Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 5, No. 4, p. 365-370, 2014
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Effectiveness of traditional processing techniques on residual removal in chilies sprayed with various pesticides

Saghir Ahmed Sheikh[1*], Aasia Akbar Panhwar[1], Benish Nawaz Mirani[1], Shafi Muhammad Nizamani[2]

[1]*Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam, Sindh, Pakistan*

[2]*National Centre of Excellence in Analytical Chemistry, University of Sindh Jamsohoro, Sindh, Pakistan*

Article published on October 21, 2014

Key words: Chilies, Traditional processing techniques, pesticide residues.

Abstract

Pesticide usage in Pakistan is rapidly increasing and cases of misuse or over-use of pesticides are simultaneously on the increase. Pesticide use raises a number of environmental concerns, and human and animal health problems. Chilies were grown on farmer field (area of about half acre) through organic farming without pesticide spray to serve as control. Besides, six plots of chilies (area about half acre each) were sprayed with six pesticides, that is, bifenthrin, profenofos, endosulfan, imidacloprid, emamectin benzoate and diafenthiuron separately at recommended doses. The sprayed chilies were harvested next day, packed in polyethylene bags with appropriate labeling and brought to the laboratory of Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam for the treatment of various traditional processing techniques to evaluate their effects. After the application of the treatments, the samples were processed for extraction and cleanup. The samples were then further analyzed by GCMS or HPLC and data obtained was analyzed statistically and presented. It was concluded that chilies were contaminated with pesticide residues well above their respective MRLs, and were unsafe for human consumption if taken in raw form. Traditional processing activities particularly washing, drying and cooking operations played effective role in large reductions in the residual level of pesticides. Frying/ cooking and sun-drying were found the most effective treatments in the reduction of residues.

***Corresponding Author:** Saghir Ahmed Sheikh ✉ sasheikhsau@gmail.com

Introduction

Food contaminated with toxic pesticides is always associated with severe effects on the human health. Hence it is pertinent to explore strategies that address this situation of food safety especially in the developing countries where pesticide contamination is widespread due to indiscriminate usage and lack of observation of codal requirements. Therefore, it is pertinent to discover and embark upon which address the issues of the food safety to keep the population in a healthy atmosphere. It therefore, becomes necessary to find out the simple and cost effective strategies to insure food safety for a healthy living (Akhtar, 2007).

Chili is one of the valuable crops in Pakistan with 1.5% share in country's economy. Two of its species namely *Capsicum annum* and *Capsicum frutescence* are more grown in the country. The world chili trade has placed Pakistan at the second place after black pepper as it accounts for approximately 16% of the spice trade. It was grown on an area of 24776 hectares with production of 40414 tones in the country and the contribution of Sindh province was 13853 hectares with production of 24113 tones (GOP, 2011-12). It has numerous medicinal and nutritional values which also contribute to country's GDP. It is an excellent source of vitamin A, B, C and E. Green chili acts as a heart stimulant, improves blood flow and strengthens arteries thereby reducing heart associated ailments (Arifeen, 2013).

Chilies are mostly vulnerable to pests including sucking insect pests and mites which directly affect the crop yield. Farmers therefore, apply pesticides indiscriminately to minimize losses and increase yields of their crop. Pesticides remain in plants in the form of residues after application for certain periods of time. It is common practice that farmers spray on chili crop and on the next day, they harvest the produce which usually is heavily loaded with pesticide residues. Therefore, there is a dire need to monitor and to reduce the residues from chilies before consumption to avoid pesticide related health hazards.

Four main groups of pesticides, the organochlorine, organophosphate, carbamate, and pyrethroid insecticides are of particular concern because of their toxicity and persistence in the environment and several of the banned pesticides are still being used on a large scale in developing countries which continue to pose severe environment and health problems (Ahmed *et al.,* 2000; Smith and Gangolli, 2002). Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species (crops), ie. air, water and soil (Miller, 2004).

The study has therefore been designed to process the chilies through cost effective traditional techniques and determine their effectiveness in the removal of pesticides.

Materials and methods

Pesticide Spray on Chilies

Chilies were grown on farmer field (area of about half acre) through organic farming without pesticide spray to serve as control. Six other separate plots of chilies (area about half acre each) were sprayed at fruiting stage with each pesticides ie. bifenthrin, profenofos, endosulfan, emamectin benzoate and diafenthiuron at recommended doses (Buriro *et al*., 2006).

Table 1. Recommended Dose of Pesticides per Acre.

Pesticides	Formulation	Active ingredient
Bifenthrin	250 ml acre^{-1}	25 ml acre^{-1}
Profenofos	800 ml acre^{-1}	400 ml acre^{-1}
Endosulfan	600 ml acre^{-1}	210 ml acre^{-1}
Imidacloprid	80 ml acre^{-1}	16 ml acre^{-1}
Emamectin benzoate	200 ml acre^{-1}	38 ml acre^{-1}
Diafenthiuron	300 ml acre^{-1}	150 ml acre^{-1}

The sprayed chilies were harvested next day, packed in polyethylene bags with appropriate labeling and brought to the laboratory of Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam for traditional processing treatments as mentioned in Fig. 1.

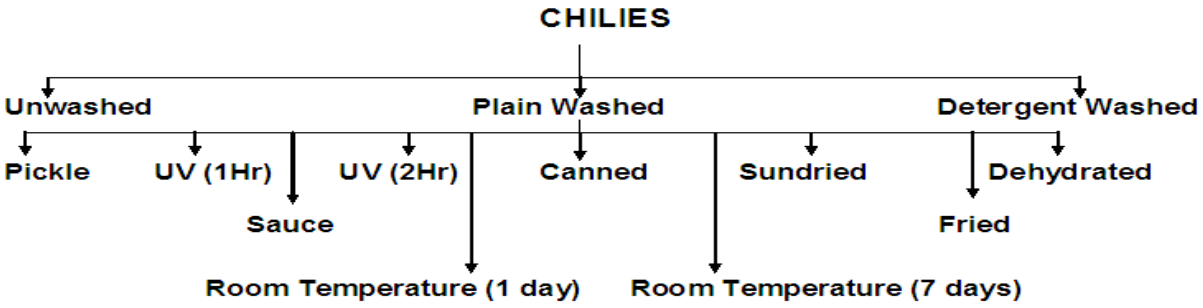

Fig. 1. Traditional processing of chilies.

The samples were plain washed, sundried, dehydrated, fried and cooked. The plain washed samples were also exposed to UV light for 1 and 2 hours and also placed at room temperature for 1 and 7 days.

Extraction, clean-up and analysis of pesticide residues

Extraction, clean-up and further analyses either by GCMS or HPLC of all pesticides were carried out as per methods described by Panhwar and Sheikh (2013).

Results

Effect of traditional processing on the reduction of bifenthrin, profenofos and endosulfan residues in chilies

Bifenthrin, a pyrethroid insecticide was reduced by sun-drying to the extent of 94.42% and 92.44% in the dehydrated chamber. The plain washing reduced the residues by 12.12% and detergent washing reduced them by 24.24%. Frying of sample reduced the pesticides by 99.02% as given in Table-2.

Table 2. Effect of traditional processing techniques on bifenthrin, profenofos and endosulfan residues in chilies.

Process/Technique	Bifenthrin Residues (ppm) (Mean±SD)	Reduction (%)	Profenos Residues (ppm) (Mean±SD)	Reduction (%)	endosulfan Residues (ppm) (Mean±SD)	Reduction (%)
Unwashed	0.99±0.07 a	0.00	5.92±0.02 a	0.00	1.12±0.07	0.00
Plain washed	0.87±0.07 ab	12.12	5.63±0.09 b	4.89	1.03±0.02	8.03
Detergent washed	0.75±0.02abcd	24.24	5.42±0.06 bc	8.44	0.92±0.05	17.85
Plain washed fried	**0.01±0.009 e**	99.02	**0.12±0.03 k**	97.95	**0.08±0.06**	92.78
Plain washed uv-1hr	0.67±0.04 bcd	32.32	**4.23±0.05 g**	28.54	0.73±0.06	34.82
Plain washed uv-2hr	0.51±0.04 d	48.48	**3.04±0.02 i**	48.64	0.51±0.06	54.46
Plain washed sun-dried	**0.21±0.04 e**	94.42	**1.55±0.05 j**	93.11	**0.29±0.04**	93.19
Plain washed dehydrated	0.59±0.1 cd	92.44	**4.51±0.07 f**	90.34	0.93±0.07	89.47
Plain washed 1 day room temp.	0.78±0.07 abc	25.41	5.38±0.04 cd	13.97	0.96±0.1	18.86
Plain washed 7 days room temp.	0.6±0.08cd	48.92	**3.92±0.06 h**	44.19	0.52±0.03	60.87

Bifenthrin MRL= 0.5 ppm, Profenofos MRL= 5.0 ppm, Endosulfan=0.5ppm.

Residues of profenofos were reduced up to 4.89 and 8.44% by plain washing and detergent washing respectively. Subsequent frying of plain washed chilies reduced the residues up to 97.95% and the values were within MRLs. Dehydration and sun drying contributed 90.34 and 93.11% reduction and lowered the residues within MRL level and making chilies fit for human consumption.

The residues of endosulfan were reduced up to 8.03 and 17.85% by plain washing and detergent washing respectively. Sun-drying and drying through dehydrated chamber reduced at the level of 93.19% and 89.47% respectively. Fried sample further reduce the residues of endosulfan up to 92.78%.

Effect of traditional processing on the reduction of imidacloprid, diafenthiuron and emamectin benzoate residues in chilies

Table-3 also reflects that plain washing followed by frying reduced the residues up to 69.13% whereas plain washed followed by dehydration and sun drying reduced the residues most effectively by 92.69 and 94.71% respectively. Ultraviolet radiations also showed the degradation of pesticide residues up to 52.77% when samples placed under UV-light for one hour, it was however, further reduced the residues up to 63.88% when left for two hours.

Diafenthiuron is water soluble pesticide which after traditional processing showed maximum reduction in sun drying and dehydration by 93.04 and 95.15% respectively. However, plain washed fried showed the reduction by 70.29. Left over samples under UV-light for four hours and at room temperature for 7 days also reflected the degradation up to the level of 67.64 and 60.33% respectively.

Table 3. Effect of traditional processing techniques on imidacloprid, diafenthiuron and emamectin benzoate residues in chilies.

Process/Technique	Imidacloprid Residues (ppm) (Mean±SD)	Reduction (%)	Diafenthiuron Residues (ppm) (Mean±SD)	Reduction (%)	Emamectin benzoate Residues (ppm) (Mean±SD)	Reduction (%)
Unwashed	0.036±0.004 a	0.00	0.034±0.002 a	0.00	0.26±0.03 a	0.00
Plain washed	0.033±0.003 ab	8.33	0.031±0.001 ab	8.82	0.23±0.03 ab	11.53
Detergent washed	0.029±0.002abc	19.44	0.027±0.008 ab	20.58	**0.2±0.03 abc**	23.07
Plain washed fried	**0.011±0.004 d**	69.13	**0.01±0.006 b**	70.29	**0.02±0.01 e**	92.23
Plain washed uv-1hr	**0.017±0.004 cd**	52.77	**0.015±0.004ab**	55.88	**0.08±0.02 cde**	69.23
Plain washed uv-2hr	**0.013±0.003 d**	63.88	**0.011±0.002ab**	67.64	**0.04±0.03 de**	84.61
Plain washed sundried	**0.01±0.003 d**	92.69	**0.009±0.002 b**	93.04	**0.009±0.001 e**	99.08
Plain washed dehydrated	**0.015±0.004 cd**	94.71	**0.013±0.013ab**	95.15	**0.1±0.02 bcde**	95.12
Plain washed 1 day room temp.	0.023±0.002abcd	39.52	0.022±0.004 ab	38.74	**0.14±0.02abcde**	49.02
Plain washed 7 days room temp.	**0.018±0.003bcd**	57.86	**0.016±0.002ab**	60.33	**0.09±0.02 cde**	70.82

MRLs= Imidacloprid=0.02 ppm, Difenthiuron=0.02, Emamectin benzoate= 0.2.

Results indicated that plain washing only reduced the emamectin benzoate residues by 11.53% whereas with detergent solution the residues further reduced up to 23.07%. Cooking/frying decreased the residues up to the level of 92.23%. However the sun dried and dehydrated samples showed the reduction of pesticide up to 99.08 and 95.12% respectively.

Discussion

In Pakistan, there is no regulatory and monitoring system to check the farm produce entering in to the markets under GAP. Monitoring of pesticide residues may be implemented in developing countries like Pakistan to surmount the implications of WTO (Anwar, 2006) and export as it significantly influences the sale of the produce in the international markets and limits the value added contribution to National exchequer.

The importing countries may reject commodities having pesticide residues above their legally permitted MRLs set by FAO/WHO. Indiscriminate use of the pesticides may be controlled and safety intervals for crop harvest must strictly be followed to ensure that the consumers are not exposed to health hazards by eating food containing pesticide residues. To minimize the risk of pesticides for a healthy living, different processing operations were applied on vegetable crop ie. chilies to reduce the pesticide residues below the MRLs.

The study under discussion was carried out to determine the level of pesticide residues in the chili crops subjected to various traditional processing techniques, such as washing, detergent washing, sundrying, thermal dehydration, UV light and cooking/boiling etc.

Unit operations in processing typically included washing the raw product with large volumes of water, frequently using high-pressure sprays and often incorporating surfactants or other washing aids, blanching with hot water and cooking of the foods ie. cooking of the product at temperatures at or above the boiling temperature of water. The residues that might have been present were also subjected to thermal degradation through frying and cooking (Anwar, 2011).

Washing happens to be the most common form of processing which is a preliminary step in both household and commercial preparation. Loosely held residues of several pesticides are removed with reasonable efficiency by variety of washing processes. The findings of present study suggest that unwashed unprocessed sample contained maximum residues of used pesticides and well above their respective MRLs. The traditional processing treatments reduced the pesticide residues progressively and reasonably well. Plain tap water washing reduced considerable amount of pesticide residues up to about 12% depending upon the type of pesticide. Although by washing, residues were reduced to some extent but not completely as pesticide residues after spraying rapidly penetrate in to wax and cuticles. Thus, washing the vegetable (chilies) would be insufficient in removing the pesticides. Elbashir *et al.* (2013) also confirmed the present results that washing of tomato fruits samples once reduced the residues of fenpropathrin, ë-cyhalothrin, and deltamethrin at the rate of 37.363±0.44, 16.744±0.25, 26.881±0.31%, respectively, where as washing by three times reduced those residues at the rate of 58.260±0.34, 39.659±0.41, 56.202±0.31%, respectively. Mohamed *et al.* (2012) also found that washing processes eliminated approximately 13-60% of organophosphorus, 20-50% of carbamates, 19-25% of cypermethrin, 60% of dicofol, 100% of penconazole and 18-75% of abamectin residues in vegetable crops.

Washing with detergent solution was also found effective in decreasing the pesticide residues adsorbed on the surface up to 24%. Due to presence of various chemicals, this process effectively removed the residues particularly fat soluble pesticides residues. These findings are in agreement with Kumari *et al.* (2005) who also reported that washing with various chemical solutions for domestic and commercial use are necessary to decrease the intake of pesticide residues. The acidic detergent solutions were more effective in the elimination of organochlorines than alkaline and neutral solutions. It has also been observed that common and simple processing techniques acquired significance in reducing the harmful pesticide residues present in the food. Mirani *et al.* (2012, 2013) also reported that in detergent washed samples, the reduction was up to 48% whereas detergent washing in combination of sun-drying, dehydration, freezing, and frying further decreased the residues below their respective MRLs. These results are also in confirmity with Satpathy *et al.* (2012). The observation of Ahmed *et al.* (2011) also revealed similar observations that vegetables treated with acidic and alkaline solutions can effectively minimize the pesticide residues.

Sun drying, dehydration and frying further reduced these residues and brought them below their respective MRLs. Frying was observed to be most effective in reducing the residues in this study. The disappearance of pesticide residues by frying could be due to decomposition due to the effect of heat.

Conclusion

In supervised trials, chilies were found contaminated with pesticide residues well above their respective MRLs and were unsafe for human consumption if taken in their raw form. Food processing activities particularly washing, drying and cooking operations lead to large reductions in residue levels. Frying/ cooking and sun-drying were most effective techniques in reduction of residues. Traditional processing methods also played effective role in removing/minimizing the residual levels of various pesticides.

Refrences

Ahmed RS, Vandana Seth Pasha ST, Banerjee BD. 2000. Influence of dietary ginger (Zingiber officinalis Rosc) on oxidative stress induced by malathion in rats. Food and Chemical Toxicology **38**, 443-450.

Akhtar AM, Ahmad T, Ali and MI, Zafar. 2007. Vegetable Growers' Awareness About Health Safety Measures and Pesticide Use in Punjab, Pakistan, Pakakistan Journal of Agriculture Sciences **44(3)**, 489.494.

Anwar T, Ahmad I, Tahir S. 2011. Determination of pesticide residues in fruits of Nawabshah district, sindh, pakistan. Pakistan Journal of Botany **43(2),** 1133-1139.

Anwar T, Ahmad I, Tahir S. 2006. Occupational exposure of farmers to pesticides in cotton growing areas of Sindh, Pakistan. International. Journal of. Biology and Biotechnology **3,** 451-454.

Arifeen M. 2013. Chilli: The most valuable cash crop. www.thefinancialdaily.com. A subsidiary of Data Research and Communication.

Buriro AS, Khaskheli AM, Jarwar AD. 2006. Handbook of safe and efficient use of pesticides. Directorate General of Agriculture Research Sindh Tando jam. Dept of Agri, Govt Sindh.

Elbashir A, Abuzar A, Albadri EAE, Ahmed HE. 2013. Residues Levels of pyrethroids pesticide in an open field tomatoes from Sudan by Gas Chromatography with Electron Capture Detector (GC-ECD). Pak Journal of Food Science and Technology **1(1),** 6-12.

Government of Pakistan Agricultural Statistics of Pakistan. 2011-2012. Ministry of Food Agriculture and Livestock (Economic Wing), Islamabad.

Kumari B, Singh J, Singh S, Kathpal TS. 2005. Monitoring of butter and ghee (clarified butter fat) for pesticidal contamination from cotton belt of Haryana, India. Journal of Environment Monitoring Assessment **105**, 111-120.

Miller GT. 2004. Sustaining the Earth, 6th ed. Thompson Learning, Inc. Pacific Grove, California.

Mirani BN, Sheikh SA, Nizamani SM, Mahmood N. 2013. Effect of House Hold Processing in Removal of Lufenuron in Tomato. International Journal of. Agriculture Science and Research **3(1)**, 235-244.

Mirani BN, Sheikh SA, Nizamani SM, Channa MJ, Panhwar AA. 2012. Effectiveness of Traditional Food Processing on bifenthrin and profenofos residues in bitter gourd peel. Biology and Life Science **3(2)**, 5-12.

Mohamed GG, Saleh M, Ibrahim M. 2012. Monitoring of Pesticide Residues in Different Agriculture Fields Effect of Different Home Processes on the Pesticides Elimination. International. Journal of. Research. Chemistry and Environment **2,** 237-253.

Panhwar AA, Sheikh SA. 2013. Assessment of Pesticide Residues in Cauliflower through Gas Chromatography-μECD and High Performance Liquid Chromatography (hplc) Analysis. International Journal of Agriculture Science and Research **3**, 7-16.

Satpathy G, Tyagi YY, Gupta RK. 2012. Removal of organophosphorus (OP) pesticide residues from vegetables using various washing solutions and boiling. Journal of Agriculture Sciences **4**, 69-78.

Smith AG, Gangolli SD. 2002. Organochlorine chemicals in seafood: occurrence and health concerns. Food and Chemical Toxicology **40**, 767-779.