# Removal of Pesticide Residues from Tomato and its Products

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**Abstract:** Plant protection agents (more commonly known as pesticides) are widely used in agriculture to increase the yield, improve the quality and extend the storage life of food crops. The study was carried out in order to determine the effectiveness of various traditional processing treatments on reducing the residual load of pesticides from tomato and its products. Results showed that lipid soluble pesticides residues were reduced most effectively in sun-drying (90-97%) followed by frying (91-99%) and thermal dehydration (89-90%). The data further indicated that profenofos residues dislodged more effectively than bifenthrin and endosulfan. The least reduction was noticed in endosulfan residues. Similarly in case of water soluble pesticides, the effect of sun-drying, frying and thermal dehydration on reduction of pesticide residues were within the range of 94-97%, 92-96% and 91-96%, respectively. Maximum reduction was found in emamectin benzoate residues followed by imidacloprid and diafenthiuron.

**Keywords:** Tomato, vegetables, pesticide residues, washing, cooking.

## INTRODUCTION

Pakistan is an agrarian country and various types of vegetables are grown in Pakistan. Tomato has an annual production of 433128 tones at 39918 hectares in Pakistan out of which the contribution of Sindh Province is 141586 tones per 18753 hectares [1]. With an increase in population, the demands of food commodities like fruits and vegetables including tomato in Pakistan are also growing. To overcome the demands, vegetables are grown in rural and peri-urban areas. Insect pests and diseases are the main constraints to vegetable production and destroy almost half of the world's food crops each year [2] for which intensive pest management practices are required.

Pesticides are plant protection agents widely used in agricultural land to obtain the goals such as increased crop yield, improved quality and extended storage life of crops [3]. Modern pesticides are synthetic chemicals that control insects, weeds, fungi and other pests that affect not only the yields but often destroy crops [4, 5]. Although, pesticides sprayed directly or indirectly on plants [6] yet, their use contaminates the crops instead of supporting economic status, consumers are forced to face great health related issues [7].

Government of Pakistan, like other developing countries has provided full support for the use of pesticide to save crops from pests [8]. Indiscriminate use of pesticides on vegetables has been observed in Pakistan [9] and is one of the largest consumers of pesticides in the world after India.

Import of pesticides started in 1970 by Government of Pakistan after then pesticides business was handed over to the private sector in the year 1980. Since then, the use of pesticides on crops consistently increasing at the rate of 25% a year [10]. It has been reported that about 27% of the total insecticide used on fruits and vegetable crops have posed extensive hazards to the human health and environment [11]. Globally, a wide range of pesticides used for protection of vegetables against heavy pest infestation throughout the growing season [12]. It has been revealed that vegetables contain pesticides residues beyond their respective maximum residue limits (MRLs) [13], which may poses a severe health hazard to consumers as well as farmers [14, 15].

The series of experiments had been conducted to ascertain the level of residues present on the raw tomato and then application of various treatments on tomato.

## MATERIALS AND METHODS

### Pesticide Spray on Tomato

Tomatoes were grown on Latif farm (area about half an acre) through organic farming without pesticides to serve as control. Supervised pesticide application experiments of tomato were also grown on area about two acres at farmer's field under the inorganic farming where pesticides were applied at fruiting stage. Six pesticides (Bifenthrin, Endosulfan, Profenofos, Imidacloprid, Diafenthiuron, Emamectin Benzoate)

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**Table 1: Recommended dose of Pesticides Per Acre**

| Pesticides | Formulation | Active ingredient |
|---|---|---|
| Bifenthrin | 250 ml /acre | 25 ml/acre |
| Profenofos | 800 ml/ acre | 400ml/acre |
| Endosulfan | 600 ml/ acre | 210 ml/acre |
| Emamectin benzoate | 200 ml/acre | 38 ml/acre |
| Imidacloprid | 80 ml /acre | 16ml/acre |
| Diafenthiuron | 300 ml /acre | 150 ml /acre |

were sprayed with Knapsack sprayer, at recommended dosages given in Table **1** on separate plots of tomato.

Tomatoes were harvested on the next day after pesticide application. For further processing tomato samples were packed in properly labeled polythene bags and brought to the laboratory of Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam.

## Traditional Processing of Tomato

The tomato samples were subjected to different traditional processing techniques, such as unwashed unprocessed, plain washed, plain washed fried, plain washed thermal dehydrated, plain washed sun-dried, plain washed ketchup, plain washed juice, plain washed pulp, plain washed paste, plain washed blanched, detergent washed and unwashed unprocessed leaves. Samples were prepared for extraction of pesticides residues and the effects of traditional processing on pesticides were observed and recorded.

## Extraction, Cleanup and Analysis of Pesticide Residues

The extraction, clean-up and analysis of fat soluble pesticides (Endosulfan, profenofos and bifenthrin) and water soluble pesticides (Imidacloprid and diafenthiuron) was done *via* GC-µECD and HPLC methods, respectively [16, 17]. However one water soluble pesticide namely diafenthiuron was extracted, cleaned up and analyzed *via* HPLC according to the process of Panhwar and Sheikh (2013) [18].

## Recovery Percentage of Bifenthrin, Profenofos, Endosulfan, Emamectin Benzoate, Diafenthiuron and Imidacloprid Residues

In order to ensure quality assurance information, before taking up analysis of test samples, the analytical method was standardized by processing spiked samples. Vegetable samples were taken from control plots where no insecticide had been sprayed. Samples were cut into small pieces of about 1–1.5 cm which were thoroughly mixed by tumbling. After quartering, 200–250g pieces were homogenized in a warring

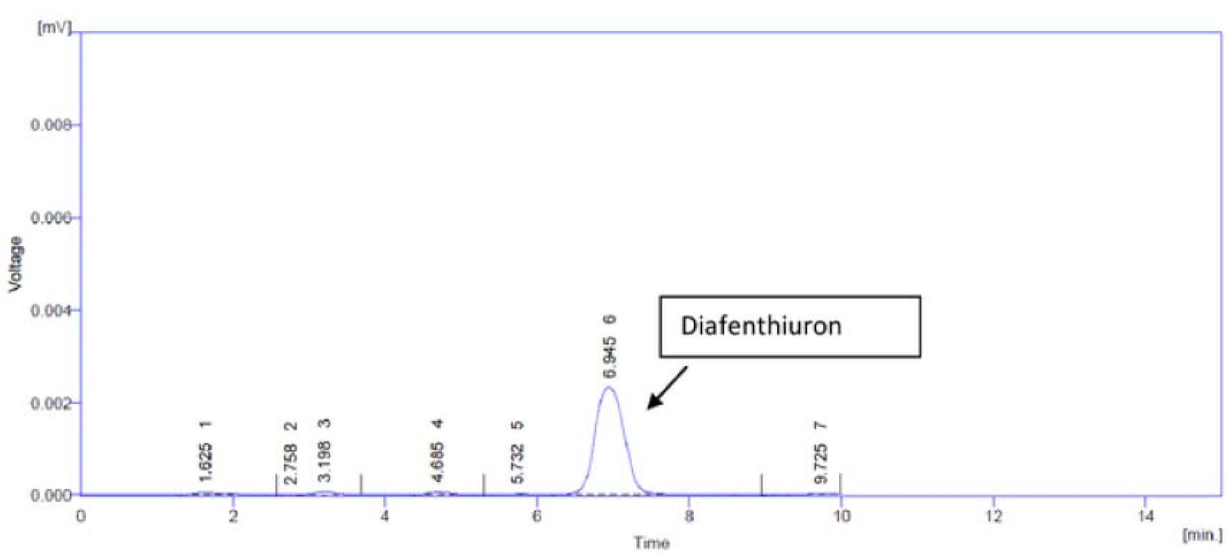


**Figure 1:** HPLC chromatogram of diafenthiuron residues.

blender. Homogenized matrix (20g), in three replicates was spiked with emamectin benzoate, diafenthiuron, imidacloprid, endosulfan, profenofos and bifenthrin separately. Control samples were processed along with spiked ones. The processes of extraction, cleanup of pesticide residues were same as described above. Average percent recoveries were 88.92-91 for emamectin benzoate, 87.01-96.24 for diafenthiuron, 76-80.1 for imidacloprid, 78.5-84.36 for endosulfan, 66.67-78.00 for profenofos and for bifenthrin were 77-89.35. Recoveries were considered satisfactory for all above insecticides in tomato with the proposed methods. Retention times and peak areas of the studied pesticides in samples were comparable with the relative standards.

### GC and HPLC Chromatograms of Pesticides

Diafenthiuron had retention time of 6.9 minutes in the HPLC chromatogram as shown in Figure **1**.

Emamectin benzoate had retention time of 10 minutes in the HPLC chromatogram as shown in Figure **2**.

HPLC chromatogram of imidacloprid residues shown in Figure **3** depicts retention time of 11.54 minutes.

The endosulfan gave two peaks one at 9.67 minutes for alpha endosulfan and second peak at 10.15 minutes for beta endosulfan as shown in Figure **4**.

The profenofos had retention time of 3.698 minutes as shown in Figure **5**.

The bifenthrin pesticide showed the retention time of 10.133 minutes as shown in Figure **6**.

## RESULTS

The results in Table **2** showed that during traditional processing weight loss occurs due to water loss. Tomato is highly perishable with moisture concentration of about 95% therefore the loss of water was also calculated. 50g of sample was taken for sun-drying, thermal dehydration and frying and results revealed that sun-drying reduced the water content of tomato up to 6.5g (87%) whereas dehydrating the

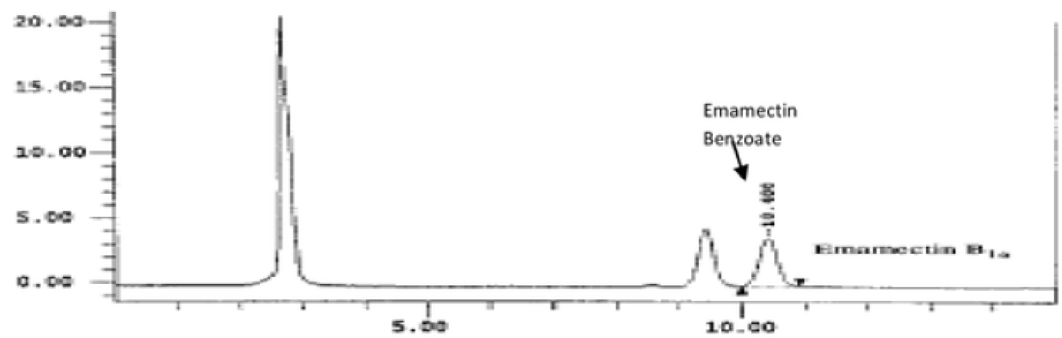


**Figure 2:** HPLC chromatogram of emamectin benzoate residues.

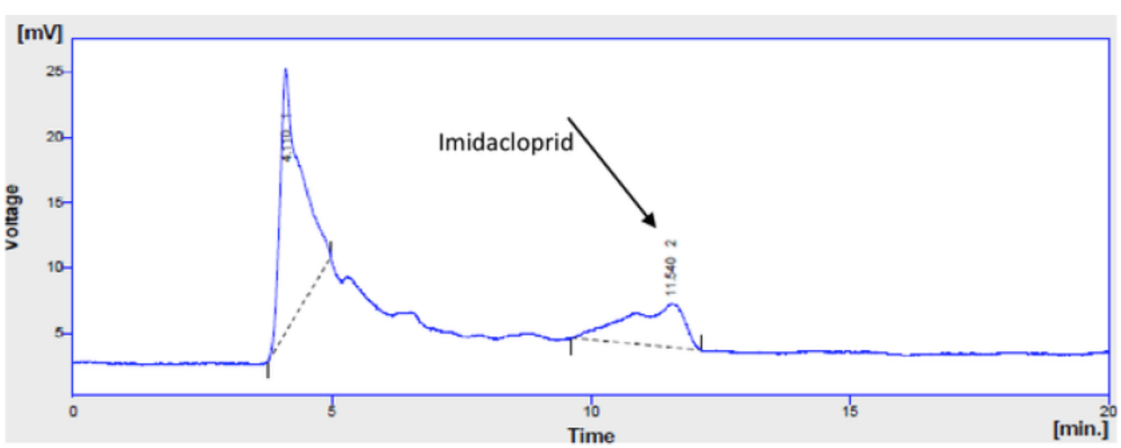


**Figure 3:** Imidacloprid HPLC chromatogram residues.

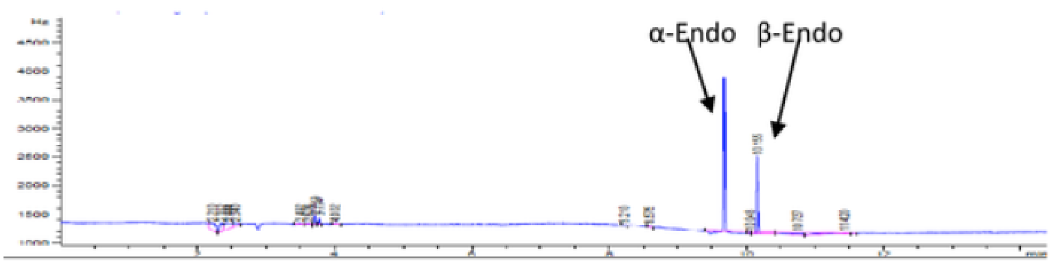


**Figure 4:** GC-μ ECD chromatogram of endosulfan residues.

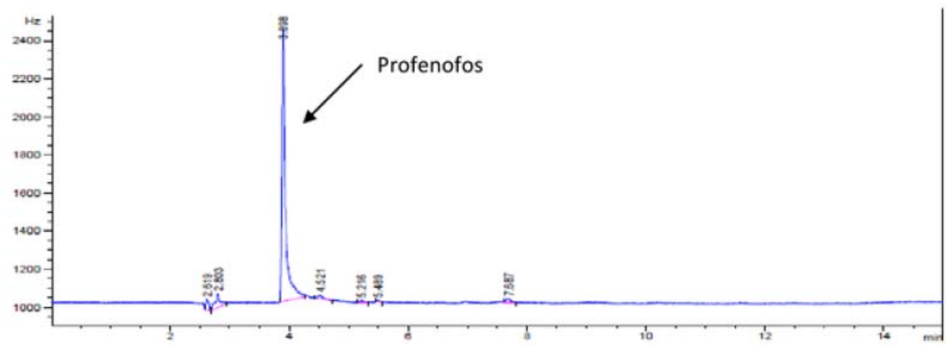


**Figure 5:** GC-μ ECD chromatogram of profenofos residues.

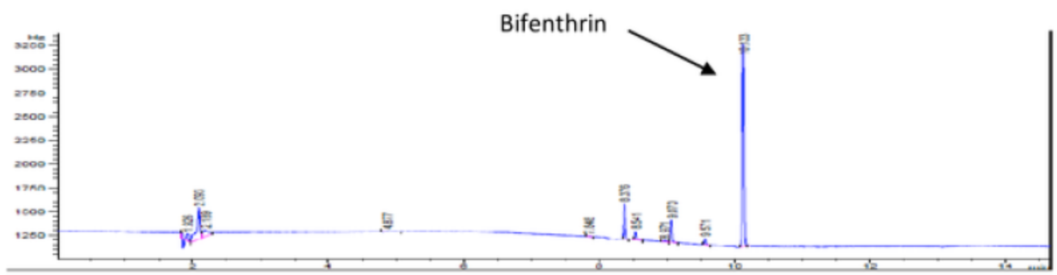


**Figure 6:** GC-μ ECD chromatogram of bifenthrin residues.

tomato samples in thermal chamber resulted in reduction of moisture by 4.5g (91%), similarly fried samples were also weighed resulted in 12.21g (75.58%) moisture reduction. The results of pesticides were shown by applying the weight loss effect.

The results of effect of various traditional methods are depicted in Figure **7**. The data in figure showed that fat soluble pesticides reduce most effectively in sun-drying (90-97%) which is followed by frying (91-99%) and after them is thermal dehydration (89-90%). The data further explained that Profenofos dislodged most effectively than Bifenthrin and Endosulfan. The least reduction was noticed in Endosulfan residues.

### Effect of Traditional Processing on the Reduction of Fat Soluble Pesticides

Similarly, water soluble pesticides viz. Diafenthiuron, Imidacloprid and Emamectin Benzoate

**Table 2: Weight Loss of Tomato Samples in Traditional Processing**

| Treatments | Weight (gm) | % of Control | % weight loss | Concentration Factor |
|---|---|---|---|---|
| Before Treatment | 50 | 100 | 0 | 1 |
| Sun-dried | 6.5 | 13 | 87 | 7.692308 |
| Thermal Dehydrated | 4.5 | 9 | 91 | 11.11111 |
| Fried | 12.21 | 24.42 | 75.58 | 4.095004 |

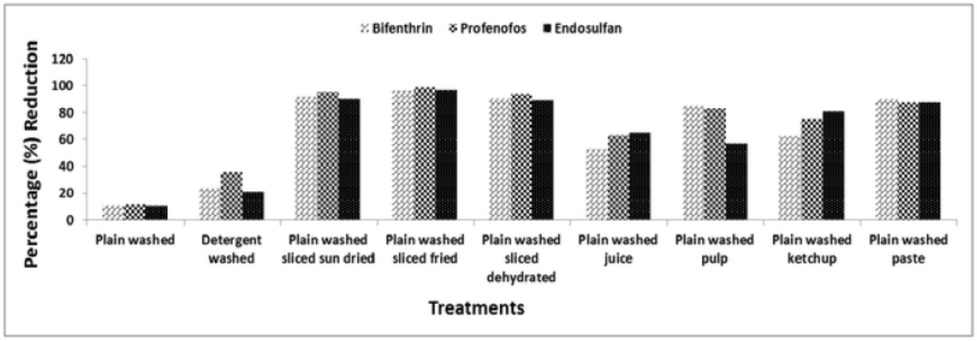


**Figure 7:** Effect of Traditional Processing on the Reduction of Fat Soluble Pesticides.

**Effect of Traditional Processing on the Reduction of Water Soluble Pesticides**

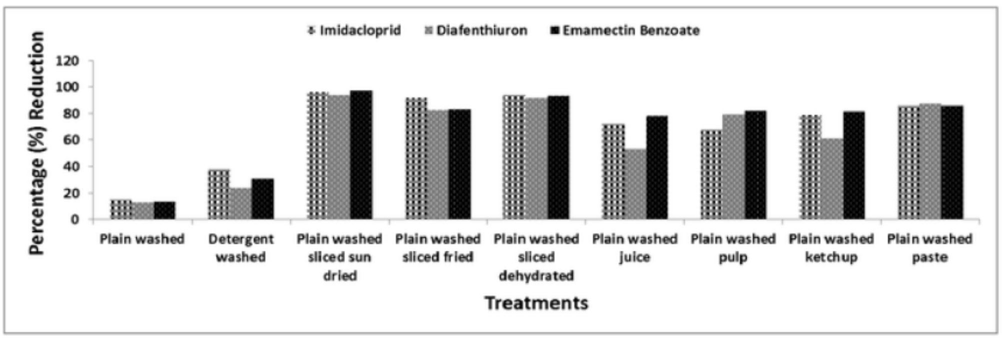


**Figure 8:** Effect of Traditional Processing on the Reduction of Water Soluble Pesticides.

were also subjected to traditional food processing in order to reduce the pesticide concentration from tomato. Figure showed that in sun-dried, fried and thermal dehydrated samples the reduction of pesticide residues was found within the range of 94-97%, 92-96% and 91-96%%, respectively. Emamectin Benzoate was found with maximum pesticide reduction followed by Imidacloprid and then Diafenthiuron.

## DISCUSSION

Tomato is used as a vegetable and fruit but most often it is consumed uncooked. Pesticides are the part of majority of chemicals applied on them [19]. The present study determined the insecticide residues in tomato, which was grown on field, sprayed, harvested, analyzed and compared with the MRLs set by FAO. Six pesticides were selected after critical interviews taken from farmers and dealers.

Traditional food processing techniques for reduction of pesticide residues has been used from the decades. In connection with these previous practices, some common and simple processing techniques have acquired to significantly reduce the extent of the harmful pesticide residues from food. Pesticide residues are influenced in food by storage, handling and processing.

An enormous literature exist and reveals that processing techniques leads to large reductions in residue levels in the prepared food, noticeably *via* washing, peeling and cooking operations. Washing with plain water and various chemicals in domestic and commercial levels are necessary to mitigate the penetration of pesticide residues. Operations such as, freezing, juicing and peeling are fruitful procedures to remove the pesticide residues from skins or peel. Cooking is also a supporting way to eliminate pesticide residues from food. The effects of pesticide residues in food is an area where available information should be consolidated and gape filling should be done through obtaining further research [20].

In the present study, rinsing with tap water and detergent solution resulted in reduction of fat soluble pesticides of about 10-35% whereas water soluble pesticides about 12-65%. Among the fat soluble pesticides profenofos, and among water soluble pesticides emamectin benzoate was found most affected by plain washing with the reduction percentage of 35 and 65%, respectively. Kumari (2008) [21] also reported that washing remained efficient in dislodging the residues as it depends on various factors like location and age of residues, water solubility and temperature and type of washing. It is also confirmed form Chauhan and Kumari (2011) [22] that rinsing of various vegetable was found very effective and the residues reached well below MRL value. Zohair (2001) [23] in his study reported that washing with plain water or detergents was imperative to minimize the intake of pesticide residues

Drying processes involving sun-drying and thermal dehydration were found most effective in dislodging the insecticide residues from tomato. The results in Figure **1** revealed that Sun-drying reduced the residues up to the level of 97% that were within their respective MRLs whereas, thermal dehydration reduced the residues by 90% these were also found within the range of MRLs set by FAO. Bifenthrin, endosulfan and profenofos are fat soluble pesticides out of which profenofos reduced most readily up to 97% in sun-drying, whereas bifenthrin was reduced more in thermal dehydration that is up to 90.7%. Emamectin Benzoate, imidacloprid and diafenthiuron are water soluble pesticides, out of which effective reduction under sun-drying and thermal dehydration was found of emamectin benzoate with 97 and 93% respectively. This could be due to UV (Ultraviolet) radiations which causes degradation of pesticides in tomato. These results are in agreement with the findings of Sheikh *et al*. (2012 a, b) [16, 17].

Frying is most common process in almost every house. It has cumulative effect on reduction of pesticides which resulted up to 99% reduction of profenofos pesticide from tomato as showed in Figure **1** containing fat soluble pesticides, and up to 96% reduction was noted in emamectin benzoate of water soluble pesticides (Figure **2**). This might be because of heat which causes hydrolysis, volatilization of pesticide residues as well as thermal degradation is major cause in pesticide degradation. Various researchers [20, 16, 17, 24, 25, 26] are also in agreement with the present results. Based upon vegetable type and the pesticide treatment, the effects of cooking on residues removal from vegetables were different [27].

Blanched samples reduced 46% profenofos residues from tomato among fat soluble insecticides, where as 78% emamectin benzoate of water soluble insecticides. Randhawa *et al*. (2007) [24] in his study declared that blanching was more effective in eliminating pesticide residues as compared to tap water washing, he further reported that all these operations for example, washing, detergent washing, blanching and cooking/boiling play a vital role in the reduction of pesticides residues.

Tomato ketchup, juice, pulp, juice treatments were also found effective in removing the pesticide residues from tomato. Kaushik *et al*. (2009) [20] in her study reported that peeling and juicing were effective tools for decontamination of pesticides.

This is concluded that unwashed samples were found above maximum residual limits which were reduced within the range by traditional food processing. Residues of contact pesticides exist on the surface as well as those of systematic pesticides penetrate inside the tissues were effectively removed through the sun-drying, frying and thermal dehydration techniques.

## REFRENCES


[1] GOP. Economic Survey of Pakistan. Economic Advisor's wing, Ministry of Finance. Islamabad 2011-12.

[2] Lantican FA. Vegetable program area research planning and prioritization. Discussion Paper. Series No. 2000-07. Philippine Institute for Development Studies 2000.

[3] Fernández-Alba AR, García-Reyes JF. Large-scale multi-residue methods for pesticides and their degradation products in food by advanced LC-MS. TrAC 2008; 27(11): 973-990.

[4] Khan, Z. J. Muller, S. K. Khan, S. Amjad, S. Nizamani and M. I. Bhanger. Journal of the Chemical Society of Pakistan 2010; 32: 542.

[5] Xiao YM, Wang JA, Wang MA, Liu JP, Yuan HZ, Qin ZH. Journal of the Chemical Society of Pakistan 2010; 32: 363.

[6] McCauley L, Beltran M, Phillips J, Lasarev M, Sticker D. The Oregon migrant farmworkers community: an evolving model for participatory research. Environ Health Perspect 2001; 109: 449-455. http://dx.doi.org/10.1289/ehp.01109s3449

[7] Jaga K, Dharmani C. Global Surveillance of DDT and DDE Levels in Human Tissues. International Journal of Occupational Medicine & Environmental Health 2003; 16(1): 7-14.

[8] Rasheed BM. Country report on international code of conduct on the distribution and use of pesticide. Department of plant protection, Ministary of Food, Agriculture & Livestock, Government of Pakistan 2007.

[9] Khan AF. Hazards of pesticide spray on vegetables. The Daily Dawn Pakistan, Internet Edition 2004.

[10] USAID, I-LED. Pesticide Evaluation Report and Safer Use Action Plan 2006-2009; p. 49.

[11] Hussain S, Masud T, Ahad K. Determination of pesticide residues in selected varieties of mango. Pak Journal of Nutrition 2002; 41-42.

[12] Kalara RL. Assessment of human exposure of pesticide residues through food, and water and other Environ Monit Assess sources in India. In Proceedings of symposium on risk assessment of pesticide residues in water and food 2003; (pp. E1-9).

[13] Taneja A. Monitoring of organochlorine pesticide residues in vegetables from Agra, India –a case study. Environmental Monitoring and Assessment 2005; 110: 341-346. http://dx.doi.org/10.1007/s10661-005-8043-6

[14] Elliion J, Sauve F, Selwyn J. Multiresidues method for determination of residues of 251 pesticide in fruits and vegetables by gas liquid chromatography/ mass spectrometry and liquid chromatography with fluorescence detector. Journal of AOAC International 2000; 83: 698-713.

[15] Mukherjee I, Gopal M. Pesticide residues in vegetable. In Proceedings of symposium on risk assessment of pesticide residues in water and food (pp. A1–8). By ILSI Washington DC, ITRC Lucknow and ICMR New Delhi India on October 2003; pp. 28-29.

[16] Sheikh SA, Nizamani SM, Jamali AA, Panhwar AA, Channa MJ, Mirani BN. Effect of Household Processing on the Removal of Pesticide Residues in Okra Vegetable. J Basic and Appl Sci 2012a; 8(1): 74-78.

[17] Sheikh SA, Nizamani SM, Jamali AA, Mirani BN, Panhwar AA, Channa MJ. Removal of Pesticide Residues from Okra Vegetable through Traditional Processing. J Basic Appl Sci 2012b; 8(1): 79-84.

[18] Panhwar AA, Sheikh SA. Assessment of Pesticide Residues in Cauliflower Through Gas Chromatography-MECD and High Performance Liquid Chromatography (HPLC) Analysis. International Journal of Agricultural Science and Research 2013; 3(1): 7-16.

[19] Tahir MU, Naik SI, Rehman S, Shahzad M. Quantitative Analysis For The Toxic Pesticide Residues In Marketed Fruits And Vegetables In Lahore, Pakistan. Biomedica 2009; 25: 171-174.

[20] Kaushik G, Satya S, Naik SN. Food processing a tool to pesticide residue dissipationea review. Food Research International 2009; 42: 26-40. http://dx.doi.org/10.1016/j.foodres.2008.09.009

[21] Kumari B. Effects of household processing on reduction of pesticide residues in vegetables. ARPN Journal of Agricultural and Biological Science 2008; 3(4): 46-51.

[22] Chauhan R, Kumari B. Reduction of endosulfan residues in brinjal fruits during processing. Sci Revs Chem Commun 2011; 1(1): 42-48.

[23] Zohair A. Behavior of some organophosphorus and organochlorine pesticides in potatos during soaking in different solutions. Food and Chemical Toxicolology 2001; 39: 751-755. http://dx.doi.org/10.1016/S0278-6915(01)00016-3

[24] Randhawa MA, Anjum FM, Asi MR, Butt MS, Ahmed A, Randhawa MS. Removal of endosulfan residues from vegetables by household processing. J Sci Ind Res 2007; 66: 849-852.

[25] Abou-Arab AAK. Behavior of pesticides in tomatoes during commercial and home preparation. Food Chemistry 1999; 65: 509-514. http://dx.doi.org/10.1016/S0308-8146(98)00231-3

[26] Stepan R, Ticha J, Hajslova J, Kovalczuk T, Kocourek V. Baby food production chain: pesticide residues in fresh apples and products. Food Additives and Contam 2005; 22 (12): 1231-1242. http://dx.doi.org/10.1080/02652030500239623

[27] Ling Y, Wang H, Yong W, Zhang F, Sun L, Yang M, *et al*. The effects of washing and cooking on chlorpyrifos and its toxic metabolites in vegetables. Food Control 2011; 22: 54-58. http://dx.doi.org/10.1016/j.foodcont.2010.06.009

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