

## **Pesticide residues in conventional, IPM-grown and organic foods: Insights from three U.S. data sets.**

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### **Summary**

Reducing dietary exposure to pesticide residues is an important goal of public health and environmental officials, farmers and other segments of the food industry, and consumers. Organic agriculture, with its strictures against the use of synthetic chemical inputs, seems to offer a low-residue alternative to conventionally-grown produce; avoiding exposure to pesticides is one major reason consumers buy organic foods. Foods sold with claims of reduced pesticide use or use of integrated pest management (IPM), sometimes certified as containing no detectable residues (NDR), are now on the market as well. In general, the effects of different agricultural production systems on dietary exposure to pesticides is a question of considerable interest to scientists, regulators and the public.

Surprisingly, few empirical analyses of residue data have addressed this question, mostly because of a dearth of data on residues in organic produce. In the absence of better data, public controversy has swirled about this issue, with conservative media commentators and critics of organic agriculture going so far as to suggest that foods grown organically have just as many pesticide residues as conventionally grown foods.

Sufficient good data now exist to resolve the issue empirically. The authors obtained data on pesticide residues in organically grown foods, foods produced with IPM/NDR systems, and foods with no market claim (assumed to be conventionally grown) from three independent sources representing tests of over 94,000 food samples, and carried out statistical analyses of residue patterns.

### ***Data Sources and Characteristics***

We obtained test data from three U.S. sources: The Pesticide Data Program of the U.S. Department of Agriculture; the Marketplace Surveillance Program of the California Department of Pesticide Regulation; and private tests conducted by Consumers Union.

**USDA Data:** The USDA Pesticide Data Program collects samples of selected foods from a representative sample of retail outlets across the country. Samples are analyzed with sensitive multi-residue methods and specific methods for additional residues of interest, with extensive quality control steps and

confirmation analyses. The PDP data are widely regarded as the best available data for assessing dietary pesticide exposure. We obtained PDP data for 1994 to 1999, which included 26,893 samples of 20 different crops. 127 of those samples were identified as organically grown, and 195 were identified as marketed with an IPM or NDR claim. The remaining 26,571 carried no recorded claim and were classified as conventionally grown for our analysis.

**Cal DPR Data:** California DPR testing is part of an enforcement program; as such, it needs rapid sample turn-around and relies on test methods with higher detection limits than those achieved by the USDA PDP. The DPR sampling strategy also emphasizes monitoring of potential problem areas, so its sampling is not precisely representative of all foods sold in California. But DPR tests large numbers of samples of multiple crops each year, and includes many organic samples. (DPR does not identify IPM or NDR samples.) We obtained DPR data for 1989 to 1998, which included results on 67,154 samples, covering 19 different crops; 1,097 of the samples were organically grown.

**CU Data:** Consumers Union conducted focused tests in 1997 designed to see whether there were differences in residues between organic, "green-labeled" and conventionally grown foods. CU tested only four crops, purchased in just six cities over a two-month period, so their sampling did not represent the broader US food supply. However, CU tested up to 20 samples of each crop from each market category, providing more samples of the selected organically-grown foods than either the PDP or DPR programs tested in any year. Analytical methods were comparable to those used by the PDP. CU's testing included 67 organic, 45 IPM or NDR and 68 conventionally grown samples.

Taken together, the three data sets provide an enormous amount of data on residues in conventionally grown samples of 20 major crops. The data also include 1,291 samples of organically grown foods and 240 samples with an IPM/NDR claim-enough to support statistical analysis and comparison of residue patterns across the three market categories.

### ***Analyses and Results***

Raw data were obtained from USDA, Cal DPR and CU and converted to Access data files. We then computed number of samples, number with residues, number of residues per sample, mean residues, and other results of interest for individual crops and samples of each crop representing the different market sectors. A statistician performed various analyses to determine the statistical significance of observed differences.

**Frequency of Positive Samples:** All three data sets showed striking, highly statistically significant differences between market categories in the percent of samples that had at least one pesticide residue. Conventionally grown samples consistently had residues far more often than other categories. Overall, across 8

fruits and 12 vegetable crops, 73 percent of USDA's conventionally grown samples had residues. For five crops (apples, peaches, pears, strawberries and celery) more than 90 percent of samples had residues. Cal DPR (using less sensitive analytical methods) found residues in 31 percent, and CU found residues in 79 percent, of their conventionally grown samples. Organically grown samples consistently had far smaller percentages with residues: 23, 6.5 and 27 percent in the USDA, DPR and CU data, respectively. In the two data sets that included samples of the third category, residues were found in 47 percent of the USDA IPM/NDR samples and 51 percent of the CU IPM/NDR samples.

We performed a second analysis of the USDA data from which we excluded residues of long-banned, environmentally persistent chlorinated organic insecticides, such as DDT, dieldrin and chlordane (i.e., residues due to environmental contamination rather than to differences in crop production methods). With these residues excluded, the fraction of positive organic samples dropped from 23 to 13 percent. The effect of excluding these residues on percents positive in other categories was much less noteworthy (conventional dropped from 73 to 71 percent, and IPM/NDR dropped from 47 to 46 percent.)

**Multiple Residues:** Conventionally grown foods often contain residues of more than one pesticide. A conventionally grown apple tested by USDA in 1996 was more likely to contain four or more residues than to contain three or less, and some individual samples have been found with as many as 14 different residues. We examined the frequency of multiple residues and again found highly statistically significant differences between the market categories. Conventionally grown samples had multiple residues in 46, 12 and 62 percent of USDA, DPR and CU samples, respectively. Organic samples had multiple residues in only 7, 1.3 and 6 percent of the samples in those three data sets. IPM/NDR samples were again intermediate, at 24 percent (USDA) and 44 percent (CU).

**Residue Levels:** We compared residues of the same pesticides found on conventional, organic, and IPM/NDR samples of the same foods. This analysis was somewhat limited by the relative rarity of residues on organic samples, but comparable residues were lower on organic samples about two-thirds of the time in all three data sets. When data from all three sources were combined, the difference was statistically significant. Comparison of residues in IPM/NDR and conventional samples from the USDA data set found residue levels in the former were also significantly lower than those in the latter.

## ***Discussion***

Our analysis shows convincingly that organically grown foods have fewer and generally lower pesticide residues than conventionally grown foods. This pattern was consistent across all three independent data sets. Organic foods typically contain pesticide residues only one-third as often as conventionally grown foods do. Foods marketed with an IPM or NDR claim fall in between organic and

conventional foods in both the frequency of residues and residue levels. Organic samples are also far less likely to contain multiple residues than conventional or IPM/NDR foods are.

While the risks to health associated with dietary pesticide residues are still uncertain and subject to debate, risk is relative, and lower exposure undoubtedly translates into lower risk. Consumers who wish to minimize their dietary pesticide exposure can do so with confidence by buying organically grown foods.

Our analysis does show, however, that organic foods are not pesticide free. Most of the residues in organic foods (and some of the residues in conventional foods as well) can readily be explained as the unavoidable results of environmental contamination by past pesticide use, or by "drift" (sprays blown in from adjacent non-organic farms). Some foods sold as organic may also be mislabeled, either because of fraud or because of lapses in maintaining the identity of foods as they move from the farm to the consumer.

A potentially significant gap in this analysis is the lack of data on natural pesticides, used by some organic farmers and some non-organic growers as well. Included are botanical insecticides such as rotenone and pyrethrum, sulfur and copper compounds, and a variety of other traditional pesticides permitted in organic agriculture. Some commentators have suggested that residues of these natural pesticides are present in organic foods and offset the absence of residues of conventional crop chemicals.

We examined that issue and conclude that there is no objective evidence to support the assertion that natural pesticide residues pose a hazard. None of the test programs from which we obtained data include data on natural pesticide residues; in fact, there are few analytical methods available to detect these substances. The botanical insecticides tend to break down rapidly in the environment, are comparatively non-toxic, and are used by a relatively small fraction of growers, ordinarily only as a last resort. Consequently, these substances are not expected to leave residues in foods. They are therefore exempt from tolerances (residue limits) as set by the U.S. Environmental Protection Agency, and no agency routinely tests for them.

The possible risks posed by natural pesticides is an interesting question that should be pursued with both better residue data and more extensive toxicity testing of some of the natural substances. However, there is currently no objective evidence of a problem with residues of natural pesticides, whereas the health risks associated with conventional pesticide residues in foods are well-established and substantial and subject to intensive regulatory efforts aimed at reducing exposure.

While our analysis shows that organic foods clearly have much fewer pesticide residues than other choices on the market today, it also suggests several

opportunities for organic growers and others to further reduce residue levels. More steps can be taken to test for and avoid contamination by persistent residues in soils. Enforcement of the new USDA national organic standards should reduce the (relatively rare) incidence of mislabeling, and ensure that consumers who buy organic get what they pay for.

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