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MARSH BULLETIN

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Determination of Mercury in Aquatic Plants, Waters and Sediments of the Southern Marshes of Iraq (Al-Amarah and Al-Basrah) and Shatt Al-Arab River By Cold Vapor Atomic Absorption Spectrometry

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Abstract

A cold vapor atomic absorption spectrometry was used for the determination of mercury levels in different sites of Al-Amarah , Al-Basrah marshes and Shatt Al-Arab river. Thirteen species of aquatic plants, water and sediments samples were analyzed. The obtained results showed that the highest levels of mercury were found in aquatic plants of all tested species. A considerably lower concentrations of mercury were found in marshes sediments compared with rivers. A comparison of observed sampling sites provides the adverse effect of industrial contamination on the water ecosystem of Shatt Al-Arab river and incomplete removal of mercury in a sewage station.

1-Introduction

The mercury cycle in water environments has long been receiving considerable attention because of its high toxicity (Houserova *et al.*, 2006) and bioaccumulation in various organisms and it can create harmful effects upon environment and human health (Rudolfs, 2000). Mercury levels in water could be arises from several sources which natural presents in bed rock and soil local sources: air born .etc (Al-Imarah *et al.*, 2001, 2002). Industrial use of mercury, a highly toxic metal, has led to significant mercury pollution of the environment (Bryan and Langston, 1992). Cleanup technologies which are capable of treating large olumes of soil, water, or sediment contaminated with relatively low levels of mercury in a cost-effective way are urgently needed (Saouter, and Barkay,1994). Patricia *et al* (2003) investigated the distribution of mercury in water and sediment and biota samples from Lake Victoria, East Africa. The levels of mercury in water and

sediments of southern part of Iraq were studied by Al-Imarah etal (2003) . Kan Atireklap etal (1998) assessed the level of contamination of mercury in sea water along Eastern coast of gulf of Thailand between 1994-1996.

The aim of this work was the determine-ation of mercury in- thirteen species of aquatic plants, water and sediments samples from different sites of Al-Amarah, Al-Basrah marshes and Shatt Al-Arab river and the influences of industrial regions of water ecosystems were also investigated.

Experimental

Apparatus

The determination of mercury in the aquatic plants samples achieved by means of cold mercury vapor atomic absorption spectrometry (CVAAS) using shimadzu atomic absorption spectrophotometer model (AA-630-12)and mercury hallow cathode lamp at (253 nm). A quartz cell of 12 cm in length and (0.8) cm in diameter with quartz windows , with and out lets ends has been used for measurements.

Reagents

Chemicals of analytical – reagent grade and distilled – deionized water were used for the preparation of all solutions:

1- 1000 ppm Hg^{2+} solution:1.3535 gm of $HgCl_2$ was dissolved in 50 ml of conc. HCl and diluted to 1 Liter with deionized water.
2- 25% (w/v) $SnCl_2$:25 gm of $SnCl_2$ was dissolved in 100 ml of 20% (v/v) HCl .
3- 0.05 % (w/v) $K_2Cr_2O_7$:0.05 gm of $K_2Cr_2O_7$ was dissolved in 2% (v/v) HNO_3 solution .
4- Crystal potassium persulphate.

2-Materials and Methods

Plants were collected from Al-Amarah and Al-Basrah marshes during 2006-2007 (Fig.1) , the samples were freeze-dried and ground with agate mortar (1gm dry wt.) were digested according to the procedure described by Goldberg *et al* (1983). Sediment samples were obtained by means of a Van Veen grab sampler from representative sites of marshes . Mercury analysis was performed on the <63 μm fraction of the sediments which had been separated by sieving after freeze-drying and grinding and treateded as the procedure described by Sturgeon *et al.* (1982).

Water samples were collected from Al-Amarah , Al-Basrah marshes and Shatt Al-Arab river from different sites (Fig.1, Fig.2) in each location about 3L .After filteration of samples , the preconcentration procedure described by Ramlal *et al.* (2002) was used.

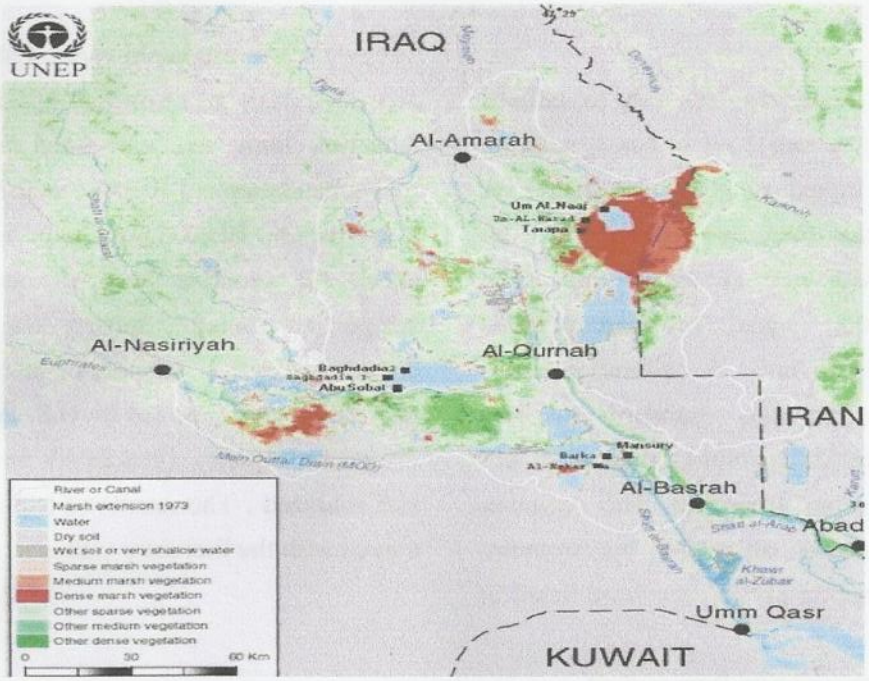

Fig.(1): Map of Southern Iraqi Marshes(Al-Amarah and Al-Basrah) showing the sampling stations .

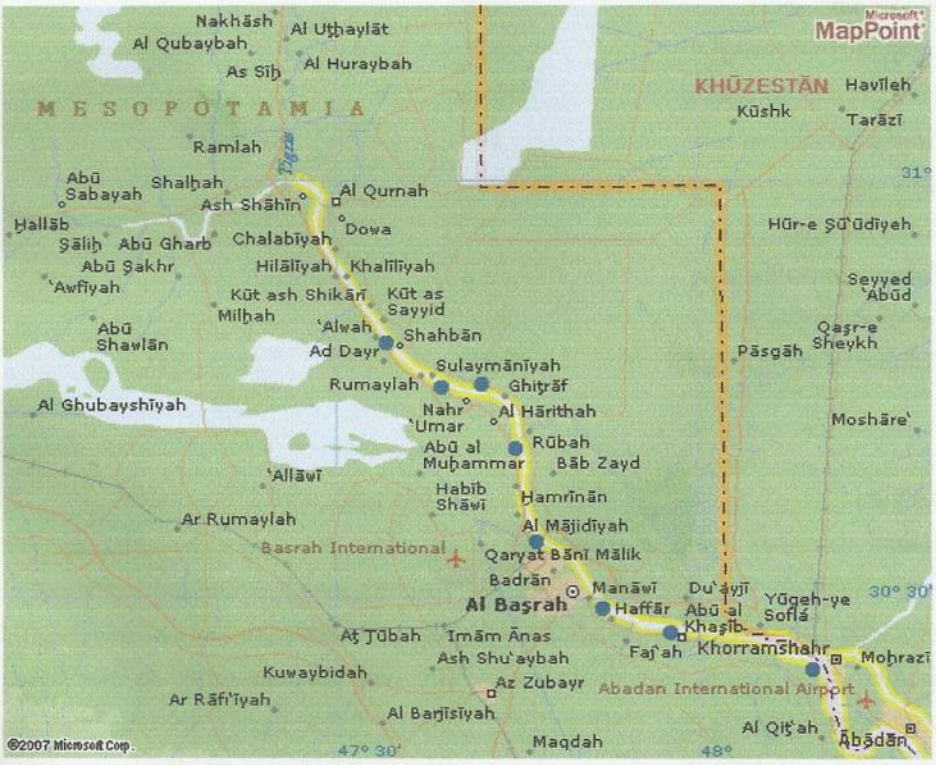

Fig.(2): Map of Shatt Al-Arab River showing the sampling stations.

Procedure

Two ml of treated samples were introduced in the reduction vessel, 2 ml of $SnCl_2$ solution were added and mixed using magnetic stirrer for 2 min. then the mercury vapor forced by nitrogen gas with rate of 250ml /min. The atomic absorption signal of mercury was measured at 253.65 nm . A calibration graph prepared from aqueous standard mercury solution to which $SnCl_2$ solution was added and forced by the same procedure. The optimum parameters of atomic absorption spectrometer for the determination of mercury were listed in Table (1). The used cold vapor system has been described in detail elsewhere (Zaki, 2002). The detection limit was calculated following the recommendations of IUPAC: as 0.73 ng Hg gm-1 dry weight. Blank values were negligible. To check the possible loss of mercury during sample processing , quality control samples containing known amounts of mercury in biota and sediments , supplied by U.S. Environmental Protection Agency (U.S.EPA) were processed and analyzed . The results of triplicate analysis agreed with the literature values to within 5%.

Table (1) :Instrumental Parameters

Wavelength (nm)	253.65
Band width (nm)	0.3
Lamp current (mA)	6.0
Back ground correction	None
Time of mixing (sec.)	60
Flow rate of carrier gas (m l min-1)	250
Conc. Of $SnCl_2$(%)	25
Volume of $SnCl_2$ (ml)	2.0
Temprature (°C)	80
Volume of sample (ml)	2.0

Statistical analyses

The statistical analyses were carried out using two-way analysis of variance with unbalanced repeated measurements .Statistical between individual time points was made by using Revised Least Significant Difference (RLSD) test. The probability level for significance was 5% or less .

3-Results and Discussion

The *Potamogeton pectinatus* plant from Al-Amarah marsh contained statistically significant higher relative contents of mercury(0.098 µg/gm dry wt.) than the other species from Al-Basrah marsh (0.066 µg/gm dry wt.) and Shatt Al-Arab River (0.044 µg/gm dry wt.) ($P>0.05$). The difference in the relative contents of mercury in *Potamogeton pectinatus* and *Phragmites*

australis from the individual sampling sites were statistically insignificant (P>0.05).It could be concluded from the results that the mercury is accumulated in the *Potamogeton pectinatus*. Significantly different results were obtained for the other tested plants in which contents of mercury between 0.022-0.095 µg/gm dry wt. were found as shown in Table(2).

Table(2): Concentrations of mercury in aquatic plants tissues (µg/gm dry wt.) .

Species	Hg level (µg/gm)		
	Al-Amarah marsh	Al-Basrah marsh	Shatt Al-Arab river
Salicornia herbacea	0.039	0.066	-
Potamogeton nodosus	0.064	0.090	-
P. perfoliatus	0.027	0.044	-
Ceratophyllum demersum	0.065	0.074	0.054
Typha domingensis	0.081	0.053	0.032
Phragmites australis	0.076	0.022	0.021
P. pectinatus	0.098	0.066	0.044
Vallisneria spiralis	0.080	0.095	-
Salicornia herbacea	0.065	0.077	0.068
Ludwigia	0.044	-	-
Euglenophyta	0.081	0.052	0.074
P. Perfoliatus	0.043	0.055	0.049
P. Crispus	0.025	0.017	0.040

In Shatt Al-Arab river, the highest contents of mercury found in the water surface near paper factory (0.140µg/ml) followed by the site (500m) (0.066µg/ml and declined to low levels at other locations.

At most the mercury levels are much higher in Shatt Al-Arab River waters (0.140µg/ml) than Al-Amarah marsh (0.03-0.05µg/ml) and Al-Basrah marsh (0. 01-0. 02 µg/ml) , this levels can be attributed to the discharge of paper factory which expected from electric cells of chlorine unit.

The results in Table (3 and 4) show that the contents of mercury in sediments samples of Shatt Al-Arab river contained considerably higher levels of mercury (0.09 µg/gm) compared with the sediments of Al-Amarah marsh (0.014-0.025 µg/gm) and Al-Basrah marsh (0.018-0.022 µg/gm) in the studied sites. The sediments composition and its movement (churn, eluviations of sediments) influence the content of mercury in sediments. Statistically significant differences in the mercury content were observed between the sediment samples in all the ecosystems. The lowest value of mercury in

sediments samples in comparison with the aquatic plants and water samples due to the bio accumulation by aquatic animals; therefore the mercury concentration in the sediments are relatively low.

Summaries of the literature values for the levels of mercury in aquatic plants and sediment samples are listed in Table (5) and Table (6), Comparison of the values from previous work in different parts of the world with ours shows certain clear differences. A possible explanation is the levels of mercury in aquatic plants and sediments supplies varies with the different regions. Most of our values are somewhat lower than those obtained in earlier studies . This may be partially due to the lower risk of contamination with mercury which was normally contaminants from industrial waste .

Table(3): Concentrations of mercury in sediment and water samples of Shatt Al-Arab river.

Locations	Samples	
	Sediment Hg levels (µg/gm)	Water Hg levels (µg/ml)
Sindbad	0.074	0.030
Maaqal	0.011	0. 015
Faw	0.032	0.024
Sahil	0.010	0.014
paper factory :		
100m*	0.090	0.140
500m	0.079	0.066
1km	0.069	0.059
2km	0.064	0.033
Potable water	-	0.029

*Oistance away from the factory

Table(4): Concentrations of mercury in sediment and water samples of Al-Amarah marsh and Al-Basrah marsh.

Locations	Samples	
	Sediment Hg levels (µg/gm)	Water Hg levels (µg/ml)
Al-Amarah marsh	0.014-0.025 (n=7)	0.03-0.05 (n=6)
Al-Basrah marsh	0.018-0.022 (n=6)	0. 01-0. 02 (n=8)

Table(5) : Mercury concentrations in aquatic plants of study regions in comparison with other areas of the world (µg/g dry weight).

Location	Hg levels (µg/gm)	Reference
Ceratophyllum	0.37	(Biney (1991
Potamogeton octandrus	0.25	(Biney (1991
Vallisneria aethiopica	0.13	(Biney(1991
Ceratophyllum demersum	0.074	This study
Potamogeton pectinatus	0.098	This study
Vallisneria spiralis	0.095	This study

Table(6) : Mercury concentrations in sediment samples of study regions in comparison with other areas of the world (µg/g dry weight)

Location	Hg level(µg/gm)	Reference
Evoikos Gulf ,Greece	0.41-1.1	(Angelidis (1981
Bahrain	13-106	(Sen Gupta (1990
Kuwait	50-170	(Sen Gupta (1990
Saudi Arabia	3-37	(Linden (1990
Jakarta Bay	0.05-4000	(Gomez (1990
Fiji	<0.2	(Brodie(1990
Al-Amarah marsh	0.014-0.025	This study
Al-Basrah marsh	0.018-0.022	This study
Shatt Al-Arab River	0.010-0.09	This study

Conclusions

The *Potamogeton pectinatus* plant contained higher relative contents of mercury than the other species. It could be concluded from the results that the mercury is accumulated in the *Potamogeton pectinatus*. The highest contents of mercury found in the water surface of Shatt Al-Arab River. The lowest value of mercury in sediments samples in comparison with the aquatic plants and water samples due to the bio accumulation by aquatic animals; therefore the mercury concentration in the sediments are relatively low.

The sewage stations can not eliminate fully the adverse effects. In view of the toxic nature of mercury, the knowledge of their sources and fate in the environment is important. Therefore we are demonstrated the need for a more precise and specific review of the occurrence of mercury in various aquatic environmental compartments in the continent.

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الملخص

تم في البحث الحالي إستخدام تقنية الإمتصاص الذري-التذرية الباردة لتقديرمستويات عنصر الزئبق في مواقع مختلفة من أهوار العمارة والبصرة ونهر شط العرب. تم تحليل ثلاثة عشر صنفا من النباتات المائية ونماذج المياه والرواسب. النتائج المحصلة أشارت الى أن أعلى مستويات للزئبق وجدت في النباتات المائية ولجميع الأصناف المدروسة. كذلك فأن أوطأ تراكيز للزئبق وجدت في رواسب الأهوار مقارنة مع نهر شط العرب. مقارنة النتائج كدالة لمواقع النماذج يعكس تأثير التلوث الصناعي على البيئة المائسة لنهر شط العرب و الإزالة غير المكتملة للزئبق في محطات الصرف.

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Determination of LC50 of linear anionic detergents and diazinon toxin on *Rutilus frisii kutum*

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Abstract

The harmful effect of Diazinon and two anionic detergents on valuable fish:*Rutilus frisii kutum*, individually and in mixed concentration under laboratory conditions have been determined. The LC50- 96 h of Diazinon pesticide was calculated (0.34) mg/l . The LC50- 96 h for the fingerling of the same species under the effect of liquid and powder detergents, were 4.69 and 12.24 mg/l respectively. The LC50- 96 h under the effect of a Diazinon and liquid detergent and the mixture of Diazinon and powder detergent was 7.27 and 0.9 mg/l respectively. The result of this survey show that the toxicity of the mixture of Diazinon and powder detergent is much more profound than the other mixture. In general , it can be said that sometimes the concentration rate of detergents in a given ecosystem is less than the calculated LC50- 96 h in a laboratory condition , but when the same concentration rate of detergent in ecosystem is mixed with another chemical material , it is very much possible that the percentage rate of mortality in fishe rises even higer.

Key words:LC50- 96 h , Acute toxicity, Anionic detergent, Diazinon, *Rutilus frisii kutum*

1-Introduction

Today, pesticides are used in agriculture and for many divers purposes such as human and animal health protection, pest control in forest and aquatic environments, and protection of buildings and other structures.

Increased and continued pesticides are estimated to actually reach the targeted pests, and therefore large amounts are entering the environment and contaminating soil and water resources(Young, 1987). Pesticides sources in the environment include those resulting from direct pesticide application for a specific purpose, such as those used for weed and insect control in aquatic environments, and those entering indirectly from spray drift, atmospheric precipitation runoff and erosion from agricultural lands, effluent discharges from

sewers and factories, accidental spills and volatilization.

The quantity of a pesticide moving with runoff and sediment to an aquatic environment depends on many factors. These include topography, intensity and duration of runoff or irrigation, soil erodibility, land management and cropping practices.

Pollution magnitude varies with aquatic environment properties such as surface area and deapth, hydraulic characteristics, however, highest pesticide residues are in rivers, lower residues occur in estuaries and the lowest are in the oceans. Pollution magnitude in lakes and reservois depends on their proximity to an agricultural or industrial area(Tami metal, 1988). Biological communities are sensitive to their chemical environment, although the degree of sensitivity varies among species and communities. The use of pesticides in Iranian agriculture is common but from environmental protection of view it is not controlled as effective as ought to be. If the fields are too near to the aquatic ecosystem the pesticides may be washed out from the treated soil and pollute the aquatic ecosystem by runoff. Espicially dangerous are in this respect these pesticides, which are used in rice fields. In this case the water of the fields is directly trested and is in connection with rivers or standing waters.

In the north of Iran there are approximately 600,000 hectare of rice field, and houses near the rivers used detergents daily. There is not any ecotoxicological data about the harmful effect of pesticide and detergent individually and in mixed concentration on aquatic organisms, in Iran.

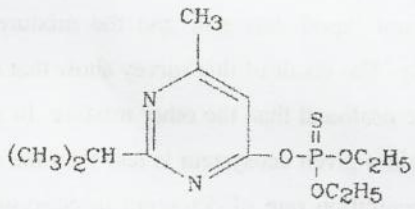
Exactly for this reason we are consider to be important the investigation of some special anionic detergents and pesticide Diazinon commonly used in rice field and other kinds of form in Iran. This is the first time in Iran to make such ecotoxicological investigations on fish.

This research should correctly imply an atleast approximate equivalence of fish species in their susceptibility to chemical compounds under the conditions described in the official guidelines(OECD, 1984).

2-Material and Methods

Diazinon is commonly used in rice fields of northern Iran were bought from pesticides shop in Bandar Anzali.

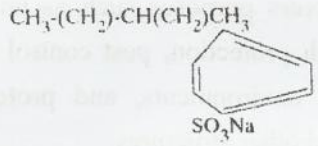
Active ingredient: EC 60% (Diazinon)
Chemical formula:



Water Solubility: In water at room temperature 40 mg/l

Toxicity: Tech(rat) : Oral LD50 300-400 mg/kg.
Inhalation: LC50 3.5mg/L(4hr).Rabbit.

L.A.S formula:



Test organism:

Rutilus frisii kutumm (White fish), was bought from Shahid Ansari fish culture and propagation station. At the Gilan Fisheries

Research Center, which was given the task of studying the effect of pesticide and detergents on fish were performed in similar equipments. The temperature room was regulated to 25±2°C. There was two light sources of 70×100cm (20w and 60cm long).

Duration of illumination (14h/day) was automatically regulated. Fish were adapted to laboratory circumastances distributed species wise in 500 liter tanks. Experiments for determining Diazinon, 24-hr, 48-hr, 72-hr, 96-hr LC10, LC50, LC90 were performed according to the TCR

standard procedures(TCR 1984). Different test concentrations plus a control were used. 1-2 g fingerling fish (*Rutilus frisii kutum)* was used for each concentration series. A total of these replicates were carried out for each one. Ten fingerling fish (1-2g weight) were placed in a 30 liter aquarium containing 20 liter tap water for each test concentration and control.

During of the test (4 day) the organisms were not fed and the medium was not renewed during the bioassay. Observation were made at each 24-h and the mortality results recorded. Control survival was always 100%. LC10, LC50, LC90 (The concentration of the toxicant that reduced survival rate to 10%, 50%, 90%) were calculated using linear regression analysis.

3-Results

1. Influences of the investigated pesticide Diazinon on *Rutilus frisii kutum* :

According to three different experiments with various concentrations of Diazinon on *Rutilus frisii kutum* (0.3 to 5 mg/l) in comparison with the control. The mortality was increased especially in high concentration. LC50-96hr was:0.34 mg/l. The results were summarized in Table 1 and Figure1 .

Influence of Anionic Detergents on *Rutilus frisii kutum*

Influence of Powder Detergent:

Concentrations of powder detergent in three experiments were from 10mg/l to maximum 24mg/l in comparison with the control. LC50-96h was 12.24mg/l. The effective concentrations are summarized in Table 2 and Figure 2.

Influence of Liquid Detergent:

Concentrations of liquid detergent in three experiments were from 5mg/l to maximum 25 mg/l in comparision with the control. LC50-96hr was 8.93mg/l. The effective concentrations are summarized in Table 3 and Figure 3.

Influence of mixed Pesticide and Anionic Detergents on *Rutilus frisii kutum* :

Mixed Diazinon and Powder Detergent:

According to three different experiments with various concentrations of mixed Diazinon and powder anionic detergent (1-4mg/l), the mortality of fish increased especially in high concentration.LC50-96hr was 0.9 mg/l. The results are summarized in Table 4 and Figure 4.

Mixed of Liquid Detergent and Diazinon:

According to three different experiments with various concentrations of mixed diazinon and liquid anionic detergent (4-20 mg/l) the mortality of fish increased especially in high concentration.LC50-96hr was 7.28 mg/l. Mixed Diazinon and powder detergent with comparison of mixed Diazinon and Liquid Detergent was highly toxic. The results summarized in Table 5 and Figure 5.

Table (1): Effect of Diazinon on Rutilus *frisii kutum*

Diazinon	Lethal Conoentration (p.p.m)	24hr	48hr	72hr	96hr
Rutilus frisii kutum	LC10	0.24	0.14	0.18	0.14
	LC50	1.7	0.08	0.49	0.34
	LC90	12.057	4.954	1.34	0.8

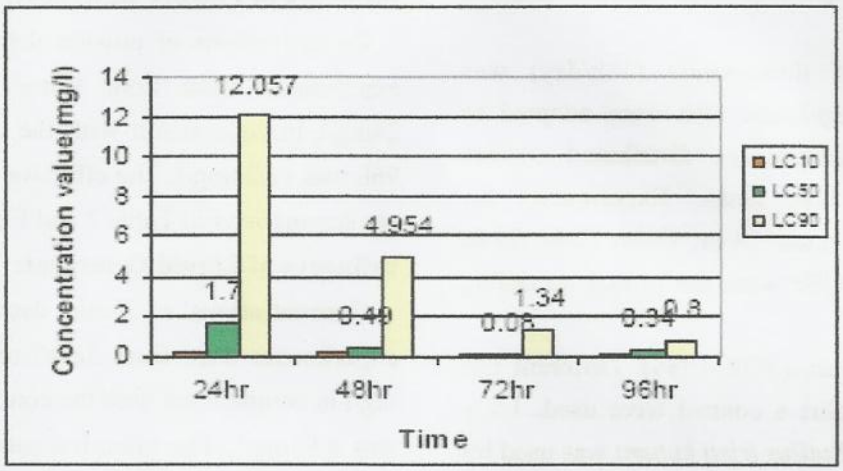


Fig. 1: Influence of Diazinon on *Rutilus frisii kutum*

Table (2): Effect of Powder detergent on *Rutilus frisii* kutums.

Diazinon	Lethal Conoentration (p.p.m)	24hr	48hr	72hr	96hr
Rutilus frisii kutum	LC10	11.54	9.88	9.54	9.07
	LC50	14.67	12.95	12.65	12.24
	LC90	18.63	16.98	16.77	16.50

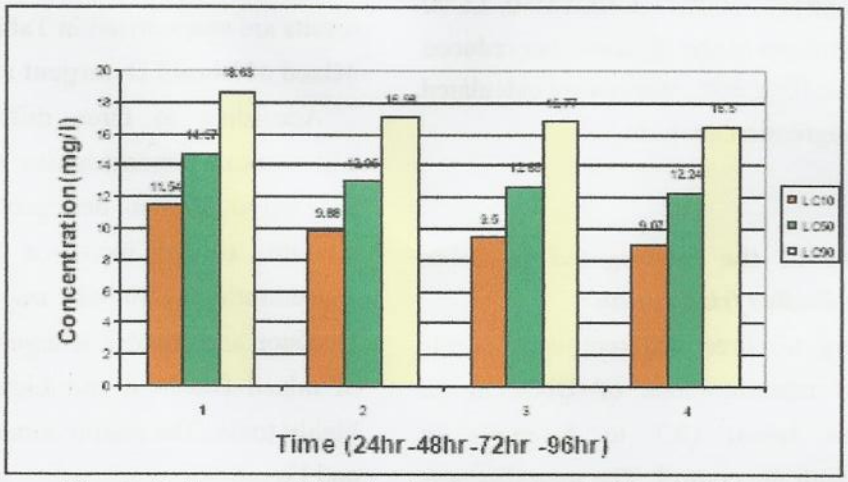


Fig. 2: Influence of Powder Detergent on*Rutilus frisii kutum*

Table (3): Effect of Liquid Detergent on *Rutilus frisii* kutum

Diazinon	Lethal Conoentration (p.p.m)	24hr	48hr	72hr	96hr
	LC10	7.80	6.05	7.24	6.59
Rutilus frisii kutum	LC50	11.68	11.06	10.08	8.93
	LC90	17.49	13.2	16.89	15.40

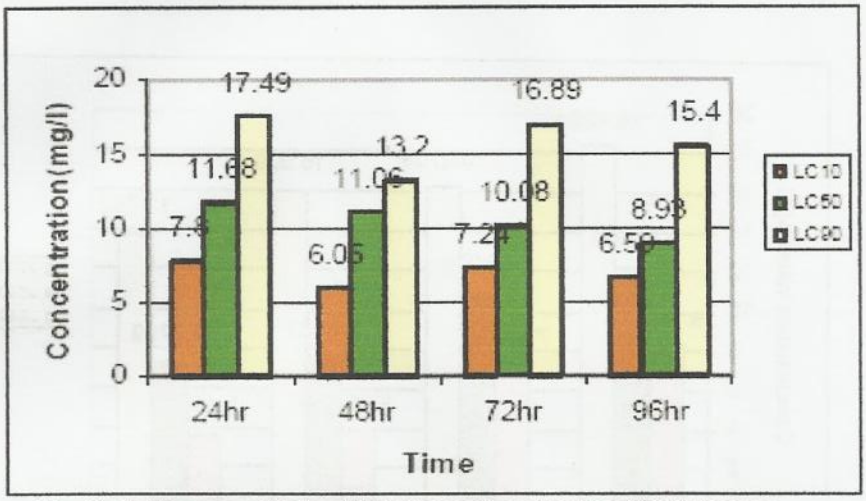


Fig. 3: Influence of Liquid Detergent on*Rutilus frisii kutum*

Table (4): Effect of mixed Diazinon and Powder Detergent on *Rutilus frisii kutum*

Diazinon	Lethal Conoentration (p.p.m)	24hr	48hr	72hr	96hr
	LC10	1.1553	1.0055	0.9446	0.5152
Rutilus frisii kutum	LC50	1.7313	1.5677	1.4762	0.8970
	LC90	2.5945	2.4444	2.3067	1.5615

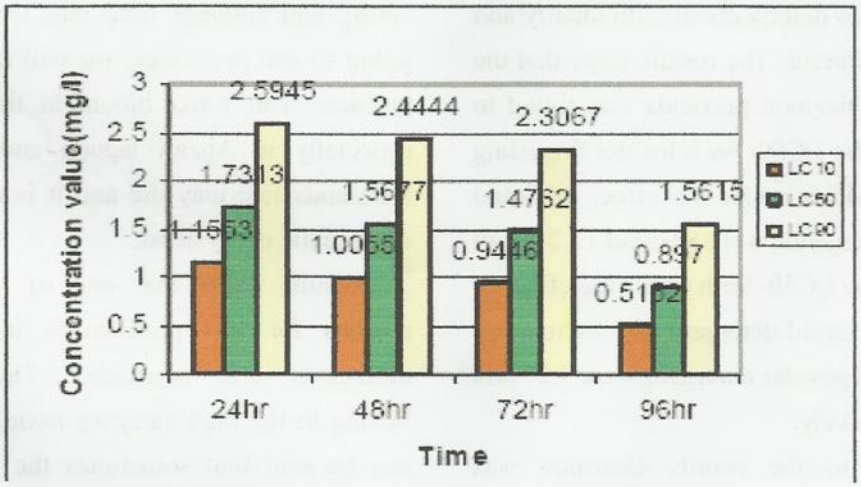


Fig. 4: Influence of Mixed Diazinon and Powder Detergent on*Rutilus frisii kutum*

Table 5: Influence of mixed Diazinon and Liquid Detergent on *Rutilus frisii kutum*

Diazinon	Lethal Conoentration (p.p.m)	24hr	48hr	72hr	96hr
Rutilus frisii kutum	LC10	8.1995	7.4043	3.8637	3.6386
	LC50	12.2831	10.9760	7.632	7.2759
	LC90	18.4061	16.2708	16.009	13.703

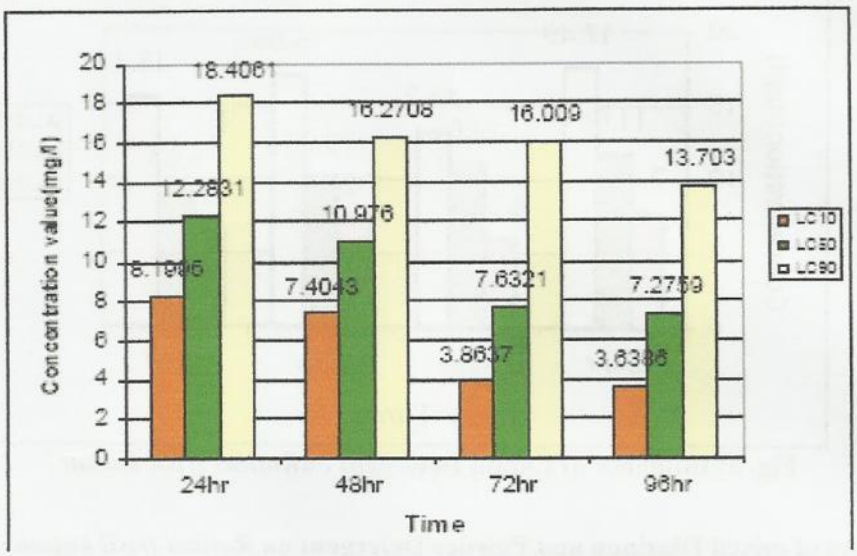


Fig. 5: Influence of Mixed Diazinon and Liquid Detergent on*Rutilus frisii kutum*

4-Discussion

This study indicates that the effect of the pesticide and two detergents in individually and in mixed are different. The results show that the LC50-96hr of Diazinon pesticide was found to be 0.34 mg/l. The LC50- 96 h for the fingerling of the same species under the effect of liquid and powder detergents, were 8.93and 12.24 mg/l respectively. The LC50- 96 h under the effect of a Diazinon and liquid detergent and the mixture of Diazinon and powder detergent were 7.27 and 0.9 mg/l respectively.

According to the results Diazinon was highly toxic, and it´s LC50–96hr was 0.34 mg/l. It is clear that if Diazinon enter to lagoons, water bloom, will happen, and nowadays in spring and summer time that the farmers are going to use pesticides, we will have a serious problem with water bloom in fish ponds and especially in Anzali lagoon and every years thousands fish may die and it is dangerous for our aquatic ecosystems.

Results show that one of the important reasons for this problem is the mixing of detergents and pesticides. These mixtures belong to the high category toxic. In general it can be said that sometimes the concentration rate of detergents under a given ecosystem is

less than the calculated LC50-96hr in a laboratory condition, but when the same concentration rate of detergent in ecosystem is mixed with another chemical material, it is very much possible that the percentage rate of mortality in fishes rises even higher.

During the first 15 minutes of exposure, there was a rapid increase in the rhythm of opercular movements. Fish would also swim to the surface, gasping for air. A side from increased opercular rates, exposed fish also exhibited dark colorations on its dorsal side, along the entire dorsal lengh. Then the fish started to lose equilibrium, swimming in a vertical head down position, and setting on the bottom vertical side up. It would lie quietly, operqular movement becoming irregular with occasional bursts of frenzied swimming. Fish were also less sensitive to noise or movement. Death occurred within 3-9hr after the body darkening reaction started.

This pigment modification of the dorsal surface of both investigated fish typically resembled fish under stress(Tames and Gacutan, 1994). Eyeballs become expanded and abnormal behavior of fish increase with the increase of concentration of pesticide and detergents. In the all experiments dissolved oxygen in the aquatic medium of fish was always near to 80-100% of air saturation. The pH values have significantly decreased from 7.57 at concentration in aquatic medium to minimum 6.1.Hardness of water in the experiments was increased from 326 to 658 mg/l. When test were finished (96hr), the control aquaria showed a very clean aquatic medium, but aquaria with pesticide and detergents individually and in mixed showed a very turbid medium. This turbidity was probably caused by the fish residues or the suspended compounds or its degradation products on water.

5-References

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تحديد التركيز المؤثر LC50 للمساحيق ذات الايونية السالبة الخطية وللقاح الدايازينون على اسماك *Rutilus frisii kutum*

الملخص

تم تحديد وحساب التركيز المؤثر القاتل لمركب الدايازينون ونوعين من المساحيق ذات الايونية السالبة على بعض انواع الاسماك المعروفة *Rutilus frisii kutum* .

تمت الدراسة باستخدام المبيد الدايازينون والمساحيق كل على انفراد وكذلك استخدام تراكيز مختلفة من خليط لهما وتحت ظروف مختبرية مسيطر عليها. ووجد ان التركيز القاتل LC50-96h للدايازينون هو ((0.34 mg/l)، بينما كانت القيم المؤثرة للمسحوقين السائل والصلب على هذا النوع من الاسماك الصغيرة هي: 4.69mg/l و 12.24 على التوالي. اما التركيز المؤثر لخليط الديازينون مع المسحوق السائل وخليط المبيد مع المسحوق الصلب فقد بلغ 7.27mg/l و 0.9 على التوالي.

دلت نتائج هذه الدراسة على ان سمية خليط الديازينون والمسحوق الصلب هي الاكثر تأثيراً وبشكل كبير، وبصورة عامة يمكن القول : في بعض الاحيان يكون معدل تركيز المساحيق في نظام معين هو اقل من التركيز المؤثر LC50-96h المحسوب مختبرياً ولكن عند خلط نفس التركيز بان معدل نسبة التحسس عند السمك سيزداد ازدياداً ملحوظاً.