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Research Article

PESTICIDE RESIDUES IN INDIAN MAJOR CARPS REARED IN WASTEWATER

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ABSTRACT: The use of pesticides in agricultural fields and public health care has led to transport and accumulation of pesticide residues in different environmental compartments including the water bodies like ponds, lakes, wetlands, rivers and estuaries are quite often found to be contaminated with pesticides as a result of run–off and discharges from different sources. Since pesticides are toxic chemicals, they adversely affect the non target organisms including fish, a common protein source to human. The present study was undertaken with the objective to find the extent and level of any persistent organochlorine pesticides (OCP) residue in edible fishes grown in waste waters, namely Mudiyali Fisheries Co-operative society and Rahara fish farm, West Bengal, India. The results revealed the presence of DDT and endosulfan in muscles and gills of Indian Major Carps (IMC) like Rohu (*Labeo rohita),* Catla *(Catla catla)* and Mrigal (*Cirrhinus mrigala)* reared in wastewater. However, the level of the pesticide residues found in IMCs were below the tolerance limits (TL) set by FSSAI which indicated that those fishes were safe for consumption. But, emphasis should be laid on continuous monitoring program from food safety point of view.

Key words: Organochlorine pesticides , Indian Major Carps, Muscles, Gills.

INTRODUCTION

India is one of the major fish producing countries in the world, producing 9.58 Mts of fish during 2013-14 (DAHD 2014 -15). Fish is an important source of animal protein and component of diet of many Indians. In India many reports are available on the presence of organochlorine pesticide (OCP) residues in inland freshwater fishes (Sarkar *et al.* 2003, Kaur *et al.* 2008) and marine fish (Muralidharan *et al*. 2009). The pesticides applied on land eventually find their way in to the aquatic environment, contaminating water and sediment and subsequently get accumulated in aquatic organisms (Singh *et al.* 2005). The lipophilic nature, hydrophobicity and low chemical and biological degradation rates of OCPs have led to their widespread accumulation in food chain (Aulakh *et al.* 2006). Aquatic organisms like fish accumulate higher concentration of pesticide residues than in surrounding water due to biomagnifications (Siddiqui *et al.* 2005). OCP residues have been detected in foodstuffs, drinking water, sediments as well as wide range of biota including fish (Ize-Iyamu 2007). It has been observed that more than 80% of the total intake of pesticide residues in human beings is through the food chain (Martinez *et al.* 1997). Keeping in view of public health significance of pesticide residues and safety of consumers, the present study was proposed to monitor 16 targeted OCPs in Indian Major Carps reared in waste water.

MATRERIALS AND METHODS

Indian major carps (IMC), namely, Rohu (*Labeo rohita*), Catla (*Catla catla*) and Mrigal (*Cirrhinus mrigala*), (n=6, for each species) were collected from the Mudiyali Fisheries Co-operative Society, South 24 Parganas District and Rahara fish farm of ICAR-CIFA Regional Research Center, North 24 Parganas District of West Bengal, India. The samples were collected from their natural environment and stored in an ice container before transporting to the laboratory. In the laboratory, fishes were washed with distilled water to remove surface contaminants, descaled and muscle and gill tissue (18 pieces of muscles tissue and 12 numbers of gills from each species) were collected for pesticide analysis.

Residue analysis of fish samples was done according to Tanabe *et al*. (1994) with little modification. Subsamples of 5g tissue (muscle and gill) were homogenized with anhydrous sodium sulfate, put in thimbles made of Whatman filter paper and extracted with hexane and acetone (1:1 v/v) continuously for 6 hours in Soxhlet apparatus. Extracts were subsequently concentrated in a rotary vacuum evaporator to approximately 5 ml volume and subjected to column clean

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up. A glass column was prepared with pre-activated florisil, sodium sulfate and silica gel in hexane to which the concentrated extract was passed and eluted with 50 ml of hexane and acetone (1: 1 v/v). The eluate was evaporated to dryness in rotary vacuum evaporator and reconstituted in hexane for chromatographic analysis.

Analysis: Agilent 6890 N Gas Chromatograph (GC) fitted with Ni^{63} electron capture detector and HP-5 MS capillary (30 mm × 0.25 mm id × 0.25 ìm film thickness) was used in the analysis.

The operation parameters of GC:

Column Temperature 180° C for 1 min, followed by increment @ 3°C/min to 230° C for 5 minutes then @ 10 °C/min to 265 °C for 10 min, Injector Temperature 260° C, split ratio (1:10), Detector Temperature 300° C.

Carrier gas : Helium @ 1ml/min and make up with N_2 @ 30ml/min. Injection volume : 1 µl. The pesticides were identified and quantified based on the external standard (99.5%) solution of 16 different OC pesticides *viz.* HCH (∝, β, γ and δ), DDD (op′, pp′), DDE (op′, pp′), DDT (op′, pp′), endosulfan (∝, β sulfate), aldrin, heptachlor and dicofol. Data were analyzed by one-way ANOVA Snedecor and Cochran (1994) and differences between the means of treatments were examined using least significance difference (LSD).

RESULTS AND DISCUSSION

Among 16 different OCPs tested pp DDE and op DDD were mainly detected in most of the flesh samples. Total DDT concentration comprising of individual isomers and metabolites in fish flesh was found in the range of 0.154-0.294, 0.39-0.49 and 0.13-0.19 mg/kg with mean concentration of 0.224±0.07, 0.44±0.05 and 0.16±0.07 mg/kg in Catla, Mrigal and Rohu respectively. Among the other OCs, only endodulfan was found present only in one sample of mrigal (out of 18samples) at a concentration of 0.056 mg/kg. Endosulfan (∝, β) in gills of Catla and Mrigal and ∝-HCH in gill of Catla were recorded. Total endosulfan concentrations in gills were 0.055 mg/kg and 0.249 mg/kg in Catla and Mrigal respectively (Table 1). The obtained results have shown that in case of muscles of IMCs, DDT was significantly ($P<0.05$) higher in Mrigal whereas endosulfan was only detected in the muscles of Mrigal. In case of gills, DDT was not detected in any species of Rohu, Catla and Mrigal. Endosulfan was not found in the gills of Rohu whereas, it was significantly ($P<0.05$) higher in mrigal.

The tolerance limit (TL) of DDT, DDE and DDD, either singly or in combination, for meat, poultry and fish on a whole product basis is 7 mg/kg, as recommended by Food Safety and Standard Authority of India (FSSAI) (FSSR 2011). In all the samples where DDT was recorded in the present study, concentrations were below the tolerance limit and thus were safe for human consumption. The tolerance limit of endosulfan in fish is 0.20 mg/kg. So, in the present findings, total endoulfan concentration (0.249 mg/kg) in gill of Mrigal was above the prescribed limit. But in gill of Catla and flesh of Mrigal endosulfan concentration was below the limit. The level of ∝-HCH (0.03 mg/kg) in gill of catla was below the tolerance limit of 0.25 mg/kg.

Table 1. The Pesticide levels (mg/kg) in muscles and gills of Indian Major carps.

Pesticide	*C.catla*	*C.mrigala*	*L.rohita*
Pesticide concentration in muscle			
DDT	0.224^{a}±0.07	0.44^{b}±0.05	0.16^{a}±0.03
Endosulfan	ND	0.056	ND
Pesticide concentration in gills			
DDT	ND	ND	ND
Endosulfan	0.055^{a}±0.004	0.249^{b}±0.002	ND
HCH	0.03	ND	ND

ND- not detected.

Data presented as Mean±S.E. Superscripts ^{ab} in a column differs significantly ($p<0.05$).

Presence of OCP in aquatic ecosystem and their accumulation in fish are not unusual and have been reported in many instances from India and abroad. In India, level of 0.01 mg OCPs/kg in *Channa punctatus* has been reported with dominance of pp DDE among the DDTs (Malik *et al*. 2007). Kannan *et al*. (1992) reported p.p. DDE as main contaminant metabolite of DDT followed by p.p. DDD and pp DDT. Pandit *et al*. (2001) found that among DDT metabolites p.p. DDT and p.p. DDE were at highest levels followed by o.p. DDT and p.p. DDD in marine environment. Amaraneni and Pillala (2001) found maximum concentration of DDT in fish to be 157.4 mg/kg. Anupma *et al*. (2001) detected residue levels of DDT in fish from river Ganga and the range was 0.0726–1.666 mg/kg. Kole *et al*. (2001) reported presence of endosulfan and HCH residues in fishes sold at Calcutta market. Choudhury *et al*. (2013) reported p.p.-DDT (0.0012 to 0.002 µg/g), endosulfan-I (0.0012 to 0.0013 µg/g) and endosulfan-II (0.0012 to 0.0013 µg/g) in tissues of fishes collected from different markets of Jorhat district of Assam. Akan *et al*. (2014) reported that the highest levels of p.p. DDT and its metabolites were present in the liver of *Tilapia Zilli* while the flesh of *Hetroties niloticus* recorded the lowest contamination in Lake Chad, North Eastern Nigeria. Adeyemi *et al*. (2008) observed that adult *Tilapia zilli* from Lagos Lagoon, Nigeria contained 0.21 mg/kg of DDT, whereas adult species of *Ethmalosa fimbriata* contained 0.15 mg/kg

DDT. Feng *et al.* (2003) reported that DDT residues in fish from Taihu Lake region, China ranged from 3.7 to 23.5 mg/kg. Afful *et al*. (2010) indicated high level of endosulfan residue in fish of Densu basin of Ghana. The health effects associated with OCPs include reproductive failures, birth defect, endocrine disruption immune system dysfunction and cancer (Winter 1992). DDT in particular can block potassium influx across the membranes of nerve fibres and causes increase negative after potentials. DDT also induces the mixed function oxidize system thereby altering the metabolism of xenobiotics and steroid hormones (Ademorti 1996). The results of this study revealed that fishes grown in waste water contain residues of few persistent OCPs like DDT in their muscle tissue and gill. Among the DDTs, pp DDE was most commonly encountered suggesting that DDT was not used recently and because of its earlier use over the years DDT has been metabolized and accumulate in the environment and fishes as the most stable DDE.

CONCLUSION

The observed value of pesticide residues were mostly below the permissible limits of FSSAI for human consumption. However, continuous monitoring program needs to be put in place for environmental safeguard and food safety point of view

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