FATE OF ENDOSULFAN AND DELTAMETHRIN RESIDUES DURING TOMATO PASTE PRODUCTION

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ABSTRACT

In this study, the effects of tomato paste processing steps on pesticides with active ingredient endosulfan and deltamethrin were investigated in Biga/Canakkale. Residue data were obtained by analyzing samples taken during harvesting, taken after washing and chopping, taken after pulping (pulp and pomace) and taken from the tomato paste with GC-ECD. In the process of making tomato paste, washing decreased endosulfan and deltamethrin, 30.62% and 47.58%, respectively. Pre-heating, pulping, evaporation and half-pasteurization increased deltamethrin 2.33% while decreasing endosulfan 66.5% after washing. The whole process decreased endosulfan and deltamethrin, 76.8% and 46.3%, respectively. The residues were mostly collected in pomace.

KEYWORDS: pesticide residue, processing study, tomato

INTRODUCTION

Pesticides used during agricultural production have increasingly been causing concerns due to their adverse effects on human health. Pesticides are toxic chemicals used in preventing, destroying, repelling, or mitigating pests [13]. Pesticide residues in or on plants may be unavoidable even when pesticides are used in accordance with Good Agricultural Practice[6]. Pesticide residues are reduced by processing or household preparation stages such as washing, peeling and cooking etc. [12,20]. Processing studies allow a better estimate of the consumer exposure to the residues [6].

Endosulfan is a broad-spectrum organochlorine insecticide and acaricide. Technical endosulfan contains a mixture of alfa- and beta- isomers in the approximate ratio 70:30. In soil and on plant surfaces, endosulfan sulfate is the primary degradation product of endosulfan. Endosulfan is a highly toxic pesticide in EPA toxicity class I and suspected endocrine disrupter [3,5,7].

Deltamethrin is a broad-spectrum synthetic dibromo-pyrethroid insecticide. It is a lipophilic compound of high molecular weight. It has been listed as a potential endocrine disrupter by the German Federal Environment Agency [4,8].

In Canakkale region of Turkey, tomatoes are mainly grown in the Biga province. Pesticides with active ingredients endosulfan and deltamethrin have been predominantly used in this region. The objective of this project is to investigate the effects of tomato paste processing steps on these pesticides.

MATERIAL-METHOD

Field Experiment: The trial was conducted at a 12 ha field that belongs to DEMKO Corporation. Biga. Tomato plants (var. NDM-055) were transplanted to the field. Endosulfan (Hektionex 35 WP) and deltamethrin (Decis 2.5 EC) were applied by Horizontal Sleeve Boom Sprayer 12-18 M (Degania Sprayers, Israel) twice at 10 and 5 days intervals, respectively. Application rates were 133.3 g/da and 100 g/da for endosulfan and 41.7 cc/da and 31.25 cc/da for deltamethrin. The minimum and maximum temperatures were 19.4 and 38.1°C, respectively. The minimum relative humidity was 29% and maximum relative humidity was 96%. Rainfall was observed twice about 5 minutes after the pesticide treatment.

Paste Processing and Sampling: Tomatoes were harvested from the field weighted 20 tones. In same day, the tomatoes were processed tomato paste in 30-32 cb paste line (Fig 1). To investigate the effects of the process on endosulfan and deltamethrin residues, samples were taken during harvesting (10×1kg), after washing and chopping (4×250 gr glass jar), after pulping: Pulp (4×250 gr glass jar), from pomace (1kg) and from tomato paste (4 can) (Fig 1).

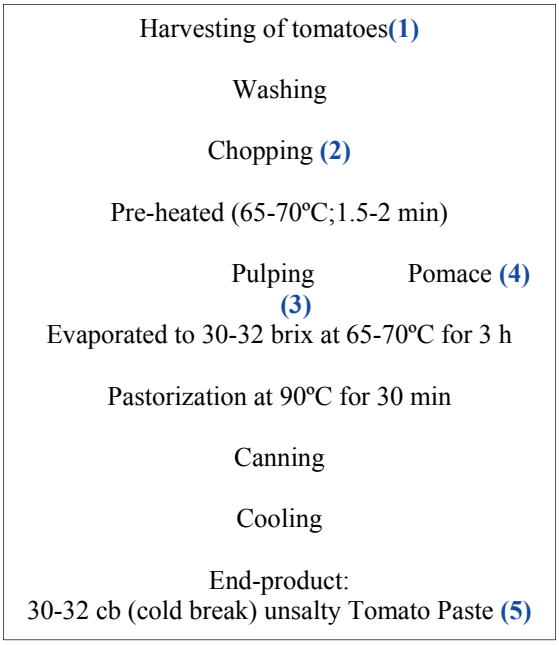

Figure 1. Tomato paste production flow chart and sampling steps

Residue Analysis: Residues were extracted from samples following Luke, M.A., *et al.* (1975) and Luke, M.A., *et al.* (1981) [18] and were detected and quantified by the Agilent 6890 Series (Hewlett Packard) GC System with capillary column HP-PAS 5 and Agilent 6890 µECD detector. Injector temperature was 200°C. Injector was in split mode and the gas carried was He. The oven temperature was programmed to increase from 180°C (hold 0 minute) to 260°C at a rate of 3°C/min. Then, the temperature was hold at 260°C for 11 minutes, and post run was carried at 180°C for one minute.

Endosulfan alpha+beta (10ng/µl), endosulfan-sulfate (10ng/µl) and deltamethrin (100ng/µl) reference materials were obtained from Dr. Ehrenstorfer GmbH, Germany. The efficiency of the method, recovery (%) from organic tomato and organic paste were evaluated using reference solutions. Spike levels of reference solutions to samples were 0.02 mg/kg for endosulfan isomers and endosulfan-sulfate and were 0.006-0.012 mg/kg for deltamethrin. Recoveries (%) of endosulfan isomers (alpha and beta), endosulfan sulfate and deltamethrin ranged between 70-109.95 % and relative standard deviation (RSD) ranged between 3-20 %. All residue data have been adjusted for

Table 1. Residue data from paste processing steps

Processing Steps	Residue (mg/kg)				
	α- Endosulfan	α- Endosulfan	Endosulfan Sulfate	Σ Endo.	Deltamethrin
	$\overline{X} \pm S_{\overline{x}}$	$\overline{X} \pm S_{\overline{x}}$	$\overline{X} \pm S_{\overline{x}}$	$\sum \overline{X}_i$	$\overline{X} \pm S_{\overline{x}}$
Harvest	0.02092±0.00257Ab	0.04654±0.00476Aa	0.00208±0.00027Ac	0.06954	0.00855±0.00061Ac
Washing	0.01687±0.0018ABb	0.02992±0.00352Ba	0.00146±0.00009Ac	0.04825	0.00448±0.00074Ac
Pulp	Not detected	Not detected	Not detected	-	Not detected
Pomace	0.20050	0.55350	0.03575	0.78975	0.25420
Paste	0.00563±0.00046Ba	0.00971±0.00036Ca	0.00082±0.00001Ba	0.01616	0.00459±0.00076Aa

Note: Column values with different capital superscripts and row values with different lower-case superscripts differ (P<0.01).

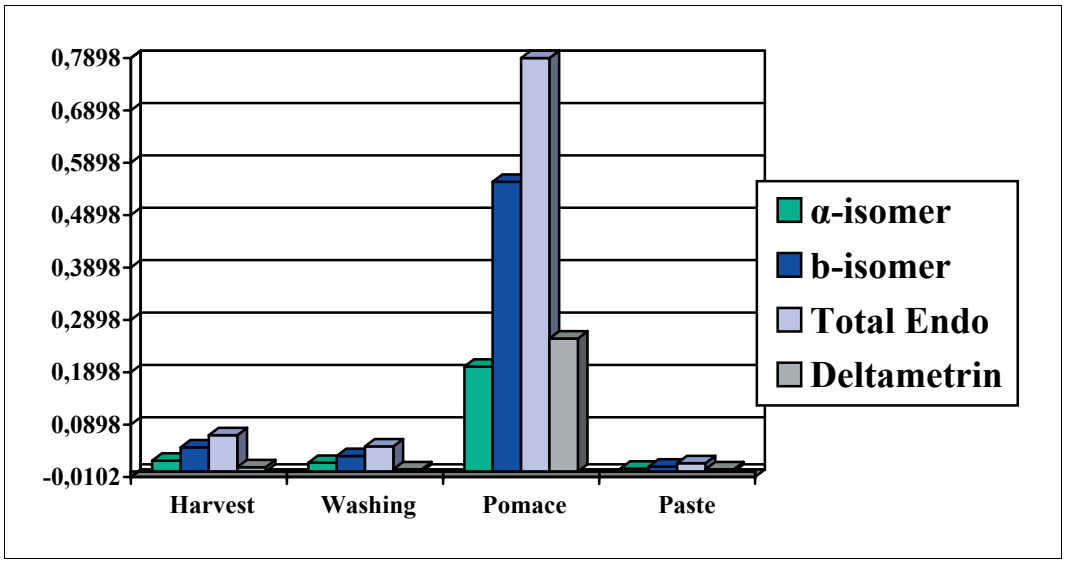

Figure 2. Distribution of pesticide residues during paste production

efficiency of recovery.

Statistical Analysis: All residue data were evaluated using Minitab for Windows (ver. 13.0) and SPSS for Windows (ver. 11.0), statistics program, and different groups were determined using MSTAT.

RESULTS

Experimental data (Table 1) on the fate of pesticide residues during paste processing were obtained by analyzing samples taken during harvesting, after washing and chopping, after pulping (pulp and pomace), and from tomato paste, which is the end-product. Effects of processing-step*pesticide interaction on the amount of residues were large (P<0.01).

During the process of making tomato paste, endosulfan and deltamethrin residues on tomatoes were washed up 30.62 per cent and 47.58 per cent, respectively. Combined effects of pre-heating, pulping, evaporation and half pasteurization decreased endosulfan for 66.5 per cent and increased deltamethrin for 2.33 per cent after the washing. No residues were detected in pulp samples, either. But, α- and β-endosulfan, endosulfan sulfate and deltamethrin residues in paste samples obtained after the evaporation of pulp were detected as 0.00563, 0.00971, 0.00082, 0.01616, 0.00459 mg/kg, respectively. Analyses made on pomace revealed that most of the residues were discarded with pomace (Fig 2). The whole process of making tomato paste decreased endosulfan 76.8 per cent and deltamethrin 46.3 per cent. However, effect of processing on decreasing of deltamethrin residues were nonsignificant according to Duncan test results on Table 1.

DISCUSSION

Pesticide residues after the spraying rapidly spread in

to wax and cuticulas [9]. Thus, washing the vegetable would be insufficient in removing the pesticides. This hypothesis was confirmed in literature and in the present study [9,10,11,15,16]. Water solubility of endosulfan and deltamethrin at 20C° and 25C° were 0.32 g/l and 0.002mg/l, respectively [7,8]. Effects of the washing steps were not associated with water solubility of these pesticides.

Results in Table 1 show that residues levels in pomace were enormously high from both of MRLs (0.5 mg/kg for total endosulfan; 0.05mg/kg for delthamethrin) recommended for tomatoes in Turkey [2]. Feeding pomace that has lipophilic pesticide residues to livestock creates problems. Liphophilic pesticides are collected in fatty tissues like milk in body [17,19] and may be carried to humans.

Food processing studies are designed to measure changes in residue levels when raw comodity is converted to processed commodity. Changes are simply expressed as processing factors, which is formulated as residue level in processed commodity over residue level in raw commodity [14]. In the present study, processing factors for endosulfan and deltamethrin were calculated as 0.23 and 0.54, respectively. These could be used to model exposure to these pesticides found in diets.

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