The Connecticut Agricultural Experiment Station, New Haven

Pesticide Residues in Produce Sold in Connecticut 2000

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Bulletin 971

April 2001

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

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In the United States there are three government agencies that share responsibility for the regulation of pesticides: The Environmental Protection Agency (EPA), The Food Safety Inspection Service of the United States Department of Agriculture (FSIS-USDA), and the Food and Drug Administration (FDA). It is the responsibility of the EPA to register (*i.e.,* approve) and set tolerances if the use of a particular pesticide may result in residues on food (CFR, 1999). A tolerance is defined as the maximum quantity of a pesticide residue permitted on a raw agricultural commodity. Tolerances impact food safety by limiting the concentration of a pesticide residue allowed on a commodity, and by limiting the type of commodity on which it is allowed. Tolerances are the only tool the EPA has under the law to control the quantity of pesticides on the food we consume.

The FSIS branch of the USDA is responsible for monitoring and enforcing tolerances of pesticide residues on meat, poultry and certain egg products. The FDA is charged with enforcing tolerances in imported and domestic foods (predominantly fresh fruits and vegetables), and in this state, the Connecticut Department of Consumer Protection (DCP) is responsible for enforcing these tolerances. To be able to enforce the EPA mandated tolerances, both the FDA and DCP must know the quantity and the type of pesticide residue present in foodstuffs offered for sale.

The FDA approach to pesticide residue monitoring involves collecting samples of individual lots of domestically produced and imported foods as close as possible to their point of entry into the distribution system. Imported samples are collected at their point of entry into U.S. commerce. The samples are analyzed for pesticide residues to enforce the tolerances set by the EPA. The FDA approach places emphasis on raw agricultural commodities. These are analyzed in a raw, unpeeled and unprocessed state. The FDA also analyzes processed foods for pesticide residues. When illegal pesticide residues are found, the FDA can impose various sanctions including seizure of the commodity or injunction. For those samples imported into the United States, shipments will be stopped at the port of entry if they are found to contain illegal residues. If there is reason to believe that future lots from a particular foreign grower or geographic region may be in violation during a given season the FDA can invoke detention without physical examination (automatic detention). In this case, the produce will be detained at the port of entry until analysis is complete (FDA, 1999).

The FDA residue monitoring program targets states that produce and/or export the largest volumes of food. In 1999 the FDA tested 3,426 samples from 47 states (no samples were collected from Oklahoma, New Hampshire or Rhode Island) and 6012 samples from 92 countries with the largest number of samples (2,463) coming from Mexico (FDA, 1999). Taken collectively samples from the three states of Washington (747), California (403), and Florida (338) comprised about 43 percent of the total domestic samples examined for pesticide residues (FDA, 1999). The FDA examined only one sample from Connecticut for pesticide residues in 1999 (FDA, 1999).

To supplement the FDA study The Department of Analytical Chemistry at The Connecticut Agricultural Experiment Station has established a program in conjunction with DCP to examine fruits and vegetables sold in the state for pesticide residues. This market basket survey concentrates on fresh produce grown in this state, but also includes fresh produce from other states and foreign countries and some processed food. The primary goal of this program is to determine if the amounts and types of pesticides found on fruits and vegetables are in accordance with the tolerances set by EPA. Violations of the law occur when pesticides are not used in accordance with label registration and are applied in excessive amounts, or when pesticides are applied to crops on which they are not allowed.

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 DCP. 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 coextracted 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 percent to 114 percent, and has an average detection limit of 10 parts per billion.

RESULTS AND DISCUSSION

In 2000 a total of 145 samples representing a wide variety of fresh and processed produce were tested. Of these 120 (83%) were fresh produce and 25 (17%) were processed foods. Pesticide residues were found in 55 samples or 42 percent of the fresh produce samples and 5 samples or 20 percent of the processed foods, see Tables 1 and 2. The value of 42 percent in fresh produce is less than the corresponding value of 49 percent for fresh produce found in 1999, and nearly identical to the value of 39 percent in 1998. The value of 20 percent for processed foods was nearly identical to the value of 19 percent found in 1999 and higher than the value of 10 percent found in 1998.

Of the samples analyzed in 2000 only one sample, or 0.7 percent, was found to contain a pesticide residue that was violative. This number is slightly lower than the average value of one percent of violative samples found in our survey over the past eleven years, and is lower than the 4.1 percent of violative samples found in 1999 as can be seen in Table 3. In 2000, a sample of fresh produce, specifically Macintosh apples, grown within the state was found to contain residues of permethrin above the EPA mandated tolerance level of 0.05 part per million (ppm). This violation is significant because it is only the seventh time in our eleven year survey that an over tolerance violation was found. Based on the values in Table 3 it can be calculated that 0.2 percent of the samples analyzed over the past eleven years were over tolerance violations. All violations are immediately reported to DCP, which has the responsibility for enforcing pesticide tolerances within the state of Connecticut.

The 1999 FDA residue-monitoring program tested 1063 fruit samples and 1414 vegetable samples of domestic origin. Comparatively, over the past eleven years of our market basket survey a total of 1600 domestic fruit samples and 1344 domestic vegetable samples were tested. The 1999 FDA data suggests that fruits contain more pesticide residues than do vegetables as seen in Figure 1. Our eleven year market basket data very closely approximates the FDA vegetable data. Notably, however, the fruits tested in our survey appear to have fewer pesticide residues than in the FDA residue monitoring study. This may be due to the large number of locally grown samples included in our study that are not pesticide intensive.

In 2000 five samples (3.4%) of produce were found to contain either residues of DDE, a soil metabolite of DDT, or dieldrin. This number of persistent organohalogen pesticides (POPs) is nearly identical to the average number of 3.6 percent found annually on food crops in our survey since 1990. The use of POPs on food crops was banned in the U.S. in 1978. Residues of these pesticides continue to persist in the environment, and their uptake and accumulation by crops such as squash, cucumbers and carrots have been well documented (Pylypiw, et al., 1991, Pylypiw et al., 1997, Mattina et al., 2000). In 2000 dieldrin was found in one cucumber sample and two squash samples grown within Connecticut. Additionally, two samples of processed spinach grown outside Connecticut were found to contain DDE. The FDA has set action levels (allowable amounts) for these residues in produce (Duggan, 1998). No sample that contained DDE or dieldrin was above the FDA action level.

A total of 74 pesticide residues were found on 55 samples of processed and fresh produce in 2000. The most commonly found pesticides were the fungicides, captan and iprodione, and the insecticide endosulfan. Combined residues of these three pesticides accounted for 69 percent of the total residues found in 2000. Captan was found 26 times in 2000 over a wide variety of fresh produce; as in previous years, no processed produce contained captan. Captan accounted for 35 percent of the residues found during the past year, and has accounted for approximately 13 percent of our findings since 1990. It is interesting to note that captan is more prevalent on fresh produce and has only been found once on processed produce during the past eleven years. During processing produce is routinely washed with water to remove loose dirt. A recent study conducted in our laboratories (Krol et. al., 2000) has shown that captan is dramatically reduced by rinsing under tap water. Iprodione and endosulfan were found 11 and 14 times, respectively, on both fresh and processed produce. Endosulfan is the most commonly found pesticide residue on fresh and processed produce, accounting for about 27 percent of the residues found since 1990. Iprodione is the fourth most commonly found pesticide residue through the eleven year period of the

survey, accounting for some 7 percent of all residues (Krol et al., 1999).

FRUIT AND VEGETABLE WASHES PROVIDE NO BENEFIT OVER TAP WATER RINSING ALONE

In the Spring and Summer 2000, the effectiveness at removing pesticide residues from produce of four commercially available fruit and vegetable wash products was compared to a one percent solution of Palmolive® dish washing liquid and to rinsing with tap water alone. The nine pesticides examined in this study included many of those from our previous study (Krol et. al., 2000). The three fungicides chlorothalonil, iprodione, and vinclozolin were examined as was the herbicide DCPA, and the insecticides bifenthrin, diazinon, endosulfan, malathion, and permethrin.

A total of twenty-eight harvests were made, including sixteen of lettuce, four of strawberry, four of tomatoes, and four control lettuce batches. Each batch was divided into seven treatment groups. One group was analyzed in an unrinsed state as received from the field; one group was rinsed under tap water for one minute. The five remaining groups were individually treated with either FIT®, Fruit & Vegetable Wash™, Organiclean™, Vegi-Clean™, or a one percent solution of Palmolive® dish washing liquid and then rinsed under tap water for one minute. In the case of the control lettuce batches all seven-treatment groups were processed in an unrinsed state to ensure that each group contained statistically equivalent pesticide residue levels.

A total of 196 samples were processed. Detailed statistical analysis showed that in all cases at least one group was different from the rest. Pairwise comparison showed that the group that was different was the unrinsed produce. There is little or no difference between tap water rinsing or using a fruit and vegetable wash in reducing residues of the nine pesticides studied. The removal of waxes and/or dirt from the produce was not examined as part of this study.

CONCLUSIONS

A summary of our market basket survey findings over the past eleven years and the results of the past ten years of the FDA residue-monitoring program are presented in Figure 2. The pie charts show that 34 percent of the samples in our market basket survey contain pesticide residues, and that 36 percent of the samples in the FDA residue program contain pesticide residues. In 2000, 38 percent of the produce tested in our market basket survey was found to contain pesticide residues. This number is slightly above the average value of 34 percent over the past ten years of our survey, and slightly below the value of 41 percent found in 1999. Our findings continue to show that residues of pesticides on fruits and vegetables in Connecticut are generally well within tolerances set by the EPA. Work conducted in our laboratories (Krol et. al., 2000) indicate that rinsing fresh produce under tap water helps reduce the levels of nine of the twelve pesticides studied and that rinsibility of pesticide residues is not correlated to their water solubility. Further work conducted in our laboratories showed there was no advantage to using a fruit and vegetable wash product over rinsing with tap water alone.

ACKNOWLEDGEMENTS

Samples were collected by inspectors from the Food Division of the Department of Consumer Protection.

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Table 1. Summary of Pesticides Found in Fresh Fruits and Vegetables Sold in Connecticut, 2000.

Commodity / Pesticide	Samples with Residues	No. of Times Detected	Residue Range (ppm)	EPA Tolerance (ppm)
Apples (21 samples)	9			
Captan		8	0.1-0.22	25
Dicofol		3	0.53-1.3	5.0
Permethrin		1	0.09	0.05(a)
Asparagus (2 samples)	0			
Beans, Snap (2 samples)	2			
Chlorothalonil		1	0.048	5.0
Endosulfan		1	0.17	2.0
Blueberries (12 samples)	3			
Captan		1	5.0	25
Iprodione		1	1.6	15
Malathion		1	0.24	8.0
Cucumbers (1 sample)	1			
Dieldrin		1	0.02	0.5(b)
Endosulfan		1	0.16	2.0
Eggplant (3 samples)	0			
Grapes (10 samples)	9			
Captan		7	0.008-0.77	50
Chlorpyrifos		2	0.012-0.03	0.5
Iprodione		5	0.02-0.46	60
Peaches (3 samples)	1			
Endosulfan		1	0.16	2.0
Pears (4 samples)	1			
Captan		1	0.04	25
Endosulfan		1	0.011	2.0
Peppers (8 samples)	1			
Endosulfan		1	0.05	2.0
Potatoes (4 samples)	2			
CIPC		2	0.08-1.7	50
Raspberries (3 samples)	3			
Iprodione		2	0.74-1.8	15
Vinclozolin		1	0.08	10
Spinach (1 sample)	1			
Permethrin		1	0.2	20
Squash, Summer (5 samples)	2			
Dieldrin		2	0.08-0.09	0.1(b)

Table 1. Summary of Pesticides Found in Fresh Fruits and Vegetables Sold in Connecticut, 2000 (continued).

Commodity	Pesticide	Samples with Residues	No. of Times Detected	Residue Range (ppm)	EPA Tolerance (ppm)
Strawberries (21 samples)		15			
	Captan		9	0.062-5.6	25
	Endosulfan		8	0.028-0.22	2.0
	Iprodione		3	0.24-0.66	15
	Malathion		1	0.073	8.0
Tomatoes (8 samples)		2			
	Chlorothalonil		2	0.02-0.17	5.0
Miscellaneous (1 sample of each)		0			
Shell Beans, Beets, Beet Tops, Cabbage, Carrots, Cherries, Corn, Cranberries, Lettuce, Mushrooms, Winter Squash, Watermelon					

(a) Residue over amount allowed on this commodity
(b) Allowed in accordance with FDA Action Level

Table 2. Summary of Pesticides Found in Processed Fruits and Vegetables Sold in Connecticut, 2000.

Commodity	Pesticide	Samples Analyzed	Samples with Residues	No. of Times Detected	Residue Range (ppm)	EPA Tolerance* (ppm)
Juices						
Apple Cider		12	0			
Fruits & Vegetables, canned						
Spinach		1	1			
	Permethrin			1	0.66	20
Fruits & Vegetables, packaged fresh						
Carrots		3	0			
Green Beans		1	1			
	Endosulfan			1	0.2	2.0
Lettuce		1	0			
Spinach		4	3			
	DDE			2	0.004	0.5(a)
	Permethrin			2	0.028-2.0	20
Squash		1	0			
Fruits & Vegetables, frozen						
Corn		2	0			

(a) Allowed in accordance with FDA Action Level
*Based on Raw Agricultural Commodity

Table 3. Summary 1990-2000 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
1998	180	115	63	0	2
1999	195	115	72	0	8
2000	145	90	54	1	0
Total	3665	2355	1262	7	41

(a) Over FDA Action Level.

Figure 1. Comparison of 1999 FDA Fruit and Vegetable Samples with 11 Year Connecticut Data.

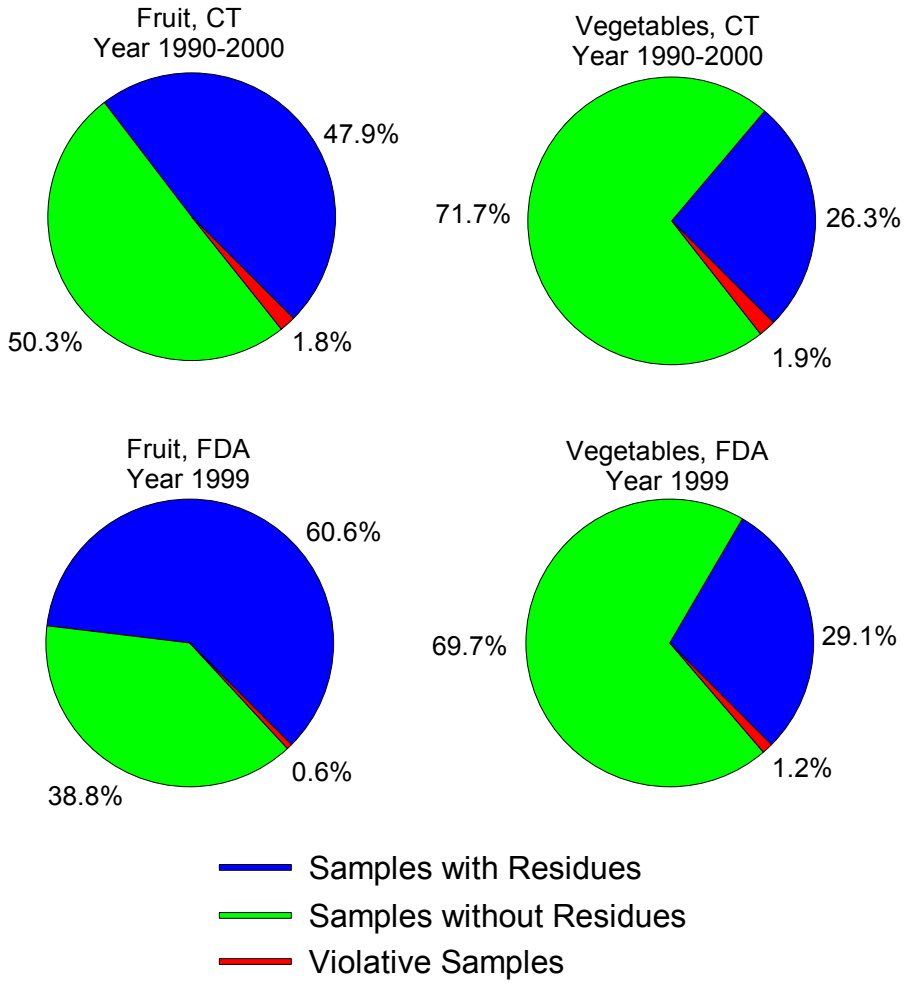

Figure 2. Summary of Connecticut Data from 1990-2000 and of FDA Data from 1988-1999.