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RESEARCH ARTICLE

Distribution of Organochlorine Pesticide (OCPs) Residues in Water and Sediment from Euphrates River, Iraq

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Abstract

The distribution and levels of organochlorine pesticides residues in water and sediment were determined along Euphrates river from June 2013 to May 2014.

The water and sediment samples analyzed using GC-MS. In all the water and sediment samples analyzed ,OCPs residues determined (TCMX, Alph-BHC, Gamma-BHC, Beta-BHC ,Delta –BHC, Heptachlor, Aldrin , Heptachlor-epoxide, Trans-chlordane, Cis-chlordane P,P,-DDE ,Endosulfan I, Dieldrin,Endrin,P,P,- DDD, EndosulfanII , p, p,-DDT, Endrin aldehyde, Methoxychlor, Endosulfan sulfate, Endrin Ketone, Decachlorobiphenyl) were present .

The level of Endrin ketone (24.7%) was highest in water samples followed by Endrin aldehyed (22.5%) and TCMX as lowest level (0.490 %) .

The pesticides residues in sediment samples were ranged between 211.104 µg/g as highest value in site 1 and 29.389 µg/g as lowest value in site 3 .

In this study, the concentrations of OCPs in water lower than that of sediment. The pesticides may be washed into Euphrates River by leaching from agriculture lands, rain fall and fisheries.

The results showed that Euphrates river was still contaminated by organochlorine pesticides and their residues despite bans on the production and usage over a long time.

INTRODUCTION

Water pollution with pesticide associated with declined of water quality has been detected in different aquatic systems in various location (Zhou *etal* , 2006)

Water and sediments play an important role in the distribution of pesticide in aquatic system , while organochlorine pesticide molecules can dissolve in water a large proportion binds to suspended particles and sttles at the bottom of the water body (Akan *et al* ., 2014) . Organochlorine pesticides (OCPs) have been of worldwide concern due to their chronic toxicity , persistence , accumulate in biota and potential negative impacts on human and wild life (Erkmen *et al* .,2013) .

Input pathways of orangchlorine pesticids into the river systems include run-off from non- point sources , discharge of domestic sewage and industrial wastewater and wet or dry deposition (Yang *et at* ., 2005) .Residues and metabolites of the many OCPs are very stable ,with long half lives in the environment (El_ Mekkawi *et al* ., 2009) and these compounds are characterized by low polarity , low aqueous solubility and high lipid solubility and bioaccumulation in the food chain posing to human and the environment globally (Afful *et al.*, 2010) .The persistent nature of orangchlorine residues in the environment may pose the problem of chronic toxicity to animals and human via air, water and food intke and many environmental

effects such as reproduction bird defects , immune system dysfunction ,endocrine disruptions and cancer (Rao *et at*., 2014)

Orangchloride pesticides fate and distribution in aquatic environment has influenced by weather spically temperature (Falahudin and Munawir, 2012).

OCPs could distribute to the components of the ecosystem such as water and sediment ,and accumulate in the biota. The sediment reservoir is important because it serves as a sink from which water and biota are continuously polluted (William, 2013).Hight polluted sediments are adversely affecting the ecological functioning of rivers due to persistence in the environment and long range transport(Raghuvanshi *et at*., 2014)

Acute toxic effects of OCPs can influence the survival or reproduction of aquatic species leading to the disruption of predator - prey relationships and a loss of biodiversity. Moreover, OCPs showed very resistant characteristic to microbial degradation and are employed to control ectoparasites of farm animals and pests (Shingga *et al*., 2015)

The distribution and level of residues of OCPs present in the environmental compartments should be ascertained to understand their dynamic , and predict resultant effects (Sikoki *et el.*,2014)

Long rang transport of OCPs could be another possible route of contamination . OCPs become concentrated in different environmental matrix via biogeochemical processes that further deposite on the bottom of sediments (Mahmood *et al*.,2014)

The levels and distribution in water and sediments can provide a valued record of pollution in the aquatic ecosystem(Syed and Malik, 2011)

The concentration of OCPs have been detected in almost all segments of environment due to their extensive use in past , which have shown potential to biomagnified / accumulate in animal tissue , human blood, adipose tissue and breast milk (Raghuranshi *et al*., 2014).

This study was aime to determine the concentration and levels of organochlorine pesticides residues in water and sediment from Euphrates river middle of Iraq.

Materials and Methods

The study area for this investigation is Euphrates river on middle part of Iraq.

Sampling was conducted between June 2013 and May 2014. Fight sampling sites were selected .Water and sediment samples from this area were collected from Al- Musayabe district and Al-kifil city middle region of Iraq.

Prior to sampling, sample bottles and glass wares washed with detergent, rinsed with distilled water and pure acetone and then heated in an oven overnight at 100c.

Water samples were preserved by adding 5ml of concentrated H_2SO_4 to avoid biological activity the preservative did not show any inference with OCP_S compounds.

Surface sediment samples were collected with a grab sampler. The upper 15 cm of the surface sediments were carefully removed and stored in glass vials.

For extraction of water samples, 500ml of water samples was extracted with 25ml of n-hexane in 1L sapatory funnel three times. The combined extracts were dried over anhydrous sodium sulphate (0.5g).

Samples were evaporated completely at 50c and then dissolved in n- hexane pro GC-MS analysis (USEPA, 2007 Erkmen *etal*. 2013).

Surface sediments were homogenized with a stainless spatula and then mixed with anhydrous Na_2SO_4. The samples were extracted twice with 10 ml dichloromethane, followed by centrifugation for 15 min and then evaporated on a rotary evaporator near to dryness. The residues for determining OCP_s were dissolved in 1ml of hexane (Imo *etal*., 2007).

The organochlorine pesticides were analyzed by GC-MS type (Varian Instruments, Sunnyvale, CA, USA).

Results and Discussion

The concentration ranges, mean values and annual percentage pesticide in water and sediment from Euphrates river are shown in Tables (1-10).

The results of the study showed that analyzed (13) compound of from organochlorine pesticides in the study area .The compounds detected were TCMX, Alph-BHC, Gamma-BHC, Beta-BHC ,Delta –BHC, Heptachlor, Aldrin , Heptachlor-epoxide, Trans-chlordane, Cis-chlordane P,P,-DDE ,Endosulfan I, Dieldrin,Endrin,P,P,- DDD, EndosulfanII , p, p,-DDT, Endrin aldehyde, Methoxychlor, Endosulfan sulfate, Endrin Ketone, Decachlorobiphenyl .

The compound Endrin Ketone and Endrin aldehyde regarded in higher percentage in water samples (24.6 , 22.3 ,24.7 ,22.5 , 24.6 , 22.3 ,24.5 , 22.3 ,24.8 , 22.5%) respectively in study sites.

Endrin is an organochlorin pesticide, as well as rodenticides. The compound Endrin became infamous due to its persistence in the environment .(Shingga *et al.*, 2015) and the lowest value percentage value recorded to the compound TCMX (0.477 ,0.446 ,0.468 ,0.490 and 0.429%) in all study sites respectively.

In the rainy or wet season there a significant decrease in the residue level of this pesticides , these decrease may be attributed to dilution of these chemical in water and sediment analyzed (Sikoki *et al* .,2014) .

Generally , higher concentrations value of OCPs in water recorded in site(4) but lower concentrations recorded in site(2).

The total organochlorine pesticide concentration(∑OCPs) in water samples were in the range of 395.337µg/L as high value in winter in St.4 and 36.115 µg/L as low value in summer in St.2 .

Investigation of organochlorine pesticides in sediment was conducted to record of contamination levels in the aquatic environment (Falahudin and Munawir, 2012).

The result showed high concentration of OCPs in sediment samples from study area.

Higher percentage of OCPs recorded to the compound Erdin Ketone in sites (1,2,4,5)(25.620, 26.278, 26.106, 25.975%) respectively, but in site 3 the compound Erdin aldehye was recorded as high percentage(25.490%)compared with Erdin Kiton (17.765%).

Also, TCMX was recorded as Lowes percentage of OCPs in sediment samples in all study sites (0.079%).

The residue levels of the OCPs in the environmental matrices analyzed from this region increased over time, reflecting increase in the release of these pesticides into the environment , probably due to increase in agricultural activities with the attendant subtle use of pesticides in the various forms (Sikoki *et al*.,2014).

Concentration of the total OCPs (∑OCPs) in sediment samples varied from 211.104 µg/ g in site 1 as higher value and 29.389 µg/ g in site 3 as lower value .

The result of this study showed some compounds of OCPs not detected in some study sites such as Alpha –BHC in site 1 , Beta-BHC, Delta-BHC in sites (1,3,5), Endosulfan I, II in sites(3,5)and P,P-DDD in sites(2,3).

The OCP compounds were still detected in all sites samples are Endrine Ketone , P,P-DDT and Endrine aldehyde . Composition of commercial DDT as one of the olds group of the OCPs has contain of 75% P,P-DDD,15% O,P-DDT, 5%P,P-DDE and <0.5 O,P-DDE and < 0.5% of unidentified compounds (WHO, 1979) However, some environmental condition might degraded of DDT to its derivations , such as DDE(aerobic condition) and DDD(anaerobic condition) (Qui *et al*.,2010).

In this study , the concentration of organochlorine pesticides in water from the study sites were lower than that of sediment samples maybe due to the hydrophobic characteristics of the OPC compounds and because these compounds preferably bind to the

Particle phase in aquatic system and then accumulated to the sediment via sediment via sedimentation processes.(Erkman *et al*.,2013)

This can be attributed to huge commercial crop production with use of herbicides for weed control. (Ezemonye *et al*.,2008).The pesticide may be washed into river by rain fall or by fishering (Raghuranshi *et al*.,2014)

Similar results for OCPs levels in aquatic ecosystems have been reported in recent investigations (DouAbul *et al*.,1987; Mahmood *et al*.,2014; Akan *et al*.,2014; Williams, 2013 ; Benbakhta *et al*., 2014 ; Gbaguidi *et al*.,2014 ; Imo *et al*., 2007 and Ize-lyamu *et al*., 2007)

OCPs	Summer 2013	Autumn 2013	Winter 2013-2014	Spring 2014	Mean	SD ±
TCMX	7.057	10.374	17.092	14.151	12.168	3.792
Alpha-BHC	11.473	16.631	N.D	N.D	7.026	7.259
Gamma-BHC	N.D	12.481	20.454	N.D	8.233	8.703
Beta-BHC	65.281	N.D	148.776	N.D	53.514	61.116
Delta-BHC	52.907	N.D	N.D	100.897	38.451	42.028
Heptachlor	42.119	60.059	96.391	80.487	69.764	20.509
Aldrin	8.397	12.274	20.125	16.688	14.371	4.432
Heptachlor-epoxide	48.124	68.567	109.972	91.848	79.627	23.372
Trans-Chordane	49.239	70.146	112.492	93.957	81.458	23.903

Cis-Chordane	33.393	47.692	76.654	63.976	55.428	16.348
P,P'-DDE	35.265	50.347	80.892	67.521	58.506	17.242
Endosulfan I	37.804	53.943	86.631	72.323	62.675	18.451
Dieldrin	20.659	29.649	47.857	39.887	34.513	10.278
Endrin	73.222	104.133	166.738	139.334	120.856	35.339
P,P'-DDD	40.465	57.714	92.649	77.356	67.046	19.720
Endosulfan II	42.075	59.997	96.294	80.406	69.693	20.489
P,P'-DDT	18.065	25.973	41.990	34.978	30.251	9.041
Endrin aldehyde	337.275	478.303	763.933	638.905	554.604	161.229
Methoxychlor	104.326	148.208	237.084	198.181	171.949	50.168
Endosulfan sulfate	N.D	N.D	100.234	83.702	45.984	46.354
Endrin ketone	371.687	527.067	841.763	704.013	611.132	177.636
Decachlorobiphenyl	56.678	80.689	129.319	108.032	93.679	27.450
Mean ± SD	139.146 ± 186.277	198.218 ± 263.960	317.857 ± 421.294	265.487 ± 352.425		
LSD (0.050	Seasons : 37.365	Compounds :87.628	Interaction 175.26			

– Zhou ,R.,zhu, L ., Yang, , k. and chen , y . (2006) Distribution of organochlorine pesticides in surface water and sediments from Qiantang river , east china . J. Hazard Mater, 137 , 68 – 75 .-Shinggu ,D.y. , Maitera , o.N. and Barminas , J.T. (2015) . Level of organochlorine pesticides Residue in Fish , water and sedhment in Biu Dam (Reservoir) Borno state Nigeria . International Research Journal of pure and Applied chemistry, 5 (2) : 150 – 159 .

Table 1 :Concentration of Organochorine pesticides in water (µg/L) from Site 1 on Euphrates river during 2013 - 2015

Table 2: Concentration of Organochorine pesticides in water (µg/L) from Site 2 on Euphrates river during 2013 -2015

OCPs	Summer 2013	Autumn 2013	Winter 2013-2014	Spring 2014	Mean	SD ±
TCMX	3.145	4.924	8.526	6.949	5.886	2.033
Alpha-BHC	5.513	8.279	13.882	11.430	9.776	3.163
Gamma-BHC	3.942	6.054	10.329	8.458	7.195	2.414
Beta-BHC	34.368	49.168	79.143	66.022	57.175	16.920
Delta-BHC	27.732	39.764	64.134	53.467	46.274	13.756
Heptachlor	21.947	31.567	51.050	42.522	36.771	10.998
Aldrin	3.864	5.943	10.152	8.310	7.067	2.376
Heptachlor-epoxide	25.167	36.131	58.334	48.615	42.061	12.533
Trans-Chordane	25.764	36.977	59.685	49.745	43.042	12.818
Cis-Chordane	17.267	24.936	40.466	33.668	29.084	8.767
P,P'-DDE	18.272	26.360	42.739	35.569	30.735	9.246
Endosulfan I	19.633	28.288	45.817	38.144	32.970	9.895
Dieldrin	10.439	15.260	25.024	20.750	17.868	5.511
Endrin	38.626	55.203	88.774	74.079	64.170	18.950
P,P'-DDD	21.060	30.310	49.045	40.843	35.314	10.575
Endosulfan II	21.924	31.535	50.998	42.479	36.734	10.987

P,P'-DDT	9.048	13.289	21.877	18.118	15.583	4.848
Endrin aldehyde	180.227	255.854	409.024	341.977	296.770	86.460
Methoxychlor	55.306	78.838	126.498	105.636	91.569	26.903
Endosulfan sulfate	22.858	32.858	53.112	44.246	38.268	11.433
Endrin ketone	198.680	282.003	450.761	376.891	327.083	95.258
Decachlorobiphenyl	29.754	42.631	68.708	57.294	49.596	14.720
Mean ± SD	36.115±48.968	51.644 ±69.389	83.094±110.749	.327±92.645		
LSD (0.050	Seasons=9.822	compounds=23.35	Interaction=46.071			

Table3 : Concentration of Organochorine pesticides in water (µg/L) from Site 3 on Euphrates river during 2013 - 2015

OCPs	Summer 2013	Autumn 2013	Winter 2013-2014	Spring 2014	Mean	SD ±
TCMX	9.147	13.837	23.337	19.179	16.375	5.362
Alpha-BHC	15.391	22.685	37.459	30.992	26.631	8.339
Gamma-BHC	11.249	16.816	28.091	23.155	19.827	6.364
Beta-BHC	91.477	130.501	209.539	174.943	151.615	44.614
Delta-BHC	73.979	105.706	169.965	141.837	122.871	36.272
Heptachlor	58.725	84.091	135.465	112.978	97.814	28.999
Aldrin	11.042	16.524	27.625	22.766	19.489	6.267
Heptachlor-epoxide	67.216	96.124	154.670	129.043	111.763	33.048
Trans-Chordane	68.792	98.356	158.233	132.023	114.351	33.799
Cis-Chordane	46.386	66.605	107.557	89.632	77.545	23.116
P,P'-DDE	49.035	70.360	113.550	94.645	81.897	24.379
Endosulfan I	52.623	75.445	121.666	101.434	87.792	26.091
Dieldrin	28.381	41.092	66.838	55.568	47.969	14.532
Endrin	102.706	146.414	234.936	196.187	170.060	49.968
P,P'-DDD	56.385	80.776	130.175	108.552	93.972	27.884
Endosulfan II	58.665	84.005	135.328	112.863	97.715	28.970
P,P'-DDT	24.713	35.895	58.541	48.628	41.944	12.783
Endrin aldehyde	476.078	675.494	1079.377	902.586	783.383	227.979
Methoxychlor	146.688	208.736	334.406	279.397	242.306	70.936
Endosulfan sulfate	61.128	87.495	140.899	117.523	101.761	30.145
Endrin ketone	524.738	744.447	1189.429	994.649	863.315	251.179
Decachlorobiphenyl	79.312	113.264	182.026	151.927	131.632	38.814

Mean ± SD	96.084±129.120	137.030±182.967	219..959±292.026	183.659±244.288		

OCPs	Summer 2013	Autumn 2013	Winter 2013-2014	Spring 2014	Mean	SD ±
TCMX	17.935	26.332	43.339	35.894	30.875	9.600
Alpha-BHC	29.113	42.171	68.619	57.042	49.236	14.929
Gamma-BHC	21.698	31.664	51.849	43.014	37.056	11.394
Beta-BHC	165.324	235.187	376.683	314.747	272.985	79.870
Delta-BHC	133.998	190.798	305.835	255.480	221.527	64.935
Heptachlor	106.690	152.101	244.073	203.815	176.669	51.915
Aldrin	21.329	31.141	51.014	42.315	36.449	11.218
Heptachlor-epoxide	121.892	173.642	278.454	232.576	201.641	59.163
Trans-Chordane	124.712	177.639	284.832	237.911	206.273	60.507
Cis-Chordane	84.600	120.798	194.112	162.021	140.382	41.383
P,P'-DDE	89.342	127.519	204.840	170.995	148.174	43.645
Endosulfan I	95.767	136.623	219.369	183.149	158.727	46.708
Dieldrin	52.369	75.125	121.215	101.040	87.437	26.016
Endrin	185.427	263.673	422.149	352.780	306.007	89.454
P,P'-DDD	102.502	146.167	234.602	195.891	169.790	49.919
Endosulfan II	106.582	151.947	243.827	203.610	176.491	51.863
P,P'-DDT	45.801	65.819	106.362	88.616	76.649	22.885
Endrin aldehyde	853.847	1210.848	1933.890	1617.395	1403.995	408.135
Methoxychlor	264.163	375.245	600.223	501.745	435.344	126.993
Endosulfan sulfate	110.992	158.196	253.801	211.953	183.735	53.966
Endrin ketone	940.960	1334.289	2130.909	1782.208	1547.091	449.667
Decachlorobiphenyl	143.546	204.327	327.428	273.543	237.211	69.487
Mean ± SD	173.572±231.154	246.875±327.553	395.337±522.793	330.351±437.211		
LSD (0.05)	Seasons =46.366	compounds=108.739	Interaction=217.478			
LSD (0.050)	Seasons =25.	Compounds=60.740	interaction=121.480			

Table 4: Concentration of Organochorine pesticides in water (µg/L) from Site 4 on Euphrates river during 2013 - 2015

Table5: Concentration of Organ chorine pesticides in water (µg/L) from Site 5 on Euphrates river during 2013 - 2015

OCPs	Summer 2013	Autumn 2013	Winter 2013-201	Spring 2014	Mean	SD ±
TCMX	5.120	8.256	14.608	11.828	9.953	3.585
Alpha-BHC	9.295	14.172	24.050	19.727	16.811	5.576
Gamma-BHC	6.526	10.248	17.786	14.487	12.261	4.255
Beta-BHC	60.168	86.261	139.108	115.976	100.378	29.831
Delta-BHC	48.468	69.682	112.647	93.840	81.159	24.252
Heptachlor	38.269	55.230	89.580	74.544	64.405	19.390
Aldrin	6.388	10.053	17.475	14.226	12.035	4.190
Heptachlor-epoxide	43.947	63.275	102.421	85.286	73.732	22.097
Trans-Chordane	45.000	64.768	104.803	87.278	75.462	22.599
Cis-Chordane	30.019	43.538	70.920	58.934	50.852	15.456
P,P'-DDE	31.790	46.049	74.927	62.286	53.763	16.301
Endosulfan I	34.189	49.448	80.353	66.826	57.704	17.445
Dieldrin	17.980	26.480	43.694	36.159	31.078	9.717
Endrin	67.676	96.900	156.089	130.180	112.71	33.410

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P,P'-DDD	36.705	53.013	86.043	71.584	61.836	18.644
Endosulfan II	38.229	55.172	89.488	74.467	64.339	19.370
P,P'-DDT	15.528	23.004	38.146	31.519	27.049	8.547
Endrin aldehyde	317.323	450.658	720.705	602.498	522.796	152.433
Methoxychlor	97.083	138.571	222.597	185.817	161.017	47.430
Endosulfan sulfate	39.876	57.506	93.213	77.583	67.044	20.155
Endrin ketone	349.858	496.761	794.289	664.053	576.240	167.945
Decachlorobiphenyl	52.034	74.735	120.712	100.587	87.017	25.953
Mean ± SD	63.246±86.333	90.626±122.337	146.075±195.256	121.803±163.803		
LSD (0.050)	seasons= 17.317	compounds=40.613	Interaction=81.225			

Table 6: Concentration of Organochorine pesticides in sediment (µg/g) from Site 1 on Euphrates river during 2013 -2015

OCPs	Sumer 2013	Autumn 2013	Winter 2013-2014	Spring 2014	Mean	± SD
TCMX	10.801	15.554	25.182	20.967	18.126	5.434
Alpha-BHC	17.128	N.D	N.D	32.938	12.516	13.708
Gamma-BHC	N.D	18.572	N.D	24.997	10.892	11.127
Beta-BHC	94.233	133.781	213.878	178.817	155.177	45.212
Delta-BHC	76.501	108.653	173.773	145.268	126.048	36.758
Heptachlor	61.043	86.749	138.811	116.022	100.656	29.388
Aldrin	12.722	18.276	N.D	N.D	7.749	7.994
Heptachlor-epoxide	69.648	98.942	158.273	132.303	114.791	33.490
Trans-Chordane	71.244	101.205	161.883	135.323	117.413	34.251
Cis-Chordane	48.538	69.029	110.530	92.364	80.115	23.426
P,P'-DDE	51.223	72.833	116.602	97.443	84.525	24.706
Endosulfan I	54.859	77.986	124.827	104.324	90.499	26.440
Dieldrin	30.293	43.174	69.265	57.844	50.144	14.727
Endrin	105.613	149.906	239.615	200.347	173.870	50.638
P,P'-DDD	18.931	N.D	N.D	36.350	13.820	15.130
Endosulfan II	60.981	86.661	138.672	115.906	100.555	29.359
P,P'-DDT	21.738	N.D	N.D	N.D	5.434	9.413
Endrin aldehyde	483.987	686.075	1095.368	916.210	795.410	231.033
Methoxychlor	150.184	213.064	340.418	284.672	247.084	71.887
Endosulfan sulfate	63.478	90.198	144.318	120.629	104.655	30.549
Endrin ketone	533.299	755.951	1206.895	1009.505	876.412	254.544
Decachlorobiphenyl	81.906	116.312	185.996	155.493	134.926	39.334
Mean ± SD	±96.288 132.130	±133.769 189.017	±211.104 303.404	±180.805 251.151		
$LSD_{0.05}$	seasons=27.208	compounds= 63.808	Interaction= 127.620			

Table 7 : :Concentration of Organochorine pesticides in sediment (µg/g) from Site 2 on Euphrates river during 2013 -2015

OCPs	Sumer 2013	Autumn	Winter 2013-2014	Spring	Mean	± SD

		2013		2014		
TCMX	3.598	5.390	9.018	7.429	6.358	2.048
Alpha-BHC	6.644	9.705	N.D	N.D	4.087	4.228
Gamma-BHC	4.401	6.527	10.833	8.948	7.677	2.431
Beta-BHC	38.578	54.957	N.D	N.D	23.383	24.090
Delta-BHC	28.358	N.D	65.015	N.D	23.343	26.700
Heptachlor	22.532	32.219	51.839	43.251	37.460	11.075
Aldrin	4.322	6.416	10.655	8.799	7.548	2.393
Heptachlor-epoxide	25.775	36.814	59.173	49.386	42.787	12.621
Trans-Chordane	26.377	37.667	60.534	50.525	43.775	12.908
Cis-Chordane	17.820	25.542	41.181	34.335	29.719	8.828
P,P'-DDE	18.831	26.975	43.470	36.250	31.381	9.311
Endosulfan I	20.202	28.917	46.569	38.842	33.632	9.964
Dieldrin	10.944	15.798	25.630	21.327	18.424	5.550
Endrin	39.328	56.020	89.828	75.029	65.051	19.083
P,P'-DDD	21.638	N.D	N.D	41.561	15.799	17.299
Endosulfan II	22.509	32.186	51.787	43.207	37.422	11.064
P,P'-DDT	9.543	13.813	22.462	18.676	16.123	4.882
Endrin aldehyde	181.919	258.076	412.320	344.803	299.279	87.066
Methoxychlor	56.125	79.821	127.815	106.807	92.642	27.091
Endosulfan sulfate	23.450	33.519	53.914	44.987	38.967	11.512
Endrin ketone	200.502	284.410	454.349	379.962	329.805	95.926
Decachlorobiphenyl	30.394	43.361	69.621	58.126	50.375	14.823
Mean ± SD	36.990 ±49.293	49.460 ± 71.298	77.546 ±114.264	64.193 ± 95.671		
$LSD_{0.05}$	seasons=10.967	compounds =25.719	interaction=51.438			

Table8:Concentration of Organochorine pesticides in sediment (µg/g) from Site 3 on Euphrates river during 2013 - 2015

OCPs	Sumer 2013	Autumn 2013	Winter 2013-2014	Spring 2014	Mean	± SD
TCMX	3.924	N.D	N.D	N.D	0.981	1.699
Alpha-BHC	6.544	9.605	15.806	13.092	11.261	3.500
Gamma-BHC	4.806	7.142	11.874	9.803	8.406	2.671
Beta-BHC	38.478	54.857	88.030	73.509	63.718	18.725
Delta-BHC	31.134	44.450	71.420	59.615	51.654	15.224
Heptachlor	24.732	35.378	56.940	47.502	41.138	12.171
Aldrin	4.719	7.020	11.679	9.639	8.264	2.630
Heptachlor-epoxide	28.296	40.428	65.001	54.245	46.992	13.870
Trans-Chordane	28.957	41.365	66.496	55.496	48.078	14.186
Cis-Chordane	19.553	28.039	45.227	37.704	32.630	9.702
P,P'-DDE	20.664	29.615	47.742	39.807	34.457	10.232
Endosulfan I	N.D	31.749	51.149	N.D	20.724	21.830
Dieldrin	11.996	17.331	28.137	23.407	20.217	6.100
Endrin	43.191	61.535	98.689	82.426	71.460	20.972
P,P'-DDD	23.750	33.987	54.720	45.644	39.525	11.703
Endosulfan II	24.706	35.342	N.D	N.D	15.012	15.476
P,P'-DDT	10.456	15.150	24.655	20.494	17.688	5.366
Endrin aldehyde	199.899	283.595	453.108	378.908	328.877	95.685

Methoxychlor	61.650	87.693	140.438	117.350	101.782	29.773
Endosulfan sulfate	25.740	36.807	59.221	49.410	42.794	12.652
Endrin ketone	N.D	N.D	499.298	417.547	229.211	231.026
Decachlorobiphenyl	33.372	47.623	76.483	63.849	55.331	16.291
Mean ± SD	29.389±39.2	43.123±55.16	89.368±124.117	72.702±104.750		
$LSD_{0.05}$	seasons=20.431	compounds=47.92	Interaction=95.83			

Table9: Concentration of Organochorine pesticides in sediment (µg/g) from Site 4 on Euphrates river during 2013 -2015

OCPs	Sumer 2013	Autumn 2013	Winter 3013-2014	Spring 2014	Mean	±SD
TCMX	7.057	10.374	17.092	14.151	12.168	3.792
Alpha-BHC	11.473	16.631	N.D	N.D	7.026	7.259
Gamma-BHC	N.D	12.481	20.454	N.D	8.233	8.703
Beta-BHC	65.281	N.D	148.776	N.D	53.514	61.116
Delta-BHC	52.907	N.D	N.D	100.897	38.451	42.028
Heptachlor	42.119	60.059	96.391	80.487	69.764	20.509
Aldrin	8.397	12.274	20.125	16.688	14.371	4.432
Heptachlor-epoxide	48.124	68.567	109.972	91.848	79.627	23.372
Trans-Chordane	49.239	70.146	112.492	93.957	81.458	23.903
Cis-Chordane	33.393	47.692	76.654	63.976	55.428	16.348
P,P'-DDE	35.265	50.347	80.892	67.521	58.506	17.242
Endosulfan I	37.804	53.943	86.631	72.323	62.675	18.451
Dieldrin	20.659	29.649	47.857	39.887	34.513	10.278
Endrin	73.222	104.133	166.738	139.334	120.856	35.339
P,P'-DDD	40.465	57.714	92.649	77.356	67.046	19.720
Endosulfan II	42.075	59.997	96.294	80.406	69.693	20.489
P,P'-DDT	18.065	25.973	41.990	34.978	30.251	9.041
Endrin aldehyde	337.275	478.303	763.933	638.905	554.604	161.229
Methoxychlor	104.326	148.208	237.084	198.181	171.949	50.168
Endosulfan sulfate	N.D	N.D	100.234	83.702	45.984	46.354
Endrin ketone	371.687	527.067	841.763	704.013	611.132	177.636
Decachlorobiphenyl	56.678	80.689	129.319	108.032	93.679	27.450
Mean ± SD	66.159±92.512	87.011±133.426	149.424±209.643	23.29±175.914		
$LSD_{0.05}$	seasons=19.742	compounds=46.30	Interaction=92.60			

Table10 : :Concentration of Organochorine pesticides in sediment (µg/g) from Site 5 on Euphrates river during 2013 -2015

OCPs	Summer 2013	Autumn 2013	Winter 2013-2014	Spring 2014	Mean	±SD
TCMX	2.630	4.143	7.206	5.865	4.961	1.729
Alpha-BHC	4.643	6.996	11.760	9.675	8.268	2.689
Gamma-BHC	3.308	5.103	8.739	7.148	6.074	2.052
Beta-BHC	29.180	41.765	67.254	56.097	48.574	14.388
Delta-BHC	23.537	33.769	54.492	45.421	39.304	11.698
Heptachlor	18.618	26.799	43.366	36.114	31.224	9.352
Aldrin	3.241	N.D	N.D	7.022	2.565	2.893
Heptachlor-epoxide	21.357	30.679	49.559	41.295	35.722	10.657
Trans-Chordane	21.864	31.399	50.708	42.256	36.556	10.900
Cis-Chordane	14.639	21.160	34.366	28.585	24.687	7.455
P,P'-DDE	15.493	22.371	36.299	30.202	26.091	7.862
Endosulfan I	16.651	24.010	N.D	N.D	10.165	10.493
Dieldrin	8.833	12.932	21.235	17.600	15.150	4.687
Endrin	32.801	46.897	75.444	62.948	54.522	16.114
P,P'-DDD	17.864	N.D	N.D	34.686	13.137	14.421
Endosulfan II	N.D	26.771	43.322	N.D	17.523	18.474
P,P'-DDT	7.650	11.256	18.559	15.362	13.206	4.122
Endrin aldehyde	153.210	217.518	347.765	290.753	252.311	73.520
Methoxychlor	46.985	66.995	107.522	89.783	77.821	22.876
Endosulfan sulfate	19.393	27.896	45.119	37.580	32.497	9.722
Endrin ketone	168.902	239.755	383.256	320.442	278.088	81.002
Decachlorobiphenyl	25.257	36.206	58.381	48.675	42.129	12.517
Mean ± SD	29.820±42.820	42.473±59.725	66.561±96.209	55.795±80.284		
$LSD_{0.05}$	seasons=8.90	compounds=20.87	interaction=41.75			

Conclusion

-The results were showed that analyzed 13 compounds of OCPs.

-Endrin keton and Endrin aldehyde were showed as higher percentage and concentration ,but TCMX recorded as lowest concentration of OCPs in water and sediment along all study sites .

-The concentration of OCPs in water from the study sites was lower than that of sediment samples.

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