International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.12 No.02, pp 01-05, 2019

A Survey of Organochlorine Pesticide (OCP) residues in sediment samples of Veeranam Lake,Tamil Nadu

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Abstract : The study aimed at analyzing the levels of Organochlorine Pesticide (OCP) residues in the sediment samples of Veeranam Lake. The sediment samples were collected from 10different locations. The sediment samples were analyzed for 17 different pesticides viz., hexachlorocyclohexane (α, β & γ- HCH), Cyclodiene (aldrin, dieldrin and endrin), heptachlor, hexachlorobenzene (HCB), trans-Chlordane, cis-Chlordane, mirex and diphenyl aliphatic (p,p'-DDE, o,p'-DDE, o,p'-DDD, p,p'-DDD, o,p'-DDT, p,p'-DDT). The detection frequencies of HCHs, aldrin, dieldrin and DDTswere higher in the sediment samples of Veeranam Lake. The levels of heptachlor and cyclodiene compounds (aldrin anddieldrin)exceeded the sediment quality guidelines and probable effect levels of Canadian freshwater sediment quality guidelines (CFSQG)in some locations of the study area.
Keywords : Organochlorine Pesticide Residues, Veeranam Lake, Sediment.

Introduction

The impulsive shift of the human community from the traditional life style to modernization has exploited the valuable non-renewable natural resources and degeneration of the environment. Since the middle of last century number of environmental catastrophes have been witnessed. With the growth of civilization and urbanization, an increasing number of organic and inorganic chemicals are being developed and introduced into our environment. Persistent organochlroine pesticides are among the agrochemicals that have been used extensively for long periods. In India, the use of pesticides, in controlling vector borne disease and in agriculture started in the year 1948. Since then different categories of pesticides are in continuous use[1]. OC pesticides are characterized by low polarity, low aqueous solubility and high lipid solubility (lipophilicity) and as a result they have a potential for bioaccumulation in the food chain posing a great threat to human health and the environment globally[2]. The OCPs are long-lived compounds that become concentrated as they move through food chain. These pesticides are sufficiently resistant to degradation has resulted in long-term ecotoxicological effects[3].Many of the organochlorine compounds are substances that have high toxicity. They

DOI= http://dx.doi.org/10.20902/IJCTR.2019.120201

accumulate in organisms and biomagnified through the food chain, so consumption of fish from contaminated areas may be a real health risk for the consumers[4].Because of hydrophobic characteristics, OCPs are the least soluble in water but show a high affinity for different surface including particulate matter. Due to higher hydrophobicity, OCPs can adsorb to sedimentary surfaces which leads to accumulation in estuaries and lakes[5]. Lake Veeranam isone of the largest lakes located in Cuddalore district of Tamil Nadu state, India. The lake has the water of 1,100 mcft and covering an agricultural land area of 3885 hectares.Veeranam Lake gets water from kollidam from vadavaru river. The agricultural runoff during rainy season is one of the major source of pollution of the lake.Hence, the present the study aimed at investigating the levels of persistent organochlorine pesticide (OCP) residues in the surface sediment of Veeranam Lake.

Materials and Methods

The study area Veeranam Lake is situated at 11°30'N Latitude and 79°53'E Longitude.The surface sediments from were collected at ten different locations (Table 1) from Veeranam lake and stored in clean polyethylene bags.The sediment samples were air dried in shade before extraction.

Table 1: Geographical Position of Sampling Locations in Veeranam Lake

Sampling Locations	Sample ID	Latitude	Longitude
Sethiartope	V1	11°42‘N	79°54‘E
Paripuranam	V2	11°41’N	79°53‘E
Valakollai	V3	11°38‘N	79°53’E
Kulapadai	V4	11°37‘N	79°54‘E
Thenpathi	V5	11°36‘N	79°54‘E
KaliyaMalai	V6	11°35‘N	79°55‘E
Kanthakumaran	V7	11°35‘N	79°55‘E
Nathamalai	V8	11°35‘N	79°54‘E
Tiruchunnapuram	V9	11°33‘N	79°55‘E
Lalpettai	V10	11°30‘N	79°55‘E

Extraction of OCPs from sediment:

About 25 ml of acetone was added to10 g of sediment sample and kept overnight in a mechanical shaker. The supernatant was transferred into a separating funnel of 1L capacity and 25ml of acetone was added again and shaken well by hand for about 10 min. The supernatant (acetone extract) was transferred into the same separating funnel. About 300 ml of deionised water, 15g of NaCl, 40ml n-Hexane/ethyl acetate (3:2) were added to the extract in the separating funnel. Shaken well for 10 min and kept for layer separation. The aqueous layer was collected in a beaker. The hexane layer was then transferred to 100 ml conical flask. Again 40ml of n-Hexane/Ethyl acetate (3:2) was added to aqueous layer and shaken well for 10 minutes. The hexane layer was transferred to 100ml conical flask. 3g of Na_2SO_4 (anhydrous) was added into n-Hexane layer for dehydration and left undisturbed for few minutes. The hexane layer was taken in a condensing flask and concentrated to 1 ml by Rotary Evaporator at 35^0 C. The extract was transferred to a preconditioned 2g NH_2Column (Phenomenexstrata :12ml of acetone and 30ml of n-hexane) and eluted with 10ml of 2% acetone/n-Hexane. The eluent was then condensed to 1ml by Rotary evaporator and N_2. The final extract was collected in an amber glass vial and stored at 4^0 C until analysis and 1µl of the aliquot was injected into GCMS using autoinjector for analysis.The samples were analysed in GCMS (Gas Chromatograph- Mass Spectrophotometer) (QP 2010 Shimadzu Corp, Japan) equipped with capillary column DB-1 (30m long, ID 0.32mm) and 5% methyl phenyl silicone.

Results and Discussion

Sediment is considered as the most stable base for contamination studies mainly pollutants like organochlorine pesticides due to their low solubility in water and higher affinity to the organic matter leading to accumulation in the sediment. The dry weight concentrations of Organochlorine pesticide residues were determined in surface sediment samples of Veeranam Lake are shown in Table 2. In this table, the concentrations that are below limit of detection are mentioned as ND. (not detectable). The total concentrations of OCPs in sediment samples ranged from 16.83 -328.48ng/g (dry wt), with mean value of 121.39ng/g (dry wt). The detection frequencies of α-HCH, β-HCH, aldrin, dieldrin, DDTs were higher whereas trans-chlordane, p,p'-DDT and mirexwere least detected.γ – HCH, Endrin, cis chlordane, o,p'-DDD& DDE and p,p'-DDE were not detected in any of the sampling points.

Table 2 Concentration of OCPs (ng/g dry wt.) in the sediment samples of Veeranam Lake

Locations	α-HCH	β-HCH	Σ-HCH	HCB	Heptachlor	Aldrin	Dieldrin	trans-Chlor	p,p'-DDD	o,p'-DDT	p,p'-DDT	Σ-DDT	Mirex
V1	ND	7.4	7.4	ND	ND	ND	4	ND	0.05	ND	0.27	0.13	ND
V2	2.12	ND	2.12	1.25	1.2	ND	0.16	ND	0.08	0.33	ND	0.41	122
V3	ND	1.84	1.84	0.69	0.5	123	ND	ND	ND	0.05	ND	0.05	ND
V4	0.52	0.57	1.09	ND	ND	314	0.48	ND	ND	0.08	ND	0.08	ND
V5	0.44	0.36	0.8	0.9	ND	15.4	0.4	0.3	0.08	ND	ND	0.08	ND
V6	0.13	ND	0.13	ND	ND	16.7	ND	ND	ND	ND	ND	ND	ND
V7	1.31	0.9	2.2	0.23	2.6	19.6	0.5	ND	ND	ND	ND	ND	ND
V8	0.11	ND	0.11	ND	ND	328	0.09	ND	ND	ND	0.28	0.28	ND
V9	1.33	0.34	1.67	ND	ND	213	3.52	ND	0.07	ND	ND	0.07	ND
V10	ND	2.19	2.19	3.6	7.34	ND	13.3	0.15	0.09	ND	ND	0.09	ND

- : Not detected; ∑HCH - Sum of α and β isomers;
∑ DDT - Sum of p,p'-DDD, o,p-DDT & p,p'-DDT

The mean and the range of OCP residues are shown in Table 3. Among HCHs, only α- & β- HCH were detected. The mean concentrations of α-HCH and β- HCH were 0.6 and 1.36 ng/g respectively. The range of β-HCH (ND – 7.4 ng/g) in the sediments of Veeranam lake was less compared to levels detected in Kolleru lake in Andhra Pradesh, India[6] (1.2 – 388 ng/g). β-HCH is generally considered the most stable and relatively resistant to microbial degradation. The levels of β-HCH is slightly higher than α-HCH indicates relatively indicating recent usage of β-HCH in and around the study area. The range of Σ-DDT was ND - 0.41 ng/g and DDE was not detected. The presence of DDT and its metabolite DDD may be attributed to fresh input of contaminants to the lake. Canadian Freshwater sediment quality guidelines[7] and PEL of 3.54 & 8.5 ng/g for ΣDDD (p,p'ando,p') and 1.2 and 4.8 ng/g for ΣDDT (p,p'ando,p'). The presence of HCH isomers and DDT & its metabolites have been reported in surface sediment of river, ponds, lakes in India[8-12].

The range of HCB detected was ND- 3.6ng/g. The heptachlor in the sediment samples ranged from ND to 7.34ng/g. The Canadian freshwater sediment quality guidelines (CFSQG) for Heptachlor is 0.6 ng/g and the probable effect level (PEL) on aquatic animals is 2.74 ng/g. Paripuranam (V2), Kanthakumaran (V7) and Lalpettai (V10) in the Veeranam Lake exceeded the guidelines and the levels at V7 and V10 locations outreached the probable effect level.The heptachlor detected in the present study is comparatively less than the levels detected in the Ramgarh water reservoir, Rajasthan[1].

Among cyclodienesaldrin and dieldrin was detected whereas endrin was not detected. The mean concentration of aldrin(103 ng/g) was higher dieldrin (2.25 ng/g) and higher than any other compounds detected in the sediment samples. The range of aldrin was ND- 328 ng/g. With respect to the biological effects of sediments, the CFSQG and the PEL were 2.85 and 6.67 for dieldrin, 2.67. Sethiatope (V1), Tiruchunnapuram (V9) and Lalpettai (V10) locations exceeded the CFSQG. Aldrin and dieldrin are closely related organochlorines. They were involved in numerous incidents of wildlife mortality. When aldrin is applied in the field, it is rapidly broken down to dieldrin[13].Chlordanes were detected only in few locations. Only trans-Chlordane was found in two sediment samples at V5 (0.3 ng/g) and V10 (0.2 ng/g) locations. The levels of chlordanes detected was much lower than the sediment quality guidelines (4.5 ng/g) and probable effect level

(8.7 ng/g).In the Veeranam Lake mirex was detected in only one location (V2: 122 ng/g).Mirex was least reported in the Indian environment and also CFSQG and PEL are not available for mirex.

One of the important sink and reservoir for persistent pollutants discharged into the environment is the sediment found on river and lake beds[14]. Though regarded as a sink, the sediments may release back to overlying waters the metals and other pollutants bound on it, as a result of remobilization due to various diagenetic processes[15]. The results of the present study show that despite bans and restrictions on the usage of pesticides there still exist a variety of organochlorine pesticide residues in the freshwater ecosystem. Almost all sampling points showed pollution due to organochlorine pesticide residues. As Veeranam lake serves as one of the drinking water sources for Chennai, the quality of water should be regularly monitored and maintained.

Acknowledgement

Authors are thankful to United Nations University, Tokyo, Japan and Shimadzu Corporation, Japan for the GC-MS facility sponsored through the project "Environmental Governance and Monitoring of POPS in the Asian Coastal Hydrosphere". Also thank the university authorities for the facilities provided to carry out this research.

Table 3 Mean and Range of OCPs (ng/g dry wt.) in the sediment samples of Veeranam Lake

OCPs	Range	Mean
α-HCH	0-2.12	0.6
β-HCH	0-7.4	1.36
Σ-HCH	0-7.4	1.96
HCB	0-3.6	0.67
Heptachlor	0-7.34	1.16
Aldrin	0-328	103
Dieldrin	0-13.3	2.25
trans-Chlor	0-0.3	0.05
p,p'0DDD	0-0.09	0.037
o,p'0DDT	0-0.33	0.046
p,p'0DDT	0-0.28	0.055
Σ-DDT	0-41	0.15
Mirex	0-122	12.2

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