The Connecticut Agricultural Experiment Station, New Haven

Pesticide Residues in Produce Sold in Connecticut 1998

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Fresh fruits and vegetables supply us with the essential vitamins, minerals, and fiber required as an essential part of a healthy diet and lifestyle. The need to feed an expanding population has placed an enormous burden on farmers to increase the productivity of their land by eliminating the loss of crops to vermin and disease. Farmers quickly adopted the use of pesticides to increase their overall crop yield and profitability. Concomitantly, public awareness of the safety risks associated with pesticide residues in food has increased. Children, in particular, may be more susceptible to these risks owing to their higher overall consumption of fruits and vegetables and different metabolic pathways (National Academy of Science, 1993).

Within the United States, the use of pesticides on crops falls under the jurisdiction of the U.S. Environmental Protection Agency (EPA). All pesticides used to protect commodities in the U.S. must be registered with the EPA. The EPA sets allowable tolerances for pesticides for each commodity under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA) (Duggan, 1998). A tolerance is defined as the maximum quantity of a pesticide residue allowable on a raw agricultural commodity, and is designed to reflect the highest residue concentrations likely under normal agricultural practice. Tolerances impact food safety by limiting the concentration of a pesticide residue allowed on a commodity, and by limiting the number of commodities on which it is allowed. Tolerances are not based primarily on health considerations nor do they provide a good basis about actual exposure. The EPA currently lists over 8500 pesticide residues allowed on raw agricultural commodities (40CFR part 180) and processed agricultural products (40CFR part 185 and 186) (Duggan, 1998). Tolerances are the only tool the EPA has under the law to control the quantity of pesticides on the food we consume. The enforcement of these food tolerances falls under the jurisdiction of the U.S. Food and Drug Administration (FDA), and in this state, the Connecticut Department of Consumer Protection (DCP). To be able to enforce the EPA mandated tolerances these agencies must know the quantity and the type of pesticide residue present in foodstuffs offered for sale.

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 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 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% to 114%, and has an average detection limit of 10 parts per billion.

RESULTS AND DISCUSSION

In 1998 a total of 180 samples were tested; of these 180 samples, 161 (89%) were fresh produce and 19 (11%) were processed foods. Pesticide residues were found in 63 samples or 35% of the fresh produce and 2 samples or 10% of the processed foods, see Tables 1 and 2. These values are similar to the corresponding values of 37% for fresh produce, and 10% for processed foods found in 1997.

Of the samples analyzed in 1998, only two samples contained pesticide residues that were violative. Specifically, a locally grown lettuce sample was found to have residues of chlorothalonil, and a Canadian grown sample of lettuce was found to have residues of chlorpyrifos. Neither of these is allowed on lettuce. Violations are immediately reported to DCP, because this agency has the responsibility for enforcing pesticide tolerances. In the case of a violation from produce grown outside of Connecticut, DCP notifies the FDA.

In 1998, ten samples (6%) of fresh and processed produce were found to contain trace residues of either chlordane or DDE, a soil metabolite of DDT. The use of these persistent organohalogen pesticides has been banned on food crops in the United States since 1978. Residues of these pesticides continue to persist in the environment, and their uptake and accumulation by crops such as squash, cucumbers and carrots has been documented (Pylypiw et al., 1991, Pylypiw et al., 1997). This year chlordane and DDE were found in samples of fresh cucumbers and squash, and packaged fresh spinach. The FDA has set action levels (allowable amounts) for these residues in produce (Duggan, 1998). No sample that contained these pesticides was above the FDA action levels.

In 1998, 91 pesticide residues were found on 65 samples of fresh and processed produce. The most commonly found pesticides were the insecticide, endosulfan, and the fungicides, captan and vinclozolin. Endosulfan residues were found 26 times in 1998 on all types of fresh produce, from apples to strawberries. By far, endosulfan continues to be the most common pesticide residue found on fresh produce during the period of this survey from 1990 to 1998. It accounted for 28% of all the residues found (See Fig. 1). Captan and vinclozolin were each found 12 times on fresh produce in 1998. Captan residues were more widely distributed, being found on apples, peaches, and strawberries, while vinclozolin residues were restricted exclusively to strawberries. They were the second and third most common pesticides found during the period of this survey from 1990 to 1998 (Fig. 1).

One of the most commonly surveyed commodities in our market basket survey is strawberries, which have been sampled 366 times during 1990-1998. A total of 122 samples (33%) contained no pesticide residues. This should be compared with the full survey in which 65% of the samples did not contain a residue. A breakdown of the data by point of origin showed that strawberries shipped into Connecticut contained captan residues on 66% of the samples as opposed to those grown in Connecticut, which contained captan on 25% of the samples. The 1997 FDA national survey found captan residues on 61% of the samples (Food and Drug Administration, 1998). Residues of vinclozolin on strawberries grown in Connecticut were found on 65% of the samples versus the 13% of strawberry samples shipped into Connecticut in our survey, while residues of the fungicide iprodione were more likely to be found on out of state strawberries (52%), and virtually non-existent (2.8%) on locally grown produce. These variations may be the result of the different regional growing conditions, and the time required to transport produce from the field to the consumer.

These findings prompted us to review our residue data for the past nine years. Since 1990, a total of 28 different pesticide residues have been found 1494 times. The average concentration of <u>all</u> pesticides found on <u>all</u> fresh produce during the course of our work is 0.31 parts per million (ppm). While endosulfan is the most common pesticide found, the average concentration at which it has been found is among the lowest of all the pesticides, averaging about 0.06 ppm (See Fig. 2). The tolerance for endosulfan residues is 2.0 ppm on most commodities. The average concentration of captan found during the period of this survey is a relatively high 1 ppm (Fig 2), but the tolerance for strawberries is also a relatively high, 25 ppm. The average concentration of vinclozolin found over the past ten years is 0.1 ppm (Fig 2), while the tolerance for strawberries is 10 ppm.

Although it has been thought for many years that washing fruits and vegetables prior to consumption reduces the amount of residues ingested, the anecdotal approach needs laboratory confirmation. We have found that different pesticides, in fact, have different rinsability profiles (Arsenault et al., unpublished). Samples of produce were split into two subsamples. One of these subsamples is analyzed for residues in the usual way, and the second subsample is rinsed with water prior to normal analysis. Endosulfan and vinclozolin do not seem to be easily removed from produce by rinsing. The average concentration on produce is less than 0.1 ppm, and both

have significantly lower tolerances than does captan. The higher tolerances for captan may be offset by the fact that on average about 65% of captan residue can be removed from produce by rinsing (Arsenault et al., unpublished). The average concentration of captan can be reduced from 1 ppm, (the average concentration at which it has been found over the course of this survey), to 0.4 ppm by rinsing with water.

A summary of findings of our market basket survey from the past nine years is presented in Table 3 and Figure 3. The findings in 1998 were once again consistent with those from previous years (Pylypiw et al., 1997), with pesticide residues being detected on 35% of the fresh produce sampled. The results obtained from the Connecticut Agricultural Experiment Station are consistent with those obtained by the FDA (Food and Drug Administration, 1998). Our findings continue to show that the residues of pesticides in fruits and vegetables in Connecticut are generally well within tolerances set forth by the EPA.

ACKNOWLEDGMENTS

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Table 1. Summary of pesticides found in fresh fruits and vegetables sold in Connecticut, 1998.

Commodity / Pesticide	Samples with residues	No. of times detected	Residue range (ppm)	EPA tolerance (ppm)
Apples (18 samples)	3			
Captan		1	0.1	25
Chlorpyrifos		1	0.01	1.5
Endosulfan		1	0.04	2.0
Beans, Snap (5 samples)	3			
Chlorothalonil		2	0.04-0.18	5
Endosulfan		2	0.002-0.071	2.0
Blueberries (11 samples)	1			
Endosulfan		1	0.06	0.1
Broccoli (1 sample)	1			
Endosulfan		1	0.08	2.0
Chlorothalonil		1	0.08	5
Broccoli Raab (1 sample)	1			
DCPA		1	0.025	5
Corn (8 samples)	0			
Cucumbers (5 samples)	3			
Chlordane		1	0.06	0.1[a]
DDE		1	0.01	0.1[a]
Endosulfan		2	0.01-0.04	2.0
Eggplant (2 samples)	0			
Grapefruit (1 sample)	1			
Ethion		1	0.06	2.0
Grapes (2 sample)	2			
Iprodione		2	0.45-0.52	60.0
Lettuce (3 samples)	2			
Chlorothalonil		1	23	0[b]
Chlorpyrifos		1	0.13	0[b]
Endosulfan		1	0.003	2.0
Nectarines (3 samples)	3			
Endosulfan		2	0.03-0.2	2.0
Iprodione		1	0.26	20.0
Peaches (11 samples)	7			
Captan		2	0.31-2.6	50
DCNA		2	0.04-0.18	0.05
Endosulfan		2	0.04-0.18	2.0
Iprodione		3	0.23-0.7	20.0

Table 1. Summary of pesticides found in fresh fruits and vegetables sold in Connecticut, 1998 (continued).

Commodity / Pesticide	Samples with residues	No. of times detected	Residue range (ppm)	EPA tolerance (ppm)
Pears (6 samples)	0			
Peppers, Bell (5 samples)	2			
Endosulfan		2	0.03-0.04	2.0
Potatoes (8 samples)	3			
CIPC		2	0.5-1.0	50
DCNA		1	0.004	0.25
Potatoes, sweet (5 samples)	5			
DCNA		5	0.06-0.56	50
Raspberries (5 samples)	0			
Sprouts, various (3 samples)	0			
Squash, Summer (11 samples)	6			
Chlordane		3	0.01-0.04	0.1(a)
DDE		4	0.002-0.02	0.1(a)
Endosulfan		2	0.01-0.02	2.0
Strawberries (32 samples)	19			
Captan		9	0.17-4.3	25
Chlorpyrifos		1	0.017	0.2
DCPA		2	0.001-0.023	2
Endosulfan		10	0.02-0.13	2.0
Malathion		1	0.073	8
Vinclozolin		12	0.01-0.17	10
Tomatoes (9 samples)	1			
Chlorothalonil		1	0.03	5
Miscellaneous (1 sample of each) Cantaloupe, Carrots, Chard (green), Mushrooms, Onions, Spinach	0			

(a) Allowed as per FDA Action Level

(b) Residue not allowed on this commodity

Table 2. Summary of pesticides found in processed fruits and vegetables sold in Connecticut, 1998.

Commodity / Pesticide	Samples Analyzed	Samples with residues	No. of times detected	Residue range (ppm)
JUICES				
Apple Cider/Juice	8	0		
FRUITS & VEGETABLES*				
Artichokes	1	0		
Corn	2	0		
Mushrooms	1	0		
Peppers	1	0		
Peas	2	0		
Salad Mix	1	0		
Spinach	2	2		
Permethrin			2	0.41-5.2
DDE			1	0.006
Tomato paste	1	0		

*All were canned except for the salad mix and spinach. The salad mix, and one sample of spinach had been washed, chopped and packaged, and the other sample of spinach was frozen.

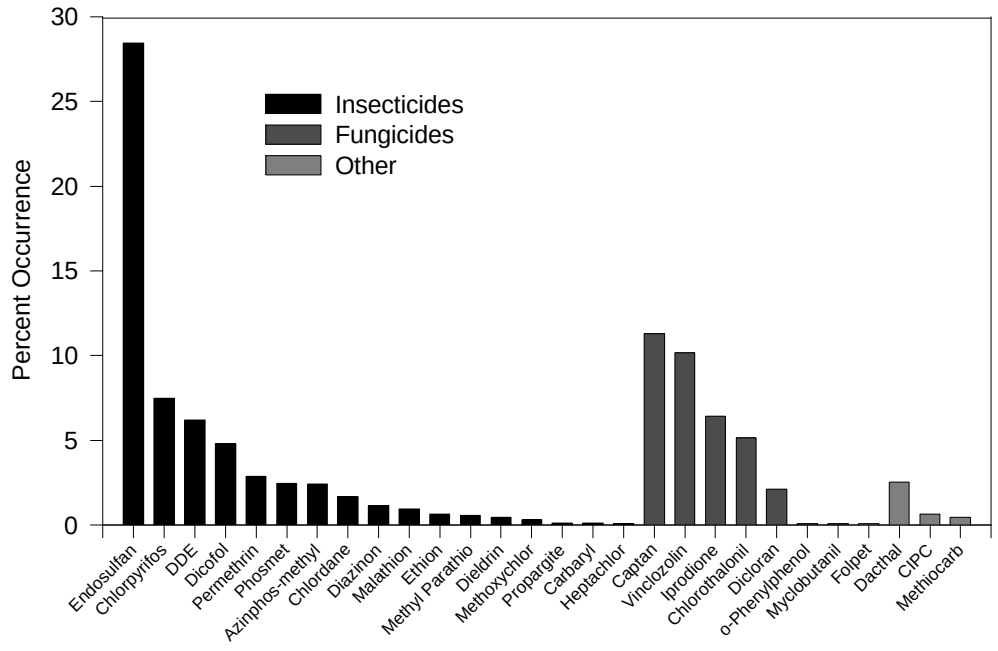

Fig. 1. Percent occurrence of the 28 pesticides found during 1990-1998.

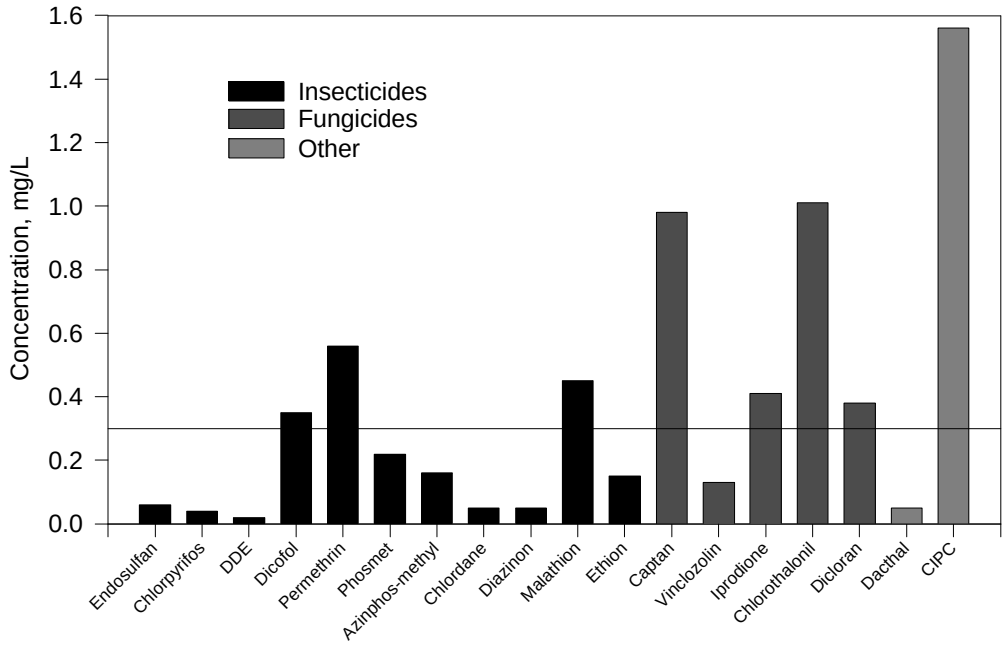

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Fig. 2 Average concentration of the 18 pesticides found ten or more times from 1990-1998. The line represents the average concentration of all residues weighted by the number of occurrences.

Table 3. Nine 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
1998	180	115	63	0	2
Total	3325	2150	1136	6	33

(a) Over FDA action level.

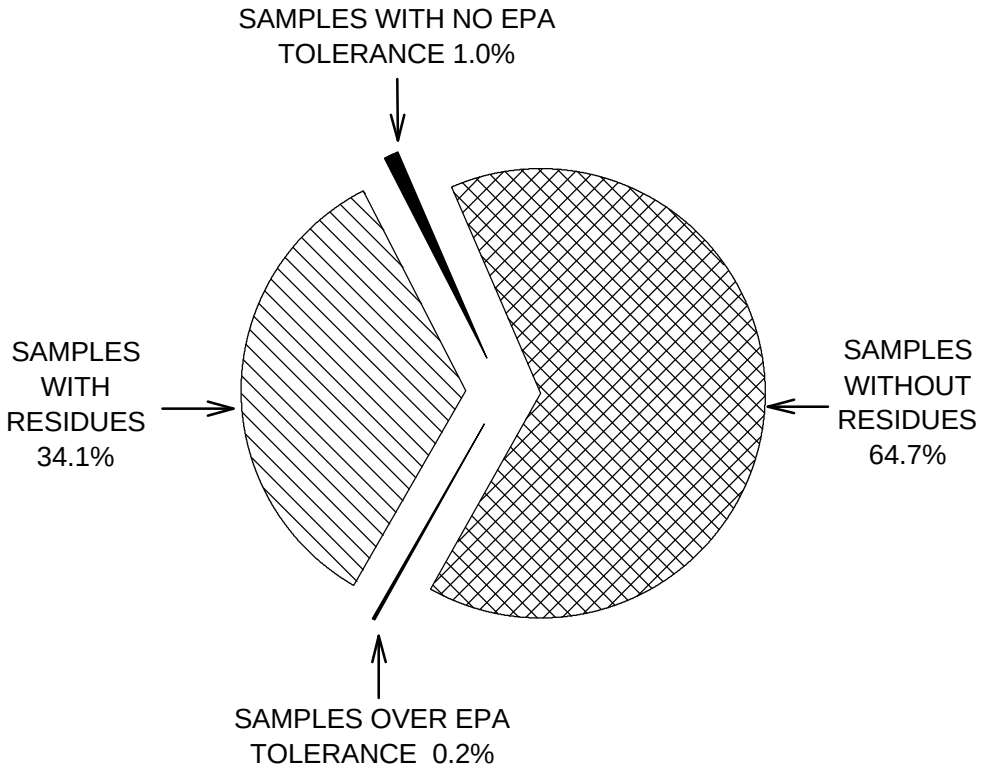

Figure 3. Summary of results from 1990-1998.