

## Organochlorine Pesticides (OCs) and Polychlorinated Biphenyls (PCBs) in *Tilapia zillii* from Lake El-Manzala, Egypt.

تركيز المبيدات الكورونية العضوية (OCs) Organochlorine Pesticides ومركبات ثنائية الفينول عديدة الكلورة (PCBs) Polychlorinated Biphenyls في سمك الباطي الأخضر *Tilapia zillii* من بحيرة المنزلة في مصر

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**Abstract:** A freshwater fish species, (*Tilapia zillii*) from Lake El-Manzala was analyzed for concentrations of several Organochlorine pesticides (OCs) and Polychlorinated biphenyls (PCBs) in liver, gonads, mesenteric fat, flesh and the digestive tract in mature fish during the breeding season. Polychlorinated biphenyls (PCBs) and Organochlorine pesticides (OCs) were calculated in (ng/g) dry weight (dw) in homogenized samples. The obtained results revealed differences in lipid content between these different organs. The females showed higher lipid content than males. There was significant positive correlation between the lipid content and organochlorines and polychlorinated biphenyls (PCBs). The results come concomitant with the lipophilicity of studied compounds. However, the recorded concentrations of these studied pollutants still do not exceed the international hazardous levels.

**Keywords:** Fish, *Tilapia zillii*, Lake Manzala, Organochlorine pesticides, Polychlorinated biphenyls, Concentration, Egypt.

**المستخلص:** لقد تم تقدير بعض المبيدات الكورونية العضوية (OCs) Organochlorine pesticides ومركبات ثنائية الفينول عديدة الكلورة (PCBs) Polychlorinated biphenyls في أنسجة أعضاء سمكة الباطي الأخضر *Tilapia zillii* أثناء مرحلة النضوج الجنسي، وهذه الأعضاء هي الكبد، المناسل، دهون الأمعاء والعضلات ونسيج القنامية الهضمية. وتم تقدير هذه المركبات في الوزن الجاف لهذه الأنسجة. وقد دلت النتائج على وجود ارتباط بين التركيزات للمركبات تحت التحليل وتركيز الدهون المرتبطة بالأنسجة. كما أوضحت النتائج أن تركيز المركبات في الأناث في جميع الأعضاء تحت الدراسة أعلى منها في حالة الذكور. كما أن النتائج تؤكد على أن هذه المركبات محبة للذوبان في الدهون. كلمات مدخلية: أسماك، الباطي الأخضر، بحيرة المنزلة، مبيدات كلورونية، مركبات ثنائية الفينول، تركيز، مصر.

### Introduction

Organochlorine pesticides (OCs) and polychlorinated Biphenyls (PCBs) have been in use in Egypt since 1950's upto 1981. This class of chemicals is characterized by persistence in the environment, and the tendency to accumulate in aquatic organisms. Although, Egypt is the largest pesticide market in Arabian countries and the fourth largest importer of pesticides among developing countries (Yamashita *et al.*, 2000). There are no regular monitoring programs in Egypt for identification and determination of pesticides in the environment. There are numerous reports on organochlorine pesticides (OCs) in the Egyptian coastal marine environment, which were heavily used in early 1960's (El-Dib and Badawy 1985), (Abd-Allah and Ali 1994), (Abd-Allah *et al.* 1998) and (Yamashita *et al.* 2000). (El-Sebae *et al.*, 1993) reported the heavy use of toxaphene (54,000

metric tons), endrin (10,500 metric tons) and (DDT) (13,500 metric tons).

The purpose of this study is to determine the levels of some organochlorine pesticides (OCs) such as cyclodienes compounds (including heptachlor, c-chlordane, c-nonachlor, and aldrin), (DDT's) isomers (*p,p'*- isomers of (DDT), (DDE) and (DDD) as well as (HCB), and (HCHs) isomers ( $\alpha$ ,  $\beta$ , lindane and  $\sigma$ ), Also polychlorinated biphenyls (PCBs) congeners (52, 101, 110,118, 138 and 180) in different tissues (liver, gonads, mesenteric fat Mesenteric Fat (Mfat), flesh and the digestive tract Digestive Tract (DT) content in mature *Tilapia zillii* from the commercial catch at Lake El-Manzala during the breeding season. Fish species was selected because it is popular fish and desire flesh taste. However, the size was chosen because it is commercial and edible size in Egypt.

## Materials and Methods

Fish samples were obtained from the commercial catch at Lake El-Manzala, monthly during the period from June to September 2004, and were frozen at (-20°C) until analyzed. The total length of the fish was measured (10.5±2.1 cm) for females and (7.4±1.8 cm) for males. The total weights were also measured (27.4±1.8) for females and (18.3±7.3) for males. The total number of fish for both sexes was (25) for each. The different organs and tissues were sampled monthly from at least (5) individuals of each fish species, and then mixed to make a composite sample (EPA, 1991). Liver, gonads, mesenteric fat (MFat), flesh and digestive tract (DT) were removed and weighted. The digestive tract (DT) was cleaned. Fish samples were homogenized and lyophilized. Lipids in sub-samples (0.5-1 g) were soxhlet extracted for (8) hours with hexane (250 ml) and re-extracted for (8) hours with dichloromethane (250 ml).

Lipids were removed from the hexane extracts by gel permeation chromatography (GPC) as described by (Metcafe and Metcafe 1997). Lipid fraction from the gel permeation chromatography (GPC) was evaporated to dryness to calculate the tissue lipid content. Dichloromethane and the n-hexane extracts were combined and rotary evaporated down to few milliliters and further reduced to (2.0 ml) under a gentle stream of pure nitrogen gas.

The clean-up and fractionation was performed by passing the extract through Florisil chromatography column (18 g) which had been activated at (130°C) for (12) hours and partially deactivated with (0.5%) water. From this column, two fractions were collected as follows: the first fraction was eluted with hexane (70 ml) for polychlorinated biphenyls (PCBs) congeners' fraction (F1) which contain also (DDE), then the column was eluted with (50 ml) mixture containing hexane and dichloromethane (70:30) for the organochlorine pesticides (OCs) fraction (F2). The two fractions obtained were concentrated to (1.0 ml) under a flow of pure nitrogen and analyzed by high-resolution gas chromatography a (Hewlett Packard (HP) 5980 series II) equipped with electron capture detector (ECD) and a fused silica capillary column (50m ~ 0.32 mm x 0.52 µm) coated with (DB-5) was used for the quantification. The injector was set at 250°C, the detector at (300°C) and the oven programmed from (70°C) for (2 min.) up to (260°C) with a range of (3°C/min) and maintains to (2) minutes Nitrogen (NO<sub>2</sub>) was used as a carrier gas at a flow of (1.5 ml/min) and make up gas at a flow of (30 ml/min).

An equivalent mixture provided by Dr.

Ehrenstorfer Laboratories (GmbH, Augsburg, Germany) with known polychlorinated biphenyls (PCBs) compositions and content was used as the standard. organochlorine pesticides (OCs) were quantified from individually resolved peak areas with the corresponding peak areas of the external standards (2,4,5-trichlorobiphenyl and (ε-HCH) mixture provided by International Atomic Energy Agency, (IAEA). Confirmation of peak identity was obtained for selected extracts using (GC) with mass spectrometry

(GC-MS-HP 5889B MS "Engine").

The accuracy and precision of the techniques were determined through repeated analyses simultaneously of reference materials (SMR 1588) as cod liver oil was purchased from the National Institute of Standards and Technology, (NIST) while a fish standard reference material (CARP1) purchased from (NRC), Canada, were analyzed for (QA/QC) purposes. Blanks were at least (20) times lower than the values of analytes in the samples. Concentrations were calculated taking into account the analytical blanks. The laboratory results showed recovery efficiency ranged from (96%-106%) for polychlorinated biphenyls (PCBs) with coefficient of variation (9%-17%) for all studies polychlorinated biphenyls (PCBs). The limit of detection in the present study were estimated to be (0.2 ng/g) for polychlorinated biphenyls (PCB) and (0.3 ng/g) for (DDTs) based on the minimum quantity of sample required for a discernible peak appeared on the chromatogram. All concentrations are expressed on dry weight basis. The concentrations of individual polychlorinated biphenyls (PCB) congeners and organochlorine pesticides (OC) compounds were calculated both on a dry weight and lipid-normalized basis. Mean (%) lipid and mean concentrations of organochlorine pesticides (OCs) and polychlorinated biphenyls (PCBs) were calculated for each tissue as average of three samples.

## Results and discussion

The highest percentages of lipid content were found in mesenteric fat (MFat), 17% for (females) and (13%) for males, while in flesh those values were (1.3%) and (0.9%) (Table 1). Concentrations of (12) organochlorine pesticides (OCs) and 6 polychlorinated biphenyls (PCBs) congeners measured in different tissues (liver, gonads, mesenteric fat(MFat), flesh and digestive tract content (DTC) in both females and males of *Tilapia zillii* were presented in (Tables 2 and 3). The lipid content of analyzed female tissues is higher than those of males. Among the different studied tissues of both sex, the

lipid content followed the same descending order: Mesenteric fat(MFat) > liver>gonad>DTC> flesh.

The overall organic pollutants content in investi-

In meanwhile, similar concentrations of (HCB) were noticed in mesenteric fat(MFat) in both females and males (3.8 ng/g). (HCB) has become virtually ubiquitous occurring in the environment as a result of the use of this compound as a fungicide, or because it is a by-product of the production of other organochlorine compounds (Villanueva *et al.*, 1974). In some marine fish flesh at Port Said, Egypt (El-Dib and Badawy 1985), the concentrations of (HCB) ranged from (0.1 to 8.0 ng/g), while this concentration in the

present study at El Manzala was (0.24 ng/g) for male and female fish flesh.

Concentrations of ( $\sum$ DDT) in females are higher than those of males in all tissues. For digestive tract (DDT) isomers, (p,p'-DDE) is the most dominant isomer in all analyzed tissues of both sexes, in which mesenteric fat (MFat) at had the highest levels (69 and 67 ng/g) for male and female, respectively. Concentration of (p,p'-DDD) in mesenteric fat (MFat) of female was (3) fold of that of male. The high proportions of (p,p'-DDE) was most predominated relative to ( $\sum$ DDTs) isomers are consistent with a relatively long period since widespread use of this compound ceased. A significant correlation ( $P < 0.05$ ) have been found between pollution index (PI) values and lipid content in all organs in both sex.

According to ( $\sum$ HCH) concentrations, the female samples recorded higher values than male, with the highest levels found in gonad (22.4 and 17.6 ng/g) for females and males fish respectively. Among (HCHs) in fish, ( $\beta$ -HCH) was the dominated isomer among the studied (HCHs). The highest concentrations ( $\beta$ -HCH) and ( $\sum$ HCHs) were recorded in gonad, in both females and males. The highest concentrations of ( $\alpha$ -HCH) were recorded in mesenteric fat(MFat) in both sex (See, tables 2 and 3). These data go with same trend which reported from Lake Manzala in 1993, by (Yamashita *et al.*, 2000), although the use of (HCH) has been officially restricted in Egypt since the 1970s. (HCHs) had the lowest correlation with average lipid content in investigated tissues.

The concentration of ( $\sum$ cyclodienes) ( $\sum$  OCs) in mesenteric fat (MFat) had (1.7) fold related to gonad and (6) fold compared to the flesh of females, while in males it was (3.2) and (6.8) related to gonad and flesh, respectively. Aldrin was most dominated

**Table (1).** Lipid content (%) in *Tilapia zillii* in Lake El - Manzala, Egypt.

	Lipid %				
	Gonad	Flesh	liver	Mfat	DT
Female	5.9 ± 2.1	1.3 ± 0.5	11.1 ± 3.3	17.3 ± 4.7	2.9 ± 0.3
Male	3.1 ± 0.9	0.9 ± 0.2	8.4 ± 2.2	13.7 ± 5.1	2.1 ± 0.5

\* MFat: Mesenteric fat

\* DT: Digestive tract

gated fish tissues were compared using the pollution index (PI) calculated with the formula (Usero *et al.*, 1997):

$$PI = (M_1 \times M_2 \times \dots \times M_n)^{1/n}$$

Where, (Mn) is the concentrations of all investigated compounds (18 compounds and isomers). The final pollution index (PI) value of each tissue is a weight mean value as it was obtained taking into account the total weight of tissues. From (tables 2 and 3), it seems that pollution index (PI) values of female fish are higher than those of males in all the studied tissues. Significant correlation ( $P < 0.05$ ) have been found between pollution index (PI) values and lipid content in all organs in both sexes. This trend well agree with other fish species, *Oreochromis niloticus* (El-Nabawi *et al.*, 1987), *Tilapia zillii* and *Oreochromis niloticus*, (Abdallah & Ali 1994), (Abu-El-Ela & Abdallah 1997), *Mugil cephalus* (Abdallah 1994), (Abdallah *et al.*, 1998), *Cyprinus carpio* (Svobodov *et al.*, 2003), *Mugil cephalus*, *Sparus auratus*, *Boops boops* and *Pegusa lascaris* (El-Nemr and Abdallah 2004).

The concentrations of studied organochlorine pesticides compounds (OCs) revealed differences between the two sexes, where females had higher concentrations of pollutants than male fish (See, tables 1, 2 and 3). This result could be attributed to the higher lipid content of the female fish and the lipophilicity potential of most of the recorded compounds. These results well agree with other studies (Abdallah *et al.*, 1998; Svobodov *et al.*, 2003).

This study showed that among organochlorine pesticides (OCs), the average of the total digestive tract (DDT) concentrations in all tissues was most predominant in both sexes, followed by total (HCHs) then total cyclodienes. The females had higher concentration of organochlorine pesticides (OCs) than males in all tissues (See, tables 2 and 3).

**Table (2)** Mean  $\pm$  SD of organochlorine pesticides (OCs) concentrations (ng/g dw) in male *Tilapia zillii* in Lake El-Manzala, Egypt.

Analyte	Organs					Average	STDEV	Maxim
	Liver	Gonad	Mfat	Flesh	DTC			
HCB	0.6 $\pm$ 0.13	0.3 $\pm$ 0.09	3.8 $\pm$ 1.6	0.24 $\pm$ 0.08	0.3 $\pm$ 0.11	1.05	1.54	3.8
$\alpha$ -HCH	2.9 $\pm$ 0.9	1.8 $\pm$ 0.3	6.4 $\pm$ 1.6	1.8 $\pm$ 0.5	2.7 $\pm$ 0.9	3.13	1.89	6.4
Lindane	0.22 $\pm$ 0.09	0.27 $\pm$ 0.1	0.1 $\pm$ 0.03	0.13 $\pm$ 0.04	0.24 $\pm$ 0.1	0.19	0.07	0.27
$\beta$ -HCH	9.3 $\pm$ 2.3	14.4 $\pm$ 3.3	5.7 $\pm$ 1.7	2.8 $\pm$ 0.9	4.8 $\pm$ 1.6	7.40	4.57	14.4
$\gamma$ -HCH	0.35 $\pm$ 0.11	1.1 $\pm$ 0.05	1.8 $\pm$ 0.5	0.09 $\pm$ 0.02	1.2 $\pm$ 0.3	0.91	0.69	1.8
$\Sigma$ HCH	12.8	17.6	14.0	4.9	8.9	11.63	4.87	17.57
Heptachlor	0.24 $\pm$ 0.09	0.28 $\pm$ 0.1	0.5 $\pm$ 0.2	0.12 $\pm$ 0.09	0.24 $\pm$ 0.07	0.28	0.14	0.5
c-chlordane	0.31 $\pm$ 0.11	0.22 $\pm$ 0.05	0.8 $\pm$ 0.4	0.22 $\pm$ 0.08	0.13 $\pm$ 0.3	0.34	0.27	0.8
c-nonachlor	0.35 $\pm$ 0.1	0.29 $\pm$ 0.14	0.6 $\pm$ 0.2	0.14 $\pm$ 0.08	0.35 $\pm$ 0.2	0.35	0.18	0.63
Aldrin	1.9 $\pm$ 0.5	1.19 $\pm$ 0.4	4.3 $\pm$ 1.8	0.42 $\pm$ 0.17	0.52 $\pm$ 0.17	1.67	1.59	4.3
$\Sigma$ Cycl.	2.8	2.0	6.2	0.9	1.24	2.6	2.2	6.2
DDE	10.9 $\pm$ 2.9	3.2 $\pm$ 1.4	67.3 $\pm$ 25.2	1.1 $\pm$ 0.3	2.2 $\pm$ 0.6	16.94	28.41	67.3
DDD	3.6 $\pm$ 1.4	2.4 $\pm$ 1.1	16.4 $\pm$ 4.6	0.5 $\pm$ 0.3	1.8 $\pm$ 0.24	4.94	6.50	16.4
DDT	0.02	0.03	0.03	0.03	0.01	0.02	0.01	0.03
$\Sigma$ DDTs	14.5	5.6	83.7	1.6	4.0	21.9	34.9	83.7
OCs	30.7	25.5	106.1	8.8	14.2	37.0	46.3	106.1
PCB52	12.9 $\pm$ 3.7	0.83 $\pm$ 0.3	30.3 $\pm$ 10.7	0.38 $\pm$ 0.2	0.93 $\pm$ 0.3	9.07	12.99	30.3
PCB101	1.29 $\pm$ 0.4	0.69 $\pm$ 0.26	4.9 $\pm$ 1.6	0.32 $\pm$ 0.16	0.44 $\pm$ 0.11	1.53	1.92	4.9
PCB110	3.7 $\pm$ 1.2	3.5 $\pm$ 1.2	16.5 $\pm$ 5.9	1.1 $\pm$ 0.5	1.5 $\pm$ 0.4	5.26	6.39	16.5
PCB118	9.0 $\pm$ 2.6	4.0 $\pm$ 1.7	47.5 $\pm$ 21.8	1.4 $\pm$ 0.5	3.1 $\pm$ 1.3	13.00	19.49	47.5
PCB138	4.7 $\pm$ 1.9	1.7 $\pm$ 0.5	25.2 $\pm$ 8.4	0.72 $\pm$ 0.3	1.1 $\pm$ 0.34	6.68	10.47	25.2
PBC180	1.6 $\pm$ 0.4	0.47 $\pm$ 0.15	7.7 $\pm$ 3.9	0.19 $\pm$ 0.07	0.36 $\pm$ 0.12	2.06	3.20	7.7
$\Sigma$ PCBs	33.19	11.19	132.1	4.11	7.4	37.60	54.0	132.1
GT	63.88	36.67	238.2	12.88	21.6	74.64	100.3	238.2
PI	1.34	0.86	3.16	0.41	0.61	1.60	1.5	3.2
DDT/PCBs	0.44	0.50	0.63	0.40	0.54			

MFat: mesenteric fat

DT: digestive tract

compound in all analyzed tissues and its level in mesenteric fat (MFat) was (5.7) and (10.2) fold of that in flesh in female and male respectively. c-nonachlor was recorded in higher levels in all analyzed female samples than (c-chlordane). The same trend was observed in males except in mesenteric fat (MFat) and flesh. (Yamashita *et al.*, 2000) reported that c-nonachlor concentration was higher than (c-chlordane) in Lake Manzala and River Nile *Tilapia zillii* flesh.

Regarding the ( $\Sigma$  polychlorinated biphenyls ( $\Sigma$ PCBs) concentrations, the females had higher levels in all tissues than male except digestive tract (DDT). However, the mesenteric fat (MFat) recorded the highest concentration among the analyzed tissues. The concentrations of polychlorinated biphenyls (PCBs) in mesenteric fat (MFat) represented (4) fold of that in liver in both sex while, those values were (3.5) and (11.8) fold compared to ovary and testes, respectively. Throughout polychlorinated biphenyls (PCBs) congeners, polychlorinated biphenyls (PCBs) (118) can be considered as a dominate one in all tissues of males and females.

The average concentration of polychlorinated biphenyls (PCBs) (110) of all tissues in females recorded (3) fold compared to that of male. Since all polychlorinated biphenyls (PCBs) components have different molecular structure, each component has its own physical and chemical properties, resulting in differences in behavior in environmental processes, such as bioaccumulation (Duniker and Hillebrand, 1983). The descending order of the concentration of the most abundant congeners was (28>138>101>153) in El-Mex bay, at Mediterranean Sea, Egypt in different fish species (*Sargus vulgaris*, *Siganus rivulatus*, *Sphyræna Sphyræna*)

While this order was (28> 101>138) in the same fish species from Lake Maryout in Egypt (El-Nabawi *et al.*, 1987); (Abdallah & Ali, 1994); (El-Nemr & Abdallah 2004). These results are in good agreement with this study.

The ranges of (DDTs, HCHs and PCBs) in *O. mossambicus* collected from (Fo Tan inland water, Hong Kong, China) were (28.2-40 ng/g) (DW), 2-4 ng/g (DW) and (267-310 ng) (DW),

**Table (3)** Mean  $\pm$  SD of organochlorine pesticides (OCs) concentrations (ng/g dw) in male *Tilapia zillii* in Lake El-Manzala, Egypt.

Analyte	Organs					Average	STDEV	Maxim
	Liver	Gonad	Mfat	Flesh	DTC			
HCB	0.7 $\pm$ 0.3	0.3 $\pm$ 0.1	3.8 $\pm$ 1.2	0.24 $\pm$ 0.13	1.1 $\pm$ 0.3	1.23	1.48	3.8
$\alpha$ -HCH	4.1 $\pm$ 1.3	2.1 $\pm$ 0.3	7.7 $\pm$ 2.3	2.2 $\pm$ 0.8	2.5 $\pm$ 3.7	3.72	2.37	7.7
Lindane	2.1 $\pm$ 0.9	2.5 $\pm$ 0.9	4.1 $\pm$ 1.3	1.2 $\pm$ 0.3	3.1 $\pm$ 1.1	2.60	1.09	4.1
$\beta$ -HCH	10.1 $\pm$ 4.3	16.4 $\pm$ 4.3	7.6 $\pm$ 2.3	1.9 $\pm$ 0.5	12.4 $\pm$ 3.3	9.68	5.42	16.4
$\sigma$ -HCH	0.43 $\pm$ 0.11	1.4 $\pm$ 0.05	0.9 $\pm$ 0.3	0.8 $\pm$ 0.2	1.2 $\pm$ 0.5	0.95	0.37	1.4
$\Sigma$ -HCH	16.73	22.40	20.30	6.10	19.20	16.95	6.40	22.4
Heptachlor	0.33 $\pm$ 0.1	0.30 $\pm$ 0.1	0.7 $\pm$ 0.3	0.16 $\pm$ 0.1	0.2 $\pm$ 0.09	0.34	0.21	0.7
c-chlordane	0.38 $\pm$ 0.1	0.29 $\pm$ 0.1	1.1 $\pm$ 0.4	0.33 $\pm$ 0.1	0.4 $\pm$ 0.15	0.50	0.34	1.1
c-nonachlor	0.5 $\pm$ 0.2	0.61 $\pm$ 0.14	0.8 $\pm$ 0.2	0.4 $\pm$ 0.15	0.7 $\pm$ 0.2	0.62	0.18	0.88
Aldrin	2.2 $\pm$ 0.6	3.3 $\pm$ 1.2	4.6 $\pm$ 1.1	0.8 $\pm$ 0.3	0.9 $\pm$ 0.3	2.36	1.62	4.6
$\Sigma$ Eycl.	3.41	4.5	7.3	1.7	2.2	3.82	2.22	7.28
DDE	22.5 $\pm$ 5.1	17 $\pm$ 4.8	69.0 $\pm$ 22.4	7.8 $\pm$ 2.2	9.1 $\pm$ 3.5	25.08	25.27	69
DDD	11.4 $\pm$ 2.3	8.6 $\pm$ 3.1	57.6 $\pm$ 21.5	2.1 $\pm$ 0.1	10.4 $\pm$ 2.6	18.02	22.42	57.6
DDT	0.06 $\pm$ 0.01	0.08 $\pm$ 0.02	0.1 $\pm$ 0.03	0.09 $\pm$ 0.03	ND	0.05	0.04	0.09
$\Sigma$ DDTs	34.0	25.7	126.7	10.0	19.5	43.15	47.47	126.61
OCs	54.80	52.88	158.00	18.03	42.00	65.14	53.93	157.99
PCB52	5.5 $\pm$ 1.4	6.1	15.4 $\pm$ 3.9	0.4 $\pm$ 0.14	1.4 $\pm$ 0.3	5.76	5.93	15.4
PCB101	2.2 $\pm$ 0.6	6.1 $\pm$ 2.4	7.5 $\pm$ 2.2	0.4 $\pm$ 0.2	0.11 $\pm$ 0.04	2.26	3.04	7.5
PCB110	9.7 $\pm$ 2.9	1.1 $\pm$ 0.3	33.2 $\pm$ 6.4	9.4 $\pm$ 2.5	13.1 $\pm$ 3.4	16.74	9.80	33
PCB118	10.5 $\pm$ 3.8	18.5 $\pm$ 4.4	55.5 $\pm$ 29.1	0.6 $\pm$ 0.2	4.5 $\pm$ 1.8	17.22	22.10	55.5
PCB138	6.9 $\pm$ 3.2	15.0 $\pm$ 3.9	31.9 $\pm$ 11.1	0.6 $\pm$ 0.2	1.5 $\pm$ 0.5	8.76	13.16	31.9
PBC180	2.9 $\pm$ 1.1	2.9 $\pm$ 0.7	10.7 $\pm$ 5.2	0.2 $\pm$ 0.07	0.62 $\pm$ 0.3	3.02	4.42	10.7
$\Sigma$ PCBs	37.7	0.7 $\pm$ 0.2	154	11.6	21.23	53.77	57.51	154
GT	92.50	97.18	311.99	29.63	63.23	118.91	111.27	312.0
PI	2.19	2.01	5.19	0.72	0.85	2.19	1.80	5.2
DDT/PCBs	0.90	0.58	0.82	0.86	0.92			

ND : not detected

MFat: mesenteric fat

DT: digestive tract content

respectively, (Zhou *et al.*, 1999). Comparing the results of this study to (Zhou *et al.*, 1999), digestive tract (DDTs) concentrations had the same range, while, (HCHs) and polychlorinated biphenyls (PCBs) had higher and lower concentrations, respectively, than those of *Tilapia zillii* in Hong Kong, China. Two features of gonadal development of fish could affect contaminant amount:

- (1) Size of the tissue.
- (2) Increased lipid content.

Both features could increase the capacity of the gonads to accumulate organochlorine pesticides (OCs) from the diet or through mobilization from other tissues (Westernhagen *et al.*, 1995). Transfer of liver lipids to the ovary has been observed in the North Atlantic flat fish, *Limanda limanda* (Kamman *et al.*, 1993). Concentrations of organochlorine pesticides (OCs) in the present study of *Tilapia zillii* flesh had the same range of that previously reported by (Yamashita *et al.*, 2000) in Lake El-Manzala and

River Nile, Egypt. Variations in the concentrations of the studied lipophilic compounds occur in fish, both between different sexes and between different tissues which may be a result of differences in lipid content, sources of contaminants and physiological and biochemical processes within the fish (Pastor *et al.*, 1996).

Regarding hazard levels, since organochlorine pesticides compounds pose a potential health hazard, the maximum permissible levels of toxic substances recommended for protection of aquatic biota have been published. The National Academy of Sciences and National Academy of Engineering (NAS-NAE 1972) recommended limits of (1,000 ng/g) for (DDTs, 500 ng/g PCB's) and (100 ng/g) dieldrin, endrin, and heptachlor (all as weight concentrations in whole body-tissue). In Sweden, the recommended tolerance limits are (5,000 ng/g) for digestive tract (DDTs), and (200 ng/g) for (HCB) (Swedish Food Regulation, 1983). From a public

health stand point, residue levels of organochlorines in all analyzed biota in this investigation are considerably lower than these tolerance levels. Moreover, Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota recommended tolerance limit to be (14.0 ng/g) for digestive tract (DDT) (CCME 2001).

### Conclusion

The study showed that female *Tilapia zillii* had higher concentrations of the studied pollutants than the male fish. The ratios of digestive tract (DDTs) to polychlorinated biphenyls (PCBs) concentrations in females and males fish for all studied tissues less than (1.0) mostly indicating that agriculture waste dumping in Lake El-Manzala, Egypt is more than industrial waste as a source of persistent organic contaminants in this area. The low lipid content of flesh may be one factor influencing the low concentrations of polychlorinated biphenyls (PCBs) and Organochlorine pesticides (OCs) in this tissue in both sexes. For this reason, consumption of *Tilapia zillii* fish from the studied lake by human is not thought to be of a significant health hazard. According to this tolerance, the levels of organochlorine pesticides (OCs) in *Tilapia zillii* in this study are still safe for consumption. However, further monitoring of these contaminants in the aquatic ecosystem is recommended to insure the protection of food sources in Egypt.

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