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Occurrence of Pesticide Residues in Cooked Chicken Meat Products

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ABSTRACT

A study was conducted to estimate the levels of various organochlorine pesticide residues in cooked chicken meat products. Wet cooked (Kadai Chicken), deep fat fried (Chicken 65) and dry cooked (Tandori chicken) chicken meat products (each 14 samples) were collected from restaurants in Hyderabad and analysed for the presence of pesticide residues using gas chromatograph equipped with an electron capture detector. Overall, 42.86 % of cooked meat products samples were showed presence of pesticide residues. Among the analysed samples, chicken 65 (57.14 %) and tandoori chicken (50.0 %) showed higher incidence of contamination. Among the pesticides, residues of aldrin (26.19%) were more frequently observed. The kadai chicken had residues of γ HCH, δ HCH and dieldrin with a concentration (ppm) of 0.011, 0.033 and 0.026, respectively. Residues of δ HCH, aldrin, dieldrin and endosulfan were observed in chicken 65. The tandoori chicken showed residues of α HCH, δ HCH, aldrin, dieldrin and endosulfan with a concentration (ppm) of 0.047, 0.010, 0.058, 0.050 and 0.012, respectively. However, the levels of pesticide residues recorded in the study were lower than the maximum residue limit stipulated by Food Safety Standards Regulations (Contaminants, toxins and Residues) 2011.

Keywords : *Pesticide residues, Cooked chicken meat products*

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INTRODUCTION

Agrochemicals, especially pesticides have been playing an important role in increasing food production and supply, since a good part of the produce is lost through diseases, pests and weeds in the field and during storage. However, higher stability and persistence of some of these chemicals in the environment led to the contamination of food stuffs including animal foods like milk and meat. Pesticides residues in animal foods comes through the contaminated feed, water and topical application of pesticides for ectoparasitic infestation in animals. It has been found that greater than 80% of the total intake of pesticide residues in human beings is through the food, especially fatty foods such as milk and meat products (Kannan *et al*. 1992; Kumari *et al.* 2005). Chronic exposure to these compounds known to induce or aggravate certain health problems in humans, such as cancer, weakening of immune systems and the disruption of hormonal functions (Brody and Rudel 2003).

Periodical monitoring of foodstuffs for the presence of pesticides residues is therefore necessary to ensure the public health. Though there are some reports available on the incidences and levels of pesticide residues in fresh meat, information on pesticide residues in the cooked or processed meat products are scanty. The levels of pesticide residues in the final products are affected by a number of physical and chemical transformations that the raw material undergoes during various types of processing and cooking (Sharma *et al.* 2005; Uygun *et al*. 2008). To properly assess the risks of pesticide residues to consumer, it is necessary to estimate the levels of pesticide residues in cooked products because processing and cooking has significant effects upon the residues (Muthukumar *et al*. 2010b). This kind of study is among the critical supporting studies required for the more realistic estimates to be made of the dietary intake of the pesticides and would help formulating regulatory guidelines for management of residues on such products by fixing or re-evaluating MRLs for their quality assurance and control.

Meat is cooked by different methods viz. wet cooking, deep fat friying and dry cooking depending on consumer preference and convenience. Therefore, it is necessary to know the levels of pesticide residues in various kinds of meat products. Chicken meat has become very popular among meat consumers in India because of its taste, nutritional value, free from religious taboos, affordable price and easy availability. Chicken meat production in India is estimated at around 2.206 MMT and thus regarded as the ninth largest in chicken meat producer in the world. Hence, the present work was carried out to study the levels of organochlorine pesticides viz., DDT and it's metabolites (p,p'DDT - para para Dichloro Diphenyl

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Trichlore ethane ; p,p'DDE - para para Dichlorodiphenyl Dichlore Ethane and p,p'DDD - para para Dichloro Diphenyl Dichloroethylene) and HCH (α, β, γ and δ isomers) and cyclodiene compounds (aldrin, dieldrin, endrin, endrinaldehyde, endosulfan, endosulfan sulphate, heptachlor and heptachlor epoxide) in certain commonly consumed chicken products prepared by different cooking/processing methods.

MATERIALS AND METHODS

Sample collection and processing for pesticide residues estimation: Wet cooked (Kadai Chicken), deep fat fried (Chicken 65) and dry cooked (Tandori chicken) chicken meat products (each 14 samples) were collected from restaurants in Hyderabad. Samples were analysed for the level of pesticide residues.

Extraction of fat and residues: A 15 g portion from each of the minced samples was ground along with twice the quantity of the anhydrous sodium sulphate in a pestle and mortar. Resultant free flowing granular tissue material thus formed was extracted for organochlorine pesticides residues with petroleum ether at 50 to 55°C in a Soxhlet apparatus (Soxplus, Chennai, India) for 6 h as outlined by Tonkabony *et al*. (1981).

The fat extracted from the samples was subjected to clean-up employing the procedures of AOAC (1995) with slight modifications. The extracted fat diluted with 15 ml petroleum ether extracted thrice with 30 ml of acetonitrile saturated with petroleum ether in the 125 ml separator. Each time, the acetonitrile portion was drained into a one litre separator containing 650 ml water, 40 ml saturated sodium chloride solution and 100 ml petroleum ether. The one litre separator containing the acetonitrile extracts was shaken thoroughly. The aqueous layer separated was drained into another one litre separator to which 100 ml petroleum ether was added and shaken thoroughly with care (back extraction into petroleum ether). After discarding the aqueous layer, the petroleum ether portion was combined with that in the first one litre separator, washed with two 100 ml portions water and the washings were discarded. The cleanup of samples to remove the residual fat was performed by column chromatography method using activated anhydrous sodium sulphate and Florisil. Elution was carried out with 200 ml of 6% eluting solvent at 40-45 drops per minute and the elute was concentrated in a vacuum evaporator (Lab Tech, Korea).

Determination of organochlorine pesticide residual concentrations: One micro litre of the reconstituted sample was injected into a gas chromatograph (Varian 450 GC, Netherlands) equipped with an electron capture detector (ECD). Instrumental settings were as follows: Temperature of injection port, column oven and detector were 260, 80-260 and 300^0 C, respectively with N_2 gas flow rate of 1 ml/ minute. This injection mode was split 1:10 ratio. The retention time along with the areas of the peak were recorded. The residue of pesticide was identified based on comparison of the measured relative retention times to those of known standards. The residue levels of organochlorine pesticides were quantitatively determined by the external standard method using peak area. Measurement was carried out within the linear range of the detector. The peak areas whose retention times coincide with the standards were extrapolated on their corresponding calibration curves to obtain the concentration. The quality of organochlorine pesticides was assured through the analysis of solvent blanks, procedure blanks and duplicate samples. For every set of ten samples, a procedural blank consisting of all reagents and glassware used during analysis was run for interference and cross contamination.

Recovery experiment: The method was optimized and validated using spiked with the internal standard to evaluate the recovery of compounds. Meat samples were fortified with the working standards (0.01 and 0.1 ppm) of investigated compounds to estimate the recovery. In the present study, the recovery of various organochlorine pesticides from spiked meat samples was above 80% and is in agreement with FDA recommendations (FDA 1994). Residue levels of pesticides were expressed as mg/kg (ppm). The detection and quantification limit of the analysed organochlorine compounds were 0.001 and 0.01 ppm, respectively.

Statistical analysis: Data was subjected to one-way analysis of variance (ANOVA) to verify any statistically significant difference among the different meat products analysed. All test were regarded as statistically significant when $p<0.05$.

RESULTS AND DISCUSSION

In the present study, the recovery of various organochlorine pesticides from spiked meat samples was above 80 % (Table 1). The efficiency of extraction methodologies is evaluated based on the recoveries of residues and a recovery of 75-102 % is considered as acceptable (Solymos *et al*. 2001).

Table 1: Retention time and recovery percentage for organochlorine pesticides in spiked meat samples

Name of Pesticide	Mean Retention Time (Min.)	Mean Recovery (%)
α HCH	24.84	96.24
β HCH	25.82	84.29
γ HCH	27.15	98.13
δ HCH	27.53	85.06
Heptachlor	34.09	101.82
Aldrin	37.59	79.73
α endosulfan	44.55	89.66
p,p' DDE	47.09	91.54
β endosulfan	48.36	80.00
p,p'DDD	50.06	80.74
Endosulfan sulphate	52.15	82.40
p,p' DDT	54.20	101.13

Overall, 42.86 % of cooked meat products samples were showed presence of pesticide residues (Table 2). The higher incidence of pesticide residues in chicken products could be due to contaminated chicken meat, vegetabes, spice mix, condiments, oil and other ingredients used in the preparation. Several authors have reported the residues of pesticides along with fungicide and herbicides in fruit and vegetables from India (Bhanti and Taneja 2005; Srivastava *et al.* 2011). Due to lipophilic nature of organochlorine compounds, muscles foods are frequently found contaminated with residues (Aulakh *et al.* 2006; Tao *et al*. 2009;Beura 2012). Further, the ubiquitous nature, higher stability in the environment (Tonkabony *et al*. 1981) and uncontrolled/misuse of pesticides in agriculture might be the reasons for higher detection frequency in various food ingredients.

Among the samples, chicken 65 (57.14 %) and tandoori chicken (50.0 %) showed higher incidence of contamination. Though the temperature and duration of cooking have serious impact on the dissipation of pesticides (Sharma *et al.* 2005; Uygun *et al*. 2008), the medium of cooking, ingredients (vegetables, spice mixes, oil, etc.) used in cooking might have contributed to the residues in the cooked chicken products. Among the pesticides, residues of aldrin were more frequently observed (26.19% of samples). The kadai chicken had residues of γHCH, δ HCH and dieldrin with a concentration (ppm) of 0.011, 0.033 and 0.026, respectively. Residues of δ HCH, aldrin, dieldrin and endosulfan were observed in chicken 65. The tandoori chicken showed residues of α HCH, δ HCH, aldrin, dieldrin and endosulfan with a concentration (ppm) of 0.047, 0.010, 0.058, 0.050 and 0.012, respectively.

Table 2: Incidence of pesticide residues in the cooked chicken products

Name of the pesticide residues	Kadai chicken (Wet cooking)	Chicken 65 (Deep fat frying)	Tandori chicken (Dry cooking)	MRL (ppm)
HCH	BDL	BDL	0.047 (7.14 %)	Total HCH 2
β HCH	0.011 (7.14 %)	BDL	BDL	
δ HCH	0.033^{b} (7.14 %)	0.029^{b} (7.14 %)	0.010^{a} (7.14 %)	
Aldrin	BDL	0.058 (35.71 %)	0.058 (42.86 %)	0.2
Dieldrin	0.026^{a} (14.29 %)	0.075^{c} (14.29 %)	0.050^{b} (14.29 %)	
E Sulfate	BDL	0.016 (7.14 %)	0.012 (7.14 %)	0.2

n=42 Means bearing different superscripts (a, b) between columns differ significantly (P< 0.05)
Values in the paranthsis indicate percentage of occurrence

Though several workers from various parts of India have reported presence of high incidence of DDT residues in chicken muscle (Aulakh *et al.* 2006; Vanitha *et al*. 2014), the DDT residues could not found in any of the analysed samples. This could be due to variation in the type of pesticides used in a particular region. The processing and cooking also might have contributed to the elimination of residueal DDT pesticide in the meat products as reported by Muthukumar *et al*. (2010b).

Among the various isomers, the occurrence of δ (7.14 %) was more followed by α (2.38%) and γ (2.38%). Muntean *et al*. (2003) reported α HCH to be the most persistent among different HCH isomers in different meats, eggs and milk samples. Widespread contamination of the water bodies, grains, oilseeds and animal tissues, might be the reason for higher incidence of HCH residues in the present study. Earlier studies in various parts of the country have reported the presence of HCH residues in water (Shukla *et al.* 2006), feed (Beura 2012), oil

(Dikshith *et al.* 1989), vegetables (Bhanti and Taneja 2005; Srivastava *et al*. 2011), chicken (Aulakh *et al*. 2006, Muthukumar *et al.* 2010a, Vanitha *et al*. 2014). Kannan *et al*. (1992) opined that the extensive use of HCH in agriculture in the past coupled with its unique chemical stability was the reason for widespread contamination in the environment and food stuffs. The presence of α HCH, γ HCH and δ HCH isomers indicates the possibility of misuse of technical HCH (α HCH- 60 %, β HCH- 5-6 %, γ HCH – 13 % and δ HCH – 5-6 %) or commercially available linden (γ HCH) may also contain various other isomers. However, the concentration of total HCH in the samples analysed in the present study is much lower than the recommended maximum limit of 2 ppm set (for lindane alone) by Food Safety Standards Regulations (Contaminants, Toxins and Residues) 2011.

Among the cyclodienes compounds, the incidence of residues of aldrin were high (26.19), followed by dieldrin (14.29) and endosulfan (4.76). The overall mean concentrations of aldrin in chicken products samples ranged from trace to 0.058 ppm. The present study is in congruent with the earlier reports on the widespread contamination of aldrin residues in the country. The presence of aldrin residues in feed (Dikshith *et* . 1989), buffalo and goat milk (Saxena and Siddiqui 1982), meat and fat (Kannan *et al*. 1992) and broiler chicken (Muthukumar *et al*. 2010a) were already reported. Aldrin levels in the samples analyzed in the present study are much lower than the recommended maximum limit of 0.2 ppm (Food Safety Standards Regulations (Contaminants, Toxins and Residues) 2011).

The residues of total endosulfan were detected in 4.76 % samples with an overall mean concentrations ranged from trace to 0.016 ppm. Reports were available on the widespread contamination of animal feed, milk, meat with endosulfan residues from different parts of the country (Dikshith *et al*. 1989; Aulakh *et al*. 2006; Muthukumar *et al*. 2010b). However, the residue levels of endosulfan in the analyzed samples in the present study are well below the maximum residue limit of 0.2 ppm.

CONCLUSIONS

The findings of the present study indicates the wide spread prevelance (42.86 %) of residues of various pesticide in the cooked chicken meat products. The incidence of contamination were more among chicken 65 (57.14 %) and tandoori chicken (50.0 %). The residues of aldrin (26.19%) were more frequently observed in the present study. However, the levels of pesticide residues recorded in the study were lower than the maximum residue limit stipulated by Food Safety Standards Regulations (Contaminants, toxins and Residues), 2011. The results of the study indicate the need for strengthening regulatory measures to monitor the pesticides usuage and also periodical monitoring of animal foods to ensure the safety of the consumer.

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