ENTOMON 40 (3): 169-180 (2015)
Article No. ent. 40305

Evaluation of some cooking ingredients decontaminating selected vegetables from pesticide residues

Pallavi Nair K.*, Thomas Biju Mathew, Naseema Beevi S., Thomas George, Rajith R., Binoy A Koshy and Sajitharani T.

Pesticide Residue Research and Analytical Laboratory, College of Agriculture, K A U, Vellayani, Kerala, 695 522 India. Email: pnkagri@gmail.com

ABSTRACT: The effect of different safe decontaminating substances on two vegetables (okra and curry leaf) grown in Kerala was studied. The plants were sprayed with a mixture of malathion, chlorpyriphos, quinalphos, profenophos, ethion, cypermethrine, fenvalerate and methyl parathion and samples of okra fruit and curry leaf were collected 1 day and 3 days after spraying. Samples were dipped in different decontaminating emulsion/suspension of tamarind 2%, common salt 2%, turmeric 1%, vinegar 2%, lukewarm water and water for 15 minutes and washed in tap water. Residues of different insecticides in these samples were estimated using gas chromatograph equipped with electron capture detector. Data showed that all treatments reduced the insecticides on the two commodities significantly. The effect varied with the insecticides and the crops involved. The decontamination technology using household substances was identified as a desirable approach for solving the insecticide residue problem in agricultural commodities. Standardization of the technique separately for different commodities and insecticides may be necessary based on a sample survey of the pesticides in different commodities in different locations.

KEY WORDS: Decontamination, pesticide, residue, vegetables

INTRODUCTION

Pesticide residues in food continue to be a matter of concern to humanity. The regulatory authorities in India are focusing on monitoring of pesticide residues in agricultural commodities to ensure food safety for consumers and for better international trade activities. A recent survey of different food commodities sold in different markets of Kerala showed that out of 16,948 samples studied, 290 (1.70%) samples contained residues of various insecticides at levels above those prescribed as safe by FSSAI (AICRP PR, 2012).

* Author for correspondence

In vegetable samples (141 in number) and fruit samples (56 in number) collected from different locations in Kerala during the period of July to September 2014 under a separate programme of Government of Kerala and Kerala Agricultural University, 12 vegetable samples and five fruit samples had detectable level of pesticide residues. Residues in green chilli, yard long bean, curry leaf, coriander leaf, amaranthus, guava and pomegranate were at higher levels (PAMSTEV, 2014).

This growing concern about pesticide residues in agricultural commodities has demanded immediate government level interventions for solutions. For tackling the problem interventions can be at production, marketing and consumption stages. Most of the vegetables marketed in Kerala are produced outside this state, and hence intervention at production level is almost impossible. The next possibility is intervention at marketing stage *ie*. to collect statutory samples, test them in an accredited testing lab and to take legal action against the food business operator, including seizing of contaminated products. This also remain elusive due to the inadequate infrastructural facilities and complicated legal procedures. Therefore intervention at consumption stage is to be explored as a practical solution for the problem, *ie*. to standardize and popularize decontamination procedures that can be adopted just before cooking/consumption.

Several substances have been reported as effective in decontaminating agricultural products from pesticide residues. They mostly covered earlier pesticides and did not gain popularity and large scale adoption. Recently different decontaminating substances like common salt, vinegar, turmeric etc were tried in India and promising results were also reported (Abou-Arab, A. A. K., 1999, Gardenmo.net, 2011, Varghese and Mathew, 2013 and Vijayasree et al., 2012). These studies do not cover the insecticide residues detected in Kerala in recent surveys and the methodology followed in the treatments also have not been standardized. In this context, two vegetables (okra and curry leaf) seen contaminated with insecticide residues in the surveys were treated with different decontaminating substances commonly used in cooking with a view to assessing the possible levels of decontamination.

MATERIALS AND METHODS

Standardization of pesticide residue estimation

Certified Reference Materials (CRM) of different pesticides having purity ranging from 95.10 to 99.99 per cent were purchased from M/s Sigma Aldrich and stored in a freezer at low temperature, with light and moisture excluded. Solvents used in the study were all glass distilled before use. The analytical method for estimation of residues of pesticides has been validated by conducting recovery studies at three different fortification levels *ie.* LOQ, 5 x LOQ and 10 x LOQ using control samples (samples having pesticide residues below detectable levels).

Decontamination study

To study the effect of different decontaminating materials on removal of pesticide residues, two vegetables *viz.,* okra and curry leaf were selected and the methodology adopted for the decontamination study was as follows.

The okra variety Varsha Upahar was raised in pots under controlled conditions in the Instructional Farm, College of Agriculture, Vellayani. An insecticide emulsion mixture containing malathion (Hilmala 50 EC 2.0 ml L^{-1}), methyl parathion (Folidon 50 EC 2.0 ml L^{-1}), chlorpyriphos (Radar 20 EC 2.0 ml L^{-1}), quinalphos (Ekalux 25 EC 1.60 ml L^{-1}), profenophos (Curacron 50 EC 3.0 ml L^{-1}), ethion (Fosmite 50 EC 3.0 ml L^{-1}), cypermethrin (Cyperkill 25 EC 1.10 ml L^{-1}) and fenvalerate (Fenval 20 EC 0.60 ml L^{-1}) were prepared and sprayed at fruiting stage using a hand sprayer. Okra fruits collected 1st day and 3rd day after spraying were used for pesticide residue estimation.

Curry leaf plants available in the Instructional Farm, College of Agriculture, Vellayani were sprayed with the above mixtures of insecticide emulsions. Curry leaves collected 1st day and 3rd day after spraying were used for residue estimation.

The different decontaminating treatments in this experiment were tamarind 2 % (20g of tamarind pulp extracted in one litre water), common salt 2 % (20g of common salt dissolved in one litre water), turmeric powder 1 % (10g of turmeric powder suspended in one litre water), vinegar 2 % (20 ml of vinegar diluted in one litre water), luke warm water and water (untreated control). Samples of 100 g curry leaves and 250 g okra fruits were dipped individually in the treatments for fifteen minutes followed by washing in tap water. Samples were then cut into small pieces and then homogenized and the representative samples (25 g each) in three replicates were collected, residues in the samples were assessed.

Analytical procedure

The standard QuEChERS protocol was followed to prepare samples and the same was analyzed in a Gas Chromatograph equipped with ^{63}Ni Electron Capture Detector (ECD), fitted with DB-5 capillary column (dimethyl polysiloxane, 30 m x 0.25 mm i.d. x 0.5 µm film thickness)

RESULTS

Recovery study

Multi Residue Methods (MRM) for pesticide residue analysis was adopted for recovery studies. The results demonstrated that the method followed had a satisfactory analytical performance in terms of selectivity and linearity. Good linearity within the range of 0.01-0.5 mg kg^{-1} for the pesticides belonging to OP and SP insecticide groups was obtained. Satisfactory recoveries and RSDs were achieved for most of the pesticides evaluated even at the lowest level of fortification. The mean recovery of all the insecticides used were in the range 70 - 110

per cent and the repeatability of the recovery results, as indicated by the RSD < 20 % confirmed that the method is sufficiently reliable for pesticide residue estimation in curry leaf and okra.

Data relating to the removal of insecticide residues and results of statistical analysis of the data are presented in Table 1 to 8.

Removal of malathion residues:

The performance of different treatments on the residues of malathion on okra fruits and curry leafs is shown in table 1. Turmeric (residue 70.56% < in control) was the best and it was closely followed by tamarind (68.92%) and common salt (62.37%). In samples collected three days after spraying also efficacy of the treatments were in the same sequence, (the percentage reduction ranging from 63.89 to 57.10%). Vinegar, lukewarm water and water were comparatively ineffective, the percentage removal being in the range of 25.88% to 41.77% only. The removal of malathion residues in curry leaf samples harvested at both the intervals was very high in all treatments, the percentage removal being in the range of 69.64 to 95.78%.

Table 1: Extent of removal of malathion residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min.

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	68.92 ± 1.44 (0.25)	57.10 ± 1.67 (0.13)	91.80 ± 0.24 (0.09)	89.04 ± 0.79 (0.04)
2% Vinegar	38.67 ± 2.83 (0.49)	41.77 ± 1.56 (0.18)	93.24 ± 0.04 (1.02)	76.36 ± 1.53 (0.09)
1% Turmeric	70.56 ± 1.27 (0.24)	63.89 ± 3.75 (0.11)	95.78 ± 0.09 (0.05)	81.34 ± 0.44 (0.07)
2% Common salt	62.37 ± 1.36 (0.30)	62.37 ± 1.36 (0.12)	94.01 ± 1.21 (0.06)	78.84 ± 0.16 (0.08)
Lukewarm water	37.53 ± 1.67 (0.50)	32.53 ± 2.89 (0.21)	87.80 ± 0.92 (0.13)	83.48 ± 0.19 (0.06)
Water	37.53 ± 1.55 (0.50)	25.88 ± 3.31 (0.23)	84.25 ± 0.60 (0.17)	69.64 ± 2.09 (0.10)
Control	(0.80)	(0.31)	(1.10)	(0.36)

Values in parentheses are concentration of insecticides in mg kg^{-1}

The residue of malathion in okra (0.31 mg kg^{-1}) harvested on 3rd day after treatment was only 38.75% of the residue in 1st day sample (0.80 mg kg^{-1}) and corresponding percentage in curry leaf was 32.72%.

Removal of chlorpyriphos residues (Table 2):

On okra samples sprayed with chlorpyriphos and collected one day after spraying tamarind (62.52% removal of residue) was the best closely followed by common salt (54.38%) and

Table 2: Extent of removal of chlorpyriphos residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min.

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	62.52 ± 3.29 (0.54)	60.22 ± 1.15 (0.20)	66.05 ± 0.93 (1.10)	62.01 ± 2.31 (0.27)
2% Vinegar	50.67 ± 0.70 (0.72)	47.30 ± 1.00 (0.26)	58.61 ± 0.33 (1.34)	34.12 ± 2.60 (0.48)
1% Turmeric	32.14 ± 1.1.9 (0.98)	8.90 ± 1.36 (0.46)	82.93 ± 0.28 (0.55)	47.38 ± 1.45 (0.38)
2% Common salt	54.38 ± 2.136 (0.66)	54.38 ± 2.36 (0.23)	69.36 ± 3.28 (0.99)	38.86 ± 1.17 (0.44)
Lukewarm water	18.68 ± 1.32 (1.18)	17.84 ± 1.89 (0.41)	47.98 ± 3.62 (1.60)	45.72 ± 0.06 (0.39)
Water	9.48 ± 0.40 (1.31)	10.80 ± 0.40 (0.45)	43.59 ± 0.82 (1.83)	34.22 ± 0.81 (0.48)
Control	(1.45)	(0.50)	(3.26)	(0.73)

Values in parentheses are concentration of insecticides in mg kg^{-1}

vinegar (50.67%). Same ranking of the treatments with the percentages of 60.22%, 54.38% and 47.30% on samples collected three days after spraying was observed. In the remaining treatments, the removal of residues ranged from 9.48 to 32.14% only.

In curry leaf harvested one day after spraying turmeric (82.93% residue removal) was the best treatment and it was closely followed by common salt (69.36%) and tamarind (66.05%). In samples collected on the 3rd day after spraying tamarind (62.01%) was the best and it was followed by turmeric (47.38%). Common salt (38.86%) came superior to vinegar and water (34.12 and 34.22% respectively). The residue in okra fruits collected on 3rd day after spraying (0.55 ppm) was only 34.8% of the residue level in samples collected one day after spraying (1.45 ppm).

Removal of quinalphos residues (Table 3):

The results of different treatments on quinalphos residues in okra fruits showed that tamarind, common salt, vinegar and turmeric which removed 65.30%, 63.14%, 54.79% and 52.88% residue from samples collected one day after spraying can be ranked as effective treatments. In the samples collected 3 days after spraying turmeric removed only 36.40% residue while the remaining treatments gave 51.48 to 61.31 per cent residue. All the treatments gave effective decontamination of curry leaf having quinalphos residues the percentages of removal in the 1st day samples being 54.23 to 85.16% and in the 3rd day samples the removal ranged from 50.90 to 69.30% except water which showed the removal of 40.55 per cent only.

Table 3: Extent of removal of quinalphos residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min.

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	65.30 ± 3.39 (0.42)	61.31 ± 1.09 (0.22)	74.00 ± 1.42 (2.13)	69.30 ± 1.85 (0.60)
2% Vinegar	54.79 ± 3.67 (0.55)	51.48 ± 0.82 (0.28)	70.67 ± 0.23 (1.38)	45.65 ± 3.53 (1.06)
1% Turmeric	52.88 ± 2.88 (0.57)	36.40 ± 1.39 (0.37)	85.16 ± 0.29 (0.79)	57.86 ± 1.03 (0.82)
2% Common salt	63.14 ± 2.10 (0.45)	56.14 ± 2.10 (0.25)	77.35 ± 2.39 (1.20)	50.90 ± 0.37 (2.97)
Luke warm water	39.67 ± 0.78 (0.74)	32.41 ± 0.79 (0.39)	61.46 ± 2.49 (2.05)	58.53 ± 0.58 (0.81)
Water	33.24 ± 2.2.0 (0.81)	18.59 ± 1.22 (0.47)	54.23 ± 0.65 (2.44)	40.55 ± 1.26 (1.96)
Control	(1.22)	(0.58)	(5.34)	(1.96)

Values in parentheses are concentration of insecticides in mg kg^{-1}

The residue level on 3rd day after spraying sample was 47.54% of the level in 1st day sample for okra and corresponding figure for curry leaf was 36.7 per cent only.

Removal of profenophos residues (Table 4):

From samplesof okra collected one day after spraying with profenophos tamarind (73.25% removal), common salt (68.24%) and turmeric (50.60%) could be ranked as good decontaminants. But in samples collected three days after spraying turmeric gave only 41.68% removal while the percentages in the remaining treatments ranged from 52.77 to 65.65 per cent. Lukewarm water and water were relatively less effective.

In the case of curry leaf, samples collected one day after spraying all treatments removed the residues (51.06 to 88.52 per cent) effectively. Samples collected 3 days after spraying also showed good performance (50.95 to 67.52 per cent removal of residues) in all the treatments except common salt and water in which the percentage removal was 48.88 and 44.55% respectively.

Percentage of residues of profenophos in 3rd day samples compared to the 1st day samples was 34.89% in bhindi and 52.84% in curry leaf.

Removal of ethion residues (Table 5):

Tamarind; common salt and vinegar gave 64.03%, 59.73% and 56.06% removal of ethion residue from okra collected one day after spraying while in samples collected on the 3rd day

Table 4: Extent of removal of profenophos residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	73.25 ± 4.12 (0.80)	65.65 ± 2.48 (0.36)	77.25 ± 0.47 (8.52)	67.52 ± 1.74 (6.43)
2% Vinegar	63.76 ± 3.01 (1.08)	52.77 ± 1.44 (0.49)	68.94 ± 0.18 (11.63)	50.95 ± 2.06 (9.71)
1% Turmeric	50.60 ± 1.26 (1.47)	41.68 ±1.62 (0.61)	87.59 ± 0.09 (4.65)	59.50 ± 0.66 (8.01)
2% Common salt	68.24 ± 2.41 (0.95)	68.24 ± 2.41 (0.33)	88.52 ± 0.98 (4.30)	48.88 ± 1.40 (10.12)
Lukewarm water	27.23 ± 1.67 (2.17)	27.66 ± 2.64 (0.75)	61.46 ± 7.88 (14.40)	59.75 ± 1.78 (7.96)
Water	23.64 ± 2.89 (2.28)	21.66 ± 0.69 (0.81)	51.06 ± 2.41 (18.33)	44.55 ± 0.87 (10.97)
Control	(2.98)	(1.04)	(37.47)	(19.80)

Values in parentheses are concentration of insecticides in mg kg^{-1}

Table 5: Extent of removal of ethion residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min.

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	64.03 ± 3.94 (1.15)	59.62 ± 0.73 (0.76)	71.26 ± 0.79 (9.02)	67.00 ± 2.11 (6.53)
2% Vinegar	56.06 ± 3.07 (1.41)	52.52 ± 0.68 (0.84)	60.37 ± 0.58 (12.44)	51.71 ± 0.49 (9.55)
1% Turmeric	41.39 ± 1.51 (1.88)	42.38 ± 1.26 (1.08)	86.99 ± 0.31 (4.08)	60.98 ± 0.52 (7.72)
2% Common salt	59.73 ± 1.67 (1.29)	59.73 ± 1.67 (0.76)	70.88 ± 2.77 (9.14)	43.34 ±1.98 (11.21)
Luke warm water	16.96 ± 1.93 (2.66)	11.48 ± 1.35 (1.66)	57.25 ± 1.63 (13.40)	57.15 ± 1.40 (8.48)
Water	5.32 ± 1.58 (3.03)	6.31 ± 2.26 (1.76)	39.94 ± 1.43 (18.85)	43.91 ± 0.59 (11.10)
Control	(3.20)	(1.88)	(31.40)	(19.79)

Values in parentheses are concentration of insecticides in mg kg^{-1}

percentage removal were 59.73%, 59.62% and 52.52% respectively in common salt, tamarind and vinegar. In turmeric the removal was 41.39% and 42.38% removal only on 1st and 3rd day samples. In the case of curry leaf all treatments removed the residues effectively (57.25% to 86.99% removed from 1st day samples and 57.15% to 67.0% removed from 3rd day samples).

Ethion residue in okra harvested on 3 day waiting period was 58% of the residue in samples collected on the 1st day of spraying. The corresponding residue content in curry leaf on 3rd day was 65% of the residue in 1st day samples.

Removal of cypermethrin residues (Table 6):

Removal of cypermethrin was relatively low 54.46% to 57.23% in 1st day samples of okra fruits in treatments with tamarind, common salt and vinegar respectively while the corresponding percentages in 3rd day samples were 52.18%, 45.61% and 50.25% respectively. In the case of curry leaf the removal percentage in treatments except water gave 58.84% to 89.37% removal in 1st day sample and tamarind, vinegar and turmeric gave 53.7% to 59.51% removal in 3rd day samples. In common salt and water treatments the removal of cypermethrin ranged from 36.26% to 49.17% only. The waiting period of 3 days followed in harvest of okra brought down the residue level to 63.6% of the 1st day sample and corresponding reduction in curry leaf was 85.7%.

Table 6: Extent of removal of cypermethrin residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min.

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	54.46 ± 1.22 (0.05)	52.18 ± 1.16 (0.03)	71.98 ± 0.70 (0.06)	59.51 ± 3.19 (0.07)
2% Vinegar	57.23 ± 1.32 (0.05)	50.25 ± 1.63 (0.03)	66.82 ± 0.49 (0.07)	53.70 ± 3.07 (0.08)
1% Turmeric	32.28 ± 1.16 (0.07)	19.59 ± 1.06 (0.06)	89.37 ± 0.20 (0.02)	56.79 ± 1.68 (0.07)
2% Common salt	54.61 ± 2.09 (0.05)	45.61 ± 2.09 (0.04)	68.14 ± 7.06 (007)	36.26 ± 3.44 (0.11)
Luke warm water	18.17 ± 1.82 (0.09)	15.49 ± 2.90 (0.06)	58.84 ± 12.69 (0.09)	48.63 ± 3.23 (0.09)
Water	6.70 ± 3.04 (0.10)	8.19 ± 2.65 (0.06)	48.58 ± 2.31 (0.10)	49.17 ± 5.18 (0.09)
Control	(0.11)	(0.07)	(0.21)	(0.18)

Values in parentheses are concentration of insecticides in mg kg^{-1}

Removal of fenvalerate residues (Table 7):

Common salt was the best for the removal of fenvalerate residue (73.21%) and it was followed by vinegar (63.67%) and tamarind (56.15%). The corresponding removal in 3rd day sample also was high (49.13% to 73.21%). In curry leaf all the treatments gave high removal in 1st day sample (except water), percentages ranging from 64.95% to 90.25%. In the 3rd day samples satisfactory removal was in tamarind (56.16%) and vinegar (52.69%) only. Residue in 3rd day sample in okra was 61.7% of the 1st day sample and in curry leaf corresponding residue was 66%.

Table 7: Extent of removal of fenvalerate residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min.

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	56.15 ± 4.98 (0.32)	50.97 ± 1.45 (0.22)	70.39 ± 0.46 (1.06)	56.16 ± 2.72 (1.03)
2% Vinegar	63.67 ± 4.04 (0.27)	49.13 ± 1.84 (0.23)	64.95 ± 0.17 (1.25)	52.69 ± 1.70 (1.12)
1% Turmeric	37.88 ± 2.01 (0.45)	16.97 ± 1.72 (0.37)	87.88 ± 0.16 (0.43)	45.32 ± 10.41 (1.29)
2% Common salt	73.21 ± 2.09 (0.20)	73.21 ± 2.09 (0.37)	90.25 ± 1.88 (0.35)	36.44 ± 1.49 (1.50)
Luke warm water	13.67 ± 0.77 (0.63)	19.73 ± 1.28 (0.36)	84.86 ± 1.76 (0.54)	49.09 ± 2.78 (1.20)
Water	9.70 ± 1.22 (0.66)	11.66 ± 1.83 (0.40)	44.08 ± 2.70 (2.00)	39.90 ± 0.82 (1.42)
Control	(0.73)	(0.45)	(3.59)	(2.37)

Values in parentheses are concentration of insecticides in mg kg^{-1}

Removal of methyl parathion residues (Table 8):

Common salt and tamarind alone were found good for removing methyl parathion residue from 1st day sample of okra fruits while in other treatments residue removal ranged from 11.69% to 40.40% only. In the third day sample the removal in common salt alone was good (54.22%). In the remaining treatments the removal ranged from 11.70% to 37.46%. Regarding curry leaf, all treatments including water gave 50.68% to 74.43% removal in 1st day samples. In 3rd day sample the removal was below 50% in all treatments. The residue levels in 3rd day samples of okra was 43.37% of the 1st day sample and in curry leaf corresponding percentage was 39.84%.

Table 8: Extent of removal of methyl parathion residues from okra fruits and curry leaves collected 1st day and 3rd day after spraying subjected to dipping in different treatment solutions for 15 min.

Treatments	Mean per cent removal of insecticides (%)			
	Okra		Curry leaf	
	1st day after spraying	3rd day after spraying	1st day after spraying	3rd day after spraying
2% Tamarind	51.62 ± 1.483 (0.95)	37.46 ± 1.37 (0.53)	61.22 ± 0.69 (3.30)	43.23 ± 3.17 (1.92)
2% Vinegar	40.40 ± 1.62 (1.17)	31.37 ± 0.82 (0.58)	69.46 ± 0.14 (2.59)	21.77 ± 1.52 (2.65)
1% Turmeric	31.33 ± 0.89 (1.35)	24.71 ±2.29 (0.64)	74.43 ± 0.28 (2.17)	20.70 ± 0.94 (2.68)
2% Common salt	54.22 ± 1.41 (0.90)	54.22 ± 1.40 (0.39)	70.79 ± 3.47 (2.48)	24.02 ± 2.12 (2.57)
Luke warm water	34.43 ± 0.96 (1.29)	15.96 ± 0.78 (0.58)	58.41 ± 3.10 (3.53	31.87 ± 2.66 (2.30)
Water	11.69 ± 1.88 (1.78)	11.70 ± 1.68 (0.71)	50.68 ± 1.49 (4.19)	9.24 ± 1.04 (3.07)
Control	(1.96)	(0.85)	(8.51)	(3.39)

Values in parentheses are concentration of insecticides in mg kg^{-1}

DISCUSSION

The data obtained from the experiments clearly show the effectiveness of the treatments in removing the insecticide residues in okra and curry leaf. From okra removal of malathion residue was comparatively better with tamarind, turmeric and common salt, while vinegar, lukewarm water and water were comparatively inferior. With chlorpyriphos residue, turmeric and water treatments were inferior to the rest of the treatments. Methyl parathion residue was best removed by tamarind and common salt while the remaining treatments were not effective. All the treatments except turmeric and water removed residues of qunalphos, profenophos, ethion, cypermethrine and fenvalerate. In the case of curry leaf the residue levels of insecticides were significantly higher than those of okra fruits. This might be due to lower bulk weight of curry leaf and consequent larger surface area available for holding the residues of insecticide for the same weight of the two commodities taken for the studies. The residues from curry leaf was being effectively removed by all treatments in the experiment including lukewarm water and water. The result bring to light the possibility of reducing the hazards of insecticide residues in vegetables by adopting simple and safe methods of decontamination in post harvest processing before cooking. Because of the variations in the performance with reference to the chemistry of insecticide, crop waiting period etc., standardization of separate techniques for different pesticides and for different commodities (identified through a farm-gate sample survey) may be necessary for tackling the problem.

The rapid fall in residues of different insecticides in samples collected 3 days after spraying when compared to the levels of residues in samples collected 1 day after spraying, highlights

the importance of adopting recommended waiting periods in harvesting the crops after spray operations. This precaution clubbed with the adoption of proper decontamination practices may provide an effective method to solve the hazards of insecticide residues in agricultural commodities. Though the decontaminating effect of a lot of substances have been studied in the recent past the pesticide studied in this experiment and the crops chosen have not been covered in early studies.

ACKNOWLEDGEMENT

The authors are thankful to member secretary, Central Sector Scheme on Monitoring of Pesticide Residues in National Level for awarding Junior fellowship and to Kerala Agricultural University for providing necessary facilities for conducting the experiments.

REFERENCES

Abou-Arab A. A. K. (1999) Behaviour of pesticides in tomatoes during commmercial and home preparation. Food Chemistry 65: 509 - 514.

AICRP PR (2012) Annual Report of All India Co-ordinated Research Project on Pesticide Residues, Indian Council of Agricultural Research, New Delhi.

Gardenmo.net. (2011) Available: http://www.gardenmo.net/vegetable-garden-2/decontamination -of-pesticide-residues-on-fruits-and-vegetables.html. [28 January 2011].

PAMSTEV (2014) Report of Production and marketing of safe to eat (pesticide free) vegetables, fruits and food products for sale through government outlets, Department of Agriculture, Government of Kerala.

Varghese T. S. and Mathew T. B.(2013) Pesticide residues – Home remedies for eliminating pesticide residues from green chilli fruits. In: Proceedings of International Conference on Insect Science; 14 -17 February 2013; University of Agricultural Science, Dharvad, Karnataka, pp 120.

Vijayasree V., Bai H., Beevi S. N., Mathew T. B., Kumar V., George T. and Xavier G. 2012. Persistence and effects of processing on reduction of chlorantraniliprole residues on cowpea fruits. Bulletin of Environmental Contamination Toxicology, doi 10.1007/s00128-012-0944-9.

(Received 17 June 2015; accepted 28 September 2015)