RISK ASSESSMENT OF ORGANOCHLORINE INSECTICIDES AND POLYCHLORINATED BIPHENYLS (PCB_S) ASSOCIATED WITH FISH CONSUMPTION BY FISHERMEN'S FAMILIES IN EDKU REGION, EGYPT

ABDEL-HALIM, K. Y. [1], SAMIA A. ABO-SEDA[1] AND NABILA M. BAKRY[2]

1. *Mammalian &aquatic Toxicology Department, Central Agricultural Pesticides Lab. (CAPL), ARC, Ministry of Agriculture, Egypt*
2. *Department of Pesticide Chemistry& Toxicology, Faculty of Agriculture, Alexandria University, Egypt.*

Abstract

Persistent organic pollutants such as organochlorine compounds (OCC_s) and polychlorinated biphenyls (PCB_s) were monitored in ventral muscles of Bolti fish *Tilapia sp* collected seasonally during 2006/2007 from Edku Lake. The potential health risks imposed on community residents consuming fish, were the main target of the current study. The mean values of OCC_s residues were 69.71, 19.03, and 15.23 ppb for lindane, endosulfan, and heptachlor, respectively. Chronic daily intake (CDI) of the detected pollutants was estimated associated with fish consumption for adults and children at both 50^{th} and 90^{th} percentiles of probability. The highest values of CDI were recorded 2.37E-03, 6.40E-04 and 3.30E-04 mg. $kg^{-1}.day^{-1}$ for lindane, endosulfan and ΣPCB_s, respectively, among adults at 90^{th} percentile. Adults are expected to be exposed to higher burden of risk than children *via* fish consumption where, risk values of OCC_s recorded were 6.58E-04 and 2.67E-03, while they were 1.31E-05 and 1.32E-04 for PCB_s at 50^{th} and 90^{th} percentiles, respectively.

Residents (either adults or children) may be at risk under the current exposure estimations since the predicted risk values exceeded the EPA threshold value (1.0E-04- 1.0E-06) particularly at 90^{th} percentile. Furthermore, Total Target Hazard Quotient (TTHQ) showed a higher trend than unity (1.13-11.23) for adults and (0.66-5.08) among children at 50^{th} and 90^{th} percentiles. Risk factors must be prevented from this region, where the estimated risks were greater than unity resulting in adverse health effects, which may be associated with high fish consumption.

Keywords: Fish, organochlorine, polychlorinated biphenyls, risk estimation, Edku habitants.

INTRODUCTION

Persistent organic pollutants (POP_s) are chemicals that may persist for a long period of time in the environment. These chemicals are prone to long –range transport through the upper levels of atmosphere and can be deposited 1000 miles away from the pollution source. They

Corresponding author: khaled_yassen68@yahoo.com

are characterized by being lipophilic (high octanol-water partition coefficient K_{ow}) and hydrophilic. Due to the persistence and lipophilic properties of them, they are able to accumulate in the ecosystem. In addition to carcinogenic/ mutagenic potential they may cause toxic effects on animal's reproduction, development, and immunological function (Suchan *et al.,* 2004).

Food consumption accounts for >90% of human exposure compared to other ways such as inhalation and dermal contact. The major food sources of POP_s had been reported to be fat-containing animal's products, fish and shellfish (Asplund *et al.,* 1994, Fries, 1995, Liem *et al.,* 2000, and Lai *et al.,* 2004). Seafood, particularly marine and freshwater fish, is a major component of the local diet of coastal cities, where fish consumption rate is about 10 times that of the average quality of seafood consumed in rest of countries (FAO, 1980a). As an example, it is estimated that an average Hong Kong person consumes of four or more times fish or shellfish per week (164.4 g. day^{-1})(Dickman and Leung, 1998), in New South Wales, Austrian was 104 fish meals per year from fishing survey. In our study, the estimated fish consumption rates were ranged from 100 to 300 g. day^{-1}. $person^{-1}$. On the other hand, based on FAO reports, dairy products, fish/seafood and meat account for long 12.4% of the whole Egyptian food consumption (Loutfy *et al.,* 2006).

Several studies have been conducted in different parts of the World for determining POP_s such as PCB_s and OC pesticides content of the food (Newsome *et al.,* 1998, Zuccota *et al.,* 1999, Saeed *et al.,* 2001, Binelli and Provini, 2003, Bordajandi *et al.,* 2003, Suchan *et al.,* 2004 and Mazet *et al.,* 2005). While, risk assessment associated with food consumption was conducted from other studies (Bickford *et al.,* 1999, Von-Stackelberg *et al.,* 2002, Binelli and Provini, 2003, Llobet *et al.,* 2003, Yamaguchi *et al.,* 2003, Stefanelli *et al.,* 2004, Jiang *et al.,* 2005, Cheung *et al.,* 2006 and Llobet *et al.,* 2007). Thus the current study was aimed to determine the levels of POP_s in fish tissue samples collected from Edku Lake during 2006/2007 to assess the potential risk to which the inhabitants consuming these fish are exposed.

MATERIALS AND METHODS

2.1. Chemicals.

An analytical standards of organochlorine mixtures α,β, and γ isomers HCH, heptachlor, heptachlor epoxide, γ-chlordane, endosulfan, *p,p'*-DDE, endrin, *p,p'*-DDD and *p,p'*-DDT were obtained from EPA-Research Triangle Park, N.C, USA. The mixture of indicator PCB_s (IUPAC numbers 28, 52, 44, 70, 101, 152, 118, 105, 138, 180 and 192) in isooctane were obtained from Dr. Ehrenstorfer (Germany). The solvents used (e.g. methylene chloride, *n*-hexane and ethanol) were all supplied by Merck (Germany). Pure sulphric acid (98%), anhydrous sodium sulphate and potassium hydroxide were obtained from BDH Lt'd Company. All chemicals were of analytical grade purity.

2.2. Studied region and Sampling.

The selected Lake lies in the north site of El-Behira governorate, longitude 30˚ 8′ 30″ and 30˚ 23′ 00″E and latitude 31˚ 11′ 00″ and 31˚ 18′ 00″N. It is connected with the Mediterranean Sea through Me'Adeyyah strait (Masoud *et al.,* 2004). The area of the Lake is about 8,000 hectares and the depth of water ranging from 1.5 to 2.5 m. Four drains (Edku, El-Khairy, Barseq and El-Bousaly) and some irrigation canals are considered the main source of industrial, agricultural runoff, and sewage. Over 2000 fishermen work into the Lake for fish catching and farming at a large scale. The Bolti fish *Tilapia sp* is the common species. Five sites were selected for sampling: El-Morda (1), Me'Adeyyah strait (2), Middle of the Lake (3), Barseq pumps (4) and Kom Belage (5)(Fig.1).

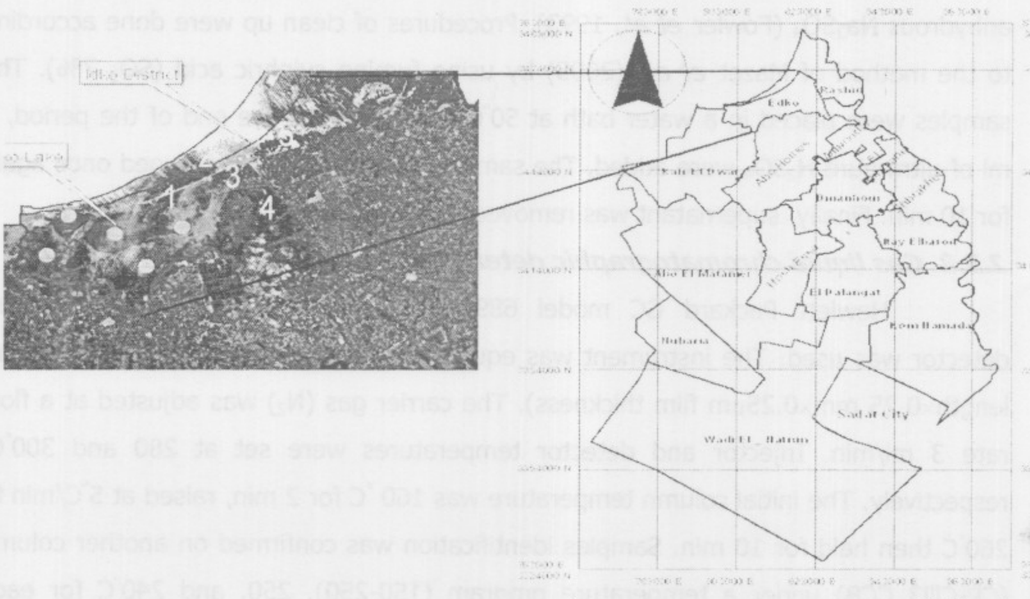

Fig 1. Sampling sites of fish caught from the Lake.

Fish samples, *Tilapia sp* were collected seasonally during 2006/2007 from the selected zones as marked in the geographic map. The samples were refrigerated, transported to the laboratory and stored at -20°C until time of analysis. Lake contamination, environmental problems and residents behavior of Edku region was investigated through questionnaires conducted on over 50 persons in Edku and Me'Adeyyah regions. The risk factors tested through the survey, were the untreated effluents dumped into the Lake, known to decrease fish population species and quality due to lack of laws and management of fish catching and farming programs. 64% of the inhabitants consume high rates of *Tilapia sp.* in their diet compared with meat, fruits, vegetables, and milk products. Thus, the average fish consumption rates were estimated to be 100-300 g. $day^{-1}.person^{-1}$. The average body weight was 70 kg for adults and 18 kg for children, a similar value of that obtained by USEPA (IRIS, 2005).

2.3. Determination of POP_s in fish.

2.3.1. Residue analysis.

Fish samples were dissected and the flesh tissues (20 gm, each) were homogenized with the same weight of anhydrous Na_2SO_4 to a free flowing powder. Then placed in Soxhelt apparatus and extracted for 18 hrs using 200 ml of CH_2Cl_2: *n*-hexane (3:1 v/v). The extract was rotary evaporated to 10 ml and dried on anhydrous Na_2SO_4 (Fowler *et al.,* 1993). Procedures of clean up were done according to the method of Mazet *et al.,* (2005) by using fuming sulphric acid (SO_3 7%). The samples were placed in a water bath at 50°C for 30 min. At the end of the period, 2 ml of ultra pure H_2SO_4 were added. The samples vortexed and centrifuged once again for 10 min. Finally, supernatant was removed and kept until analysis.

2.3.3. Gas liquid chromatographic determination.

Hewlett Packard GC model 6890 equipped with Ni^{63}-electron capture detector was used. The instrument was equipped with DB-68 capillary column (30m length×0.25 mm×0.25μm film thickness). The carrier gas (N_2) was adjusted at a flow rate 3 ml/min. Injector and detector temperatures were set at 280 and 300°C, respectively. The initial column temperature was 160 °C for 2 min, raised at 5°C/min to 260°C then held for 10 min. Samples identification was confirmed on another column (CP-Cill3 CCB) under a temperature program (150-250), 250, and 240°C for each column, detector and injection port, respectively. The nitrogen flow rate was 3.4 ml/min. Results were calculated for each individual compound and adjusted by recovery percentages.

2.4. Risk estimation.

The risk of contaminated fish consumption was estimated based on guidelines of EPA (USEPA, 1985, 1999a and 2002), concentrations of POP_s, data of surveyed questionnaire conducted on fishermen and some data of Integrated Risk Information System (IRIS, 2005).

The chronic daily intake (CDI)(mg. kg^{-1}. day^{-1}) from fish ingestion was estimated using the following formula:

$$CDI = \frac{C . I_R . E_D . E_F}{B_W . A_T}$$

where C is the concentration of chemical expressed as mg. kg^{-1}. day^{-1}, I_R is the ingestion rate (estimated under Edku community), E_D is the average period (9 year, average adult, USEPA, 1989b), E_F is the exposure frequency (meal. Year^{-1})(estimated). Body weight (B_W)(70 kg, adult average/ 18 kg, average children, USEPA, 1989c) and A_T is the averaging time (365 day. Year^{-1}, USEPA, 1989c).

Estimation of cancer risks through ingestion route depend on the availability of cancer slope factors which are provided on USEPA Web site (USEPA, 2002, IRIS, 2005). In brief, cancer risk was estimated as follows:

$$Risk_{oral} = CDI_{oral} .S.F_{oral}$$

Total cancer risk was assumed of risk values of all chemicals.

On the other hand, non-carcinogenic risk was evaluated based on the reference doses (RfD_S). Target Hazard Quotient (THQ) of chemicals *via* ingestion route was calculated as follows:

$$THQ = \frac{CDI}{RfD}$$

where, RfD is the reference dose of specified substances (USEPA, 2002, IRIS, 2005). Total THQ (TTHQ) is the sum of more than one hazard quotient for multiple substances.

Statistical analysis.

Coefficient of variation percentage between obtained data was determined by (Gomez and Gomez, 1984). Exposure estimation data were tabulated according to differences in age between adults and children. All exposure estimations, risk and hazard calculations were performed according to the 50th and 90th percentiles of probability.

RESULTS AND DISCUSSION

The risk factors and human impact of the selected region were obtained through screening questionnaires. Contamination sources of this region were industrial, agricultural runoff and sewage effluents. Most of the surveyed people (64%) consume high rates of fish in their diets. The average fish consumption rates were found to be from 100 to 300 g. day^{-1}. $person^{-1}$.

3.1. Residue levels of POP_s and PCB_s.

Organochlorine compounds (OCC_s) and polychlorinated biphenyls (PCB_s) residues in fish tissue samples collected from Edku Lake are shown in Table 1. Residues of organochlorine insecticides were higher than those of PCB_s. Lindane residues ranged from 3.52 to 135.9 ppb. Residues of heptachlor and endosulfan were 15.23 and 19.03 ppb, respectively. DDT concentration largely varied at most sites of sampling with a highest value of12.99 ppb for *p, p'*-DDT. While, *p, p'*-DDE showed the lowest value of 0.09 ppb. Based on the amount of concentrations detected, the decreasing order of the chemicals tested were as follow: lindane> endosulfan >heptachlor> ΣDDT >*p, p'*-DDT.

PCB congeners which showed response or accumulation in fish tissues were congeners 44, 105, 138, and 180. Congeners 44 and 105 were most detected in all samples and accounted for 5.69 and 11.71 ppb, respectively. On the other hand, congeners 152, 118 and 101 were the lowest detected at ranges from ND to 3.73 ppb. Recovery percentages ranged from 64.1 to 100%.

Table 1. Concentrations of organochlorine pesticides and PCB_s (ppb) in fish samples collected from Edku Lake.

chemical	Concentration (ppb)		mean	N	C.V. %
	minimum	maximum			
Lindane	3.52	135.9	69.71	2	0.1
Heptachlor	3.05	27.4	15.23	2	0.1
Hept. Epoxide	ND	0.58	0.20	1	0.05
Endosulfan	0.83	91.61	19.03	6	0.3
Dieldrin	0.35	3.75	1.52	7	0.35
Endrin	0.25	8.63	2.54	8	0.40
p,p'-DDE	0.09	1.12	0.61	3	0.15
p,p'- DDD	0.24	1.27	0.93	7	0.35
p,p'-DDT	0.15	12.99	3.73	6	0.3
ΣDDT	0.48	15.38	7.97	-	-
Congeners					
44	0.08	5.69	1.32	9	0.23
105	0.13	11.71	4.38	3	0.08
138	0.04	1.54	0.71	6	0.15
152	ND	0.44	0.22	1	0.03
118	ND	1.61	0.81	1	0.03
180	0.14	0.64	0.39	2	0.05
101	ND	3.73	1.87	1	0.03
$ΣPCB_s$	0.034	5.69	9.86	-	-

ND= indicates not detected (below detection limit). N= number of positive samples. C.V %= Coefficient of variation.

The maximum admissible concentration (μg. g^{-1} w. w) of organochlorine residues established by the EU for human consumption (97/41/CE, 99/65/CE, 99/71/CE) on the basis of the lipid percentage of food was shown in Table 2 (Binelli and Provini, 2003). On the other hand, the maximum concentration of total PCB_s allowed by the Food and Drug Administration (FDA) in edible seafood is 2 μg. g^{-1} on a wet weight basis (FDA, 2001), a threshold not exceeded by all the samples.

Table 2. EU organochlorine limit (μg. g^{-1} w. w) acceptable for human consumption.

class	Lipid percentage	ΣDDT	Lindane	Other HCH isomers	HCB
1	≤ 5	0.05	0.025	0.01	0.01
2	>5-20	0.10	0.05	0.02	0.02
3	> 20-40	0.15	0.10	0.08	0.04
4	> 40	0.50	0.10	0.08	0.08

The previous studies conducted in Egypt showed that, chlorpyrifos, DDT, dimethoate, methomyl and thiodicarb did not pose a direct hazard to human health in Menia El-Kamh (Tchounwou *et al.,* 2002). But Abdel-Halim (2008) assessed the risk of heavy metals associated with fish consumption by Edku habitants. Hazard value was greater than unity (3.64 at 90^{th} centile).

The results indicated above slow clearly that fish is a suitable bioindicator for monitoring POP_s (UNEP, 2003), to investigate the relationship between POP_s contents in fish and the ambient surrounding environment.

3.2. Absorbed doses.

Chronic daily intake (CDI_s) of POP_s *via* fish consumption by adults and children of fishermen's families was presented in Table 3. The values of CDI varied for all POP_s according to consumption rates and duration periods. Lindane and ΣDDT showed the highest values (2.37 E-03 and 1.81E-04 mg. kg^{-1}. day^{-1}), respectively, based on 90^{th} percentiles among adults. While, they reached 1.10E-03 and 1.32E-03 mg.kg^{-1}. $day^{-1}$for children at the same probability. In contrast, heptachlor epoxide, dieldrin and endrin recorded the lowest values (3.95E-07, 3.00E-06 and 5.01E-06 mg. kg^{-1}. day^{-1}), respectively, for children at 50^{th} percentile. On the other hand, ΣPCB_s accounted for 3.28E-05 and 1.01E-05 mg. kg^{-1}.day^{-1} for adults and children, respectively, at 50^{th} percentile of exposure. The results obtained were lower than those reported by the Agency for Toxic Substances and Disease Registry (ATSDR) (Table 4). The permissible values of minimal risk levels (MRL_s) for POP_s are 5.0E-04, 6.0E-04, and 3.0E-05 mg. kg^{-1}. $day^{-1}$for DDT, lindane, and PCB_s (Aroclor 1254), respectively, (ATSDR, 1996).

The estimated intake of total PCB_s by the general population depends greatly on the geographic area and eating habits. As an example, the average intake of 5-15 µg. day^{-1} for the general population in industrial countries.

Table 3. Chronic daily intake (CDI) of POP_s *via* fish consumption pathway.

chemical	Absorbed dose (mg. kg^{-1}. day^{-1})			
	adult		children	
	50th	90th	50th	90th
Lindane	2.41E-04	2.37E-03	1.37E-04	1.10E-03
Heptachlor	5.14E-05	5.10E-04	3.01E-05	2.40E-04
Hept. Epoxide	6.76E-07	6.71E-06	3.95E-07	3.16E-06
Endosulfan	6.43E-05	6.40E-04	3.75E-05	3.01E-04
Dieldrin	5.14E-06	5.10E-05	3.00E-06	2.41E-05
Endrin	8.59E-06	8.61E-05	5.01E-06	4.01E-05
∑DDT	1.78E-05	1.81E-04	1.04E-03	1.32E-03
∑PCB_s	3.28E-05	3.30E-04	1.01E-05	1.53E-04

Table 4. Minimal risk levels proposed by ATSDR for hydrochlorinated compounds.

name	duration	MRL (mg. kg^{-1}. day^{-1})	Factors of uncertainty	Endpoint
DDT	Acute	0.0005	1000	Develop.
	intermediate	0.0005	100	Hepat.
HCB	Acute	0.008	300	Develop.
	Intermediate	0.0001	90	Reprod.
	chronic	0.00002	1000	Develop.
lindane	Acute	0.01	100	Neuro.
	intermediate	0.00001	1000	Immune.
Isomers of other HCH	Acute	0.2	100	Neuro.
	Intermediate	0.0006	300	Hepat.
	chronic	0.008	100	Hepat.
PCB_s	Intermediate	0.00003	300	Neuro.
	chronic	0.00002	300	Immune.

On the other hand, in costal cities, consumption of contaminated seafood is the main pathway of human exposure. A large percent (75%) of DDT intake by Chinese was attributed to the consumption of marine food (Nakata *et al.*, 2002). Exposure to other OCC_s *via* fish consumption contributed large percentage (67% of chlordane and 60% of PCB_S) in the total exposure from all foods (Dougherty *et al.*, 2000).

3.3. Cancer risk

Estimated cancer risk resulting from fish consumption in Edku region by residents was presented in Table 5. Cancer values of POP_s were estimated on both adults and children at each of 50^{th} and 90^{th} percentiles of exposure. Lindane and heptachlor reached the highest values of cancer risk at both categories of habitants. For adults, they were 4.27E-04 and 2.11E-03, while among children they were 2.47E-04 and 1.23E-04 at 90^{th} percentile. Total risk of examined pesticides was 2.67E-03 and 3.00E-03 for adults and children, respectively, indicating that children were at greater risk than those of adults. On the other hand, PCB_s recorded values are higher among adults than those of children. They were (1.31E-05 and 1.32E-04) and (7.64E-06 and 6.12E-05) at 50^{th} and 90^{th} percentile, respectively. Thus all residents (either adults or children) are suggested to be at risk since the calculated risk values exceeded the cancer risk by 1.0E-04 to 1.0E-06.

Several studies focused on human health risk associated with seafood's consumption: in U.S (Dougherty *et al.*, 2000), Canada (Berti *et al.,* 1998), China (Jiang *et al.,* 2005), Hong Kong (So *et al.,* 2005), Italy (Binelli and Provini, 2003), and in Egypt (Tchounwou *et al.,* 2002 and Abdel-Halim, 2008).

There has been an increase in public concern that chronic low exposure to pesticide residues in food might pose a serious cancer risks to the general population (Hodgson and Levi, 1996). While, epidemiological studies have often considered pesticides as causative agents in human cancer (Blair and Zahm, 1991 and Blair, 1993), it has usually been at a marginal level of significance. Most of OCC_s are classified by EPA as a B_2 carcinogen, based on the induction of malignant liver tumors in several strains of mice. Also, PCB_s were cited in the same category.

3.4. Non-cancer risk

Values of HQ on both age categories are presented in Table 5. Lindane was the most compound causing hazard effect with value of 7.90 on adults at 90^{th} percentile. Endosufan had the lowest value in all cases of probabilities. TTHQ of the examined pesticides reached the values 11.23 and 5.08 for adults and children, respectively, at 90^{th} percentile of exposure. $\sum PCB_s$ showed the value 1.65 on adults. TTHQ values resulting from fish ingestion exceeded the threshold value (HI= 1) indicating alarming signs of toxicity for both age categories. Doses below the threshold level seemed to be metabolized and passed out of the body without harm. Exposure to the same group of toxicants may be having an additive or even synergistic effect on the same organ system, which may increase the risk. It was reported that, DDT had toxic effects on the gastrointestinal tract, heart, immune system, and nervous system (ATSDR, 1989). Endrin was also classified as carcinogen and poisons the central nervous system and liver. It was also reported to produce malformation when given to mammals during pregnancy, and to have immunologic effect (ATSDR, 1992).

Table 5. Cancer and non-cancer risk associated with contaminated fish consumption.

chemical	Weight of evidence	S. F (mg. kg^{-1}.day^{-1})$^{-1}$	Cancer risk values			
			Adults		Children	
			50th	90th	50th	90th
Lindane	S	1.8	4.34E-04	4.27E-04	2.47E-04	1.98E-03
Heptachlor	B_2	4.1	2.11E-04	2.11E-03	1.23E-04	9.84E-04
Hept. Epoxide	B_2	9.1	6.15E-06	6.11E-05	3.59E-06	2.88E-05
Dieldrin	B_2	0.16	8.22E-07	8.16E-06	4.80E-07	3.86E-06
ΣDDT	B_2	0.34	6.05E-06	6.15E-05	3.54E-06	4.49E-06
Σrisk		-	6.58E-04	2.67E-03	3.78E-04	3.00E-03
ΣPCB$_s$	B_2	0.4	1.31E-05	1.32E-04	7.64E-06	6.12E-05
		RfD (mg. kg^{-1}. day^{-1})	Non-cancer risk values			
lindane	S	3.0E-04	0.80	7.90	0.46	3.67
Heptachlor	B_2	5.0E-04	0.10	1.02	0.06	0.48
Hept. Epoxide	B_2	1.3E-05	0.05	0.52	0.03	0.24
Endosulfan		6.0E-03	0.01	0.11	0.01	0.05
Dieldrin	B_2	5.0E-05	0.10	1.03	0.06	0.48
Endrin	D	3.0E-04	0.03	0.29	0.02	0.13
ΣDDT	B_2	5.0E-04	0.04	0.36	0.02	0.03
TTHQ		-	1.13	11.23	0.66	5.08
ΣPCB$_s$	B_2	2.0E-04	0.08	1.65	0.11	0.81

S.F: slope factor, RfD: reference dose of examined chemicals (IRIS, 2005).

CONCLUSION AND RECOMMENDATIONS

Based on the assumption that over 50,000 (CAPMAS, 2006) people living in Edku have a lifespan of 70-year, those people could get more risk in the future through fish consumption. Thus it is recommended to monitor exposure levels using fast and efficient tools. Also, source points of risks, should be identified carefully and remediation programs, especially waste treatment must be carried out to minimize the risk factors in this region.

REFERENCES

1. Abdel-Halim, K. Y. 2008. Health risk assessment of heavy metals associated with fish consumption in Edku region, Egypt. J. Pest Cont. & Environ. Sci. 16, (1/2): 1-16.

2. Aspund, L., B. G. Svensson, A. Nilsson, V. Eriksson, B. Jansson, S. Jensen, U. Widqvist and S. Skerfving. 1994. Polychlorinated biphenyls, 1,1,1-trichloro-2,2-bis (*P*-chlorophenyl) ethane (*p,p'*-DDT) and 1,1-dichloro-2,2-bis (*P*-chlorophenyl)-ethylene (*p,p'*-DDE) in human plasma related to fish consumption. Arch. Environ. Health 49, (6): 477-486.

3. ATSDR. 1989. Toxicological profile for chlordane. Agency for toxic Substances and Disease Registry. Atlanta, GA: U. S. Department of Health and Human Services.

4. ATSDR. 1992. Public Health Assessment Guidance Manual. Agency for toxic Substances and Disease Registry. Atlanta, GA: U. S. Department of Health and Human Services.

5. ATSDR. 1996. Minimal risk levels (MRL_S) for hazardous substances. US Department of Health and Human Services, Public Health Service, Atlanta, GA, pp. 347.

6. Beri, P. R., O. Receveur, H. M. Chan and H. V. Kuhnlein. 1998. Dietary exposure to chemical contaminants from traditional food among adult Dene/Metis in the western Northwest Territories, Canada. Environ. Res. 76, 131-142.

7. Bickford, G., J. Toll, J. Hansen, E. Baker and R. Keessen. 1999. Aquatic ecological and human health risk assessment of chemical in wet weather discharges in the Sydney region, New South Wales, Australia. Marine Poll. Bull. 39, (1-2): 335-345.

8. Binelli, A. and A. Provini. 2003. POP_S in edible clams from different Italian and European markets and possible human health risk. Marine Poll. Bull. 46, 879-886.

9. Blair, A. and S. H. Zahm. 1991. Cancer among farmers. In: Cordes DH Rea DF (eds), Occupational Medicine: State of the Art Reviews. Philadephia: Hanley & Belfus, pp. 210-214.

10. Blair, A., M. Dosemeci and F. F. Heineman. 1993. Cancer and other causes of death among male and female farmers from twenty-three states. Am. J. Ind. Med. 23, 729- 742.

11. Bordajandi, L. R., G. Gomez, M. A. Fernandez, E. Abad, J. Rivera and M. J. Gonzalez. 2003. Study on PCB_s, PCDD/F_s, organochlorine pesticides, heavy metals and arsenic content in freshwater fish species from the River Turia (Spain). Chemosphere 53, 163-171.

12. CAPMAS. 2006. Central Authority of population mobilization and statistics. website<www.msrintranet.capmas.gov.eg./pls/indcs/cs_st_004m>

13. Cheung, K. C., H. M. Leung, K. Y. Kong and M. H. Wong. 2006. Residual levels of DDT_s and PAH_s in freshwater and marine fish from Hong Kong markets and their health risk assessment. Chemosphere 61, 810-816.

14. Dickman, M. D. and K. M. C. Leung. 1998. Mercury and organochlorine exposure from fish consumption in Hong Kong. Chemosphere 37, 991-1015.

15. Doughtery, C. P., S. H. Holtz, J. C. Reinert, L. Panyacosit, D. A. Axelrad, T. J. Woodruff. 2000. Dietary exposure to food contaminants across the United States. Environ. Res. 84, 170.

16. FAO (1980a). Food balance sheets and per caput food supplies, Rome, Food and Agriculture Organization of the United Nations.

17. FDA 2001. Food and Drug Administration. Code of Federal regulations, vol. 2 pp. 213-215.

18. Fowler, B., D. Hoover and C. Hamilton. 1993. Chemosphere 27, 1891-1905.

19. Fries, G. F. 1995. A review of the significance of animal food products as potential pathways of human exposure to dioxins. J. Anim. Sci. 73, 1639-1650.

20. Gomez, K. A. and A. A. Gomez. 1984. Statistical Procedures for agricultural Research 2nd ed. John Willy and Sans. New York, USA.

21. Hodgson, E. and P. E. Levi. 1996. Pesticides: an important underused model for the environmental health sciences. Environ. Health Perspect. 104, (Suppl. 1): 97-106.

22. IRIS 2005. Integerated Risk Information System, US Environmental Protection Agency, Cincinnati, OH. Accessed at: <http://www.epa.gov/iris>.

23. Jiang, Q. T., T. K. M. Lee, K. Chen, H. L. Wong, J. S. Zheng, J. P. Giesy, K. K. W. Lo, N. Yamashita and P. K. S. Lam. 2005. Human health risk assessment of organochlorines associated with fish consumption in a coastal city in China. Environ. Poll. 136, 155-165.

24. Lai, K. P., W. Li, Y. Xu, M. H. Wong and C. K. C. Wong. 2004. Dioxin-like components in human breast milk collected from Hong Kong and Guangzhou. Environ. Res. 96, 88-94.

25. Liem, A. K. D., P. Furst and C. Rappe. 2000. Exposure of populations to dioxins and related compounds. Food. Addi. Contam. 17, 241-259.

26. Llobet, J. M., J. L. Domingo, A. Bocio, C. Cases, A. Texyide, and L. Muller. 2003. Human exposure to dioxins through the diet in Catalonia, Spain: Carcinogenic and non-carcinogenic risk. Chemosphere 50, 1193-1200.

27. Llobet, J. M., G. Falco, A. Bocio and J. L. Domingo. 2007. Human exposure to polychlorinated naphthalenes through the consumption of edible marine species. Chemosphere 66, 1107-1113.

28. Loutfy, N., M. Fuerhacker, P. Tundo, S. Raccanelli, A. G. El-Dien and M. T. Ahmed. 2006. Dietary intake of dioxins-like PCBs, due to the consumption of dairy products, fish/seafood and meat from Ismailia city, Egypt. Sci. Total Environ. 370, 1-8.

29. Masoud, M. S., A. Abdel-El-Samie, E. Alaa. 2004. Metal distribution in water and sediments of Lake Edku, Egypt. Egypt. Sci. Maga. 1, (1): 13-22.

30. Mazet, A., G. Keck and P. Berny. 2005. Concentrations of PCB_s, organochlorinated pesticides and heavy metals (lead, cadmium, and copper) in fish from the Drome river: Potential effects on otters (*Lutra lutra*). Chemosphere 16, 810-816.

تقييم مخاطر التعرض للمبيدات الكلورونية والمركبات الهيدروكلورونية الثابتة بيئيا من خلال استهلاك الأسماك في منطقة إدكو–مصر

خالد ياسين عبد الحليم[١] ، سامية علي أبو سعده[١] ، نبيلة محمد بكري

١. *قسم سمية المبيدات للثدييات والأحياء المائية–المعمل المركزي للمبيدات–مركز البحوث الزراعية– وزارة الزراعة–مصر*

٢. *قسم كيمياء وسمية المبيدات– كلية الزراعة–الشاطبي– جامعة السكندرية–مصر.*

الملوثات العضوية الثابتة بيئيا تم رصدها في أنسجة اسماك البلطي المأخوذة موسميا خلال ٢٠٠٦/٢٠٠٧ من بحيرة إدكو. متوسط المتبقي كان ٦٩،٧٢ ، ١٩،٠٣ و١٥،٢٣ جزء في البليون لكل من اللندين ، اندوسلفان والهبتاكلور على التوالي. المقدار المأخوذ يوميا تم حسابه لكل من البالغين والأطفال عند احتمالات تعرض ٥٠ ، ٩٠ %. أعلى قيمة للمقدار المأخوذ يوميا كانت $٢،٣٧ \times ١٠^{-٣}$ ، $٦،٤ \times ١٠^{-٤}$ ، $٣،٣ \times ١٠^{-٤}$ مجم/كجم/يوم لكل من اللندين ، اندوسلفان و الهيدروكلورينات الثابتة على التوالي للبالغين عند احتمال تعرض ٩٠%. قيم الخطر السرطاني وصلت إلى $٦،٥٨ \times ١٠^{-٤}$ ، $٢،٦٧ \times ١٠^{-٣}$ للمبيدات الكلورونية بينما كانت $١،٣١ \times ١٠^{-٥}$ ، $١،٣٢ \times ١٠^{-٤}$ للمركبات الهيدروكلورنية عند احتمال تعرض ٥٠ ، ٩٠ % على التوالي.

على الجانب الآخر قيم معامل التأثير الغير سرطاني(THQ) كانت أعلى من الحد المسموح به من الــ EPA حيث وصل إلى ١،١٣–١،٢٣ للبالغين و٦٦،٠–٥،٠٨ للأطفال عند احتمالات تعرض ٥٠ ، ٩٠%. من هذا يتضح أن هناك مخاطر متزايدة مع الاستهلاك المستمر للأسماك المأخوذة من هذه المنطقة لذا نوصي بعمل إدارة للخطر في هذه المنطقة.