

Decontamination of Cyanophos Residues from Water Containing Catfish (*Clarias Lazera*) Using Activated Charcoal and Rice Husk Ash

¹Ahmed A. Romeh, ²Mohamed B. Ashour, ²Mohamed Y. Hendawi and ¹Rady A. Ramadan

¹Plant Protection Depart. Efficient Productivity. Inst., Zagazig Univ., Egypt.

²Plant Protection Dept. Faculty of Agriculture. Zagazig Univ. Egypt.

Abstract: The effect of activated charcoal and rice husk ash addition on the residues of cyanophos in water and some organs of catfish (*clarias lazera*) and their effect on some biochemical changes in blood serum were studied under laboratory conditions. The obtained results indicated that cyanophos showed high degradation in aquaria water compared with tap water. This was pronounced with the all considered post-treatment intervals. The average concentration of cyanophos in tap water and in water containing fish 2hrs after treatment was 8.73 and 6.60 Ug/ml respectively. These amounts were significantly decreased by time till reached 4.13 and 1.20 Ug/ml after 144hrs, representing 55.73 and 87.14% dislodges of the initial amounts, respectively. Penetrated amount of cyanophos significantly increased and accumulated in the inner organs as time lapsed to reach the maximum level in the gills after 24 hrs (17.39 ug/gm) and in the liver during 48 hrs (24.51 ug/gm) while in muscles during 96 hrs (7.98 ug/gm) of experimental span. Thereafter, cyanophos began to disappear from the gills, liver and muscles gradually till the end of the experimental period (144 hrs). Addition of activated charcoal and rice husk ash to water contaminated with anilophos reduced clearly levels of residues in water and in fish gills, liver and muscles. Total protein of catfish blood serum was reduced by cyanophos while blood glucose and GPT activity were increased. Data also showed that a great effect of activated charcoal and rice husk ash in elimination of cyanophos residues from water and fish and the consequence in alleviation biochemical changes.

Key words: Catfish, water, adsorbents, residues.

INTRODUCTION

Deleterious effects upon the biota should be one of the principal characteristics used to perform the initial assessment of contamination and the acceptable level of clean up at hazardous waste sites. The pollution of aquatic ecosystem with pesticides caused toxicities to the aquatic organisms and bring changes in the metabolic activities and alters physiological state thereby changing the biochemical constituents in aquatic organisms ^[1, 2].

In agriculture operations extensive use of organophosphorus insecticides is recommended for reasons of their rapid degradability although the toxicity studies in warm water teleost exposed to organophosphorus insecticides have been extensively reported ^[3]. Recent studies proved the risks of organophosphorus pesticides due to their short and long term effects on the survival and accumulation ability in the tissue of aquatic organisms ^[4-7, 35]. Several investigations had been carried out to clarify the role of adsorbent substances as physical treatments in decontamination of pesticides in water, fish and soil

^[8-10]. This study was undertaken to observe the effect of sub lethal concentration (1/3 of 96 hrs LC₅₀) of organophosphorus insecticide cyanophos on chemical parameter of protein, blood glucose and GPT activity of catfish and to investigate the distribution of such residues between the inner organs of catfish and water. The role of adsorbent substances (i.e. activated charcoal and rice husk ash) in alleviating cyanophos residues in water and fish was also studied.

MATERIALS AND METHODS

The organophosphorus insecticide cyanophos (Cyanox 50% EC. It IUPAC name is 0-4-cyanophenyl 0,0-dimethyl phosphorothioate. A formulated sample of cyanophos 50% EC under the trade name of cyanox was supplied by Ministry of Agriculture, Egypt.

Healthy living specimens of air breathing catfish *Clarias lazera* in the weight range of 45-50 g were collected from Bahr-Mowase, Sharkia governorate. Prior to experimentation the fish were allowed to acclimate to laboratory conditions for 2 weeks. The fish were fed daily on warms and shrimps during

Corresponding Author: Dr. Ahmed Aly Romeh, Plant Production Depart. Efficient Productivity. Inst., Zagazig Univ., Egypt.
Email: ahmedromeh2006@yahoo.com

acclimation and experimentation. Fish were starved for 1 day before the initiation of experiments. The LC_{50} value determined by probit analysis was found to be 28.0 mg/L for 96 hr. one third of LC_{50} value (9.33 mg/L) was chosen as a sub lethal concentration in which the fish survived for 192 hr without physical symptoms and mortality. Fish were divided into four groups of 54 each. Three were exposed to commercial formulation of cyanophos (9.33 mg/L) while the fourth group was maintained as control in cyanophos free laboratory water. The groups two and three were treated separately with activated charcoal (4-14 mesh) and rice husk ash (amorphous) fired at 450°C for 4hrs. at the rate of 100 mg/L.^[11,12] The same experiment was reported without the fish. Nine fish each from control and experimental groups and 100ml of water of two experiments were taken at the end of 2, 24, 48, 96 and 144 hr. after 144hr the remaining cyanophos contaminated fish from the group of one to three were transferred to clean fish water for 168hr (7 days). Also nine fish each from control and experimental groups (one to three) were taken at the end of 168hr.

After each test period, the blood samples were taken by cutting the tail and the exuding blood was collected into a clean centrifuge tube and left at room temperature until it has clotted then centrifuged at 3000 rpm for 15 min. to separate the serum. Serum samples were kept in deep freeze for estimation of serum blood glucose, total proteins and GPT activity. The levels of total proteins, glucose and GPT activity were determined according to^[13-15]. Analysis of variance (ANOVA) was carried out for the obtained data according to the method of^[16]. At the above-mentioned periods, water and fish tissue samples (muscles, gills and liver) were taken for residues determination. The residues of cyanophos in muscles, gills and liver were extracted and cleaned up according to^[16]. A liquid-liquid extraction method with dichloromethane was used to extract cyanophos from samples of water^[17]. The residues of the tested pesticide were directly determined using HPLC with the following conditions: Dual delivery solvent system pump 406, U.V. detector 166, Integrator spectra physics 4270, attenuation 16, chart speed 1.0 cm/ min, stainless steel column (10/250 nm) packed with C 18, flow rate 0.7 ml/min, wave length 248 nm and mobile phase methanol / water 70/30.

RESULTS AND DISCUSSION

The interaction between activated charcoal or rice husk ash addition at 100mg/L. and the residues of cyanophos in water and that on the distribution of such residues between the inner organs of catfish (*Clarias lazero*) were investigated.

The results of dissipation data in tap water and in water containing fish are shown in Table 1. Cyanophos dissipated rapidly in water containing fish than tap water. This was pronounced with the all considered post treatment intervals. The average concentration of cyanophos in tap water and in water containing fish 2hrs after treatment was 8.73 and 6.60 Ug/ml respectively. These amounts were significantly decreased by time till reached 4.13 and 1.20 Ug/ml after 144hrs, representing 55.73 and 87.14% dislodges of the initial amounts, respectively. The study clearly shows that the fish can speed up the cyanophos depletion from the water. This finding may be attributed to the metabolic detoxification process by the fish^[18,19] Showed that the rapid disappearance of fentrothion from aquatic system may involve chemical degradation as well as volatilization, adsorption, photolysis and microbial degradation.^[7] Found that chlorpyrifos-ethyl and fenpropathrin were more rapid degradation in aquaria water compared with tap water. Data showed a great effect of the tested natural adsorbents (i.e. activated charcoal and rice husk ash) in elimination of cyanophos insecticide from water. The percent loss of cyanophos in water alone were significantly increased to 53.80 and 88.85% by activated charcoal and to 48.34 and 77.49% by rice husk ash after 2 and 144 hrs of treatments, respectively. While, in water containing fish, the values were 62.84 and 97.96% by activated charcoal and 55.795 and 91.75% by rice husk ash at the same periods. Activated charcoal in water alone and in water containing the fish significantly reduced cyanophos residues by 50.63-74.82% and 46.06 – 84.17% after 2-144 hrs of exposure periods. For rice husk ash, the values were 44.79 – 54.57% and 37.73 – 53.73% after 2-48 hrs. After that, the percent adsorption of cyanophos in water alone and in water containing fish was decreased to 49.15 and 35.83% after 144 hrs of exposure (Table 1).

Data concerning the behavior of cyanophos residues in catfish and their distribution in the inner organs after 2 to 144hrs from the exposure to 1/3 of 96 hrs LC_{50} are presented in Table 2. The obtained results indicated the uptake and penetration via gills as well as other body integuments just after exposure of fish to treated water. Penetrated amount of cyanophos increased and accumulated in the inner organs as time lapsed to reach the maximum level in the gills after 24 hrs (17.39 ug/gm) and in the liver during 48 hrs (24.51 ug/gm) while in muscles during 96 hrs (7.98 ug/gm) of experimental span. Thereafter, cyanophos began to disappear from the gills, liver and muscles gradually till the end of the experimental period (144 hrs). The gills uptake magnitude amount of cyanophos from the ambient treated water within few

Table 1: Cyanophos concentration (PPm) in fresh water alone and in fresh water treated with catfish (*clarias lazero*) after treatment with activated charcoal and rice husk ash

Treatments	Exposure periods (hours)					
	0	2	24	48	96	144
Tap water						
Cyanophos alone						
Ug/ml (mean±S.D)	9.33	8.73±1.2a	7.68±0.7a	6.89±0.9a	5.12±0.6a	4.13±0.4a
% loss	0.00	6.43	17.68	26.15	45.12	55.73
Cyanophos plus						
1. Activated charcoal						
Ug/ml (mean±S.D)	9.33	4.31±0.6b	2.61±0.4b	1.92±0.1c	1.34±0.05 c	1.04±0.05 c
% loss	0.00	53.80	72.03	79.42	85.64	88.85
% elimination removal	(0.00)	(50.63)	(66.02)	(72.13)	(73.83)	(74.82)
2. Rice husk ash						
Ug/ml (mean±S.D)	9.33	4.82±0.9b	3.41±0.3b	3.13±0.1b	2.26±0.1b	2.1±0.05b
% loss	0.00	48.34	63.45	66.45	75.78	77.49
% elimination removal	(0.00)	(44.79)	(55.60)	(54.57)	(55.86)	(49.15)
Significantly	*	**	**	**	**	**
Water containing catfish						
Cyanophos alone						
Ug/ml (mean±S.D)	9.33	6.60±0.6a	5.17±0.4a	3.35±0.4a	2.40±0.3a	1.20±0.09a
% loss	0.00	29.26	44.59	64.09	74.28	87.14
Cyanophos plus						
1. Activated charcoal						
Ug/ml (mean±S.D)	9.33	3.56±0.2b	2.03±0.2c	1.10±0.1c	0.52±0.3c	0.19±0.2c
% loss	0.00	62.84	78.24	88.21	94.43	97.96
% elimination removal	(0.00)	(46.06)	(60.74)	(67.16)	(78.33)	(84.17)
2. Rice husk ash						
Ug/ml (mean±S.D)	9.33	4.11±0.6b	2.63±0.2b	1.55±0.1b	1.27±0.1b	0.77±0.01b
% loss	0.00	55.95	71.81	83.39	86.39	91.75
% elimination removal	(0.00)	(37.73)	(49.13)	(53.73)	(47.08)	(35.83)
Significantly	**	**	**	**	**	**

hours. These amounts were much higher in gills and liver than those present in the muscles (log Kow=2.65). The high amount of pollutants in gills was interpreted by [24], who indicated that gills contained high amounts of pollutants since they are the main route of entry. After which transportation to the different tissues took place directly via the vascular system. [25] stated that the degree of solubility of a pesticide in water is responsible for its adsorption to external body surfaces (mucous of gills and skin). [26] Found that uptake rates were low for chemicals with low log of its octanol-water partition coefficient (log Kow) values less than 1, increased about fourfold between log Kow 1 and 3. [27] attributed increases in absorption between log Kow 1

and 3 to greater membrane permeability for the lipophilic compound. Several investigators reported that the highest concentrations from variety of toxicants were found in gills and liver and the lowest in skeletal muscles [7, 10, 28-30]. Decontamination of pesticides from water and fish was studied by many investigators [10, 31-33].

Data also in Table 2 indicated a great effect of activated charcoal and rice husk ash in the alleviation of cyanophos residues in the inner organs of catfish. The decontamination percentage of cyanophos by activated charcoal and rice husk ash in muscles were (35.11 – 76.69%) and (29.33 – 73.43%) after 2-96 hrs and reached (40.17 – 53.03%) and (20.09 – 48.76) in

Table 2: Effect of activated charcoal and rice husk ash addition on cyanophos residues in some organs of catfish (*clarias lazera*) contaminated with 1/3 from their LC₅₀ values.

Exposure periods (hours)	Muscles						Significantly
	Cyanophos		Cyanophos plus Activated charcoal		Cyanophos plus RicePlus husk ash		
	Ug/gm (mean±S.D)	%increase	Ug/gm (mean±S.D)	% reduction	Ug/gm (mean±S.D)	% reduction	
2	2.25±0.25a	(0.00)	1.46±0.25b	(35.11)	1.59±0.1b	(29.33)	*
24	4.45±0.14a	(97.78)	1.65±0.05b	(62.92)	1.78±0.05b	(60.00)	**
48	6.72±0.22a	(198.67)	1.80±0.1b	(73.21)	2.00±0.5b	(70.24)	**
96	7.98±0.3a	(254.67)	1.86±0.15b	(76.69)	2.21±0.2b	(73.43)	**
144	4.582±0.2a	(103.64)	1.40±0.05c	(69.45)	1.66±0.15b	(63.77)	**
312*	1.342±0.11a	(-40.44)	0.057±0.02b	(95.75)	0.25±0.03b	(81.37)	**
Exposure periods (hours)	Liver						Significantly
	Cyanophos		Cyanophos plus Activated charcoal		Cyanophos plus RicePlus husk ash		
	Ug/gm (mean±S.D)	%increase	Ug/gm (mean±S.D)	% reduction	Ug/gm (mean±S.D)	% reduction	
2	7.02±0.31a	(0.00)	4.20±0.20c	(40.17)	5.61±0.29b	(20.09)	**
24	13.11±0.30a	(86.75)	7.01±0.29c	(46.53)	10.09±0.47b	(23.04)	**
48	24.51±0.50a	(249.15)	11.51±0.50c	(53.03)	12.56±0.55b	(48.76)	**
96	14.60±0.46a	(107.97)	9.79±0.30b	(32.95)	10.70±0.69b	(26.71)	**
144	9.61±0.29a	(36.8)	3.64±0.20c	(62.12)	4.94±0.35b	(48.60)	**
312*	UND	-	-	-	-	-	
Exposure periods (hours)	Gills						Significantly
	Cyanophos		Cyanophos plus Activated charcoal		Cyanophos plus RicePlus husk ash		
	Ug/gm (mean±S.D)	%increase	Ug/gm (mean±S.D)	% reduction	Ug/gm (mean±S.D)	% reduction	
2	13.83±0.80a	(0.00)	4.94±0.35c	(64.28)	6.32±0.35b	(54.30)	**
24	17.39±0.39a	(25.74)	8.41±0.4c	(51.63)	10.27±0.65b	(40.94)	**
48	13.40±0.4a	(-3.11)	7.40±0.4c	(44.78)	8.23±0.3b	(38.58)	**
96	11.59±0.61a	(-16.20)	3.01±0.21c	(74.03)	4.92±0.21b	(57.55)	**
144	5.61±0.3a	(-59.44)	0.07±0.01c	(98.75)	1.69±0.21b	(69.88)	**
312*	-	-	-	-	-	-	

* Refer to fish exposure period in fresh water within 168hr after exposed to the 144 hrs of cyanophos.

liver after 2-48hrs while reached (64.28 – 98.79%) and (54.30 – 69.88%) in gills after 2-144hr of treatment. The alleviation action of activated charcoal and rice husk ash in reducing cyanophos residues in the inner organs of catfish may be understandable on the basis of the adsorption processes, ion exchange and binding properties of adsorbents. The adsorption capacity of activated charcoal for organic pollutants depends on their physical properties such as surface hydrophobicity, acidic groups and surface oxygen groups in activated carbon^[20-23]. On the other hand, the adsorptive capacity of rice husk ash to cyanophos residue may be

attributed to the active sio₂ content that reached 94.47% and other contents,^[12].The main components of rice husk are carbon and silica (15-22% SiO₂ in hydrated amorphous form like silica gel), it has the potential to be used as an adsorbent^[37, 38]. When rice husk is burnt, about 20 wt% of the husk remains as ash. The rice husk ash has more than 95 wt% of silica with high porosity and large surface area, because it retains the skeleton of cellular structure,^[39].Also,^[39] showed that the rice husk ash can be used as an efficient adsorbent material for removal of phenolic from water and wastewater.

As evident from analytical data (Table 2), when the polluted fish with cyanophos were transferred to clean fresh water during 168 hrs, the residues of cyanophos in fish muscles, treated with activated charcoal and rice husk ash were 1.34 , 0.057 and 0.25 ug/gm, respectively. Whereas undetected in liver and gills at the same period.

Biochemical profiles of control and experimental blood serum of catfish are presented in Fig. 1. Total protein content of blood serum of exposed fish was depleted during 144 hrs of experimental span. Maximum depletion was observed at the end of 96 hrs. There after the depletion declined at the end of 144 hrs. and 312 hrs. The depression of serum protein may

be due to the binding of cyanophos to the blood proteins thereby altering the mobility as it is known that organophosphorus compounds have affinities for macromolecules of the blood in mammals and insects [3]. On the other hand, the content of blood serum glucose and amino-transaminase GPT activity were increased and reached the maximum increase at the end 96 hrs, after that the increasing in glucose content and GPT activity were reduced at the end of 144 hrs and 312 hrs. Activated charcoal and rice husk ash addition to the cyanophos contaminated fish alleviated the reduction of total protein and the elevation of blood serum glucose and GPT activity. This general was the case after 2hrs to 216 hrs. Several investigators pointed

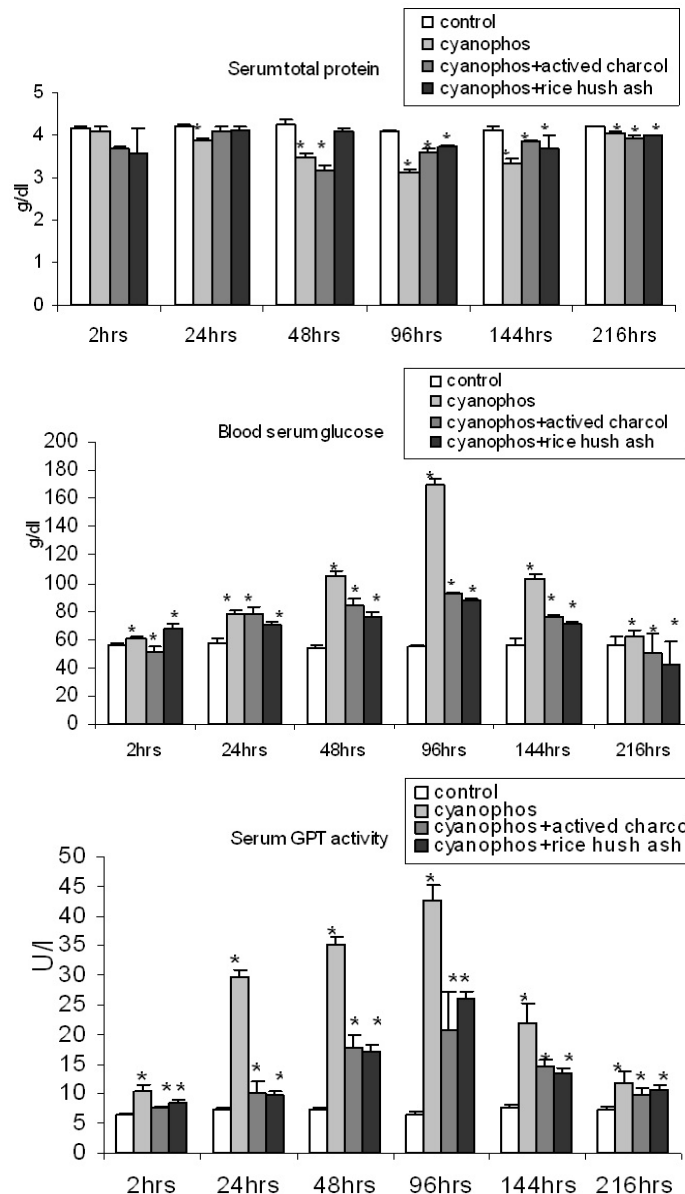


Fig. 1: Effect of cyanophos on blood serum component of catfish.

out that total protein was reduced while GPT activity and blood serum glucose were elevated in fish, laying hens, chicks, rabbits, rats and mice by certain organophosphorus insecticides [1, 18, 28, 29, and 34].

REFERENCES

1. Begum, G. and S. Vijayaraghavan, 1996. Alterations in protein metabolism of muscle tissue in the fish *Clarias batrachus* (Linn.) by commercial grade dimethoate. Bull. Environ. Contam. Toxicol., 57: 223-228.
2. Hammam, F.M. and H.N. El-Khatib, 2002. Chromosomal aberrations study in Egyptian agricultural workers exposed to pesticides. The first conf. of the Central Agric. Pesticide Lab., 3-5 sep., 246-257.
3. Mukhopadhyay, P.K. and P.V. Dehadrai, 1980. Studies on air-breathing catfish *clarias batrachus* (Linn.) under sub lethal malathion exposure. Indian J. Exp. Biol., 18, April: 348-352.
4. Serrano, R., F.J. Lopez, F. Hernandez and J.B. Bena, 1997. Bioconcentration of chlorpyrifos, chlorfenvinphos and Methidathion in *Mytilus galloprovincialis*. Bull. Environ. Contam. Toxicol., 59: 968-975.
5. Van den Brink, P.J., E. Van Donk, R. Gylstra, S.J.H. Grum and T.C.M. Brock, 1995. Effects of chronic low concentration of the pesticides chlorpyrifos and atrazine in indoor freshwater microcosms. Chemosphere, 31: 3181-3200.
6. Serrano, R., F. Hernandez, J. Pena, V. Dosda and J. Canales, 1995. Toxicity and bioconcentration of selected organophosphorus pesticides in *Mytilus galloprovincialis* and *Venus gallina*. Arch. Environ. Contam. Toxicol., 29: 284-290.
7. Affi, F.A., Z.H. Zidan, K.A. Mohamed and M.E. Osman, 2002. Persistence, distribution and bioaccumulation behavior of certain insecticides in aquaria bolti fish. The first conf. of the Central Agric. Pesticide Lab., 3-5 sep.; 156-166.
8. Hegazy, M., A. El-Sisi, M. Abou Zahw and M. Diab, 1990. Persistence of Dursban and efficiency of some suggested methods to remove it from water. Annals. Agric. Sci., 35(2): 1057-1063.
9. Gerard, M., J. Barthelemy and A. Copin, 1998. Characterization of adsorption behavior of pesticides on activated carbon in drinking water treatment. Proceedings, 50th International symposium on crop protection, Gent, Belgium, 63(20): 231-242.
10. Ademoroti, C.M., 1980. the effect of pH on the coagulating and purification of waste-water., Efflux. Wat. Treat. J.V.K., 20: 541-549.
11. Romeh, A., 2006. Effect of activated charcoal and rice husk ash addition on the residues of diniconazole and their effect on some blood components off catfish (*clarias lazera*). Zagazig. J. Agric. Res., 33(2): 267-281.
12. Abd El-Wahed, M.G., 1990. Electrical behavior of blended cement made of rice husk ash. J. of Material Sci. letters, 9: 35-38.
13. Weichselbaum, T.E., 1946. Determination of protein in small amounts of blood serum and plasma. Amer. J. Clin. Pathol., 7: 40-44.
14. Tinder, P., 1969. Enzymatic determination of glucose in blood serum. Ann. Clin. Biochem., 6: 24.
15. Reitman, S.M. and S. Frankel, 1957. A colorimetric method for the determination of serum glutamic oxaloacetic and glutamic transaminase, Amer. J. Clin. Pathol., 28: 56-63.
16. El-Sheamy, M., M. Hussein and A. El-Sheikh, 1991. Residue behavior of certain organophosphorus and carbamate insecticides in water and fish. Egypt. J. Appl. Sci., 6(1): 94-102.
17. Leppert, B.C., J.C. Markle, R.C. Helt and G.H. Fujue, 1983. Determination of carbosulfan and carbofuran residues in plants soil and water by gas chromatography, J. Agric. Food. Chem., 31: 220-223.
18. Singh, N., V. Das and S. Singh, 1996. Effect of aldrin on carbohydrate, protein and ionic metabolism of a fresh water catfish, *Heteropneustes fossilis*, Bull. Environ. Contam. Toxicol., 57: 204-210.
19. Moody, R., P. Greenhalgh, L. Lockhart and P. Weinberger, 1987. The rate of fenitrothion in an aquatic ecosystem. Bull. Environ. Contam. Toxicol., 19: 31-40.
20. Coughlin, R.W. and F.S. Ezra, 1968. Role of surface acidity in the adsorption of organic pollutants on the surface of carbon. Environ. Sci. Technol., 2: 291-297.
21. Puri, B.R., S.S. Bhardwai and U. Gupta, 1976. Adsorption of phenol from aqueous solution by carbons in relation to their specific surface area. J. Ind. Chem. Soci., 53: 1095-1098.
22. Uchida, M., T. Nakamura, N. Kawasaki and S. Tanada, 1997. Adsorption characteristics of triholomethane, onto activated carbon fiber from Quaternary mixture solution. Bull. Environ. Cont. Toxicol., 59: 935-940.
23. Chaudhary, D., S. Vigneswaran, V. Jegatheesan, H. Ngo, H. Moon, W. Shim and S. Kim, 2003. Granular activated carbon (GAC) adsorption in tertiary wastewater treatment: Experiments and models. Wat. Sci. Technol., 47(1): 113-120.

24. Holden, A.V., 1962. A study of the absorption of C¹⁴ labeled DDT from water by fish. *Ann. Appl. Biol.*, 50(3): 467-477.
25. Johnson, D.W., 1968. Pesticides and fishes- A review of selected literature, *Trans. Amer. Fish. Soc.*, 97(4): 398-424.
26. Richard, T. and E. David, 2008. *The toxicology of fish*. CRC press, New York, pp: 65.
27. Saarikoski, J., R. Lindstrom, M. Tyynela and M. Viluksela, 1986. factors affecting the absorption of phenolics and carboxylic acid in the guppy (*Poecilia reticulata*). *Ecotoxicol. Environ. Saf.*, 11: 158-173.
28. El-Kenawy, D.A., 1995. Effect of some pesticides on fish. M. Sc. Pesticide, plant protection Dep. Fac. Agric. Zagazig Univ. Egypt.
29. Shalaby, A.A. and M.S. Ayyat, 1999. Effect of natural clay additions on the residues of profenofos and monocrotophos and their effect on some blood component in hens, *Egypt J. Appl. Sci.*, 14(6): 286-300.
30. Velmurugan, B., M. Selvanayagam, E. Cengiz and E. Unlu, 2007. The effect of monocrotophos to different tissues of fresh water fish *Cirrhinus mrigala*. *Bull. Environ. Contam. Toxicol.*, 78: 450-454.
31. Mullins, D.E., R.W. Young, D.F. Berry, J.D. GU, G.H. Hetzel, K.D. Racke and A.R. Leslie, 1993. Biologically based sorbents and their potential use in pesticide waste disposal during composting. Pesticides in urban environments fate and significance., 113-126, ACS symposium series No. 522.
32. Thacker, N.P., M.V. Vaidya, M. Sipani and A. Kalra, 1997. Removal technology for pesticide contaminants in potable water. *J. Environ. Sci. Health. Part B, Pesti. Food. Contaminants and Agric. Wastes.*, 32(4): 483-196.
33. Tao, S., S. Xu, J. Cao and R. Dawson, 2000. Bioavailability of apparent fulvic acid complexed copper to fish gills. *Bull. Environ. Contam. Toxicol.*, 64: 221-227.
34. Vandana, R., K. Aggarwal, K. Gupta and D. Wagle, 1991. Effect of phorate and dimethoate on growth and liver metabolism in rats. *Haryana Agric. Univ. J. Res.*, 21: 184-191.
35. Suchismita, S., K. Anilava, 2008. Acute Toxicity of Synthetic Pyrethroid Cypermethrin to Some Freshwater Organisms. *Bull. Environ. Contam. Toxicol.*, 80: 49-52.
36. Waller, R.A. and D.P. Duncan, 1969. A bays rule for symmetric multiple comparison problem. *Amer. Stat. Assoc. J. December*, 1485-1503.
37. Khalid, N., S. Ahmad and A. Toheed, 2000. Ahmad J. potential of rice husks for antimony removal. *Applied Radiation and Isotopes.*, 52: 30-38.
38. Nakbanpote, W., 2000. Preconcentration of gold by rice husk ash. *Mineral. Eng.*, 13: 391-400.
39. Mahvi, A.H., A. Maleki and A. Eslami, 2004. Potential of Rice Husk and Rice Husk Ash for Phenol Removal in Aqueous Systems. *American Journal of Applied Sciences.* 1(4): 321-326.