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Effect of Processing on Pesticide Residues in Some Edible Fresh Water Fishes

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ABSTRACT

The present study was undertaken to ascertain the effect of processing on pesticide residues in edible fresh water fishes. The fish samples were collected from two different fish markets located in Ludhiana city. Pesticide residues were detected in five different fish species by employing Gas Liquid Chromatography. Major pesticides detected include β-HCH, γ-HCH and chlorpyriphos with levels 0.30 mg kg^{-1}, 0.1-0.35 mg kg^{-1} and 0.14-0.58 mg kg^{-1}, respectively. *Catla catla, Labeo rohita* and *Cirrhinus mrigala* were found to have higher levels of pesticide residues. These fish samples were then processed by four different processing methods viz. deep frying, steaming by pressure cooker, conventional oven baking and microwave oven baking to check the reduction in residue levels. Deep frying caused maximum reduction i.e. 40-45% as compared to other processing methods. Steaming reduced pesticide residues by 14-16%, microwave oven baking resulted in 17-20% and conventional oven baking resulted in 20-21% reduction.

Keywords: Fish, processing, pesticide residues, GLC, Ludhiana

Achieving sustainable nutritional security is the major challenge being faced by most developing countries. India, after independence, has to meet with most difficult challenge of overcoming the problem of long standing food crisis owing to rapidly growing population (Jadhav and Waskar, 2011).

Pesticides are biologically active substances that are often applied to agricultural commodities to increase quantity and quality of food. The indiscriminate, heavy use of chemical pesticides results in ecological degradation, deleterious effects on the water taste and odour, lethal effect on non-target organisms in agro ecosystem and direct toxicity to users (Ansari and Kumar, 1988; Kalavathy *et al.,* 2001).

India is both the largest manufacturer and consumer of pesticides in South Asian countries (Agnihotri, 2000). India is the second largest manufacturer of pesticide in Asia after China and ranks twelfth globally. Although several eco-friendly technologies viz., integrated pest management system, use of neem based insecticides and other biopesticides are available for pest management, farmers rely mostly on the chemical pesticides because of their easy availability, immediate and spectacular effect (Little, 1996).

The pesticides applied on land eventually find their way to the aquatic environment, thus contaminating soil and water for several years and subsequently get accumulated in aquatic organisms (Singh *et al.,* 2005). The indiscriminate use of pesticides can lead to the presence of pesticide residues in water bodies near to lands and rivers (Sarkar and Gupta, 1988) resulting in high concentration in aquatic life especially fish, prawns, shrimps, etc. (Murray and Beck, 1990).

Fish are able to accumulate several fold higher concentration of pesticide residues than the surrounding water (Siddiqui *et al.,* 2005). Contamination of aquatic ecosystem by pesticides can cause acute and chronic poisoning of fish and other organisms. The pesticides are found to damage vital organs of fish, skeletal system and cause biochemical alterations in the exposed fish. The hazard to aquatic life is further increased by possible biomagnification of the pesticides from water by aquatic organisms (Murty *et al.,* 1986).

India is the third largest producer of fish and second in inland fish production with annual production of 7.5 million tonnes (Feroz and Pannikar, 2006). The percentage contribution of India to world fish production is 4.33 million tonnes. Punjab has made great strides to increase its fish production. The persistence and low solubility of organochlorine pesticides contribute to their high concentration in fish and finally accumulation in human body on consumption of the contaminated fish. Despite their low persistence, organophosphorus pesticides exhibit high toxicity to humans and animals and their presence in food raises certain safety issues (Caulibaly and Smith, 1994). Pesticide residues have detrimental effect on human health like causing cancer, epilepsy, liver and kidney dysfunction, somatic growth depression, leukemia, decreased fertility and testicular cancer (Sandhu, 1992; Ekbom *et al.,* 1996; Au *et al.,* 1999; Scheel *et al.,* 1996).

Although, India ranks second in the world in inland fish production but contribute very less in the world fish meat exports because quality aspects of our meat and meat products are of low standards. Fish is a perishable commodity and there has been large scale deterioration and losses in the quality of processed fish due to the combined effects of insect infestation and other biological agents that flourish under the tropics hot and humid conditions (Mohammad and Yusuf, 2001). To compete in the international market, it is imperative that our products, meant for exports, should be free from excessive residues to meet international standards.

MATERIALS AND METHODS

Samples of five different species of fish viz. *Catla catla*, *Labeo rohita, Ophiocephalus straitus, Wallago attu* and *Cirrhinus mrigala* (Catla, Rohu, Saul, Mulley and Mrigala respectively) were collected from two different fish markets (Jagraon bridge Market and Sherpur Market) in Ludhiana city. Five hundred grams of meat of each of the five fish species were collected in labelled polythene bags and brought to laboratory under chilled condition and representative sample of 10 g was taken for further processing. The extraction and clean up of fish samples were carried out by the method as described by Abdullah *et al.* (1990). The sample extracts were analyzed using gas liquid chromatography (GLC), model Nucon 5700 equipped with electron capture detector (ECD). The compound in the sample was identified and quantified by comparison of the retention time and peak heights of the sample chromatograms with that of standard run under identical operating conditions.

The fish samples viz. *Catla catla, Labeo rohita* and *Cirrhinus mrigala* having pesticide residues (already detected) were taken. The fish mince was prepared for different processing method. Sample of fish mince having weight 100 gm was taken for different cooking methods viz. Steaming (done with the help of pressure cooker), Conventional oven baking (200°C for 15 min), Deep frying (in vegetable oil at 180°C until golden brown), Microwave oven baking (high setting for 3 min). Cooking endpoint was based on the tenderness of the sample and varied with different samples.

RESULTS AND DISCUSSION

Pesticide residues in fishes

The analysis of fish samples from Sherpur Market revealed that *Labeo rohita*, *Cirrhinus mrigala*, *Ophiocephalus straitus* and *Wallago attu* did not contain any pesticide residues. In *Catla catla*, γ-HCH was detected with mean value of 0.20 mg kg^{-1}. Fish samples collected from Jagraon Bridge Market had different types of pesticide residues except in *Ophiocephalus straitus* (Table 1).

Table 1: Levels of pesticide residues in different fish species

Fish species	Pesticide detected	Mean ± Standard deviation (mg kg^{-1})
Catla catla	β-HCH	0.33 ± 0.025
	Chlorpyriphos	0.58 ± 0.030
	γ-HCH	0.20 ± 0.015
Cirrhinus mrigala	Chlorpyriphos	0.14 ± 0.023
	γ-HCH	0.20 ± 0.15
Wallago attu	γ –HCH	0.01 ± 0.00015
Labeo rohita	γ –HCH	0.35 ± 0.02

MRL- Maximum Residue Limit

The pesticides detected belonged to two groups of pesticides viz. organochlorine pesticides and organophosphorus pesticides. In *C. catla* two different pesticides were detected chlorpyriphos with mean value 0.58 mg kg^{-1} and β-HCH with mean value 0.33 mg kg^{-1}. *Cirrhinus mrigala* contained γ-HCH and chlorpyriphos with mean value 0.20 mg kg^{-1} and 0.14 mg kg^{-1} respectively. *W. Attu* contained γ-HCH residues having mean value 0.01 mg kg^{-1} while *L. rohita* mean value of γ-HCH was 0.35 mg kg^{-1}. The level of β-HCH and chlorpyriphos in all samples of *C. catla* was higher than maximum residue limits (MRL). In *C. mrigala* also, the level of chlorpyriphos was higher than MRL. The level of γ-HCH in *L. rohita* was also above the MRL.

The pesticides detected belonged to two groups of pesticides viz. organochlorine pesticides and organophosphorus pesticides. The main reason for the presence of organochlorine is their lipophilic nature due to which these compounds tend to absorb in the fatty tissues. The occurrence of relatively higher proportions of β and γ-HCH as compared to α and δ is due to the fact that β-HCH is recalcitrant and the use of γ-HCH, though restricted, still continues. It is also due to its most persistence form because of isomerisation of γ-HCH and α –HCH into β -HCH and also its high stability and is resistance to enzymatic and metabolic degradation (Dhananjayan and Muralidharan, 2010). Presence of high concentrations of β -HCH has been reported in various biological components (Kumari *et al.,* 2001; Kolo *et al.,* 2010). There is decline in levels of HCH residues in fish samples as compared to earlier studies conducted by Kalra and Chawla (1980), Battu *et al.* (1984), Kaphalia *et al.* (1985), Amaraneni and Pillala (2001) and Anupma *et al.* (2001).

Effect of processing on pesticide residues in fishes

It was found that the amount of pesticide residue was higher in three fish species (*Catla catla, Labeo rohita* and *Cirrhinus mrigala*), so these were selected for further processing and four different types of cooking methods were applied viz. deep frying, steaming by pressure cooker and baking was done with traditional oven as well as with microwave oven. The effect of four different methods of processing on pesticide residues was observed. The loss of pesticide residues with different processing methods in *C. catla, C. mrigala* and *L.rohita* is shown in Table 2, 3 and 4 respectively.

Table 2: Effect of different processing methods on levels of pesticide residues in *Catla catla*

Processing given to sample (*Catla catla*)	Pesticides	Pesticide detected before processing (mg kg^{-1})	Pesticide detected after processing (mg kg^{-1})	Percent loss (%)
Frying	β-HCH	0.33	0.18	45.4
	Chlorpyriphos	0.58	0.32	44.82
Steaming by pressure cooker	β-HCH	0.33	0.28	15.25
	Chlorpyriphos	0.58	0.49	15.52
Microwave oven baking	β-HCH	0.33	0.26	21.2
	Chlorpyriphos	0.58	0.46	20.69
Oven baking	β-HCH	0.33	0.27	18.2
	Chlorpyriphos	0.58	0.47	18.9

Table 3: Effect of different processing methods on levels of pesticide residues in *Cirrhinus mrigala*

Processing given to sample (*Cirrhinus mrigala*)	Pesticides	Pesticide detected before processing (mg kg^{-1})	Pesticide detected after processing (mg kg^{-1})	Percent loss (%)
Frying	Chlorpyriphos	0.14	0.08	42.8
	γ-HCH	0.20	0.12	40.0
Steaming by pressure cooker	Chlorpyriphos	0.14	0.12	14.3
	γ-HCH	0.20	0.17	15.0
Microwave oven baking	Chlorpyriphos	0.14	0.11	21.4
	γ-HCH	0.20	0.16	20.0
Conventional oven baking	Chlorpyriphos	0.14	0.11	21.4
	γ-HCH	0.20	0.16	20.0

In the present study, the residue level of γ-HCH in *Labeo rohita* and *Cirrhinus mrigala* was reduced 15 per cent and 13.9 per cent, respectively and in *Catla catla,* the level of β-HCH was reduced by 15.25 per cent by using steaming method of processing. While in the previous studies (Bedi et al., 2004) in chevon reported that on boiling, residue levels of various HCH isomers viz. α-,β-,γ- and δ-HCH decreased by 25.0, 14.0, 22.0 and 11.5 per cent, respectively, while on pressure cooking, residue levels decreased by 30.0, 23.0,23.0 and 15.0 per cent, respectively. Several reports indicate that cooking causes destruction of insecticide residue in meat (Ritchey *et al.,* 1969; Wani *et al.,* 2000). Morgan *et al*. (1972) reported

60.0 per cent loss of lindane on cooking by simmering and pressure cooking.

Table 4: Effect of different processing methods on levels of pesticide residues in *Labeo rohita*

Processing given to sample (*Labeo rohita*)	Pesticides	Pesticide detected before processing (mg kg^{-1})	Pesticide detected after processing (mg kg^{-1})	Percent loss (%)
Frying	γ-HCH	0.36	0.20	44.5
Steaming by pressure cooker	γ-HCH	0.36	0.31	13.9
Microwave oven baking	γ-HCH	0.36	0.29	19.4
Conventional oven baking	γ-HCH	0.36	0.30	16.7

The levels of pesticide residues encountered in the present study were less as compared to earlier reports in fish samples from India thereby indicating decline in the levels of these pesticide residues (HCH and chlorpyriphos) in the region. Various cooking methods lead to reduction in the levels of pesticide residues in fish. Deep frying caused 45 per cent reduction which is the highest as compared to other cooking methods.

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