The Connecticut Agricultural Experiment Station, New Haven

Pesticide Residues in Produce Sold in Connecticut 1997

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A cooperative study by The Connecticut Agricultural Experiment Station and the Food Division of the Connecticut Department of Consumer Protection

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Many people include fruits and vegetables in their diet since these commodities are a good source of nutrients and fiber. However, there are concerns regarding the safety of fruits and vegetables due to the application of pesticides on this food group. Although crop production has increased as a result of farming practices that include the use of pesticides to control plant pests and diseases, a concern of many consumers is how much of these chemicals remain on the crop at the time of harvest and consumption. This is particularly important for children who, in general, eat a larger amount of fruits and vegetables, and may also be more susceptible to the effects of pesticides (National Academy of Science, 1993). These issues of food safety and consumer health are the principal reasons for pesticide testing programs. They have also prompted the Analytical Chemistry Department at this Station to increase its emphasis on food safety over the past six years.

Pesticides are registered for use in the United States by the Environmental Protection Agency (EPA). The EPA also sets tolerances for the amounts that remain in or on the produce after harvest (Code of Federal Regulations, 1994). The Connecticut Agricultural Experiment Station, in cooperation with the Connecticut Department of Consumer Protection, collects and analyzes fruits and vegetables sold in Connecticut to determine if residues are within EPA tolerances. Our sampling program is a market-basket survey, targeting products that are for sale to the general public.

This bulletin details the results of our 1997 market-basket study on pesticide residues found in produce sold in Connecticut. The results of this study are presented to assure consumers that produce grown in this state, other states, and foreign countries meets EPA pesticide tolerance levels.

METHODS

Samples of produce grown in Connecticut, other states, and foreign countries are collected at various Connecticut producers, retailers, and wholesale outlets by inspectors from the Connecticut Department of Consumer Protection. The samples collected are brought to our laboratory in New Haven for pesticide residue testing. These market-basket samples are collected without prior knowledge of any pesticide application.

Commodities are tested for pesticides using a multi-residue method developed in our laboratories (Pylypiw, 1993). In most cases, each sample is prepared in its natural state as received, unwashed and unpeeled. The sample is chopped and a portion is placed into a blender. Organic solvents are added and the mixture is blended to extract the pesticides from the sample. Interfering co-extracted compounds, such as organic acids, are removed from the solvent extract with water. A small amount of the extract is then injected into various gas chromatographic instruments to determine how much, if any, pesticides are present. Our method is capable of determining pesticides with recoveries ranging from 81% to 114%, and has an average detection limit of 10 parts-per-billion.

RESULTS AND DISCUSSION

In 1997 a total of 412 samples representing a wide variety of fresh and processed produce were tested. Of those 412 samples, 354 (86%) were fresh produce and 58 (14%) were processed foods. Pesticide residues were found in 130 samples or 37% of the fresh produce and 6 samples or 10% of the processed foods, see Tables 1 and 2. Three samples contained pesticide residues that were violative and are explained below. Ninety-three of the 412 samples (23%) were labeled as certified organically grown. Since these samples are assumed not to have been treated with pesticides, they are not included in Tables 1 and 2.

Results of all tests are forwarded to the Connecticut Department of Consumer Protection which has the responsibility for enforcement of pesticide tolerances. None of the samples tested in 1997 exceeded EPA tolerances. A total of 3 samples fell into a violative category. Specifically, one sample of nectarines contained a residue (0.1 ppm) of permethrin, an insecticide not registered for use on nectarines. Two samples contained pesticide residues which put them out of compliance with the Connecticut Organic Law (State of Connecticut General Statutes). A sample of potatoes contained a residue (0.1 ppm) of CIPC, a sprout

inhibitor registered for use on potatoes. Since this sample was certified to have been organically grown, no residues of any pesticide are allowed by Connecticut Organic Law. A sample of lettuce that was certified organic, contained a residue (0.006 ppm) of chlorpyrifos, an insecticide not registered for use on lettuce. This was a violation of both EPA regulations and Connecticut Organic Law.

Twenty-five samples (7.1%), of fresh produce contained either a trace residue of DDE (a soil metabolite of DDT), chlordane, and/or dieldrin. The use of these persistent organohalogen pesticides (POPs) on food crops in the United States was banned between 1972 and 1978; however, they have remained in the environment (Pylypiw et al., 1991). Even though there is no EPA tolerance for these pesticides, the Food and Drug Administration (FDA) recognizes their persistence in the environment and has set action levels (allowable amounts) for these compounds in produce (Compliance Policy Guides, 1986). No sample that contained these pesticides was above the FDA action levels.

This year the Department of Consumer Protection increased the number of certified organically grown samples brought in for testing. In past years, from four to nine percent of the samples tested were labeled as organic produce. This year we received 93 samples (23% of the total samples) of certified organic produce. Most of these samples were fresh produce purchased from supermarkets during the month of December. Ten of these samples contained a POP residue. Residues of these agrochemicals are considered unavoidable when certain crops are grown in soil containing POPs. Those crops that are known to uptake POPs selectively when grown in contaminated soil include squash, cucumbers, and carrots, while crops such as tomatoes, peppers, and strawberries do not (Pylypiw et al., 1997).

These findings prompted us to examine our residue data for organic produce over the past eight years. A summary of our findings is given in Table 3 for the years 1990 through 1997. Out of 266 samples tested 18 (6.8%) contained a detectable pesticide residue. Most of the pesticide residues that we have found in organically grown produce are POPs. When pesticide violations do occur in certified organically grown produce, they are not usually violations of EPA statues, but are technically violations of Connecticut Organic Law. Although organic laws vary widely across the United States, Connecticut Organic Law is one of the most restrictive since it states that no produce can be labeled as organic if it was "subjected to pesticides" (State of Connecticut General Statutes). New federal standards regarding the labeling of produce as "organically grown" may resolve this issue. Table 4 gives a comparison of selected commodities that we have tested over an eight year period, sorted by the percentage of organic samples in each commodity. Based on the data we may conclude that the crops at the bottom of the list are less likely to be grown organically.

The overall summaries of our findings for the past eight years are detailed in Table 5 and Figure 1. Our 1997 findings were consistent with past years' with roughly 65% of the samples tested containing no pesticide residues. Most of the fresh produce tested, 47%, was from Connecticut farms and orchards, 38% was from other states and 12% from foreign countries. The results of pesticide residue testing at this Station over the past eight years are consistent with the testing performed by FDA (Food and Drug Administration, 1995). Over these eight years, approximately 35% of the samples we tested had detectable quantities of pesticide residues. The percentage of violative samples in 1997 was similar to testing performed in other years. As in earlier years, our findings continue to show that the residues of pesticides found in fruits and vegetables sold in Connecticut are generally well within the safety limits established by EPA.

ACKNOWLEDGMENTS

Samples were collected by Ellen Sloan, an inspector from the Food Division of the Department of Consumer Protection. Phillip Sheridan, a 1997 participant in our Commitment to Chemistry and the Community Internship Program, and Todd Dogolo provided technical assistance.

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Table 1. Summary of pesticides found in fresh fruits and vegetables sold in Connecticut. (excluding organic samples)

Commodity / Pesticide	Samples with residues	No. of times detected	Residue range (ppm)	EPA tolerance (ppm)
APPLES (23 samples)	11			
Captan		2	0.1-0.46	25
Chlorpyrifos		4	0.003-0.11	1.5
Endosulfan		7	0.02-0.04	2.0
Methoxychlor		1	0.31	14
ASPARAGUS (3 samples)	0			
BEANS, SNAP (6 samples)	3			
Chlorothalonil		1	0.5	5
Endosulfan		2	0.02-0.07	2.0
BEETS (2 samples)		1		
Chlordane		1	trace	0.1(a)
DDE		1	0.002	0.2(a)
BEET TOPS (2 samples)	2			
Chlordane		1	trace	0.1(a)
DDE		1	0.004	0.2(a)
Permethrin		1	0.2	20.0
BLUEBERRIES (39 samples)	8			
Captan		1	0.3	25
Chlorothalonil		1	0.003	0(b)
Endosulfan		7	0.01-0.03	0.1
Malathion		1	0.8	8
BRUSSELS SPROUTS (1 sample)	1			
Endosulfan		1	0.03	2.0
CABBAGE (4 samples)	0			
CELERY (1 sample)		1		
Endosulfan		1	0.02	2.0
CHERRIES (1 sample)	1			
Iprodione		1	0.38	20.0
CORN (4 samples)	0			
CRANBERRIES (2 samples)	2			
Chlorpyrifos		2	0.003-0.05	1.0

Table 1. Summary of pesticides found in fresh fruits and vegetables sold in Connecticut (continued). (excluding organic samples)

Commodity / Pesticide	Samples with residues	No. of times detected	Residue range (ppm)	EPA tolerance (ppm)
CUCUMBERS (5 samples)	5			
Chlordane		1	0.09	0.1[a]
Chlorothalonil		1	0.01	5
DDE		2	0.004-0.02	0.1[a]
Endosulfan		3	0.004-0.02	2.0
GRAPES, TABLE (8 samples)	2			
Captan		1	0.1	50
Chlorpyrifos		1	0.04	0.5
Iprodione		1	0.1	60.0
Vinclozolin		1	0.4	6.0
KIWIFRUIT (2 samples)	1			
Vinclozolin		1	0.02	10.0
LEMONS (1 sample)	1			
Chlorpyrifos		1	0.02	1.0
LETTUCE (2 samples)	1			
DDE		1	0.006	0.5[a]
LIMES (3 samples)	0			
MUSHROOMS (3 samples)	0			
NECTARINES (3 samples)	2			
Dicloran		1	0.13	20
Endosulfan		1	0.01	2.0
Iprodione		1	0.45	20
Permethrin		1	0.1	0[c]
ONIONS (3 samples)	0			
PEACHES (9 samples)	8			
Captan		1	0.03	50
Chlorpyrifos		1	0.01	0.05
Endosulfan		4	0.01-0.4	2.0
Iprodione		3	0.08-0.48	20.0
Permethrin		3	0.02-0.1	5.0
Vinclozolin		1	0.01	25.0
PEARS (4 samples)		2		
Endosulfan		2	0.01-0.2	2.0
Permethrin		1	0.07	3.0

Table 1. Summary of pesticides found in fresh fruits and vegetables sold in Connecticut (continued). (excluding organic samples)

Commodity / Pesticide	Samples with residues	No. of times detected	Residue range (ppm)	EPA tolerance (ppm)
PEAS (2 samples)	0			
PEPPERS, BELL (8 samples)	2			
Chlorpyrifos		2	0.01-0.06	1.0
Endosulfan		2	0.03-0.1	2.0
PLUMS (1 sample)		1		
Iprodione		1	0.13	20.0
POTATOES (8 samples)	5			
CIPC		3	1.1-1.8	50
DDE		2	0.004-0.005	1[a]
SPINACH (2 samples)	1			
Permethrin		1	0.19	20.0
SQUASH, SUMMER (8 samples)	7			
Chlordane		2	0.06-0.09	0.1[a]
DDE		4	0.01-0.04	0.1[a]
Endosulfan		3	0.04-0.06	2.0
SQUASH, WINTER (7 samples)	3			
Chlordane		2	0.01-0.02	0.1[a]
DDE		2	0.02-0.02	0.1[a]
Dieldrin		1	0.02	0.1[a]
STRAWBERRIES (67 samples)	52			
Captan		21	0.016-4.8	25
Chlorpyrifos		2	0.01-0.02	0.2
DCPA		2	0.02-0.066	2
Dicofol		1	0.08	5
Endosulfan		19	0.01-0.21	2.0
Iprodione		13	0.054-1.2	15.0
Malathion		3	0.12-0.21	8
Methoxychlor		1	0.02	14
Vinclozolin		22	0.005-0.68	10
TOMATOES (22 samples)	6			
Chlorothalonil		4	0.02-0.25	5
Endosulfan		4	0.01-0.03	2.0
TURNIPS (1 sample)	1			
DCPA		1	0.03	2

Table 1. Summary of pesticides found in fresh fruits and vegetables sold in Connecticut (continued). (excluding organic samples)

Commodity / Pesticide	Samples with residues	No. of times detected	Residue range (ppm)	EPA tolerance (ppm)
MISCELLANEOUS (1 sample of each)	0			
Artichokes, Bananas, Blackberries, Broccoli, Cantaloupe, Carrots, Cauliflower, Grapefruit, Kohlrabi, Oranges, Radicchio, Radishes, Yams				

(a) Action Level per FDA Compliance Policy Guidelines
(b) Allowed on this commodity due to regional tolerance
(c) Residue not allowed on this commodity

Table 2. Summary of pesticides found in processed fruits and vegetables sold in Connecticut, 1997.

Commodity	Pesticide	Samples Analyzed	Samples with residues	No. of times detected	Residue range (ppm)
BABY FOOD					
Cereal		5	0		
Fruits		3	0		
Vegetables		8	2		
	Dicloran			2	0.02-0.02
JUICES					
Apple Cider/Juice		11	0		
Miscellaneous Juices		4	1		
	Permethrin			1	0.07
FRUITS & VEGETABLES					
Blueberries		2	0		
Broccoli		4	1		
	Chlorpyrifos			1	0.02
Carrots		1	0		
Corn		1	0		
Peas		2	0		
Sauces		3	0		
Snap Beans		3	0		
Spinach		2	1		
	Permethrin			1	1.0

Table 3. Eight year summary of market-basket organic samples, including fresh and processed foods.

Year	Total Samples Tested	Samples With No Residues	Samples With Residues Within EPA Tolerances	Samples With Residues Of POPs	Samples With Residues With No EPA Tolerances
1990	37	36	0	1	0
1991	12	12	0	0	0
1992	11	11	0	0	0
1993	31	30	1	0	0
1994	29	27	0	2	0
1995	29	28	1	0	0
1996	24	22	1	2	0
1997	93	82	1	10	1
Total	266	248	4	15	1

Table 4. Eight year summary of fresh and processed food commodities with over twenty samples tested, and the percent of organics within the commodity.

Commodity	Number Organic Samples	Number Regular Samples	Total Number Samples	Percent Organic Samples
Carrots	17	25	42	40%
Potatoes	21	37	58	36%
Broccoli	10	18	28	36%
Lettuce	29	59	88	33%
Beets	6	17	23	26%
Winter Squash	7	20	27	26%
Eggplant	5	21	26	19%
Cabbage	5	29	34	15%
Bananas	4	25	29	14%
Spinach	6	38	44	14%
Tomatoes	21	156	177	12%
Peppers	9	76	85	11%
Grapes	5	43	48	10%
Summer Squash	9	100	109	8%
Mushrooms	2	23	25	8%
Raspberries	2	26	28	7%
Apples	13	425	438	3%
Pears	2	69	71	3%
Peach	1	80	81	1%
Blueberries	2	163	165	1%
Strawberries	4	329	333	1%

Table 5. Eight year summary of all market-basket samples tested, including organic and processed food samples.

Year	Total Samples Tested	Samples With No Residues	Samples With Residues Within EPA Tolerances	Samples With Residues Over EPA Tolerances	Samples With Residues With No EPA Tolerances
1990	418	186	230	0	2
1991	285	190	94	0	1
1992	273	179	89	1	4
1993	441	305	128	3	5
1994	545	414	125	1	5
1995	444	307	129	0	8
1996	327	188	134	1 (a)	4
1997	412	266	144	0	2
Total	3145	2035	1073	6	31

(a) Over FDA action level.

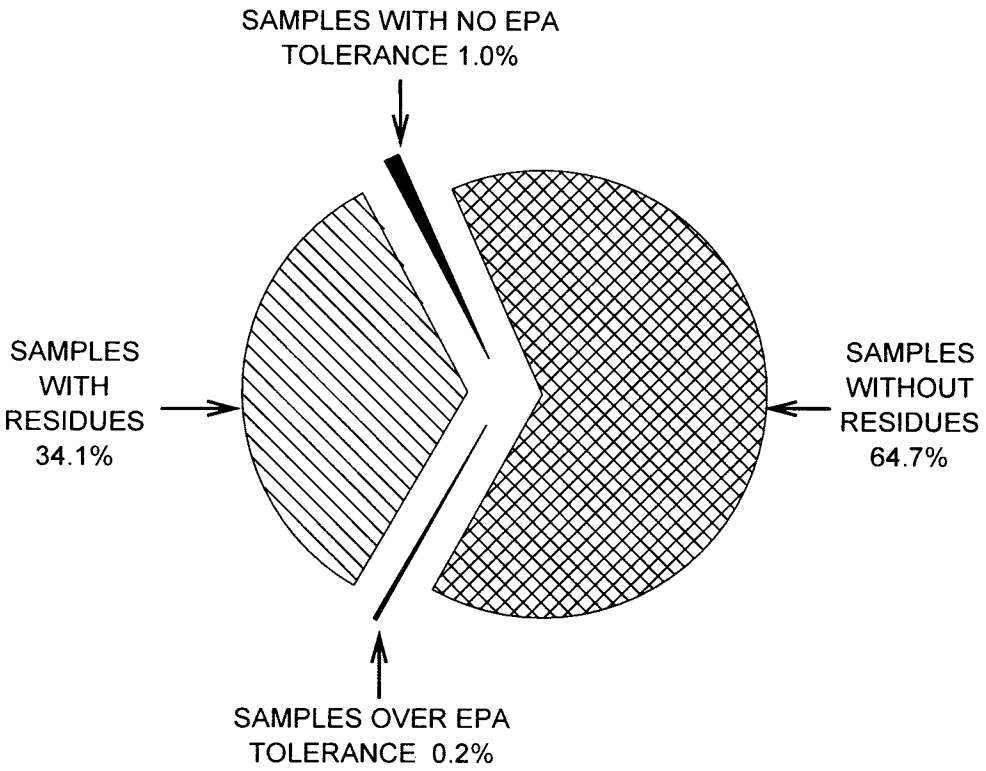

Figure 1. Summary of results from 1990-1997.

The Connecticut Agricultural Experiment Station, founded in 1875, is the first experiment Station in America. It is chartered by the General Assembly to make scientific inquiries and experiments regarding plants and their pests, insects, soil and water, and to perform analyses for State agencies. The laboratories of the Station are in New Haven and Windsor; its Lockwood Farm is in Hamden. Single copies of bulletins are available free upon request to Publications; Box 1106; New Haven, CT 06504-1106

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