

## The concentration of some organochlorine pesticides in the surface sediments of the Shatt Al-Arab River

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### Abstract

Thirteen organochlorine compounds have been identified in the surface sediments of six stations along the Shatt Al-Arab estuary for the period from Sep. 2020 – Mar. 2021 as organochlorine pesticides, namely DDD, DDE, Aldrine, Dieldrin, Heptachlor, Epoxyheptachlor, Endrine, Endrine ketone, Lindane, Methoxychlor, Endosulfan, Alpha-lindane, and Delta-lindane, using a gas chromatographic device connected to a GC- mass spectrometer equipped with an electronic hunting detector GC-ECD.

The highest total concentration of pesticides (41.54 µg/kg dry weight) was recorded in Al- Fao station, while the lowest total concentration of pesticides (21.61 µg/kg dry weight) was in the Al-dayer station. The percentage of organic matter TOC% in sediments and the texture of the sediments were also measured. positive correlation between TOC% and the total rate of pesticides in the six stations, and there is a correlation between the percentage of each silt and mud with the total rate of pesticides in sediments.

**Keywords:** Organochlorine, Pesticides, Surface Sediments, Shatt Al-Arab estuary.

### 1. Introduction

The Shatt Al-Arab River is of great economic importance as it forms part of the important border between Iraq and Iran, and it is Iraq's only passage to the Arabian Gulf. Shatt Al-Arab River is the most important source of fresh water and the vital artery of Basrah city (Al-Mahmoud, 2020). It considers of great economic importance, it has a long relationship with commercial, industrial, and agricultural purposes (Al-Mahmoud *et al.*, 2019).

Pollution is one of the most serious problems facing the modern world. Pollution

problems have increased in the twentieth century as a result of development and modern industrial technology. The increase in the world's population at high rates over a hundred years has led to an increase in the demand for food, water, clothing, and many other commodities, and these requirements are practiced great pressure and depletion of natural and environmental resources and contributed significantly to the pollution of air, water and soil as a result of human activities at present, as a large number of pollutants and waste are disposed of to the environment. Thousands of tons of toxins

are released into the air, water, and soil, and very large quantities of chemical compounds are produced annually. (Rani and Dhania, 2014; Helal and Abo El-Seoud, 2014; Karishma and Hari, 2015).

Among those chemicals are chemical pesticides, which have been used for thousands of years since the Sumerians, Greeks, and Romans used various compounds such as sulfur, mercury, copper, and arsenic to kill or reduce the impact of pests (Al-Trace *et al.*, 2004) causing a great imbalance in the bio-environmental balance (Al-Sultan, 2021).

Nowadays, agriculture has become highly dependent on the use of pesticides of all kinds, as pesticides have played a major role in food production, as they protect and increase production (Prohand *et al.*, 2015).

Pesticides are defined under the Environmental Pest Control Act (EPCA) as any substance or mixture of substances used to prevent, destroy or mitigate the impact of any pest (pests including insects, rodents, worms, fungi, bacteria, weeds, and other forms of terrestrial and aquatic plants or microorganisms (Ubuoh *et al.*, 2012).

The rapid development in the use of pesticides began significantly after World War II with the introduction of DDT (dichlorodiphenyltrichloroethane), BHC (benzene hexachloride), aldrin, dieldrin, endrin and 2,4-D (dichlorophenoxyacetic

acid). The new chemicals are effective, easy to use and inexpensive and thus have become popular (Ortiz-Hernandez *et al.*, 2013).

Sediments are considered a habitat and environment for benthic organisms such as insects, snails, shrimp and fish. Some pollutants transfer from the water column of rivers to the bottom of the river (Barsher and Anton, 2000). Therefore, the current study aims to study the concentration of organochlorine pesticides in the Shatt Al-Arab River surface sediments.

### Materials and methods:

The Shatt Al-Arab River is located in the southeast of Iraq and extends from of Al-Qurna city north of Basrah governorate to flow into the Arabian Gulf south of Fao. The length of the Shatt Al-Arab from al-Qurna to Fao is approximately 204 km, with a width in some areas of about two km. Six stations were chosen along the Shatt Al-Arab River, to collect sediment samples seasonally for the period from Sep. 2020 – Mar 2021. The locations of these stations were determined using a GPS device (Geological Positioning System), as shown in Figure (1).

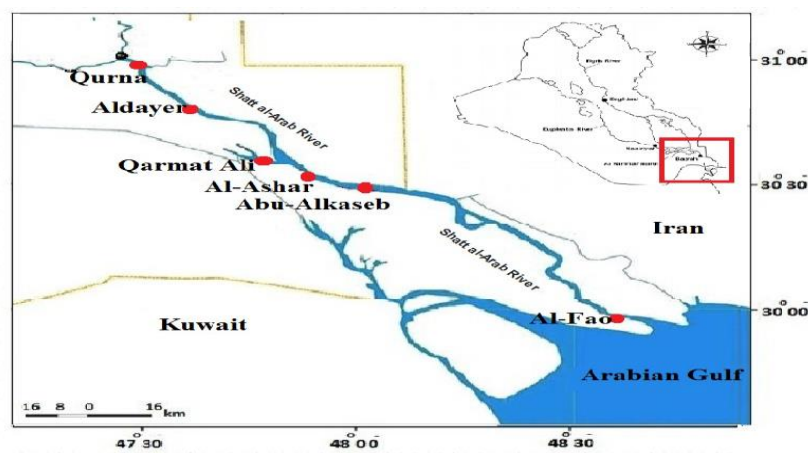


Figure (1) Map of the Shatt Al-Arab estuary and the sampling stations.

Surface sediment (5-10) cm was collected from the six study stations using the Grab Sampler, and stored in an ice box after being wrapped in aluminum foil until reaching the laboratory.

Water samples were also collected from the six stations using Winkler bottles for measuring the dissolved oxygen, fixed in the field by adding 2 ml of manganese sulfate, 2 ml of basic iodide, and 2 ml of concentrated sulfuric acid. The air and water temperature were also measured using a simply graduated mercury thermometer (0-100). The pH of the water was also measured using a pH meter. The electrical conductivity of the water was measured using the EC electrical conductivity device.

The sediment samples were air dried, ground, and sieved (63 $\mu$ m). Twenty-Five gm of the sieved sample was hot extracted for 24 hrs. using dichloromethane solvent. The samples were evaporated to near dryness. The process of removing fat was carried out by adding 25 ml of acetonitrile and 25 ml of

hexane according to the method described by AL-Ali (2012).

The pesticides were purified and separated by passing the sample on a separation column consisting of a layer of sodium sulfate, then fluorosil, then a layer of sodium sulfate (EPA, 2007; AL-Ali, 2012). The quality and quantity of residues were determined using a GC-MS device with an AGILENT-type electron-Ionization-Detector of the SIM type. The volume of the injector is 3 microliters and the carrier gas is Helium gas, with a flow rate of 1 ml/min, and a column temperature of 290°C. A Capillary column was used, 30 meters long, 0.25 mm in diameter, and 0.25  $\mu$ m thick.

### Results:

The residual organochlorine pesticides in the surface sediments of the Qurna station showed that In the summer, the highest concentration of 0.9  $\mu$ g/kg was recorded for epoxyheptachlor, and the lowest concentration was imperceptible (ND) for the pesticide endrin-aldehyde, table (1).

**Table (1) Residues of organochlorine pesticides ( $\mu$ g/kg) in the surface sediments of the Qurna station.**

pesticide	Summer	Autumn	Winter	Spring
Alpha-lindane	0.1	0.1	2.7	1.23
lindane	0.1	0.1	0.04	0.03
delta-lindane	0.7	0.4	0.01	0.05
heptachlor	0.4	0.3	0.18	0.13
aldrin	0.2	0.2	0.65	0.56
epoxyheptachlor	0.9	0.4	0.71	0.43
D.D.E	ND	0.1	ND	0.02
dieldrin	ND	0.1	1.67	1.72
D.D.D	ND	0.3	2.55	1.3
Endrin aldehyde	ND	ND	ND	ND
Endrin ketone	0.1	1.8	1.01	1.15
Methoxy chlor	0.1	1.5	ND	0.2
endrin	0.5	9.6	1.73	0.25
endosulfan	ND	ND	0.39	0.41
Total Pesticides	3.1	14.9	11.64	7.48

Table (2) shows the residues of organochlorine pesticides in the surface

sediments of Al-dayer station. In the summer, the highest concentration of 1.8

$\mu\text{g}/\text{kg}$  of endrin was recorded and the lowest imperceptible concentration of endrin aldehyde, endosulfan.

**Table(2) Residues of organochlorine pesticides ( $\mu\text{g}/\text{kg}$ ) in surface sediments at Al-dayer station.**

Pesticide	Summer	Autumn	Winter	Spring
Alpha-lindane	0.2	0.1	2.13	1.37
lindane	0.1	0.4	ND	ND
delta-lindane	0.3	0.1	ND	ND
heptachlor	0.7	1.5	ND	0.02
aldrin	0.5	0.5	0.51	0.56
epoxyheptachlor	0.5	0.3	0.45	0.08
D.D.E	0.2	0.4	ND	ND
dieldrin	0.1	ND	0.90	0.79
D.D.D	0.4	0.2	2.70	1.5
Endrin aldehyde	ND	ND	ND	ND
Endrin ketone	0.5	0.1	ND	ND
Methoxy chlor	0.4	0.4	ND	0.06
endrin	1.8	0.4	0.18	0.26
endosulfan	ND	ND	0.13	0.2
Total Pesticides	5.7	4.4	7	4.84

Table (3) shows the residues of organochlorine pesticides in the surface sediments of the station Karmat Ali, as it recorded in the summer the highest concentration of 5.8,  $\mu\text{g}/\text{kg}$  of endrin and the lowest imperceptible concentration of endrine- aldehyde, methoxychlor, endosulfan.

Table (4) shows the residues of organochlorine pesticides in the surface sediments of Al-Ashar station, where the highest concentration was recorded at 2.0  $\mu\text{g}/\text{kg}$  of epoxyheptchlor and the lowest imperceptible concentration of endrine- aldehyde pesticides and endosulfan.

**Table 3: Residues of organochlorine pesticides ( $\mu\text{g}/\text{kg}$ ) in surface sediments in Karmat Ali station.**

Pesticide	Summer	Autumn	Winter	Spring
Alpha-lindane	0.3	0.1	0.46	0.3
Lindane	0.1	0.4	ND	0.1
delta-lindane	0.3	0.2	ND	0.2
heptachlor	0.6	1.5	0.17	0.8
Aldrine	0.9	2.3	0.27	0.4
epoxyheptachlor	0.7	0.2	0.60	0.73
D.D.E	0.2	0.1	0.20	0.3
Dieldrin	0.2	0.1	1.73	1.65
D.D.D	0.1	ND	3.04	0.04
endrin aldehyde	ND	ND	ND	ND
endrin ketone	0.1	0.3	0.20	0.4
Methoxychlor	ND	0.6	ND	0.01
Endrin	5.8	1.2	0.18	1.2
endosulfan	ND	ND	0.41	0.6
Total Pesticides	9.3	7	7.26	6.73

**Table 4: Residues of organochlorine pesticides ( $\mu\text{g}/\text{kg}$ ) in surface sediments at Al-Ashar station**

Pesticide	summer	autumn	winter	spring
Alpha-lindane	0.7	0.4	0.48	0.27
Lindane	0.3	0.1	0.09	ND
delta-lindane	0.4	0.5	0.09	0.06
Heptachlor	0.8	0.4	0.33	0.20
Aldrine	1.3	0.5	0.86	0.46
epoxyheptachlor	2	1.3	0.26	0.22
D.D.E	0.1	0.1	ND	0.1
Dieldrin	0.1	ND	2.56	0.86
D.D.D	0.6	0.1	ND	0.06
Endrin aldehyde	ND	ND	ND	ND
Endrin ketone	1.3	0.1	ND	0.2
Methoxy chlor	0.4	1.5	ND	0.03
Endrin	0.9	1.2	0.25	0.6
endosulfan	ND	ND	0.20	0.36
Total Pesticides	8.9	6.2	5.12	3.42

The residues of organochlorine pesticides in the surface sediments of Abi Al-Khasib station showed that in the summer, the highest concentration of 3.4  $\mu\text{g}/\text{kg}$  of DDD

was recorded, and the lowest concentration was imperceptible for the pesticides endrin aldehyde, endrin ketone, methoxychlor, endosulfan. (table 5).

**Table 5: Residues of organochlorine pesticides ( $\mu\text{g}/\text{kg}$ ) in surface sediments at Abi Al-Khasib station.**

Pesticide	Summer	Autumn	Winter	Spring
Alpha-lindane	0.1	0.1	2.25	1.87
Lindane	0.1	0.2	ND	0.08
delta-lindane	0.4	0.1	ND	ND
heptachlor	0.1	0.1	0.20	0.33
Aldrine	0.3	0.2	0.65	0.27
epoxyheptachlor	0.4	0.7	0.08	0.7
D.D.E	0.2	0.1	ND	0.3
Dieldrin	0.2	0.2	1.12	2.1
D.D.D	3.4	0.1	0.29	0.12
Endrin aldehyde	ND	ND	ND	ND
Endrin ketone	ND	0.1	ND	0.1
Methoxychlor	ND	0.2	ND	ND
Endrin	0.4	0.6	2.20	1.7
endosulfan	ND	ND	0.64	0.48
Total Pesticides	5.6	2.7	7.43	8.05

Table (6) shows residues of chlorine pesticides in the surface sediments of Al - Fao station. In the summer, the highest concentration of  $1 \mu\text{g}/\text{kg}$  of aldrine was

recorded, and the lowest concentration was imperceptible. For the pesticides endrine aldehyde, endosulfan.

**Table 6: Residues of organochlorine pesticides ( $\mu\text{g}/\text{kg}$ ) in surface sediments at Al-Fao station.**

Pesticide	Summer	Autumn	Winter	Spring
Alpha-lindane	0.2	0.2	8.99	7.85
Lindane	0.2	0.4	0.09	0.02
delta-lindane	0.9	0.3	0.1	0.7
Heptachlor	0.4	ND	1.02	0.18
Aldrine	1.0	0.8	0.14	0.14
Epoxyheptachlor	0.6	0.4	0.42	0.60
D.D.E	0.2	0.1	ND	ND
Dieldrin	0.3	0.1	1.93	1.15
D.D.D	0.4	0.1	2.59	2.03
Endrin aldehyde	ND	ND	ND	ND
Endrin ketone	0.9	0.9	0.03	0.9
Methoxy chlor	0.4	0.5	ND	ND
Endrin	0.8	0.5	0.21	1.5
Endosulfan	ND	ND	0.17	0.18
Total Pesticides	6.3	4.3	15.69	15.25

Tables (1-6) showed that the highest concentration of alpha-lindane was 8.99  $\mu\text{g}/\text{kg}$  in Al-Fao station in winter and the lowest concentration was 0.1  $\mu\text{g}/\text{kg}$  in Al-Qurna and Abi Al-Khasib station in summer and autumn, and in Al-Ashar and Al-dayer stations. And the Karmat Ali in autumn, the results of the statistical analysis showed that there were no significant differences ( $P > 0.05$ ) between the studied stations, as the highest rate of 4.310 was recorded in the Al-Fao station and the lowest at the rate of 0.290 in the Karmat Ali station. The results of the statistical analysis also showed there are no seasonal significant differences ( $P > 0.05$ ), the highest average was 2.835 in the winter season and the lowest was 0.167 in the fall season. The highest concentration of 0.40  $\mu\text{g}/\text{kg}$  of lindane was recorded in the Fao station, Karmat Ali and Al-dayer station in the fall season, and the lowest imperceptible concentration was in Al-dayer station in the spring and Karmat Ali station in the winter. The results of the statistical analysis showed no significant differences ( $P > 0.05$ ) between the studied stations, where the highest rate of 0.177 was recorded in Al-Fao station and the lowest rate of 0.0675 in Al-Qurna station. The results of the statistical analysis showed the presence of seasonal significant differences ( $P \leq 0.05$ ) where the highest rate was 0.267 in the autumn season and the lowest rate was 0.037 in the winter season. As for the delta-lindane pesticide, the highest concentration of 0.90  $\mu\text{g}/\text{kg}$  was recorded at the Fao station in the summer, and the lowest concentration was imperceptible in the Al-dayer, Karmat and Abi Al-Khasib stations in the winter and in the Abi Al-Khasib and Al-dayer stations in the spring. The results of the statistical analysis showed no significant differences ( $P > 0.05$ ) between stations, where the highest rate of 0.5 was recorded in Al-Fao station and the lowest rate of 0.05 in Abi Al-Khasib station, and the results of the statistical analysis showed the presence of seasonal significant differences ( $P \leq 0.05$ ) where the highest rate was 0.450 in the summer and the lowest rate was 0.033 in the

winter. As for heptachlor, the highest concentration was recorded at 1.50  $\mu\text{g}/\text{kg}$  in Al-dayer and Karmat Ali stations in the autumn season, and the lowest concentration was undetectable. The results of the statistical analysis showed that there were no significant differences ( $P > 0.05$ ) between the studied stations, as the highest rate of 0.767 was recorded in Karmat Ali station and the lowest rate of 0.207 in Abi Al-Khasib station, the results of the analysis showed no significant seasonal differences ( $P > 0.05$ ), as the highest rate was 0.633 in the autumn season and the lowest rate was 0.277 in the spring.

The highest concentration of 2.30  $\mu\text{g}/\text{kg}$  of aldrine was recorded at Karmat Ali station in the autumn season, and the lowest concentration was 0.14  $\mu\text{g}/\text{kg}$  in the FAO plant in the spring and winter season. A rate of 0.967 in the Karmat Ali station and the lowest rate of 0.355 in Abi Al-Khasib station, and the results of the statistical analysis showed that there were no significant differences ( $P > 0.05$ ) seasonally, with the highest rate of 0.7500 recorded in the autumn season and the lowest rate of 0.428 in the spring season.

As for epoxyheptachlor, the highest concentration of 2  $\mu\text{g}/\text{kg}$  was recorded in Al-Ashar station in the summer, and the lowest concentration was 0.08  $\mu\text{g}/\text{kg}$  in Al-dayer station in the spring. The results showed no significant differences between the studied stations, and the highest rate was 0.945 in Al-Ashar station and the lowest rate 0.332 in Al-dayer station, and the results of the statistical analysis showed that there were no significant seasonal differences ( $P > 0.05$ ), where the highest rate of 0.850 was recorded in the summer and the lowest rate of 0.420 in the winter. The highest concentration of 0.40  $\mu\text{g}/\text{kg}$  of DDE was recorded in Al-dayer station in the autumn season. The lowest concentration was undetectable in the Gurna station in the summer and in the Gurna station and Al-dayer and Al-Ashar, Abi Al-Khasib and Al-Fao in the winter and Al-dayer station and Al-Fao in the spring. The results of the statistical analysis showed that



there were no significant differences ( $P > 0.05$ ) between the studied stations, and the highest rate of 0.2 was recorded in Karmat Ali station and the lowest rate was 0.03 in Al-Qurna station, and the results of the statistical analysis showed no seasonal significant differences ( $p > 0.05$ ), where the highest rate of 0.150 was recorded in autumn and summer and the lowest rate of 0.033 in winter.

The highest concentration of 2.56  $\mu\text{g}/\text{kg}$  of dieldrine was recorded at Al-Ashar station in the winter and the lowest undetectable concentration in Al-Qurna station in the winter season. In the summer and at Al-dayer and Al-Ashar stations in autumn, the results of the statistical analysis showed that there were no significant differences ( $P \leq 0.05$ ) between the studied stations.

The highest rate was recorded at 1.6517 in the winter season and the lowest at 0.0833 in the autumn. The concentration of 3.40  $\mu\text{g}/\text{kg}$  of D.DD was recorded in the winter and in the autumn, and the results of the analysis were ( $P > 0.05$ ) surrounded by the stations. The highest rate was 1.280 in Fao and the lowest rate was 0.190 in Al-Ashar station, and the results of the statistical analysis showed that there were no significant differences ( $P > 0.05$ ) in season. The highest rate was 1.862 in the winter season and the lowest rate was 0.133 in the autumn season. As for endrine-aldehyde, no concentration was recorded for it in the six stations and in all seasons. The highest concentration of 1.8  $\mu\text{g}/\text{kg}$  of endrine-ketone was recorded in Al-Qurna station in the fall season, and the lowest concentration was imperceptible in Abi Al-Khasib station in the summer, Al-dayer Al-Ashar and Abi Al-Khasib station in the winter and in Al-dayer station in the spring. The results of the analysis showed significant differences ( $P \leq 0.05$ ) between stations, where the highest rate was recorded at 1.0150 in Al-Qurna station and the lowest at 0.050 in Abi Al-Khasib station. The results of the statistical analysis showed that there were no significant differences ( $P > 0.05$ ) quarterly, where the highest rate was 0.550 in the autumn season and the lowest

rate was 0.2067 in the autumn. As for the pesticide methoxychlor, the highest concentration of 1.5  $\mu\text{g}/\text{kg}$  was recorded in Al-Ashar and Al-Qurna stations in the fall season, and the lowest concentration was imperceptible in the Karmat Ali and Abi Al-Khasib stations in the summer. The average rate was 0.4825 in Al-Ashar station and the lowest rate was 0.050 in Abi Al-Khasib station, and the results of the statistical analysis showed that there were significant differences ( $P \leq 0.05$ ) seasonally, and the highest rate was 0.7833 in the fall season and the lowest intangible rate in the winter. The highest concentration of 9.6  $\mu\text{g}/\text{kg}$  of endrine was recorded at Al-Qurna station in the autumn season, and the lowest concentration was 0.18  $\mu\text{g}/\text{kg}$  in Al-dayer station ( $P > 0.05$ ) among the stations. The highest rate was 3.020 in Al-Qurna station and the lowest rate was 0.660 in Al-dayer station. The results of the statistical analysis showed that there were no significant differences ( $P > 0.05$ ) in season. The highest rate was 2.250 in the autumn season and the lowest rate was 0.792 in the winter season. Also, the highest concentration of 0.64  $\mu\text{g}/\text{kg}$  of endosulfan was recorded in Abi Al-Khasib station in the winter season, and the lowest concentration was undetectable in Al-Qurna station, Karmat Ali and Al-Ashar, Abi Al-Khasib, Al-Fao stations and Al-dayer in the summer and autumn seasons. The results of the statistical analysis showed no significant differences ( $P > 0.05$ ) between stations, and the highest rate was 0.2800 in Abi Al-Khasib station and the lowest rate was 0.0825 in Al-dayer station. The results of the statistical analysis showed that there were seasonally significant differences ( $P \leq 0.05$ ), and the highest rate was 0.3717 in the spring season and the lowest imperceptible rate in the summer and fall seasons.

As the results of the current study showed that the highest total concentration of pesticides 41.54  $\mu\text{g}/\text{kg}$  dry weight was in the FAO station as in Figure (2), while in the Al-Qurna station the total concentration of pesticides was 37.22  $\mu\text{g}/\text{kg}$  dry weight as in



Figure (3), but in Karmat Ali station the total concentration of pesticides was 29.28  $\mu\text{g}/\text{kg}$  dry weight as shown in Figure (4), and in Abi Al Khasib station the total concentration of pesticides was 23.87  $\mu\text{g}/\text{kg}$  dry weight as shown in Figure (5), and in Al Ashar station

the total of pesticides was 23.6  $\mu\text{g}/\text{kg}$  Dry weight as shown in Figure (6), and the current study showed that the total pesticides for Al-dayer station were 21.61  $\mu\text{g}/\text{kg}$  dry weight as in Figure (7).

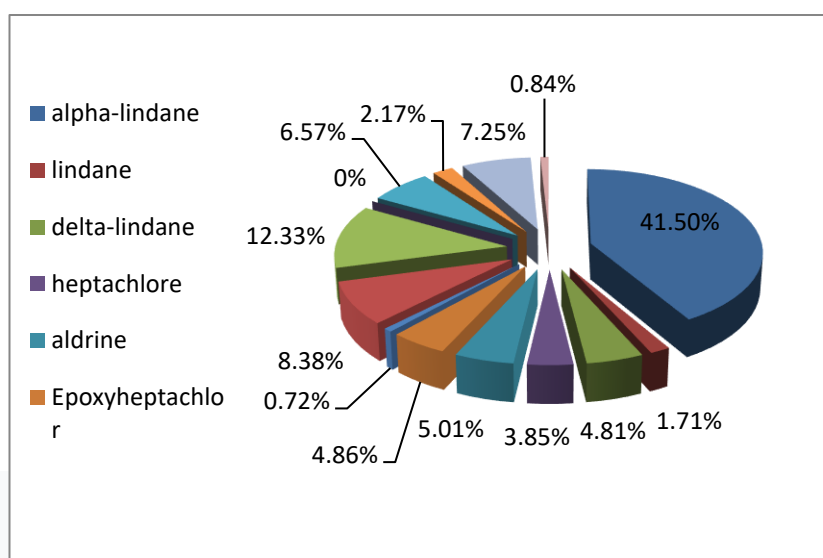


Figure (2): Percentages of pesticides in the Fao station

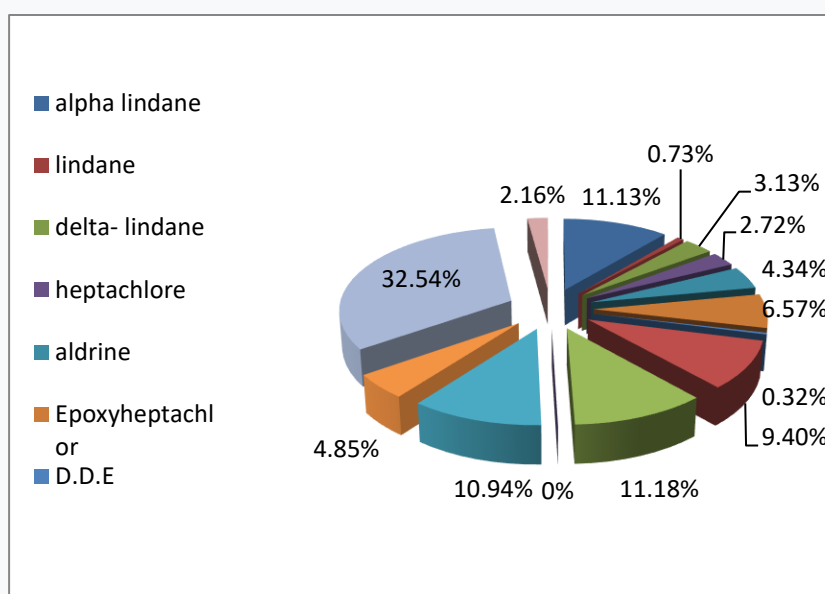


Figure (3) Percentages of pesticides in Al-Qurna station



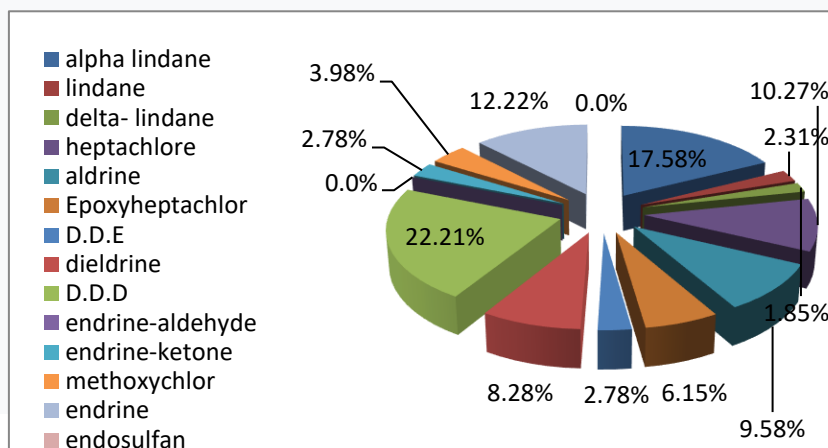


Figure (7): Percentages of pesticides in Al-dayer station

### Total organic carbon (TOC%)

The highest value of the total organic carbon content of 22.55% TOC was recorded in the Al-Fao station in the winter season, and the lowest value was 6.17 in the Al-Ashar

station in the autumn season, as shown in Table (7). Also, the percentages of organic carbon content are positively and significantly correlated with total pesticides ( $r = 0.300$ ).

**Table (7): Total Organic Carbon Content (TOC %) for the current study with season and station rates and standard deviation values**

Stations	summer	autum n	winter	spring	Station rates
Qurna	17.92	17.03	20.81	16.7	18.115
Al-Dair	16.76	17.6	17.96	16.03	17.0875
Karmat-Ali	19.06	12.35	22.04	19.61	18.265
Al-Ashar	15.54	6.17	19.46	15.48	14.1625
Abi-alkhasib	16.83	8.39	19.11	14.73	14.765
Al-Fao	15.72	16.55	22.55	14.26	17.27
Seasons rates	16.97	13.01	20.32	16.135	
standard deviation	1.337	4.86	1.786	1.914	

### The Sediments Texture:

Results in table (8) showed the percentages of the surface sediment texture, the ratio of silt to clay is dominant in the surface sediments in four stations, which are Al-Qurna, Karmat Ali, Al-Fao and Abi Al-Khasib, which are predominantly Silty clay. As for Al-dayer station, the ratio of silt to sand. It is prevalent in the surface sediments silty sand, and Al-Ashar station, the ratio of

sand to silt is prevalent in the surface sediments, sandy silt. There is a positive significant relationship between the total rate of pesticides and the proportion of silt  $r = 0.312$ , and there is also a relationship between the total rate of pesticides and the proportion of clay  $r = 0.397$  (clay), while the total rate of pesticides is not associated with the proportion of sand in the sediments.

**Table (8) Percentages of sediment texture.**

Stations	clay %	Silt%	sand%	Sediment texture
Qurna	26	72	2	Silty clay
Al-Dair	12	74	14	Silty sand
Karmat-Ali	19	70	11	Silty clay
Al-Ashar	5	28	67	Sandy silt
Abi-alkhasib	35	50	15	Silty clay
Al-Fao	25	60	15	Silty clay

**Discussion:**

The current study showed that there is a local and seasonal variation in the total concentrations of pesticides. The highest rate of pesticides recorded in the Al-Fao station reached 10.385  $\mu\text{g}/\text{kg}$  because the station is located down the Shatt Al-Arab River which has many farms that leach pesticides from agricultural lands. Also, there are a lot of fishing boats painted with pesticides materials in Al-Fao station, and it may be the result of sedimentation of suspended substances that carry pesticides, as organochlorine pesticides are poorly soluble in water and have a high tendency to bind to sediments, especially clay and silt (DouAbul *et al.*, 1987), which characterized Al-Fao station. It was followed by the Al-Qurna station, with the highest rate reaching 9.28  $\mu\text{g}/\text{kg}$ . because this station has many animal sheds and the use of pesticides is frequent. The area is also surrounded by agricultural lands, and pesticides are usually used in farms. Also, the silty nature of the sediments of the Al-Qurna station, and thus the adsorption of silt particles to pesticides increases and increases the concentration of pesticides (Al-Ali, 2012), as there is a positive correlation between the concentration of pesticides and the silt in the sediments ( $r = 0.454$ ), and there is also a positive relationship between the concentration of pesticides and the clay in the sediments ( $r = 0.359$ ). In the Karmat Ali station, the total concentration of pesticides

was 7.57  $\mu\text{g}/\text{kg}$ . due to a large number of farms in it, in addition to being fishing areas and pesticides are used in fishing. Also, the nature of the sediments in the Karmat Ali station is sandy silty, thus the suspended pesticide particles increase, as there is a positive correlation between the concentration of pesticides and silt in the sediments ( $r = 0.454$ ), a significant positive correlation was observed between the total concentration of pesticides and TOC% ( $r = 0.300$ ), and this agrees with Al-Ali (2012) founding, who found that there is a positive correlation,  $r = 0.196$ ).

As for Al-Ashar station, the total rate of pesticides was 6.02  $\mu\text{g}/\text{kg}$ , because it is a densely populated area and the frequent use of insect and rodenticides in homes, in addition to the presence of woodworking plants and carpentry workshops where pesticides are used to prevent mold and termites. As for the Abi Al-Khasib station, the total rate reached 5.942  $\mu\text{g}/\text{kg}$  due to their being agricultural areas in addition to being a populated area, and thus the use of pesticides for domestic purposes increases. As for Al-dayer station, the total rate of pesticides reached 5.485  $\mu\text{g}/\text{kg}$  which is the lowest rate for pesticides due to the low population density in the study station and there are few farms, and there are fish farms where they use only fungicide and bacterial pesticides in very small quantities compared to what is used to control agricultural pests.

The results of the current study showed a high concentration of total organochlorine pesticides in the Al-Fao station compared to the Al-dayer station, and this is consistent with what was found by DouAbul *et al.*(1988), as they noticed that the Shatt Al-Arab sediments in Abi- Al-Khasib contain high amounts of total chlorine pesticide residues compared to those found In the Karmat Ali area, this was attributed to the sedimentation of suspended particles carried by the Shatt Al-Arab to the bottom.

Seasonal variation in the total concentrations of pesticides, as the results showed an increase in the values of pesticides in winter and spring, as the highest rate of pesticides reached 8.66 µg/kg in the winter season. There is a negative correlation ( $r = - 0.262$ ) between the concentration of pesticides and the temperature, as the temperature decreases, the decomposition processes of the organic matter decrease, and thus the percentage of CO<sub>2</sub> in the water decreases, so the basicity of the water increases. There is a positive correlation ( $r=0.435$ ) between the concentration of pesticides and the pH. In the autumn season, the rate of pesticide concentration was 6.48 µg / kg, because the water begins to settle in the autumn consequently, the sedimentation process increases and the percentage of pesticides in the sediments increases because the sediments act as reservoirs for pollutants in the aquatic environment (Chee *et al.*, 1996). The lowest rates were in the summer season reaching 6.48 µg/kg. due to the low pesticide use in the summer season because it affects the growth of plants due to high temperatures.

### Conclusion

Thirteen organochlorine compounds have been identified in the surface sediments of six stations along the Shatt Al-Arab estuary as organochlorine pesticides.

The highest total concentration of pesticides was recorded in Al-Fao station, while the lowest was in the Al-dayer station. positive correlation between TOC% and the total rate

of pesticides, and there is a correlation between the percentage of each silt and mud with the total rate of pesticides in sediments.

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## تركيز بعض المبيدات الكلورينية العضوية في الرسوبيات السطحية لشط العرب

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### المستخلص

تم تحديد ثلاثة عشر مركبا من المركبات الكلورينية العضوية في الرسوبيات السطحية لست محطات على طول شط العرب للفترة من ايلول 2020 إلى مارس 2021 كمبيدات آفات كلورينية عضوية، وهي DDD و DDE و Aldrine و Dieldrine و Heptachlor و Epoxyheptachlor و Endrine و Endrine ketone و Lindane و Methoxychlor و Endosulfan و Alpha-lindane و Delta-lindane، باستخدام جهاز كروماتوغرافي غازي متصل بمطياف كتلة GC مجهز بكاشف صيد إلكتروني GC-ECD. وسجل أعلى تركيز كلي للمبيدات (41.54 ميكروغرام/كغم من الوزن الجاف) في محطة الفاو، في حين سجل أدنى تركيز إجمالي للمبيدات (21.61 ميكروغرام/كغم من الوزن الجاف) في محطة الداير. كما تم قياس النسبة المئوية للمادة العضوية TOC % في الرسوبيات ونسجة الرسوبيات. وكانت هناك علاقة ارتباط موجبة بين TOC % والمعدل الكلي للمبيدات في المحطات الست، وهناك علاقة ارتباط بين نسبة كل من الغرين والطين مع المعدل الكلي للمبيدات.