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Effect of Household Processing on Reduction of Acephate, Profenofos and Triazophos residues in Brinjal

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ABSTRACT

Experiments were conducted to investigate the effects of household processing on removal of acephate, profenofos and triazophos residues in brinjal. Brinjal crop was raised in the field and sprayed with insecticide at recommended rate (RR). Brinjal fruit samples were collected at 1, 3 and 5 day interval after spraying and subjected to household processings like washing with tap water, salt water washing (2% NaCl), lukewarm water washing, open pan cooking and microwave cooking after processing brinjal fruits were analysed by QuEChERS method and insecticide residues were estimated by GC-FPD. Washing processes of brinjal fruits provided 21.95-54.54 per cent relief from acephate, 22.10-61.40 per cent relief from profenofos and 20.00-61.81 relief from triazophos residues. Open pan cooking provided 52.43-56.97 per cent, 52.63-68.42 per cent and 50.21-67.27 per cent relief from acephate, profenofos and triazophos residues, respectively. Microwave cooking provide higher relief from residues in compariso to the other processes like washing and open pan cooking.

Key words: *Brinjal, Processing, Acephate, Profenofos, Triazophos, Washing, Cooking Residue*

INTRODUCTION

Vegetables are the inseparable components of Indian cuisine and are consumed throughout the country in different forms and preparations. They form the bulk and are the major source of vitamins and nutrients, hence fulfilling the requirements of our balanced diet[5]. India produced about 13.443 million MT of brinjal, on 7.22 lakh hectare of land in different parts of the country. It contributes 8.3 per cent of the total vegetable production of the country. Brinjal (*Solanum melongena* L.) is a popular solanaceous and economically important vegetable and is native to India. Brinjal is rich in calcium, phosphorus, potassium, fibre, folic acid, sodium and vitamins B and C. It has low calorific value and high water content. Brinjal is attacked by a number of insect pests from seedling to fruiting stage affecting its growth and productivity. Patial and Mehta[15] reported 27 insect-pest species attacking this crop.

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Major insect-pests of brinjal are fruit and shoot borer *Leucinodes orbonalis*, beetle *Henosepilachna vigintioctopunctata*, jassids *Amrasca devastans*, brinjal stem borer *Euzophera perticella* and aphids *Aphis gossypii*[19]. Fruit and shoot borer (*Leucinodes orbonalis*) is the most devastating pest causing a significant yield loss of 60-70 per cent in India[12]. For managing insect pests of brinjal farmers rely mainly on the application of insecticides. Different insecticides are approved and recommended against insect-pests of various crops. However, the recommended use of these insecticides vis-à-vis their effectiveness on wide range of pests, provoke the farmers to use them against pests of other crops also, on which they are not recommended, thus leaving harmful residues on treated crop at harvest. Insecticides have to undergo very stringent regulatory checks, before being approved for use on crops. The consecutive excessive and indiscriminate use of insecticides on crops thus, causing exposure of farm labour and consumers to insecticide residues. As a result, considerable amount of these insecticides that are absorbed by vegetables, reach the human body and results in many health hazards. Contamination of vegetables with pesticide residues has been reported by several researchers[6,18]. Scientists and food processors have long been interested in the effect of commercial processing on persistence of pesticide residues in food. Several researchers examined the effects of common household processing on various types of produce[5,9] and suggested that residues decreased due to different treatments. Therefore, the present investigations were carried out to study the effect of different household processes of brinjal on acephate, profenofos and triazophos residues.

MATERIALS AND METHODS

Chemicals and reagents

Formulated acephate (Acevip 75 SP, Godrej Agrovet Limited), profenofos (Profex 50 EC, Nagarjuna Agrichem Limited) and triazophos (Triazophos 40 EC, Gharda Chemicals Limited) were purchased from local market. Analytical grade reagents viz. acetone, acetonitrile, n-hexane, magnesium sulfate, sodium chloride, sodium sulphate were obtained from Merck Specialties Private Limited, Mumbai, India. Graphitized Carbon Black (GCB) was obtained from Crescent Scientific Pvt. Ltd. Mumbai. Primary secondary amine (PSA) was procured from M/S Agilent Technologies Pvt Ltd, Worli, Mumbai. Certified reference material of acephate, profenofos and triazophos were procured from Dr Ehrestorfer GmbH-Bgm Schlosser Str. 6 A -86199 Augsburg - Germany.

Field trials

The experiment was laid out in a randomized block design at the experimental farm of the Department of Entomology, Dr. Yashwant Singh Parmar university of Horticulture and Forestry Nauni, Solan (H.P.) during 2013. Brinjal (*Solanum melongena* L.) variety Pusa Purple Long was planted at planting distance of 60×45 cm, as per standard package of practices in 3×2 sq. m plot. The brinjal crop was sprayed twice at 10 days interval during fruit formation stage. Acephate was sprayed at the rate of 560 g a.i. ha^{-1}. Profenofos and triazophos were applied at the rate of 500 g a.i. ha^{-1}. Control plots was sprayed with only water. Inesticide were sprayed on the brinjal crop with the help of a knapsack sprayer. Each treatment was replicate thrice.

Decontamination Processes

After the second spray, brinjal fruit samples (2kg) from each replication were collected randomly at 1, 3 and 5 days intervals and subjected to different decontamination processes viz. washing and cooking in the Pesticide Residue Laboratory, Department of Entomology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh.

A. Washing

1. **Washing with running tap water:** Brinjal fruits were washed under running tap water and hand rubbed for 2 minutes.
2. **Washing with sodium chloride solution:** Fruit samples were dipped in

2% NaCl (w/v) solution for 5 minutes followed by tap water washing.

3. **Lukewarm water washing:** Brinjal fruit samples were dipped in lukewarm water ($50^{O}C$) for 5 minutes.

B. Cooking

1. **Open pan cooking:** Unwashed samples from each replication were chopped and put in an open pan of 1 litre capacity and boiled till softness (10-15 minutes).
2. **Microwave cooking:** Fruit samples were kept in microwave for 5 minutes for cooking at 1400 W power output.

After completing decontamination process, samples were extracted and cleaned up according to modified QuEChERS method[14]

Extraction and Cleanup

Processed brinjal fruit samples were homogenised in a domestic mixture. A representative homogenized 15g sample was taken in 50 ml polypropylene centrifuge tube containing 30 ml acetonitrile and homogenized at 15000 rpm for 3 minutes using low volume high speed homogenizer (Heidolph silent crusher: Heidolph, Germany). Then, 10 g sodium chloride was added, shaken tube at 50 rpm for 3 minutes with Rotospin mixer (Tarson Products Pvt. Ltd) and centrifuged at 2500 rpm for 3 minutes in eppendorf centrifuge (Eppendorf India Ltd.,) to separate the organic layer. The top organic layer of about 15 ml was taken into the another 50 ml polypropylene centrifuge tube containing 10 g anhydrous sodium sulphate to remove the moisture content. After removing moisture content, 6 ml of extract was taken in to 15 ml polypropylene centrifuge tube, containing 0.15 g PSA (Primary Secondary Amines) sorbent, 0.9 g anhydrous magnesium sulphate and 0.05 g Graphitized Carbon Black. The sample tube was capped, shaken for 3 minutes at 50 rpm in Rotospin mixer and then centrifuged for 10 minutes at 2500 rpm. The extract of about 4 ml was transferred into test tubes and evaporated to dryness in the TurboVap® LV concentration Work station (Caliper Life Sciences) at 45°C in the presence of nitrogen current. Reconstituted the volume with 2 ml n-hexane and injected 1µl into gas chromatograph (GC) equipped with flame photometric detector (FPD).

Residues estimation

The cleaned extract was analyzed on Shimadzu GC 2010 equipped with capillary glass column, Rxi®-5ms (30 mt, 0.25 mm ID, 0.25 µm film thickness) coupled with flame photometric detector (FPD). The oven temperature for acephate was set initially at $80^{0}C$ for 1 minute then increased to $150^{0}C$ @ $5^{0}C$ and kept for 2 minutes. Temperature was again increased to 250 ^{0}C @ $5^{0}C$ and held for 2 minutes. For profenophos and triazophos analysis oven temperature was set initially at $80^{0}C$ held for 3 minutes and then increased to $250^{0}C$ @ $20^{0}C$ and held for 20 minutes. Under these operation parameters, retention time of acephate, profenofos and triazophos was 17.124, 16.252 and 18.117 minutes, respectively. The limit of determination (LOD) for acephate, profenofos and triazophos was 0.05 mg kg^{-1}.

Acephate, profenofos and triazophos residues (mg/kg) were determined for each replication and then mean residues were calculated. Per cent relief from residues in each treatment was calculated from the mean residues, by the following equation:

$$\text{Per cent relief} = 100 - \frac{\text{Residue in processed sample (mg kg}^{-1})}{\text{Residue in unprocessed sample (mg kg}^{-1})} \times 100$$

Validation of Analytical Method

Unprocessed samples from untreated plot were spiked with each insecticide at 0.05, 0.10, 0.25, 0.50 and 1.00 mg kg^{-1} fortified levels. Data presented in Table 1 depicts reliability of analytical method, as the recovery of insecticide was above 84 per cent. Recovery of acephate, profenofos and triazophos varied between 88.66-106.00, 84.00-97.30 and 86.93-103.38 per cent respectively from fortified brinjal fruits.

RESULTS AND DISCUSSION

The effects of food processing on pesticide residue levels may be influenced by the physical location of the pesticide residue as well as the physico-chemical properties of the pesticide such as solubility, volatility, hydrolytic rate constants, water–octanol partition coefficient and thermal degradation[10]. Field treated brinjal fruits subjected to household processes revealed reduction in insecticide residues to different levels.

Effect of Washing

Washing is 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 varied types of washing processes. Washing of 1 day sampled brinjal fruits under running tap water provided 21.95 per cent relief whereas 27.90 and 36.36 per cent relief from acephate residues was observed from 3 and 5 days old samples (Figure 1). Tap water washing of 1, 3 and 5 day sampled brinjal fruits provided 22.10, 30.40 and 43.85 per cent relief from profenofos residues (Figure. 2). Per cent reduction in triazophos residues due to tap water washing was 20.00, 28.44 and 43.63 from 1, 3 and 5 day sampled brinjal fruits, respectively (Figure. 3). Singh[17] found tap water washing as least effective, showing up to 21.70-41.37 per cent loss of acephate residues from capsicum fruits which is in accordance with present findings. The removal of pesticide residues by washing has also been found to depend on the age of the chemical[7]. Harinathareddy *et al*[8]., also found that washing of okra fruits with tap water could remove the residues of profenofos to the extent of 49.4 per cent. Okra treated with triazophos sprays received initial deposits of 0.543 mg kg^{-1} which were removed to extent of 41.75 per cent by 10 minutes of washing with tap water[21].

Washing of treated brinjal fruits with saline water (NaCl 2 per cent) for 5 minutes dislodged 28.65, 37.19 and 48.48 per cent acephate residues from 1, 3 and 5 days old samples, respectively (Figure. 1). Washing of brinjal fruits with 2 per cent saline solution provided 32.63- 54.38 per cent relief from profenofos residues (Figure. 2). Washing of 1, 3 and 5 days sampled brinjal fruits with saline water (NaCl 2 per cent) provided 30.21, 38.79 and 54.54 per cent relief from triazophos (Figure. 3). Reddy and Rao[16] odserved that dipping of grape berries in salt solution (2%) for 30 minutes followed by washing facilitated in the removal of acephate residues to an extent of 72.74 and 45.36 per cent correspondingly from samples collected at 1 and 5 days intervals after spraying. Kong *et al*[11]., performed decontamination of rice with salt (NaCl) solutions and obtained up to 35.3 per cent loss of residues. Harinathareddy *et al*[8]., observed that dipping of tomato fruits in 2% salt solution reduced the residues of profenofos by 55.9 per cent. Washing the okra with brine water solution resulted in 54.69 per cent reductions in the initial deposit of triazophos[21].

Dipping of brinjal fruits in luke warm water for 5 minutes facilitated the removal of 37.19, 43.02 and 54.54 per cent acephate residues from samples collected 1, 3 and 5 days after spray, respectively (Figure. 1). Per cent reduction in profenofos residues due to luke water washing was 38.94, 45.60 and 61.40 on the corresponding days (Figure. 2). Luke warm water washing provided 35.31, 43.10 and 61.81 per cent relief from triazophos residues was observed in 1, 3 and 5 days old samples (Figure. 3). Kumari[13] reported 32-100 per cent reduction of OP's insecticide residues by lukewarm water washing of cauliflower. The chlorpyriphos residues on tomato fruits was decreased by 43.09 per cent by washing for 5 minutes with lukewarm water[4]. Whereas, Singh[17] found loss of triazophos residues up to 60.65 per cent by washing capsicum fruit with lukewarm water.

Effect of Cooking

Application of heat to the food commodities is commonly done through ordinary cooking, pressure cooking, microwave cooking, frying, sterilization and canning. The heat through cooking processing's affected the acephate, profenofos and triazophos residues level in brinjal fruits (Figure 1, 2 and 3). Open pan cooking of 1 day sampled brinjal fruits provided 52.43 per cent relief whereas 56.97 per cent relief from acephate residues was observed in 3 days old samples and residues were below the limit of determination (BDL) in 5th day cooked fruits (Figure. 1). When 1, 3 and 5 day sampled brinjal fruits were cooked in an open pan, then 52.63, 56.80 and 68.42 per cent relief was observed from profenofos residues, respectively (Figure. 2). Open pan cooking of triazophos treated brinjal fruits 50.21, 59.48 and 67.27 per cent relief from residues from 1, 3 and 5 day sampled fruits, respectively (Figure. 3). Harinathareddy *et al*[8]., found that cooking could reduced up to 42.9 per cent of profenofos residues in tomato. Reduction of 66.34 per cent residues of triazophos in contaminated brinjal fruits through cooking has been reported[21]. The disappearance of pesticide residues from boiling extract could be due to decomposition by the effect of heat, the stronger adsorption of pesticide onto plant tissues and or/the poor solubility of pesticides in water[1,3]. Kumari[13] reported 100 per cent reduction of OP's insecticide residues by cooking of brinjal fruits. Joshi *et al*[9]., reported 42.97 per cent reduction of chlorpyriphos residue by cooking in garden pea.

Per cent reduction in acephate residues due to microwave cooking was 58.53 and 65.11 from 1 and 3 day sampled brinjal fruits, respectively (Figure. 1). The extent of insecticidal removal with microwave cooking was 63.15-73.68 per cent in case of profenofos on the corresponding days (Figure. 2). Cooking of 1, 3 and 5 day treated brinjal fruits in microwave showed 60.00, 66.37 and 72.72 per cent reduction from triazophos residues, respectively. Microwave cooking of brinjal fruits containing cypermethrin residues for 5 minutes resulted in reduction of 40.89 per cent residues[19]. Total triazophos degraded to an extent of 72 per cent upon cooking of fruits and vegetables at 100^{O}C for 20 minutes[2]. Microwave cooking of brinjal could reduce chlorpyrifos residues up to 39.8 per cent[20].

Table 1: Recovery of acephate, profenofos and triazophos from brinjal fruits samples

	Fortification level, (mg kg^{-1})	**Fruits Mean Recovery (%)**	**Relative Standard Deviation (%RSD)**
Acephate	0.05	88.66	6.818
	0.10	96.66	6.25
	0.25	91.33	7.456
	0.50	84.66	7.565
	1.00	106.00	2.453
Profenofos	0.05	96.00	14.583
	0.10	92.66	2.174
	0.25	96.00	10.833
	0.50	84.00	2.381
	1.00	97.30	1.747
Triazophos	0.05	90.66	4.444
	0.10	89.66	1.124
	0.25	86.93	0.922
	0.50	94.80	1.899
	1.00	103.38	5.712

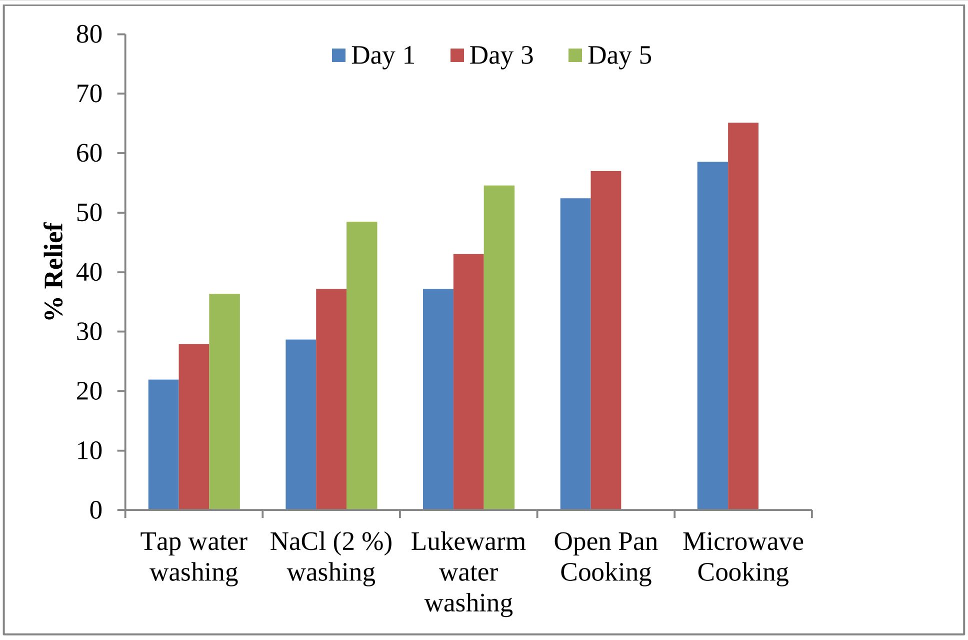

Fig. 1: Per cent relief from acephate residues after brinjal decontamination processes

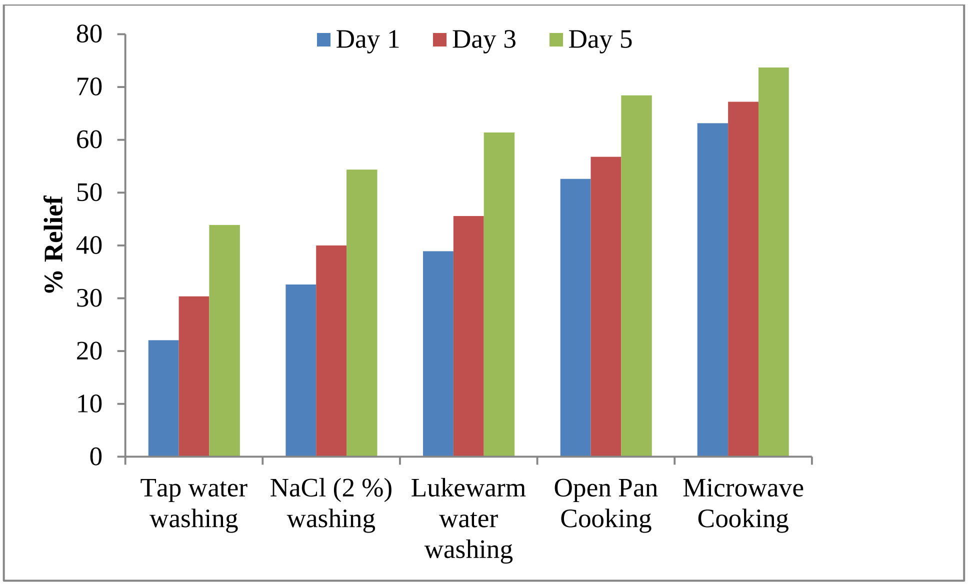

Fig. 2: Relief from profenofos residues with different decontamination processes

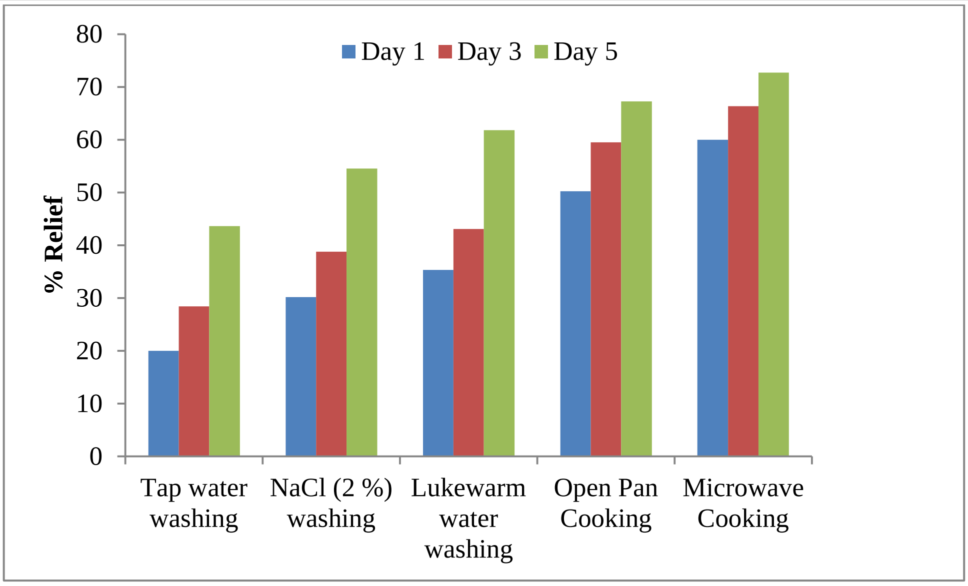

Fig. 3: Relief from triazophos residues with different decontamination processes

CONCLUSION

It was concluded that traditional processing are effective tool for pesticides residues reduction and suggest that conventional processing techniques can effectively reduce pesticide residues in vegetables. Pesticide residues in food are influenced by storage, handling and processing which is post-harvest of raw agri-cultural commodities but prior to consumption of prepared food-stuffs processing leads to large reductions in residue levels in the prepared food, particularly through washing and cooking operations. A critical analysis of whole decontamination data revealed that the microwave cooking removed much higher residues from contaminated fruits as compared to the simple washings.

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