PERSISTENT ORGANOCHLORINE POLLUTANTS (POP'S) IN COASTAL ENVIRONMENTS OF SOUTHEAST GULF OF MEXICO

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Abstract

Analyses to determine the presence and concentrations of persistent organochlorine pollutants (POP's) were carried out in sediments and estuarine organisms (*Crassostrea virginica*) from five coastal lagoons of the Southeast Gulf of Mexico. The results of this study show high levels of POP's in sediments with high concentration of Heptachlor, Aldrin, Dieldrin and ppDDT, either in sediments or biological tissues. According to national regulations, the use and dispersion of these chemical have been severely restricted o totally prohibited in developed countries, however their presence in coastal areas indicate an extensive use and recent application of them.

1. INTRODUCTION

In the last three decades, a large variety and quantity of chlorinated pesticides has been introduced into the developing countries coastal areas as a result of their use in agriculture, for protection and higher efficiency concerning harvest and decease vector control like malaria and paludism. While the application and production of those compounds has been restricted or totally banned in developed countries, they are commonly used in other regions like Central America, South America and Africa [1, 2].

Mexico presents an annual chlorinated pesticides production consisting of 4000 tons DDT and 1800 tons of Lindane, Toxaphene, Dieldrin, Chlordane and Heptochlor, which are widely used in the national agriculture [3] and are also exported mainly to Central America and Asia.

Recent environmental studies show high agrochemical concentrations in food, fruits, vegetables and milk products [4], maternal milk and in organisms of coastal areas.

Thus, the following study was carried out in order to obtain basic information about the concentration and distribution of selected chlorinated pesticides in coastal lagoons in the southeast of the Gulf of Mexico, because their ecological importance as producers and harvest centers for oysters, clams and shrimps.

2. MATERIALS AND METHODS

The study includes five important systems of coastal lagoons southeast of the Gulf of Mexico: the lagoon Alvarado in Veracruz (95°34'–95°58' W longitude and 18°14'-18°18'N latitude), Carmen-Machona located in the littoral fringe of the state of Tabasco (93°34' – 95°58' W longitude and 18°42' – 18°46' N latitude), and Terminos lagoon in Campeche State (91°00'-92°20' W longitude and 18°20'-19°00' N latitude) (Fig. 1).

The sediments samples were obtained from 25 locations within the lagoon areas using a Van Veen dredge with a 5 kg capacity; the bivalve mollusks (*Crassostrea virginica*) were taken out manually from 10 different banks in both lagoons obtaining an approximate number of 50 organisms from each bank. The analytical methods used for the extraction, purification and quantification of the chlorinated hydrocarbons were those recommended by the [5] for sediments and the [6] for organisms.

The sediments and organisms were extracted with 200 ml of bidistilled hexane for 8 hours in a soxhlet apparatus and the extract was reduced to 2 ml by rotoevaporation prior to fractionation using chromatographic columns (15 cm long., 3 cm ID) packed with 13 g of 1.25% deactived florisil and eluted with hexane and a mixture consisting of hexane-diethylether.

The volume was concentrated to 5 ml in order to be analyzed by gas chromatography using a Hewlett Packard chromatography model 5890, a 30 m x 0.25 mm ID x 0.25 μm bonded 5%-phenyltheysilicone, fused silica column was used. Nitrogen was the carrier gas with a flow 1 ml per minute, the oven temperature was programmed from 60°C to 300°C with an increase of 8°C per minute and the injector temperature was 260°C. A reference standard containing a mixture of 15 chlorinated pesticides was used.

3. RESULTS AND DISCUSION

In Mexico there is very little information dealing with the presence of chlorinated compounds in the tropical coastal areas inspite of their ecological importance and environmental impact.

TABLE I. TYPE OF SEDIMENTS AND PERCENTAGE OF ORGANIC CARBON IN SEDIMENTS FROM COASTAL LAGOONS.

STATIONS	TYPE OF SEDIMENTS	% TOC
CARMEN LAGOON		
1	Sand slime	1.26
2	Sand slime	1.17
3	Sand slime	1.37
4	Sand slime	1.30
5	Mud	1.29
MEAN VALUE		**1.28%**
MACHONA LAGOON		
1	Slime sand	1.43
2	Sandy mud	1.05
3	Slime sand	0.88
6	Mud	1.43
7	Slime sand	1.27
MEAN VALUE		**1.20%**
ALVARADO LAGOON		
1	Sand	1.02
2	Slime sand	0.66
3	Slime sand	0.74
4	Slime sand	2.05
5	Slime sand	0.85
MEAN VALUE		**1.06%**
MECOACAN LAGOON		
1	Sand	0.22
2	Sandy mud	0.96
3	Slime mud	1.32
4	Slime mud	3.46
5	Slime mud	2.84
MEAN VALUE		**1.76%**
TERMINOS LAGOON		
1	Sandy mud	0.62
2	Slime mud	1.34
3	Slime mud	1.68
4	Slime mud	2.64
5	Slime mud	2.70
MEAN VALUE		**1.80%**

According to the Official Catalogue of Pesticides in Mexico (1991), the use the Heptachlor, Dieldrin, Aldrin and Endrin has been totally prohibited, while DDT, Lindane and HCH are severely restricted; the results of this study, however, revealed the presence of the majority of the above mentioned chemical indicating either high persistence or recent applications.

Table 1, shows the type of sediments and percentage of total organic carbon in the sampling sites of the lagoon areas. The sediments have low percentages of organic carbon and the mean average in the five studied lagoon are in a range of 1.20% for Machona lagoon to 1.80% for Terminos lagoon. The main type of sediments were the sand slime and slime mud with low correlation with the concentration of POP's.

The Table II shows the mean values and standard deviation for the individual chlorinated hydrocarbons in sediments of the lagoons. The pesticides with highest concentrations were Heptachlor, Aldrin, Dieldrin, Endrin and ppDDT. The presence of these compounds indicates that the environmental conditions may originate their transformation and degradation, specially concerning that of Aldrin to Dieldrin and p'p'DDT to p'p'DDE.

The concentration of POP's in sediments of Alvarado Lagoon is almost two higher than in the other sites, and its worth to mention that the rivers discharging into this lagoon cross important industrial cities (Cordoba and Orizaba) and extensive coffee crops areas, and it is also related to the watershed dynamic. The variability in concentrations obtained also would be influenced by other factors as the type of sediments and the total organic carbon content, however, for this factor the correlation values were low significant.

TABLE II. THE MEAN CONCENTRATIONS OF POP'S IN SEDIMENTS FROM THE COASTAL LAGOONS (ng g^{-1}).

	LAGOON				
COMPOUNDS	CARMEN	MACHONA	ALVARADO	MECOACAN	TERMINOS
α HCH	0.12 ± 0.08	0.09 ± 0.04	0.47 ± 0.19	0.26 ± 0.08	0.32 ± 0.06
χ HCH	0.24 ± 0.11	0.28 ± 0.16	0.85 ± 0.08	0.62 ± 0.11	0.30 ± 0.10
β HCH	0.50 ± 0.25	0.62 ± 0.34	1.86 ± 0.60	0.54 ± 0.32	0.62 ± 0.12
Heptachlor	5.19 ± 2.30	2.30 ± 0.40	3.91 ± 1.21	2.36 ± 0.61	1.89 ± 0.26
Heptachlor Epox.	0.19 ± 0.10	0.27 ± 0.12	0.86 ± 0.14	0.68 ± 0.16	0.84 ± 0.18
Aldrin	0.70 ± 0.53	1.15 ± 0.29	2.11 ± 0.60	1.64 ± 0.24	2.60 ± 0.76
Dieldrin	6.84 ± 1.28	0.92 ± 0.22	2.44 ± 0.23	1.90 ± 0.16	2.80 ± 0.52
Endrin	2.73 ± 0.61	4.90 ± 1.40	7.80 ± 0.81	3.60 ± 0.63	4.20 ± 0.83
DDE	0.15 ± 0.07	0.26 ± 0.08	1.80 ± 0.18	1.40 ± 0.18	0.80 ± 0.16
DDT	1.48 ± 0.82	0.90 ± 0.12	2.30 ± 0.42	1.60 ± 0.26	2.20 ± 0.40
TOTAL	18.14	11.69	23.46	14.60	16.57

Table III shows the mean concentrations and standard deviation for individual chlorinated hydrocarbons in tissues of the american oyster *Crassostrea viriginica.* The accumulation and persistence of pesticides in biological tissues depend on environmental factors, content of lipids, age and sex of the organisms [7].

The values obtained were in most cases two times higher compared to the sediments and again Alvarado Lagoon shows the highest concentration (42.5 ng g^{-1}).

TABLE III. THE MEAN CONCENTRATIONS OF POP'S IN TISSUES OF THE AMERICAN OYSTER CRASSOSTREA VIRGINICA (ng g-1) DRY WEIGHT.

	LAGOON				
COMPOUND	CARMEN	MACHONA	ALVARADO	MECOACAN	TERMINOS
β HCH	0.62 ± 0.15	0.97 ± 0.16	2.08 ± 0.94	1.40 ± 0.22	0.80 ± 0.16
Heptachlor	2.10 ± 0.86	1.70 ± 0.50	2.90 ± 0.73	1.60 ± 0.30	1.80 ± 0.20
Heptachlor Epox	2.50 ± 0.44	3.20 ± 0.70	2.40 ± 0.60	2.00 ± 0.62	2.30 ± 0.36
Aldrin	2.50 ± 0.95	1.60 ± 0.10	6.70 ± 0.74	3.20 ± 0.44	1.80 ± 0.20
Endrin	1.50 ± 0.22	10.60 ± 1.16	8.00 ± 1.12	2.40 ± 0.26	3.20 ± 0.60
DDE	4.20 ± 0.86	BDL	BDL	1.20 ± 0.32	BDL
DDT	BDL	5.60 ± 0.86	1.60 ± 0.24	BDL	1.80 ± 0.26
Endosulphane II	0.80 ± 0.18	BDL	1.30 ± 0.18	0.80 ± 0.10	1.10 ± 0.18
Endosulphane II	14.90 ± 2.16	8.80 ± 0.44	17.60 ± 0.94	5.40 ± 0.70	2.80 ± 0.64
TOTAL	29.12	32.47	42.58	18.00	15.60

BDL = 0.010 ng g^{-1}

Published data [8] indicate that the oysters found on the american coasts concentrate pesticides up to two times more intensively compare to sediments due to their progressive concentration mechanisms for certain pesticides.

Previous studies carried out in Carmen-Machona and Alavardo lagoons showed lower concentration [9]. Thus, comparing both studies a clear increasing tendency of pesticides concentration can be observed with the passing years.

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