EFFECT OF HOUSEHOLD PROCESSING METHODS ON THE REMOVAL OF PESTICIDE RESIDUES IN TOMATO VEGETABLE

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ABSTRACT

The study has been designed to determine the extent of pesticide residues removal from tomato through household processing. For this, tomato crop was grown on university farm and application of pesticides dimethoate, profenophos, chlorpyrifos, malathion, phosalone, quinalphos, triazophos and lambda cyhalothrin were carried out at recommended dosage. After 2 hours, the tomato was harvested, labeled and brought to the laboratory of pesticide residues., Acharya N.G., Ranga Agricultural University, Hyderabad, India for their analyses and further processing such as washing with tap water, 2% salt solution, 2% tamarind solution, lemon water, baking soda, vinegar, biowash (available in market) and cooking etc. being practiced at various households processed methods. Pesticide residues were extracted from tomato by solvent partitioning and cleaned by C18 cartridges/activated charcoal by using acetonitrile for elution and then cleaned up residues were analyzed through GC ECD. The analysis of data revealed that organo phosphate pesticides are highly effective against pests at low dosages. In tomato samples washing with tap water reduced the residues in the range of 37.0-73.2%, lemon water reduced by residues in the range of 42.5-72.3%, 2% tamarind solution reduced by residues in the range of 26.1-69.1%, 2% salt solution reduced by residues in the range of 44.3-78.7%, Baking soda reduced by residues in the range of 24.0-65.1%, vinegar reduced by residues in the range of 17.1-58.5%. Bio-wash removed by residues in the range of 44.5-75.2%, cooking reduced by residues in the range of 42.9-83.2%. Cooking of tomato samples was found more effective followed by 2% salt solution in dislodging the residues.

Key Words: Pesticide, Processing, Residues, Washing, Boiling, Cooking

INTRODUCTION

Vegetables are the fresh and edible portion of the herbaceous plants. They are important food and highly beneficial for health. They contain valuable food ingredients, which can be successfully utilized to build up and maintain health of the body. In India, vegetables are major constituents of diet as majority of Indians are vegetarian, with a per capita consumption of 135 g per day as against the recommended 300 g per day. It is still very less than recommended diet level. However, several factors limit their productivity, mainly insect pests and diseases. As several insect pests attack the vegetables, they are produced under very high input pressure. Among the vegetables, tomato, brinjal, cauliflower and okra are very common and give better return over investment to the farmers. But all the four are badly affected by insect-pest attack because of that spraying, pesticides for these crops are very important. Among all the vegetables, reduction of pesticide residues using different processing methods in tomato, brinjal, cauliflower and okra are very important. Tomato (Lycopersicon esculentum Mill.) is most widely grown vegetable in the world for several hundred years and known as...
apple of poor men. The crop is susceptible to attack by a number of insect pests from the time plant first emerges in the seed bed until harvest. In the field, it is mainly attacked by jassids, aphids, tobacco caterpillar, flea beetles, leaf miners and fruit borers. Tomato is an important vegetable crop grown extensively in India. It suffers heavily at fruiting stage due to attack of shoot and fruit borer causing 70% damage to the crop making it totally unfit for human consumption. Cabbage (Brassica oleracea Var. capitata L.) and cauliflower (Brassica oleracea var. botrytis L.) are two important cole crops of India which are mainly consumed as vegetables in winter season. In India, the area under cabbage and cauliflower were 265.4 and 320.6 thousand hectares with a production of 5,887.8 and 5,796.6 thousand tonnes respectively. Tomato (Lycopersicon esculentum) is one of the most important protective foods because of its special nutritive value and also because of its wide spread production. It is one of the most versatile vegetable with wide usage in Indian culinary tradition. Tomatoes are used for soup, salad, pickles, ketchup, puree, sauces and in many other ways, it is also used as a salad vegetable. It is an economically important vegetable crop of India with an annual production of around 10 million tonnes. In India, tomato occupies second position amongst the vegetable crops in terms of production. Fruit borer (Helicoverpa armigera) is an important pest of tomato. It causes serious damage during the fruiting stage and the infested crop exhibits damaged fruits, shoots and leaves.

AIMS AND OBJECTIVES

To evaluate the pesticide residues of four different chemical groups i.e., organo phosphorous in tomato to assess the effect on residues of some household processes like washing with tap water, 2% salt solution, 2% tamarind solution, lemon water, baking soda, vinegar, bio wash (available in market) and cooking.

MATERIAL AND METHODS

Tomato was grown on University farm (area about half acre) through organic farming without pesticide spray to serve as blank. Two separate plots of tomato (area about half acre each) were sprayed with each pesticides and were harvested after two hours for determining the effect of various traditional processing techniques such as washing with tap water, 2% salt solution, 2% tamarind solution, lemon water, baking soda, vinegar, bio wash (available in market) and cooking etc. on the level of removal/reduction in pesticide residue contents. The pesticides, profenophos 50EC@ 2ml/lit, chlorpyrifos 20EC@ 2ml/lit, dimethoate 30EC @ 4ml/lit, malathion 50EC@3ml/lit, phosalone 35EC@3ml/lit, quinalphos 25EC@ 2ml/lit, triazophos 40EC @ 2.5 ml /lit, lamda cyhalothrin 5EC@ 0.6ml/lit. were sprayed at recommended dose respectively with Knapsack sprayer. After about 2 hours the tomato was harvested and packed in polyethylene bags and brought to the laboratory of pesticide residues, Acharya N.G., Ranga Agriculture University, Hyderabad for further processing.

Household processing of tomato samples

The tomato samples were subjected to different traditional processing techniques such as :

Control

1 kg tomato sample is directly analyzed to know the deposits of total pesticides (Table 1).

Washing with tap water

4 lts of water and 1 kg tomato sample dipped in tap water for 10 min. followed by analysis.

Dipping in 2% salt solution for 10 min.

80 grams of table salt is added to 4 lts of water and 1 kg tomato sample dipped in salt water for 10 min. followed by analysis.

Dipping in 2% tamarind solution for 10 min.

80 grams of tamarind is added to 4 lts of water, and 1 kg tomato sample dipped in salt water for 10 min. followed by analysis.

Dipping in lemon water (1 lemon/1 litre) for 10 min.

Juice of 4 lemons is added to 4 lts of water and 1 kg tomato samples is dipped in lemon water and kept for 10 min. followed by analysis.

Dipping in 0.1% sodium bicarbonate solution for 10 min.

4 grams of sodium bicarbonate is added to 4 lts of water and 1 kg tomato sample is dipped in solution and kept for 10 min. followed by analysis.

Dipping in 4% acetic acid solution for 1 min.

160 ml of acetic acid is added to 4 lts of water and 1 kg tomato samples dipped in the solution for 10 min. followed by analysis.
Cooking in pressure cooker

1 kg tomato sample is cooked in pressure cooker for 10 min.

Washing with bio wash for 10 min.

8 ml of commercial formula bio wash is added to 4 lts of water and 1 kg tomato samples is dipped in solution for 10 min. followed by analysis. Samples were prepared for extraction of pesticides residues and to determine the effect of traditional processing on pesticide residues.

Chemicals

Pesticide standards of high purity (97.4%) were obtained from Sigma Aldrich and commercial pesticides were purchased from local market Hyderabad, India. The solvents of HPLC grade were acetonitrile, n-hexane obtained from Merck Germany. All the other chemicals and solvents of analytical grade were obtained from Merck, Mumbai (India). Primary Secondary Amine (PSA, 40 lm, Bondesil), Analytical-grade sodium chloride and anhydrous magnesium sulphate was procured from Agilent scientific (Lake Forest CA 9630). Stock solutions (1,000 µg ml⁻¹) were prepared by dissolving reference standards in acetonitrile.

Table 1: Pesticide residues (mg/kg) in tomato samples collected at 2 hrs after spray control

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>Residues (mg/kg)</th>
<th>SDEV</th>
<th>% RSD</th>
<th>MRL (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R1</td>
<td>R2</td>
<td>R3</td>
<td>Average</td>
</tr>
<tr>
<td>Dimethoate</td>
<td>1.716</td>
<td>1.587</td>
<td>1.587</td>
<td>1.630</td>
</tr>
<tr>
<td>Chlorpyriphos</td>
<td>4.447</td>
<td>4.450</td>
<td>4.450</td>
<td>4.449</td>
</tr>
<tr>
<td>Quinolphos</td>
<td>0.912</td>
<td>0.887</td>
<td>0.887</td>
<td>0.895</td>
</tr>
<tr>
<td>Profenophos</td>
<td>1.354</td>
<td>1.363</td>
<td>1.363</td>
<td>1.360</td>
</tr>
<tr>
<td>Phosalone</td>
<td>1.610</td>
<td>1.577</td>
<td>1.577</td>
<td>1.588</td>
</tr>
<tr>
<td>Lambda cyhalothrin</td>
<td>2.285</td>
<td>2.227</td>
<td>2.227</td>
<td>2.246</td>
</tr>
<tr>
<td>Malathion</td>
<td>0.150</td>
<td>0.153</td>
<td>0.153</td>
<td>0.152</td>
</tr>
<tr>
<td>Triazophos</td>
<td>1.965</td>
<td>1.885</td>
<td>1.885</td>
<td>1.911</td>
</tr>
</tbody>
</table>

Extraction and cleanup of pesticide residue analysis

After 10 min. of each treatment, tomato samples were taken out and air dried for 5 min. Tomato samples were analyzed for dimethoate, profenophos, chlorpyriphos, malathion, phosalone, quinalphos, triazophos, lambda cyhalothrin pesticide residues following the AOAC official method 2011 (QuEChERS). After validation of the method at the laboratory, the samples were homogenized with robot coupe blixer and homogenized 15±0.1 g sample was taken in 50 ml centrifuge tube. Then added with 30±0.1 ml acetonitrile sample is homogenized at 14000-15000 rpm for 2-3 min. using Heidolph silent crusher and then added with 3±0.1 g sodium chloride and mixed by shaking gently followed by centrifugation for 3 min. at 2500-3000 rpm to separate the organic layer. The top organic layer of about 16 ml was taken into the 50 ml centrifuge tube and added with 9±0.1 g anhydrous sodium sulphate to remove the moisture content. 8 ml of extract was taken in to 15 ml tube, containing 0.4±0.01 gr PSA sorbent (for dispersive solid phase d-SPE cleanup) and 1.2±0.01 g anhydrous magnesium sulphate. The sample tube was vortexed for 30 sec then followed by centrifugation for 5 min at 2500-3000 rpm. The extract of about 2 ml was transferred into test tubes and evaporated to dryness using turbuvap with nitrogen gas and reconstituted with 1 ml n-hexane for GC analysis with ECD detector.

Estimation

The cleaned extracts were analyzed on Shimadzu 2010 GC equipped with phenominex capillary columns using ⁶³Ni Electron Capture Detector (ECD) and Nitrogen-Phosphorous Detector (NPD). Operating conditions were as per details: Detector : ECD (⁶³Ni), column : Phenominex MR2 column of 5% diphenyl/ 95% dimethyl fused silica capillary column (30 m×0.32 mm ID, 0.25 µm film thickness) with split system. Temperatures (⁰C) : 150⁰C (5 min) → 5°min⁻¹
→ 190°C (2 min) → 15° min⁻¹ 280°C (10 min), injection port: 280°C, detector: 300°C, carrier gas: (N₂), flow rate 60 ml min⁻¹, 2 ml through column and split ratio 1:10. Carrier gas, N₂, flow rate 60 ml min⁻¹, 2 ml through column. For OPs: Detector: FPD, column: Phenomenex MR2 column of methyl silicone (10 mx0.5 mm ID, 2.65 μm film thickness). Temperatures (°C): Oven: (°C):150°C (5 min) → 5° min⁻¹ → 190°C (2 min) → 15° min⁻¹ 280°C (10 min); injection port: 280°C; detector: 300°C, carrier gas N₂ 60 ml min⁻¹, H₂ 1.5 ml min⁻¹ and zero air 130 ml min⁻¹.

RESULTS AND DISCUSSION

The data obtained for the estimation of percentage reduction of various pesticides such as dimethoate, chlorpyrifos, quinolphos, profenophos, phosalone, lamda cyhalothrin, malathon and triazophos. After washing with tap water for 10 min., the percentage reduction was found to be in the range of 37.0 – 73.2% for various pesticides. Washing with lemon water for 10 min. the percentage reduction was found to be in the range of 42.5-72.3% for various pesticides. Washing with 2% tamarind solution for 10 min., the percentage reduction was found to be in the range of 26.1-69.1% for various pesticides. Washing with 2% salt solution for 10 min, the percentage reduction was found to be in the range of 44.3-78.7% for various pesticides. Washing with 0.1% sodium bicarbonate for 10 min, the percentage reduction was found to be in the range of 24.0-65.1% for various pesticides. Washing with 4% acetic acid for 10 min, the percentage reduction was found to be in the range of 17.1-58.5% for various pesticides. Washing with bio-wash for 10 min, the percentage reduction was found to be in the range of 44.5-75.2% for various pesticides, cooking in pressure cooker for 10 min, the percentage reduction was found to be in the range of 42.9-83.2% for various pesticides is represented in Table 2. Organo phosphate is highly effective against pests at low dosages and its residues in processed as well as unprocessed Tomato samples were within MRL (0.5ppm). Chlorpyrifos was reduced highly 83.2% by cooking followed by 2% salt solution reduced to 78.7% seen in (Fig 1), dimethoate was reduced highly 70.4% by cook-ing followed by 2% salt solution reduced to 55.1% (Fig 2), quinalphos was reduced highly 55.9% by 2% salt solution followed by bio-wash reduced to 52.7% (Fig 3), phasalone reduced highly 55.1% by cooking followed by 2% salt solution reduced to 52.0% (Fig 4). Lamda cyhalothrin reduced highly 58.5% by 2% salt sol-ution followed by bio wash reduced to 56.3% (Fig 5), Malathion reduced highly by 2% salt solution followed by cooking reduced to 50.8% (Fig 6), Triazophos reduced highly 69.8% by 2% salt solution followed by 0.1% NaHCO₃ reduced up to 55.4% (Fig 7). Profenophos reduced highly 55.9% by 2% salt solution followed by lemon water reduced up to 52.3% (Fig 8).

Table 2: Percentage (%) removal of pesticide residues over control

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Tap water</th>
<th>Lemon water</th>
<th>2% tamarind solution</th>
<th>2% salt solution</th>
<th>0.1% sodium bicarbonate solution</th>
<th>4% Acetic acid solution</th>
<th>Bio wash</th>
<th>Cooking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethoate</td>
<td>42.3</td>
<td>52.2</td>
<td>39.9</td>
<td>55.1</td>
<td>37.9</td>
<td>38.0</td>
<td>47.6</td>
<td>70.4</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>73.2</td>
<td>72.3</td>
<td>69.1</td>
<td>78.7</td>
<td>65.1</td>
<td>58.5</td>
<td>75.2</td>
<td>83.2</td>
</tr>
<tr>
<td>Quinolphos</td>
<td>37.0</td>
<td>42.5</td>
<td>26.1</td>
<td>44.3</td>
<td>24.0</td>
<td>17.1</td>
<td>44.5</td>
<td>47.4</td>
</tr>
<tr>
<td>Profenophos</td>
<td>49.4</td>
<td>52.3</td>
<td>39.0</td>
<td>55.9</td>
<td>39.1</td>
<td>33.7</td>
<td>52.7</td>
<td>42.9</td>
</tr>
<tr>
<td>Phosalone</td>
<td>44.7</td>
<td>48.9</td>
<td>33.6</td>
<td>52.0</td>
<td>32.9</td>
<td>26.6</td>
<td>50.0</td>
<td>55.1</td>
</tr>
<tr>
<td>Lamda cyhalothrin</td>
<td>49.6</td>
<td>54.6</td>
<td>36.7</td>
<td>58.5</td>
<td>40.5</td>
<td>29.8</td>
<td>56.3</td>
<td>47.4</td>
</tr>
<tr>
<td>Malathion</td>
<td>44.3</td>
<td>50.0</td>
<td>28.8</td>
<td>51.1</td>
<td>35.3</td>
<td>18.6</td>
<td>55.3</td>
<td>50.8</td>
</tr>
<tr>
<td>Triazophos</td>
<td>62.3</td>
<td>66.1</td>
<td>54.4</td>
<td>69.8</td>
<td>55.4</td>
<td>44.8</td>
<td>66.1</td>
<td>54.3</td>
</tr>
</tbody>
</table>
Fig. 1: Effect of different household processing methods in the removal of chlorpyrifos residues from tomato samples

Fig. 2: Effect of different household processing methods in the removal of dimethoate residues from tomato samples

Fig. 3: Effect of different household processing methods in the removal of quinophos residues from tomato samples
Fig. 4: Effect of different household processing methods in the removal of phosalone residues from tomato samples

Fig. 5: Effect of different household processing methods in the removal of lambda cyhalothrin residues from tomato samples

Fig. 6: Effect of different household processing methods in the removal of malathion residues from tomato samples
Unwashed unprocessed tomato contained maximum residues. The viable option is to reduce pesticide residue through traditional processing. The household processing decreased pesticides residues progressively. 2% salt water washing, washing with tap water removed residues adsorbed on tomato surface which formed the major portions of polar pesticides such as OP pesticides. Washing methods decreased the water soluble pesticides dimethoate, profenophos, chlorpyrifos, malathion, phosalone, quinalphos, triazophos and lambda cyhalothrin. Important factor during the washing operation was the solubility of pesticides in tap water as well as in 2% salt water. Therefore, cooking was more effective in eliminating pesticide residues as compared to 2% salt water washing and tap water washing. All these operations such as washing, detergent washing, blanching and cooking/boiling play a role in the reduction of residues. Each operation has a cumulative effect on the reduction of the pesticides present. Reduction percentage of pesticides residues in tomato through household processing may help in reducing pesticide residues in marketed tomato within MRLs and render it fit for human consumption.

**CONCLUSION**

From these household processing, it is concluded that water soluble contact pesticides residues such as oragano phosphate pesticides can successfully be removed from tomato by plain washing and/or by detergent washing.
Vegetable consumers are advised to take vegetable after treatment of properly being washed for at least 10 minutes in salt.

REFERENCES
7. Ling Y. et al., The effects of washing and cooking on chlorpyrifos and its toxic metabolites in vegetables. *Food Cont.*, 22(2), 54-58, (2011)