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Domestic processing: A mean to mitigate pesticide residues in tomato

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Abstract
A study was conducted to evaluate the effect of domestic processing techniques on pesticide residues in tomato. Domestic processing techniques *viz,* washing under tap water for 1, 2 and 3 minutes, dipping in hot water for 2, 4 and 6 minutes and dipping in salt water for 1 minute at the concentration of 1, 2 and 3 percent were selected. Tomatoes were exposed to two pesticides i.e. indoxacarb and lambda-cyhalothrin as per their recommended field dosages. Tomato fruit samples were collected after spray and the estimation of pesticide residues was carried out by High Performance Liquid Chromatography (HPLC). The results of the study revealed that dipping of tomatoes in salt water (3.0%) for one minute was found to be the most effective giving a reduction of 80.06 percent of indoxacarb and 80.40 percent of lambda-cyhalothrin residues followed by hot water dipping for six minutes with respective reduction of 73.52 percent and 64.14 percent and washing under tap water for three minutes (58.49% and 41.40%). On the other hand, least reduction of indoxacarb and lambda-cyhalothrin (32.67% and 26.24%) was observed in tomatoes when washed under tap water for one minute. Processing factors for indoxacarb and lambda-cyhalothrin were also found to be < 1, which concluded a substantial reduction of pesticide residue in samples.

Keywords: Tomato, pesticide, residues, domestic processing

1. Introduction
Vegetables are the indispensable component of Indian cuisine but highly sensitive to the attack of insect and pests. About 30-40 percent of the vegetables grown are damaged by pest attack only. India is the second largest producer of vegetables after China (Kumar & Kumar 2012) [14]. Production of vegetables in India has increased to 204.84 million tonnes as against 200.45 million tonnes in 2020-21 (Indiastat 2022) [22]. Among the vegetables, tomato which is not only functional food but is one of the main commercial off season crop of the region. Tomato (*Solanum lycopersicum*) which belongs to family *Solanaceae* is an important vegetable crop grown extensively in Himachal Pradesh. It provides vitamin C (an antioxidant), rich in lycopene, and enhances flavour. Tomatoes are one of the most frequently farmed and well-liked vegetables in the world, ranking second in terms of importance. About 187.35 lakh tonnes of tomatoes were produced in India in 2015–16, with a productivity of 24.20 MT/ha (Patra *et al*. 2020) [16]. Tobacco caterpillar, whiteflies, serpentine leaf miner, tomato fruit borer, and other insect pests cause annual yield losses ranging from 22 to 38 percent (Dhandapani *et al*. 2003) [7] and it suffers heavily at fruiting stage due to attack of fruit borer and fruit fly causing 90 percent damage to the crop making it totally unfit for human consumption.

Pesticides are widely used to increase the production of fruits and vegetables despite knowing the fact that they can adversely affect the health of the consumers. Their residues are a major concern to consumers due to their adverse deleterious effects, but these are still widely used in food production to achieve food security. Currently, India is the largest producer of pesticides in Asia and ranks 12th in the world for the use of pesticides (Dhananjayan & Muralitharan 2010) [6]. The different household processing techniques such as washing, cooking, washing plus cooking, salt water washing play important role in the reduction of pesticide residues (Aktar *et al*. 2010) [2].

While washing with normal tap water has not given any promising results in the removal of contaminants below MRL values, washing with 2 percent salt water has produced excellent results. Boiling was found more effective than washing, which further support the fact that at least the vegetables may not be consumed in raw form (Kumari 2008) [15]. Commercial and domestic food processing methods like washing, peeling, cooking, blanching, and concentrating can lower food residue levels, and further lessens the negative effects on human health (Arab 1999; Soliman 2001; Zohair 2001; Byrne & Pinkkerton 2004; Pugliese *et al*. 2004; Zhang *et al*. 2007) [3, 23, 26, 4, 17, 25]. Keeping in view the scope of processing techniques in removal of pesticide residues, the study was undertaken.

2. Materials and Methods

Tomato (var. Palam tomato hybrid 1) crop raised under polyhouse conditions in the Department of Vegetable Science and Floriculture was sprayed with recommended concentration of indoxacarb (@ 75 g a.i. /ha) and lambda-cyhalothrin (@ 15 g a.i./ha) using knapsack sprayer. The tomato fruits were collected 2 hours after the application of pesticides to obtain approximately 3 kg samples each of indoxacarb and lambda-cyhalothrin treated tomato and packed in polythene bags and brought to laboratory for storage under refrigerated conditions. Each sample was divided into two lots representative of analytical subsamples. One lot was not subjected to any processing (unprocessed sample) and was used to determine the initial deposit of pesticides. While another lot was processed as per various selected techniques and analyzed for the analysis of indoxacarb and lambda-cyhalothrin residues. The selected household processing i) washing under running tap water, ii) hot water (50-55 °C) dipping, and iii) dipping in salt water with different concentrations for one minute were used.

2.1 Extraction, cleanup and determination of residues

Indoxacarb residues on tomato were extracted as per the protocol given by Sharma and Mohapatra (2005) [20]. Using a mixer blender on high speed for 2 minutes, 50 mL of acetonitrile was added to 50 g of tomato fruit sample, which were then filtered *via* a Buchner funnel using Whatman No. 1 filter paper. The filtrates were concentrated to around 5 mL under reduced pressure using a rotary vacuum evaporator. After that the sample was loaded to the glass column packed with activated silica gel (activated at 110 °C for 1 hour). The eluate was evaporated to dryness, and residues were then re-dissolved in 10 mL acetonitrile for analysis.

With a few minor modifications, the procedure described by Ahmed *et al*. (2015) [1] was used to analyse the lambda-cyhalothrin residues in tomatoes. A 50 g sample of tomatoes was macerated for 2 minutes at high speed in a blender with 100 mL acetone. Using acetone (2 x 50 mL), the combined samples were transferred to a 250 mL conical flask and mechanically shaken for 30 minutes. The material was then filtered using Whatman No. 1 filter paper through a Buchner funnel. In a separatory funne l,100 mL of saturated NaCl solution and 75 mL dichloromethane (DCM) were added to the extract. After passing through activated anhydrous sodium sulphate, the DCM layer was recovered. Dichloromethane was used twice throughout the procedure, and the DCM layers were collected and evaporated to dryness using a rotary vacuum evaporator. The extract was dissolved in 5 mL of a 9:1 hexane-acetone combination before being run through a pre-washed column packed with 10 g of activated alumina over a 2 cm layer of anhydrous sodium sulphate. After loading, 50 mL of a 9:1 hexane-acetone combination was used to elute the column. A rotary vacuum evaporator was used to dry the eluate to near dryness. The final volume was reconstituted with 5 mL acetonitrile for analysis. Recovery studies were performed to examine the efficacy of extraction and clean up methods. Control samples of tomato were spiked with known concentration of the pure pesticide standard solutions and extraction & clean-up was performed as described earlier. The recovery studies were carried out by fortifying the tomato samples at 3 different levels i.e. 0.2, 0.4 and 0.8 ppm. The HPLC (Shimadzu) analysis parameters for indoxacarb and lambda-cyhalothrin are shown in Table 1.

3. Results and Discussion

Indoxacarb and lambda-cyhalothrin are widely used pesticides due to their low persistence in the environment, low mammalian toxicity and high insecticidal activity. It has moderate toxicity but its crude formulation contains impurities which are far more toxic to mammals (Kaushik and Nail 2009) [13].

All the recoveries were found within the acceptable range of 81.62-90.50 percent (Table 2). Since the recoveries were found within the acceptable range no correction factor was applied during final calculations. Tomato samples when fortified with indoxacarb @ of 0.2, 0.4 and 0.8 ppm resulted in recovery of 0.177, 0.328 and 0.653 ppm, thus the recovery was 88.50, 82.00 and 81.62 percent.

Amount recovered in samples when fortified with lambda-cyhalothrin at the rate of 0.2, 0.4 and 0.8 ppm was 0.181, 0.336 and 0.662 ppm and percent recovery as 90.50, 84.00 and 82.75 with mean recovery of 85.75 percent.Similar results were observed by Saimandir and Gopal (2009) [18] who reported 84.04 percent recovery of indoxacarb in brinjal fruits. On the contrary, Sharma & Mohapatra (2005) [20] reported 90-95 percent recovery from fortified samples of tomato fruits, which may be due to different extraction procedures.

3.1 Effect of processing on indoxacarb residues in tomato

Indoxacarb is the first commercialized insecticide of theoxadiazine group (Dupont) (US EPA 2000) [24]. The chemical has low vapour pressure with relatively non-volatile nature, low water solubility, Henry's law constant, octanol-water coefficient and volatilization is not a major factor in disappearance (Dias 2006) [8].

From the data presented in Table 3, it is evident that initial residues of indoxacarb in unprocessed sample were 0.306 ppm. When the samples were treated with different treatments, a substantial reduction in residues was observed. When samples were washed under tap water for 1, 2 and 3 minutes respectively, the residues reduced to 0.206, 0.164 and 0.127 ppm. On the other hand, when samples were treated with hot water dipping for 2, 4 and 6 minutes respectively, the values were calculated as 0.135, 0.101 and 0.081 ppm. Further, the residues reduced to 0.100, 0.082 and 0.061 ppm when dipping in salt water with different concentration (1, 2 and 3%) was processed. From the data it was clear that processing techniques reduced the indoxacarb residues by 32.67-80.06 percent which is statistically significant. Washing was effective in dislodging the residues but it depends on a number of factors like location of residues, age of residues, water solubility and temperature and type of washing. Current results are in consistent with those of Kumari (2008) [15] where 10-30 percent reduction of alphamethrin residues was found in tomato and 24-25 percent in brinjal and cauliflower. Shiboob (2012) [22] also reported the reduction of pesticide residues on tomato by washing under tap water to extent of 84.25 percent.

There was significant residual reduction to the extent of 55.88-73.52 percent when tomato fruits were dipped in hot water. These results are in agreement with those of Sakthiselvi *et al*. (2020) [19] who reported that the effectiveness of tap water washing was the lowest (15-28%), while hot water (44-52%), tamarind water (34-45%), and lemon juice (27-40%) were the other decontamination procedures that significantly decreased the insecticide residues in the tomato fruits (50-56%). When the samples were treated with salt at the concentration of 1.0, 2.0 and 3.0 percent for 1 minute, the reduction was found maximum which ranged from 67.32-80.06 percent. A notable effect was observed with salt treated samples when compared with other processing techniques. The present findings are in agreement to those reported earlier that soaking of contaminated potatoes in neutral (NaCl) solution (5 and 10%) for 10 min resulted in 100 percent removal of pirimiphos methyl residues (Zohair *et al*. 2001 and Chandra *et al*. 2015) [26, 5].

3.2 Effect of processing on removal of lambda-cyhalothrin residues in tomato

The initial residues of lambda- cyhalothrin were 0.541 ppm in unprocessed sample. Washing in tap water with different time period reduced the residue content in the range of 0.317-0.399 ppm with overall reduction of 26.24-41.40 percent. Similarly, when the samples were dipped in hot water for 2, 4 and 6 minutes the reduction in residue was found in decreasing order i.e. 0.273, 0.255 and 0.194 ppm (Table 4). The total reduction was calculated as 49.53-64.14 percent.

The residues of lambda-cyhalothrin obtained from the samples treated with different concentration of salt i.e. 1, 2 and 3 percent as 0.163, 0.119 and 0.106 ppm in comparison to unprocessed samples. Salt was found quite effective in reducing the pesticides. There was a maximum reduction ranging from 69.87-80.40 percent in comparison to all treatments and sub-treatments. On comparison, the results of the present study showed greater reduction than a previous study in which bifenthrin residues were reduced by 77 percent in plain washed fried okra (Sheikh *et al*. 2012) [21]. In a study, washing removed 21.00 percent of malathion in cucumbers (Gehad *et al*. 2012) [9] and the reduction in present study was slightly higher. Similar results were obtained by Arab (1999) [3] who reported 22.70 percent reduction of profenofos. Rinsing of various vegetables was found very effective. Harinathareddy *et al*. (2014) [10] reported 49.6 percent reduction of lambda-cyhalothrin in tomato.

3.3 Processing factor for tomato

Processing factors for tomatoes which are necessary to refine the risk assessment of detected pesticides. It was calculated to see the effect of removal of indoxacarb and lambda-cyhalothrin in tomatoes. In case of indoxacarb, when tomatoes sample were treated with washing under tap water for 1,2 and 3 minutes respectively, the processing factors were observed as 0.67,0.54 and 0.41. Similarly, when the tomato sample was given hot water treatment for varied time, the processing factors were established as 0.44, 0.33 and 0.26 respectively. Processing factors in salt treated samples attained the values at lower ebb i.e. 0.33, 0.27 and 0.19, respectively for salt water treatment with different concentrations.

On the other hand, processing factors for lambda-cyhalothrin were also calculated (Table 5). A close scrutiny of the data revealed that the processing factors for treatments; washing under tap water for 1, 2 and 3 minutes; dipping in hot water dipping for 2, 4 and 6 minutes; dipping in salt water with varying concentration for one minute for 1,2 and 3 percent were calculated as 0.74, 0.62 and 0.56; 0.50, 0.47 and 0.36 and 0.30, 0.21 and 0.19, respectively. Thus, it is clear that the processing factors values in all the treatments were obtained < 1, it means there is a substantial reduction of pesticide residues in samples. All the treatments are sufficiently effective in the reduction of pesticide residues. It is inferred that the dipping in salt solution yielded very good effect in the removal of residues below MRL levels followed by hot water treatment and washing in tap water. On the contrary, Huan *et al*. (2015) [11] reported that the processing factor value of 1.0 after washing with tap water for 3 minutes which is higher than present findings.

Table 1: The HPLC (Shimadzu) analysis parameters for indoxacarb and lambda-cyhalothrin

Parameters	Pesticide	
	Indoxacarb	Lambda-cyhalothrin
Column	RP-18e 5µm, 250 mm x 4.6 mm	RP-18e 5µm, 250 mm x 4.6 mm
Mobile phase	Acetonitrile + water (80:20 v/v)	Acetone + water (80:20 v/v)
Flow rate, isocratic (mL/min)	1.0	1.25
Detector	UV-VIS	UV-VIS
Wavelength (nm)	310	230
Volume injected (µL)	20	20
End Time (min)	10.0	20.0
Retention time (min)	3.5	15.8

Table 2/; Recovery of pesticides in fortified samples of tomato

S.N.	Pesticides	Fortification level (ppm)	Amount recovered (ppm)	Recovery percent	Average percent recovery
1	Indoxacarb	0.2 ppm	0.177	88.50	84.04±3.87
		0.4 ppm	0.328	82.00	
		0.8 ppm	0.653	81.62	
2	Lambda-cyhalothrin	0.2 ppm	0.181	90.50	85.75±4.16
		0.4 ppm	0.336	84.00	
		0.8 ppm	0.662	82.75	

Average of 3 replications; Figures following ±signs are the standard deviations

Table 3: Effect of processing on removal of indoxacarb residues in tomato

Treatment		Residues (ppm)*	% reduction in residues
Unprocessed		0.306±0.030	-
Washing under tap water (minutes)	1	0.206±0.019	32.67
	2	0.164±0.015	46.40
	3	0.127±0.010	58.49
Dipping in hot water(minutes)	2	0.135±0.007	55.88
	4	0.101±0.007	66.99
	6	0.081±0.003	73.52
Dipping in salt water (concentration %)	1	0.100±0.010	67.32
	2	0.082±0.002	73.20
	3	0.061±0.002	80.06

*Average of 3 replications; Figures following ±signs are the standard deviations of the means CD ($p \leq 0.05$):0.024

Table 4: Effect of processing on removal of lambda-cyhalothrin residues in tomato

Treatment		Residues (ppm)*	Percent reduction in residues
Untreated		0.541±0.049	-
Washing under tap water (minutes)	1	0.399±0.023	26.24
	2	0.338±0.011	37.52
	3	0.317±0.006	41.40
Dipping in hot water(minutes)	2	0.273±0.010	49.53
	4	0.255±0.012	52.86
	6	0.194±0.011	64.14
Dipping in salt water (concentration %)	1	0.163±0.006	69.87
	2	0.119±0.008	78.00
	3	0.106±0.013	80.40

*Average of 3 replications; Figures following ±signs are the standard deviations of the means CD ($p \leq 0.05$): 0.034

Table 5: Processing factor for tomato

Treatment		Indoxacarb	Lambda-cyhalothrin
Unprocessed		-	-
Washing under tap water (minutes)	1	0.67	0.74
	2	0.54	0.62
	3	0.41	0.56
Dipping in hot water (minutes)	2	0.44	0.50
	4	0.33	0.47
	6	0.26	0.36
Dipping in salt water (concentration %)	1	0.33	0.30
	2	0.21	0.21
	3	0.19	0.19

4. Conclusions
Though all the processing methods helped in reduction of pesticides residues in tomato but dipping in 3.0 percent salt solution for one minute was found to be most effective for removal of indoxacarb and lambda-cyhalothrin residues. Reduction percentage through household processing may help in reducing the pesticide residue below MRL values and render it safe for human consumption.

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6. References
1. Ahmed M, Baha EHY, Elaziz S, Azhari OA, Mark DL. Detection of insecticide residues on tomato fruits grown in greenhouses in Khartoum state. University of Khartoum Journal of Agricultural Science. 2015;23:49-65.
2. Aktar MW, Sengupta D, Purkait S, Choudhary A. Risk assessment and decontamination of quinalphos under different culinary processes in/on cabbage. Environment Monitoring Assessment. 2010;163:369-377.
3. Arab A. Behavior of pesticides in tomato during commercial and home preparation. Food Chemistry. 1999;65:509-514.
4. Byrne LS, Pinkkerton SL. The effect of cooking on chlorpyriphos and 3, 5, 6-tricholor-2-pyridinal level in chlorpyrifos fortified produce for use in reefing dietary exposure. Journal of Agricultural and Food Chemistry. 2004;52:7567-7573.
5. Chandra S, Kumar M, Mahindra AN, Shinde LP. Effects of household processing on reduction of pesticides residues in brinjal and okra. International Journal of Advances in Pharmacy, Biology and Chemistry. 2015;4(1):98-102.
6. Dhananjayan V, Muralitharan S. Organochlorine pesticide residues in inland wetland fishes of Karnataka, India and their implications on human dietary intake. Bulletin of Environmental Contamination and Toxicology. 2010;85:619-623.
7. Dhandapani N, Umeshchandra R, Murugan M. Bio-intensive pest management (BIPM) in major vegetable

crops: An Indian perspective. Journal of Food, Agriculture and Environment. 2003;1:333-339.
8. Dias JL. Environmental fate of indoxacarb. Environmental Monitoring Branch, Departmentof Pesticide Regulation CA USA; c2006.
9. Gehad G, Saleh MM, Hala M. Monitoring of pesticide residues in different agriculture fields effect of different home processes on the pesticides elimination. International Journal of Research in Chemistry & Environment. 2012;2:237-253.
10. Harinathareddy A, Prasad NBL, Devi KL. Effect of household processing methods on the removal of pesticide residues in tomato vegetable. Journal of Environment Research and development. 2014;9(1):50.
11. Huan Z, Xu Z, Jiang W, Chen Z, Luo J. Effect of Chinese traditional cooking on eight pesticides residue during cowpea processing. Food Chemistry. 2015;170:118-122.
12. Indiastat. http:/www.indiastats.com.22 December 2022.
13. Kaushik G, Nail SN. Food processing tool to pesticides dissipation. Food Research International. 2009;42:26-40.
14. Kumar S, Kumar S. Performance of vegetable production in India with special reference to Punjab. Indian Journal of Economics and Development. 2012;8:41-52.
15. Kumari B. Effect of household processing on reduction of pesticide residue in vegetable Journal of Agricultural and Biological Science. 2008;3:46-45.
16. Patra S, Ganguly P, Barik SR, Goon A, Mandal J, Samanta A, *et al*. Persistence behaviour and safety risk evaluation of pyridalyl in tomato and cabbage. Food Chemistry. 2020;309:125711.
17. Pugliese P, Molto JC, Damiani P, Marin R, Cossignani L, Manes J, *et al*. Gas chromatography evaluation of pesticide residue contents in nectarines after non-toxic washing treatments. Journal of Chromatography A. 2004;1050:185-191.
18. Saimandir J, Gopal M. Application of indoxacarb for managing shoot and fruit borer of eggplant (*Solanum melongena* L.) and its decontamination. Journal of Environment Science Health B 2009;44(3):292-301.
19. Sakthiselvi T, Paramasivam M, Vasanthi D, Bhuvaneswari K. Persistence, dietary and ecological risk assessment of indoxacarb residue in/on tomato and soil using GC-MS. Food Chemistry. 2020;328:127134.
20. Sharma D, Mohapatra S. Dissipation pattern of indoxacarb and thiamethoxam residues in vegetables. Journal of Vegetable Science. 2005;32:166-168.
21. Sheikh AS, Nizamani SM, Jamali AA, Panhwar AA, Channa MJ, Mirani BN, *et al*. Removal of pesticide residues from okra through traditional processing. Journal of Basic & Applied Sciences. 2012;8:79-84.
22. Shiboob MH. Residues of dimethoate and profenofos in tomato and cucumber, and dissipation during the removal within home processing method. Meteorology, Environment & Arid Land Agriculture Science. 2012;23(1):51-63.
23. Soliman KM. Changes in concentration of pesticide residue in potato during washing and home preparation. Journal of Agricultural and Biological Science. 2001;3:46-51.
24. US EPA. Pesticides Fact Sheet, Indoxacarb; c2000. https://www3.epa.gov/pesticides/chem_search/reg_actions/registration/fs_PC-067710_ 30-Oct-10.pdf. Accessed 16 March, 2020.
25. Zhang ZY, Liu XJ and Homg XY. Effect of home preparation on pesticide residue in cabbage. Food Control 2007;18:1484-1487.
26. Zohair A. Behavior of some organophosphorus and organochlorine pesticides in potatoes during soaking in different solutions. Food Chemistry and Toxicology. 2001;39:751-755.