basins (Table 5). According to Faust and Aly (1981), it is difficult to establish a range of concentrations for phosphate in natural waters because the inputs from many sources are quite variable. Commercial fertilizers, domestic and industrial waste water and to a less extent, decomposition of organic phosphorus compounds in biological systems are the most pollution sources for phosphate. Phosphate and OOM are strongly correlated in El Moghazy water with r = 0.879 (Table 5). Nitrite, ammonia and phosphate concentrations showed a negative correlations in water basins with r = - 0.47 for all of them.

Reactive silicate

Silicate is an important mineralogical component of sediments. It plays an important role in the biological processes. Silicate could be lost by precipitation, metabolic utilization, freezing or melting of samples, and could be increased by silicate desorption from the particulate matter (Elsevier Science Publishers, 1990). The input sources, El Khandek and El Moghazy recorded the highest values of silicate with an average of 203.39 and 178.13 µmol/L, respectively (Table 2). Silicate is a good indicator of fresh water dispersion and the potential for diatom (Fahmy, 2001). Table (5) showed that the content of silicate increased generally with the increasing of DO in water basins and El Moghazy water with r= 0.445 and 0.621, respectively. El Beer recorded the lowest average value during the period of study with an average of 57.39 µmol/L like phosphate. In the present study, phosphate and silicate are strongly correlated in water basins and El Moghazy water with the related coefficients, r=0.731, and 0.425, respectively. The data proved that both of them have the same origin and the distribution conditions of PO_4-P and SiO_2-Si are related to the influence of the brackish water.

Polychlorinated pesticides and PCBs in water of El Max fish farm

Water samples showed the presence of a wide variety of organochlorine including α, β- and γ-HCH, dieldrin, aldrin, heptachlor, DDT and the metabolites of DDT as well as PCBs (Tables 6-8). Concentrations of all these organochlorine pesticides in water samples collected from El Max fish farm were low in the studied area. The concentrations of organochlorines in water decreased in the order of PCBs > cyclodienes > DDTs > HCHs for most of the samples. DDT is generally used against a wide variety of agricultural and forest pests and against insect pests including vectors such as mosquito and tse-tse fly. In the environment DDT, can be degraded by solar radiation or metabolised in organisms. Dehydrochlorination of DDT gives the metabolite DDE. The maximum concentration of DDT (59.03 ng/l) was recorded in Basin 8. Concentrations of p,p-DDT in water samples were in the range of 0.17–59.03 ng/l with an average of 22.03 ng/l. Among DDT metabolites, p,p-DDE accounted for a range from 0.14-31.00 ng/l in all water samples. This composition is indicative of fresh inputs of DDT. Also, Dieldrin was the most dominant organochlorine compound. Aldrin is an alicyclic chlorinated hydrocarbon and is therefore less resistant to oxidation than the aromatics. It is being rapidly converted to the epoxide form (Dieldrin). The presence of 373.03 ng/L of Dieldrin recorded at El Moghazzy source with low detection of Aldrin in the same location declares that conversion process.

Higher metabolic transformation of DDT under oxidative conditions leads to p,p-DDE, whereas under anaerobic conditions, p,p-DDD is formed. The higher percentage of non-degraded DDT suggests more recent usages of DDT in the investigated area and attests to the stability of DDE and the very slow degradation of DDT compounds in this environment (the persistence of DDTs in soils with half-lives up to 20 years is well-known (Wolfe et al., 1977; WHO, 1989).

HCH (hexachlorocyclohexane) is a fully chlorinated alicyclic compound. The most common isomers are α, β and γ-HCH. The γ isomer known as Lindane is one normally used as an agricultural pesticide. HCH is a reasonably stable compound and only under alkaline condition decomposes to yield trichlorobenzene. It is considered as one of the less persistence organochlorine pesticide. A maximum of 44.48 ng/l of total HCHs was recorded at El mothales. The variation between concentrations of different locations depends on their distance from the input source of pollution. Also, the higher concentrations of total HCHs in El Max Farm is represented by discharging of municipal wastes into the nearest area to El Noubariya canal and the industrial Land Drain. Ethyl benzene as identified by Grimalt et al. (1984) is a marker of domestic wastes in the Mediterranean. Chloroniation of ethyl benzene could easily give hexachlorocyclohexane (HCH). Beside atmospheric deposition organochlorine compunds reach the marine environment through agricultural run-off, rivers and discharge of industrial and municipal wastes. Comparison of atmospheric and river input rates of organochlorine compunds to the world's Oceans was made recently by GESAMP (1993). They showed that pollution of the marine environment by these substances through the atmosphere is more important than river discharge. Also, the potential effect of pesticidal pollutants carried by the river Nile and its associated canals and Drainage systems were investigated by EL Sebae and EL Amayem (1979). Their results indicated the presence of some chlorinated pesticides in concentrations ranging from 340-950 ng/l in Mahmoudieh canal water and from 190-950 ng/l in slaughter waste water. From the above discussion, we can conclude that at open seas atmospheric fallout (rain water) is the major source of pollution by organochlrine compounds. Table 7 presents the concentrations of organochlorine pesticides during June, 2004. It is clear that the concentrations were below the detection limit during June compared to that recorded during May. Table 8 indicates the comparison of organochlrine compounds between the area of investigation with other relevant environmental compartments. It is apparent that El Max Farm posses high content of organochlrine compounds during May, 2004. This indicated higher agricultural and industrial wastes discharges into the are of study.

PCBs concentration (ng/l) in water samples collected from El Max fish farm include 28(2,4,4-Trichlorobiphenyl); 52(2,2,5,5-tetrachlorobiphenyl); 101(2,2,4,5,-tetrachloro biphenyl); 118(2,3,4,4,5-pentachlorobiphen-yl);138 (2,2,3,4,4,5-hexachlorobiphenyl); 153 (2,2,4,4,5,5-hexachlorobiphenyl) and 180 (2,2,3,4,4,5,5-Heptachlorobiphenyl). Total PCBs concentrations were ranged from 4.65-313.09 ng/l with an average of 82.28 ng/l. The PCB concentrations were higher at: basin 6, 313.09 ng/l; Basin 8, 186.89 ng/l and Mothals, 180.03 ng/l.

Pesticides and PCBs have strong lipophilic properties, which have caused extensive concerns due to their persistence in the environment and enrichment in food chains (Winter and Streit, 1992; Marth et al., 1997; Fernandez et al., 1999). These hydropholic compounds are mainly stored in fat tissues and when fats are mobilized, the toxic substances re-enter the circulatory system disturbing the normal physiology of the organisms.

Hazard levels in water and tolerable levels

Since organochlorine compounds pose a potential health hazard, maximum permissible levels of toxic substances, recommended for the protection of aquatic biota, has been published. The environmental quality objective set by the European community (UNEP, 1990) is 10 ng/l of p,p-DDT and 25 ng/L of total DDTs. For HCH isomers, the permissible level should be set at 20 ng/L. In comparison to most other organochlrine pesticides, HCH isomers are relatively soluble in water and not therefore so markedly accumulated by marine organisms as DDTs compounds (GESAMP, 1993). Therefore, no reason to suppose that the present levels of total HCHs (0.38-64.60 ng/l), present any risk to organisms in the area of investigation. On the contrary, it is notable that the results of total DDTs exceed the limited acceptable levels markedly in El Moghazzy (Tables 6-11).

The maximum permissible levels of organochlorine pollutants recommended by the National Academy of Sciences and National Academy of Engineering (NAS–NAE, 1972) are 1000–500 ng/g for PCBs and 100 ng/g for cyclodienes (all as wet weight concentrations in whole body tissue). The recommended levels by Swedish Food Regulation are 5000 ng/g for DDTs, 2000 ng/g for PCBs and 200 ng/g for HCB (SFR, 1983). The US Food and Drug Administration (FDA) tolerance limit of 2000 ng/g wet weight for total PCBs in fish and shelfish (Kannan et al., 1997; Henry et al., 1998), which is much higher than the PCBs and/or pesticides concentration (ng/l) recorded in the present study.

CONCLUSION

- Dissolved oxygen (DO) in El Mogahazy and El Khandek was almost below 5ml/l during 2003-2004. However, in most of the studied basins reached > 5ml/l. In addition, basin 9, which is located close to El Moghazy was almost have the maximum concentration of DO up to 18 mlO_2/L during June, 2004.
- It is obvious that OOM was higher in all basins than El Moghazy source. This may reflect increasing dissolved inorganic phosphate concentration almost in all basins.
- pH in water basins was > 8 (almost alkaline), compared to pH of 7.15 up to 7.65 in both of El Moghazy and El Khandek sources, respectively.
- Total alkalinity in all bains was less than that recorded in El Moghazy and El Khandek.

It reached > 4meq./L indicating high fertility of fish farm ponds.

- Salinity of water basins is considered as brackish water source. It was ranged from 3.2 to 4.7 ‰ (higher than feeding sources). However, in El Beer had a mean value of 32.28 ‰.
- Nutrient salts; phosphate and silicate concentrations were highly correlated in all basins with r = 0.731. However, in El Moghazy, r value was equal 0.43. Generally, phosphate concentration of El Moghazy was higher than all other basins. This is related to high total content of plankton in El Moghazy source. The same was true for silicate concentration.

The average concentration of ammonia in water basins was < 100 µmol/L (ranged from 54.51-99.6 µmol/L). However, it was > 100 µmol/L in El Moghazy source. In addition, ammonia recorded a negative correlation with DO in all water basins. Nitrate concentration was closely near that of nitrite as recorded in basins; 8 and 11.

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Table 1. Physicochemical parameters of the input sources of El Max Fish Farm, 2004

Input sources	pH								
	Jan.	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Oct.**	**Aver.**
El Khandek		6.8	7.7	7.5	7.75	7.65			7.48
El Moghazy	7.83	7.15	7.55	7.55	7.65	7.6	7.7	7.35	7.55
EL Beer	7.38	7.45	7.3	8.35	8.05	8.3	7.68	6.35	7.61
Temperature, (°C)									
El Khandek		18.8	21.5	22	27	31.6			24.18
El Moghazy	16.5	19.5	21.5	23	27.5	31.8	27	27	24.23
EL Beer	20	19.5	22	21.5	29,27	31	24.4	26.5	23.56
T.Alk. ml eq./l									
El Khandek		6.6	3.6	3.3	5.45	5.77			4.94
El Moghazy	6.33	6.6	3.9	3.3	5.45	5.995			5.26
EL Beer	4.33	3.45	2.4	3	3.488	5..014			3.33
DO ml/l									
El Khandek		1.04	4.78	1.422	2.777	3.74			2.75
El Moghazy	8.64	1.74	5.01	3.082	3.402	4.268	3.61	3.84	4.20
EL Beer	6.4	1.74	5.92	4.268	3.703	10.195	4.52	2.48	4.90
OOM mg O_2/l									
El Khandek		1.428	1.088	0.7224	0.8904	19.908			4.81
El Moghazy	2.416	0.739	0.608	0.7896	0.991	2.469		0.855	1.27
EL Beer		1.445	0.512	0.9405	0.5576	1.209		0.063	0.79
S%									
El Khandek		4.4	3.9	3.3	4.2				3.95
El Moghazy	3.1	4.5	3.6	3.2	3.6				3.60
EL Beer	34.9	34.3	33.6		26.3				32.28
NH_4.N,µmol/l									
El Khandek		79.01	195	151.1	86.54	86.9			119.71
El Moghazy	104.7	82.51	175.9	148	86.6	84	85.9	81.24	106.11
EL Beer	25.9	24.192	63.7	10.6	8.75	58.5	50.5	31.55	34.21
NO_2-N,µmol/l									
El Khandek		0.95	21.8	2.9	1.75	12.625			8.01
El Moghazy	24	0.7	24.3	1.925	2.8	6	10.3	14.3	10.54
EL Beer	0.475	0.05	0.2	3.775	1.375	6.4	0.98	0.05	1.66
NO_3-N,µmol/l									
El Khandek		6.664	15.79	2.744	3.192	17.332			9.14
El Moghazy	3.86	6.86	23.02	2.8	1.344	3.75	O.00	5.93	6.79
EL Beer	1.27	12.796	7.084	11.564	2.604	3.75	0	0.55	4.95
PO_4-P,µmol/l									
El Khandek		26.95	22.9	38.5	21.08	5.55			23.00
El Moghazy	16.8	26.9	23.4	25.8	22.45	5.2	23.6	12.2	19.54
EL Beer	24.85	0.05	7.8	7.76	12.4	2.85	19.1	11.9	10.84
SiO_2.Si,µmol/l									
El Khandek		189.96	219	228	215.2	164.8			203.39
El Moghazy	33.6	171.12	216	230.4	211.4	190.9	282	89.7	178.13
EL Beer	35.52	163.92	174.1	36.36	126.2	88.9	202	159	123.28

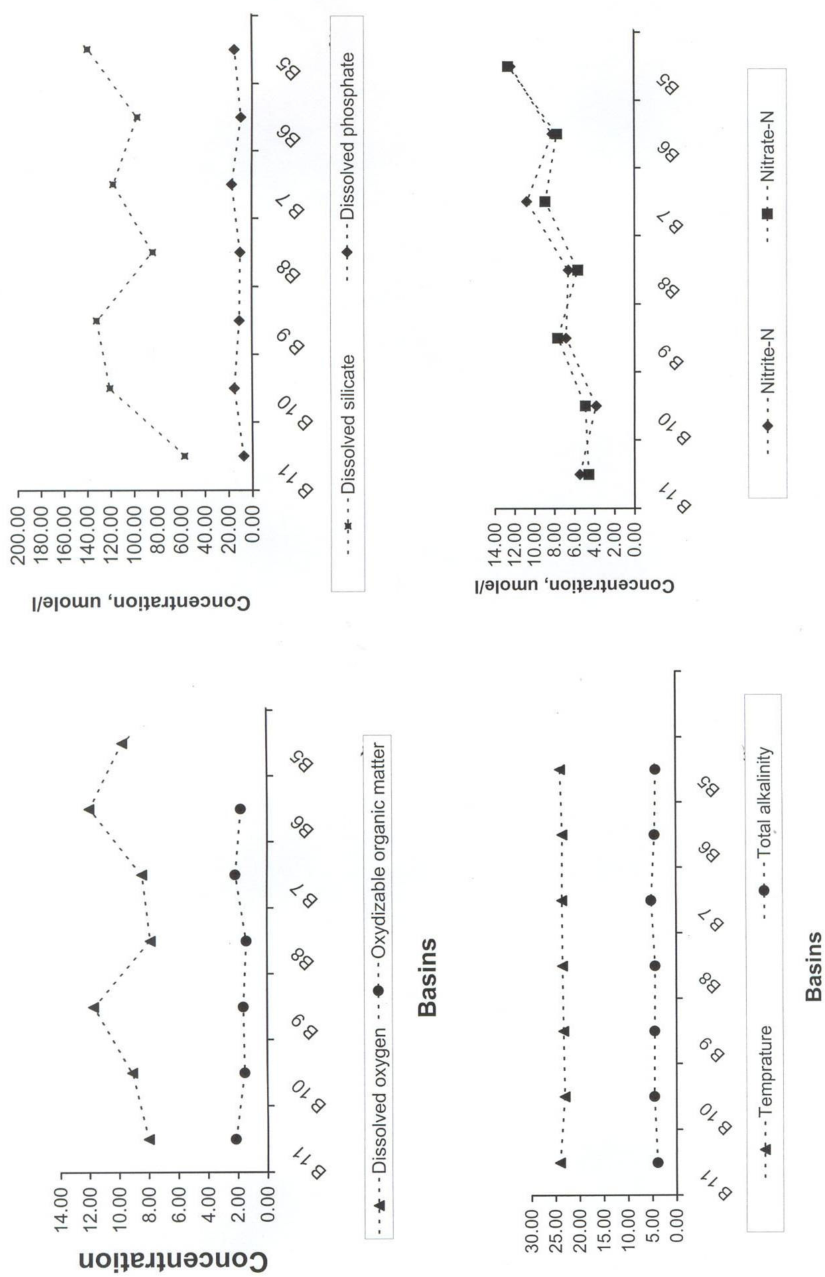

Fig. 2. Mean values of different parameters measured in El-Max fish farm during 2004

Table 2 Monthly variations of temprature, pH, total alkalinity and salinity of El Max Fish Farm water Basins and their averages.

A						
	pH					
Basin	**Jan.**	**March**	**April**	**May**	**June**	**July**
B 11	8.97	7.65	8.35	8.9	8.05	9
B 10		7.35	8.35	8	8.8	8.05
B 9	9.02	8.3	8.2	8.55	9.15	8.07
B8	7.98	8.58	8.1	7.9	9.2	9.05
B 7	8.28	8.25	7.75	7.45	9.15	8.6
B6	7.83	8.3	8		9.15	8.75
B5	7.38	8.1	8.45	8.45	9	8.9
El mooghazy						

B						
Temp., C						
Jan.	**March**	**April**	**May**	**June**	**July**	**Aver.**
17	19.5	23.5	22.5	30	32	24.08
11.5	21.5	22	22.5	29.5	31.5	23.08
15.5	19.5	22	22	29.5	31.4	23.32
15	19.5	22	22	31	31.5	23.50
15.3	19.5	22	22.5	30.5	31.8	23.60
15.5	18.9	22.5		29	31.6	23.50
16.5	19.5	22.5	22		31.5	23.92
14.88	19.73	22.17	22.20	29.90	31.55	24.230

C							
	T.Alk.ml eq./l						
Basin	**January**	**March**	**April**	**May**	**June**	**July**	**Aver.**
B 11	6.5	6.6	3.6	2.7		3.82	3.88
B 10	6.5	7.04	3.66	3.45	4.91	4.91	4.57
B 9	6.78	7.04	4.05	3.45	4.25	4.69	4.49
B8	5.3	6.16	3.75	3	4.58	5.83	4.39
B 7	9.29	6.22	3.75		5.23	5.56	5.19
B6	5.76	3.3	3.75		5.12	5.56	4.43
B5	6.04		3.6	3.15	5.34	5.67	4.18
Aver.	6.61	5.95	3.76	3.15	4.91	5.37	5.26

D						
S%						
January	**March**	**April**	**May**	**June**	**July**	**Aver.**
16.9			5.3	5.5		
6.5	4.5	4.3	4	4.7		4.38
5.8	4.3	4	3.7	4		4.00
5.5	4.1	3.6	3.5	3.5		3.68
7.33	4.5	3.6	3.2	3.8		3.78
5		3.7		2.9		
3.9		3.9	3.5	3.8		3.73
5.67		3.85	3.58	3.78		

Table 3 Monthly variation of dissolved oxygen, oxidizable organic matter, silicate and phosphate of El Max water basins and their averages.

	A							B						
	OOM, mg O_2/l							DO ,ml/l						
Basin	January	March	April	May	June	July	Aver.	January	March	April	May	June	July	Aver.
B 11	2.640			0.907	0.689			1.92	5.91	13.66	10.906	8.101	7.545	8.01
B 10	3.376	1.646	1.596	1.042	0.874	4.351	2.15	11.48	6.72	10.92	3.794	12.708	9.01	9.11
B 9	2.416	1.562	1.152	1.378	1.344	1.243	1.52	14.4	7.53	10.24	4.979	18.15	15.174	11.75
B8	0.544	1.243	0.922	1.210	1.579	4.099	1.60		7.18	4.09	6.165	8.17	13.752	7.87
B 7	2.256	2.184	1.378	0.958	1.004	0.538	1.39	0.96	5.33	12.06	4.505	16.339	11.381	8.43
B6	4.848	2.671	0.941		0.857	1.394	2.14	15.04	5.44	11.38	5.927	19.062	15.174	12.00
B5	4.816	1.226	1.438	0.773	1.344	1.042	1.77	15.68	7.07	12.29	6.876	3.008	13.515	9.74
El Moghazy	3.04	1.76	1.24	1.07	1.17	2.11		11.51	6.55	10.16	5.37	12.91	13.00	4.20

	C							D						
	SiO2-Si, umole/l							PO_4,umole/l						
Basin	January	March	April	May	June	July	Aver.	January	March	April	May	June	July	Aver.
B 11	66.36	46.2	164.16	21.72	4.8	41.1	57.39	3.9	12.3	19.8	4.7	1.8	2.45	7.49
B 10	45.54	145.68	185.16	215.28	85.9	47.1	120.78	19.65	16.25	16.5	21.15	14.55	2.3335	15.07
B 9	39.06	201.12	251.1	258.72	4.3	38.8	132.18	15.3	6.35	18.55	20.2	1.85	1.4	10.61
B8	21.42	141	166.1	166.2	6.3	3.2	84.04	11.7	3.05	20.75	19.75	2.35	1.05	9.78
B 7	51.9	148.86	176.82	204.96	14.6	110.5	117.94	25.35	18.1	21.55	23.45	6.9	5.85	16.87
B6	18.72	210.72	164.3	170.4	2.6	14.6	96.89	3.9	2.9	19.1	21.8	5.35	3.1	9.36
B5	18.12	174.72	163.68	147.24	147.2	188.9	139.98	9.45	21.4	18.3	21.25	15.15	2.85	14.73
Aver.	32.46	170.35	184.53	169.20	43.48	67.18	178.13	14.23	11.34	19.13	21.27	7.69	2.76	12

Table 4. Montly variations of the nutrient salts (Ammonia, nitrite and nitrate) of El Max fish Farm bains and their averages.

A

Basin	NH_4,umole/l						
	Jan.	**March**	**April**	**May**	**June**	**July**	**Aver.**
B 11	92.2	66.82	157.7	20.8		4.95	68.49
B 10	93.2	34.56	143	20.9	71.6	68.8	72.01
B 9	83.2	66.1	126.6	16.6	2.6	31.95	54.51
B8	33.5	0.864	173.6	137.6	2.6	31.8	63.33
B 7	149.7	22.368	161.6	129.4	53.8	80.75	99.60
B6	22.2	2.592	148.7	82.3	31.4	54.65	56.97
B5	37	78.34	152.4	9.5	1.17	60.95	56.56
El Moghazy	69.80	34.14	150.98	66.05	27.20	54.82	106.11

B

Basin	NO_3-N ,u mole						
	January	**March**	**April**	**May**	**June**	**July**	**Aver**
B 11	1.75	7.672	12.768	3.08		9.94	7.04
B 10	2.12	21	5.628	2.296	7.756	3.612	7.07
B 9	4.89	6.468	8.064	3.668	9.016	0.784	5.48
B8	0.21	6.552	18.172	5.964	0.42	8.008	6.55
B 7	1.15	27.748	15.54	4.928	14.868	4.984	11.54
B6	4.3	7.616	10.556	5.04	25.452	9.66	10.44
B5	3.38	29.764	12.908	9.52	11.984	3.752	11.88
Aver.	2.68	16.52	11.81	5.24	11.58	5.13	5.930

C

Basin	NO_2-N, umole/l						
	January	**March**	**April**	**May**	**June**	**July**	**Aver.**
B 11	0.125	7.1	5.9	0.875		8.85	
B 10	11.5	1.075	4.7	1.8	3.675	6.725	4.91
B 9	12.7	17.95	4.9	1.625	5.3	305	57.91
B8	0	2.6	15.73	3.25	3.525	8.75	5.64
B 7	0	9.675	20.7	3.35	11.1	8.625	8.91
B6	4.95	2.675	18.45	3.9	7.525	8.825	7.72
B5	14.065	22.375	17.53	7.25	8.125	6.4	12.62
Aver.	7.20	9.39	13.67	3.53	6.54	57.39	178.13

Table 5 Correlation between the average parameters

Parameter		correlation r	
		Water basins	El Moghazy
DO,ml/l	OOM,mgO_2/l	0.332	0.646
DO,ml/l	$PO_{4,\mu}$mol/l	-0.144	-0.346
DO,ml/l	SiO_3,µmol/l	0.445	0.621
DO,ml/l	S%	0.29	0.68
OOM,mgO_2/l	$PO_{4,}$µmol/l		0.879
$PO_{4,}$umole/l	SiO_3,µmol/l	0.731	0.425
Temprature,C	T.alkalinity,ml equ/l	-0.518	-0.061
S%	T.alkalinity,ml equ/l	0.459	0.45
DO,ml/l	NH_4-N,µmol/l	-0.554	
NO_3-N, umole/l	NH_4-N,µmol/l	0.322	0.708
NO_2-N, umole/l	NH_4-N,µmol/l	-0.369	0.406
pH	Temprature,C	0.16	--
pH	NH_4-N,µmol/l	-0.47	--
pH	NO_2-N, µmol/l	-0.476	--
pH	$PO_{4,\mu}$mol/l	-0.467	--
pH	S%	0.401	--
S%	$PO_{4,\mu}$mol/l	0.303	0.303

Table 6. Concentrations (ng/L) of Organochlorine pesticides in water samples collected from El Max Farm during May, 2004

Chem. Name	Location					
	El Moghazy	El Mothals	Basin 6	Basin 8	Basin 9	Basin 10
α-HCH	N.D	10.24	20.96	N.D	N.D	9.92
β&γ-HCH	30.8	34.24	15.32	N.D	11.28	24.7
total HCHs	30.8	44.48	36.28	N.D	11.28	34.62
Aldrin	3.6	N.D	N.D	N.D	N.D	29.3
o,p-DDE	N.D	N.D	N.D	N.D	N.D	N.D
Dieldrin	373.03	36.68	22.72	13.12	12.26	57.2
p,p-DDE	N.D	N.D	N.D	N.D	N.D	N.D
o,p-DDD	23.19	N.D	N.D	N.D	N.D	N.D
Endrin	N.D	N.D	N.D	N.D	N.D	N.D
p,p-DDD	N.D	N.D	N.D	N.D	N.D	N.D
o,p-DDT	N.D	N.D	N.D	N.D	N.D	N.D
p,p-DDT	39.95	13.2	7.64	59.03	N.D	7.0
total DDT	39.95	13.2	7.64	59.03	N.D	7.0

N.D: not detected.

Table 7. Concentrations (ng/L) of Organochlorine pesticides in water samples collected from El Max Farm during June, 2004

Chem. Name	Location					
	El Moghazy	El Mothals	Basin 6	Basin 8	Basin 9	El Beer (surface)
α-HCH	N.D	N.D	9.08	24.42	1.952	4.99
β&γ-HCH	N.D	31.536	N.D	N.D	4.2	N.D
total HCHs	N.D	31.536	9.08	24.42	6.152	4.99
Aldrin	N.D	N.D	N.D	N.D	N.D	N.D
o,p-DDE	N.D	N.D	N.D	N.D	N.D	N.D
Dieldrin	N.D	N.D	N.D	18.26	N.D	N.D
p,p-DDE	N.D	N.D	N.D	N.D	N.D	N.D
o,p-DDD	N.D	N.D	N.D	65.21	N.D	N.D
Endrin	N.D	N.D	49.4	N.D	N.D	N.D
p,p-DDD	N.D	N.D	N.D	N.D	N.D	N.D
o,p-DDT	N.D	N.D	N.D	N.D	N.D	N.D
P,p-DDT	N.D	N.D	N.D	N.D	N.D	N.D
total DDT	N.D	N.D	N.D	N.D	N.D	N.D

Table 8. A comparison between the average concentrations (ng/L) of chlorinated pesticides in water of El Max Farm with other areas in the Mediterranean Sea and the Gulf of Suez

Station	total DDT		total HCHS		Reference
	average	range	average	range	
El Max Farm	21	Jul-59	31	Nov-64	Present study (May, 2004)
El Max Farm	N.D	N.D	15	31-May	Present study (June, 2004)
Itlay	12	16-Sep	6	7-Jun	Leoni *et al*., 1976
Yogouslavia	5	N.D-10	8	N.D - 7	Picer and Picer (1982)
Greek	10	N.D- 2	50	12-Oct	Fytianos *et al*., 1985
El Max gulf	153	Oct-45	19	14- 42	Abdallah, 1994
Gulf of Suez	154	10-Mar	71	10-May	Said and Hamed, 2001

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